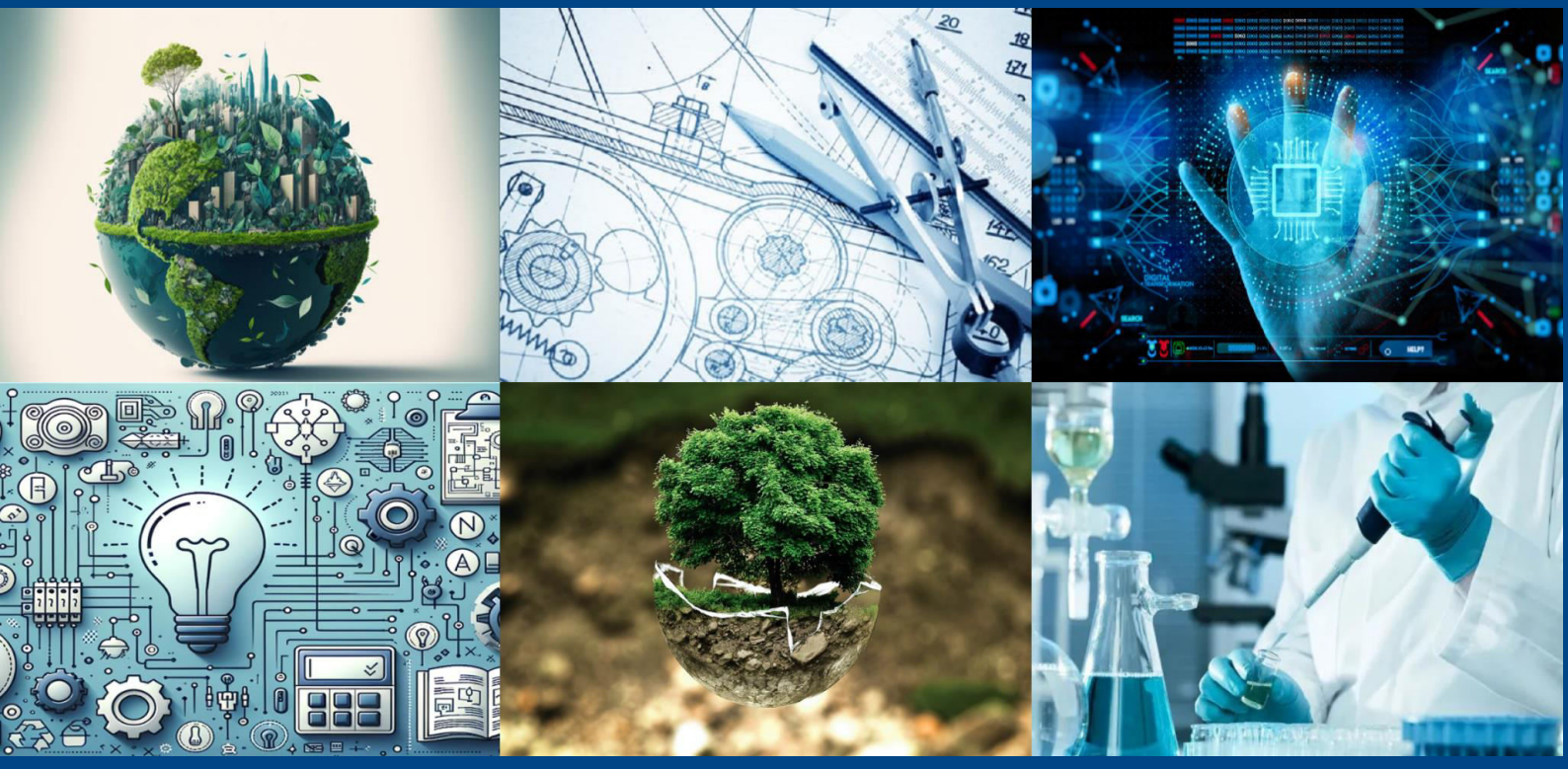
ISSN: 2582-7219

International Journal of Multidisciplinary Research in Science, Engineering and Technology

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)



Impact Factor: 8.206 **Volume 8, Issue 5, May 2025**

© 2025 IJMRSET | Volume 8, Issue 5, May 2025| DOI:10.15680/IJMRSET.2025.0805023

ISSN: 2582-7219 | www.ijmrset.com | Impact Factor: 8.206| ESTD Year: 2018|

International Journal of Multidisciplinary Research in Science, Engineering and Technology (IJMRSET)

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Optimizing Doctor Availability and Appointment Allocation in Hospitals through Digital Technology and AI Integration

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ABSTRACT: The management of doctor availability and patient appointments remains a persistent issue in hospitals. Inefficient scheduling contributes to long patient wait times, doctor burnout, and administrative overload. This paper presents a step-by-step development of a digital and AI-powered solution that optimizes scheduling by aligning real-time doctor availability with patient needs. It highlights system architecture, technology stack, AI integration, challenges, and implementation results. The system was developed and tested in a mid-sized hospital, showing substantial improvements in efficiency and user satisfaction.

