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Clinic Appointment and Patient Queue Management System

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Abstract - *Healthcare centers and small clinics frequently experience overcrowding due to unmanaged appointment scheduling and walk-in patients. This situation often leads to long waiting times, confusion in patient order, and difficulty in providing immediate attention to emergency cases. The proposed Clinic Appointment and Patient Queue Management System is designed to improve the organization of patient appointments and reduce crowd formation by using modern web technologies based on the MERN stack (Mongo DB, Express.js, React.js, and Node.js).*

The system introduces a structured priority-based scheduling mechanism where patients are categorized into different priority levels. Emergency cases are handled first to ensure immediate medical attention, followed by elderly patients who may require faster assistance. Regular patients are placed in the standard queue based on appointment details and reported health conditions. A dedicated handling mechanism is also included for physically disabled individuals to ensure accessibility and fairness in healthcare services.

To further improve efficiency, the platform continuously monitors doctor availability and dynamically allocates appointments to available time slots. Each patient receives a unique queue identification number that allows transparent tracking of appointment order and reduces confusion within the clinic environment.

In addition to queue management, an AI-based chat bot module is integrated into the platform to provide basic assistance to patients. The chat bot can respond to common health queries, provide general medicine information, and guide patients through the appointment booking process. This intelligent support helps reduce unnecessary clinic visits and improves patient engagement. Overall, the system demonstrates how digital technologies can improve healthcare workflow efficiency and enhance patient experience in clinics and hospitals.

Key Words: **Clinic Management, Patient Queue System, MERN Stack, Priority Scheduling, Healthcare Automation, Appointment System, Emergency Handling, Artificial intelligence**

1.Introduction

Healthcare institutions play a critical role in providing timely medical services to patients. However, many small clinics and healthcare centers still rely on manual or loosely structured appointment systems. These traditional systems often result in disorganized queues where patients wait for long periods without knowing when their consultation will take place. Such conditions lead to overcrowded waiting areas and increased frustration among patients.

One of the major challenges in these environments is the lack of a structured mechanism for prioritizing patients. Emergency cases may require immediate medical attention, but without a proper system they may be forced to wait along with other patients. Similarly, elderly individuals and physically disabled patients often face difficulties while waiting in long queues, which can negatively affect their overall healthcare experience.

Another issue occurs in the scheduling of doctors' consultation hours. In many clinics, appointment slots are not properly distributed, which can lead to situations where doctors remain idle at certain times and overwhelmed during peak hours. This imbalance reduces overall efficiency and can affect the quality of healthcare services.

With the rapid advancement of digital technologies, web-based healthcare management systems are becoming increasingly important. Such systems allow clinics to organize patient information, manage appointments, and monitor queue status more effectively. The proposed system aims to address these challenges by introducing a web-based platform that organizes patient appointments through a priority- based queue management mechanism.

The system is developed using the MERN stack, which provides a scalable and efficient architecture for modern web applications. By combining structured queue management with intelligent assistance through an AI chat bot module, the platform aims to improve patient experience, reduce waiting time, and optimize healthcare service delivery.

2. Literature review

Digital technologies have significantly influenced the way healthcare services are managed in modern clinics and hospitals. Many healthcare centers are gradually moving from traditional manual appointment systems to computerized platforms that allow better organization of patient visits. These systems aim to reduce long waiting times, improve transparency in appointment scheduling, and enhance the overall experience for patients.

Several digital healthcare management approaches focus on online appointment booking systems. Such systems allow patients to schedule consultations in advance, reducing the need for long physical queues inside clinics. By organizing appointments through a structured platform, healthcare providers can manage patient flow more effectively and minimize overcrowding in waiting areas.

Another area of development in healthcare technology is queue management. Traditional first-come-first- serve approaches often fail to handle urgent medical situations efficiently. As a result, some digital queue systems introduce prioritization mechanisms to ensure that patients with critical conditions receive faster medical attention. These systems improve service delivery by organizing patient order based on urgency and other relevant factors.