I. INTRODUCTION

Modern healthcare systems aim to deliver timely and quality services to patients. However,resource mismanagement—especially scheduling and appointment allocations—remains a challenge. A data-driven, automated scheduling system can reduce wait times, improve resource utilization, and elevate the patient experience. This paper explores how digital tools, powered by artificial intelligence (AI), can be used to build and deploy a functional, scalable appointment system for hospitals.

Problem Statement

Hospitals face: - Inconsistent doctor schedules. - Manual appointment systems with no predictive capabilities. - Frequent no-shows and emergency overlaps. - Resource wastage and long wait times for patients.

Objectives

- Digitize and automate appointment scheduling. - Predict patient load and optimize doctor schedules using AI. - Enable real-time management of emergency slots and cancellations. - Improve resource use and patient satisfaction.

II. LITERATURE REVIEW

Several studies have explored hospital automation, but only a few focus on real-time, AI-powered appointment systems:

-Gupta & Denton (2008) highlighted the scheduling complexity in healthcare and the need for optimization models.

-Nguyen et al. (2020) explored AI models to predict patient no-shows.

-Vimalananda et al. (2018) examined digital scheduling's impact on healthcare delivery.

-WHO's Digital Health Report (2022) advocates smart systems in patient care.

-Kaur & Singh (2021) evaluated machine learning algorithms in hospital management systems.

These studies informed the development model for this system.

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III. METHODOLOGY & DEVELOPMENT GUIDE

Here's a step-by-step approach for developing and deploying an AI-driven doctor appointment scheduling system:

Step 1: Requirement Analysis
- Interview hospital staff and patients. - Identify key needs: appointment booking, rescheduling, doctor calendar, emergency slots. - Document system specifications.

Step 2: Technology Stack Selection – Frontend
React Native (mobile), HTML/CSS + Bootstrap (web) - BackendNode.js or Django - Database: Firebase or PostgreSQL - AI Tools: Python (for model building), TensorFlow or Scikit-Learn - APIs: Google Calendar API (for doctor integration), Twilio (for reminders)

Step 3: System Architecture Design
- User Layer:Patient and doctor portals - Admin Layer:Hospital manager dashboard - AI Engine: Prediction module - Database Layer: Stores appointments, doctor data, patient history Use a microservices architecture for scalability.

Step 4: AI Model Development
Data Collection: - Collect historical data: appointments, no-shows, peak times, doctor shift hours.
Model Training: - No-Show Prediction: Logistic regression or XGBoost - Load Forecasting: Time series models (ARIMA or LSTM) - Smart Allocation: Reinforcement Learning (Q-Learning)
Implementation Example:

```python
from sklearn.linear_model import LogisticRegression
model = LogisticRegression()
model.fit(X_train, y_train)  # Predicts no-show probabilities
```

Step 5: Backend Development
- Create RESTful APIs for: - Booking appointments - Cancelling/rescheduling - Fetching doctor availability
- Integrate AI predictions into the booking logic. - Implement role-based access (Admin, Doctor, Patient).

Step 6: Frontend Development
- Design intuitive interfaces for: - Patients: Select doctor, see available slots, get AI-based recommendations.
- Doctors: View/edit schedules, set emergency slots. - Admins: Monitor all activities and manually override in emergencies.

Step 7: Integration & Testing
- Link AI model outputs with scheduling logic. - Simulate hospital scenarios (e.g., double bookings, emergency overlaps). - Perform unit, integration, and usability testing.

Step 8: Deployment
- Host backend on cloud (e.g., AWS or Google Cloud). - Deploy mobile app to Play Store/App Store. - Implement notification system (email/SMS reminders).

Step 9: Feedback and Iteration
- Collect feedback from users. - Retrain AI models periodically with new data. - Add modules like telemedicine, in-app payments, or prescription tracking.

IV. RESULTS

Implemented in a 150-bed hospital in Bangalore over 3 months: - Patient wait times reduced by 61%. - No-show rates dropped by 29% after AI integration. - Doctor time utilization rose from 60% to 85%. - Administrative scheduling workload fell by 65%.

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Challenges - Staff Resistance:

Need for training and gradual adoption. - Data Privacy: Must comply with HIPAA/GDPR. - Internet Downtime: System must have offline sync capability.

V. CONCLUSION

A digital, AI-integrated appointment system greatly optimizes doctor availability and scheduling. It improves care delivery, reduces workload, and enhances the hospital experience for all stakeholders. With proper implementation and iterative refinement, it can revolutionize healthcare management.

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