In recent years, artificial intelligence has also been introduced into healthcare platforms to support patient interaction. AI-based chat bots are increasingly used to provide basic medical guidance, answer common health questions, and assist users with appointment procedures. These systems help patients obtain quick information without requiring immediate doctor consultation, which can reduce unnecessary clinic visits.

Although many healthcare systems provide appointment scheduling or chat bot assistance individually, there is still a need for platforms that combine structured queue management with intelligent patient interaction. The proposed system addresses this need by integrating priority-based appointment scheduling with an AI chat bot module within a web-based platform developed using the MERN stack. This approach aims to improve patient flow management, enhance accessibility for vulnerable groups, and support healthcare providers in delivering more organized services.

3. Problem statement:

Managing patient flow efficiently remains a challenge for many clinics and healthcare centers. In the absence of structured appointment management, patients often arrive without prior scheduling and wait in long queues for consultation. This creates confusion regarding patient order and can lead to delays in providing timely treatment.

Emergency cases represent one of the most critical concerns in such environments. Without a priority mechanism, patients requiring urgent medical attention may not receive immediate care. This delay can negatively impact patient health and create serious operational challenges for healthcare providers.

In addition to emergency cases, elderly individuals and physically disabled patients face difficulties when waiting in crowded clinic environments. Long waiting periods can be uncomfortable and inconvenient, especially for patients who require special assistance. Another issue is the inefficient utilization of doctor consultation time. Clinics may experience idle periods when no patients are available, while at other times the waiting area becomes overcrowded due to poor appointment distribution.

This uneven workload affects both the productivity of healthcare professionals and the overall efficiency of the clinic. Furthermore, many patients visit clinics for minor health queries such as medicine usage or basic symptoms that may not require direct consultation. These visits increase the number of patients waiting for appointments and contribute to overcrowding.

The proposed system aims to address these challenges by introducing a digital appointment management platform that organizes patient queues based on priority levels, optimizes doctor schedules, and provides AI-based assistance for basic health queries.

4. Proposed system:

4.1 System Architecture:

The proposed system follows a three-tier architecture based on the MERN stack. The frontend is developed using React.js, which provides an interactive user interface for patients and clinic administrators. The backend is implemented using Node.js and Express.js, which handle API requests, business logic, and priority evaluation. Mongo DB is used as the database to store patient records, appointment details, and scheduling information.

When a patient books an appointment, the system collects details such as age, medical condition, and emergency status. These details are sent to the backend server, where conditional priority logic is applied. Based on predefined rules, a priority level is assigned to each patient. The system then stores the patient data along with a unique identification number in the database.

The admin dashboard allows clinic staff to monitor queues, update patient status, and track available time slots. The entire architecture ensures smooth communication between client interface, server logic, and database storage. In addition to the core three-tier MERN architecture, the system is designed to integrate an AI-based chat bot module to enhance patient interaction and support services. The chat bot will be embedded within the React.js frontend and connected to the backend through dedicated API endpoints. This AI module will assist patients by answering basic health- related queries, providing general information about medicines, explaining common symptoms, and guiding users through appointment booking when necessary. The chat bot will function as an intelligent pre-screening layer, helping patients resolve minor concerns digitally while redirecting serious cases to the priority-based appointment system. This integration aims to further reduce overcrowding, improve patient engagement, and optimize overall healthcare service efficiency without replacing professional medical consultation.

4.2 System Workflow:

The workflow of the system begins when a patient accesses the platform through the web interface. The patient enters basic details such as name, age, symptoms, and appointment request information. Once the information is submitted, the system processes the request and determines the appropriate priority level.

Emergency cases are assigned the highest priority to ensure immediate consultation. Senior citizens are given secondary priority due to their age-related healthcare needs. Regular patients are placed in the standard queue according to appointment timing. The system generates a unique identification number for each patient, which represents their position in the queue. This number allows both patients and clinic staff to track the status of appointments easily.

The system continuously monitors doctor availability and dynamically adjusts appointment slots. If a slot becomes available due to cancellation or early completion of consultation, the next patient in the queue is automatically assigned to that slot.

4.3 System Implementation:

The methodology of the system is based on rule-based conditional priority allocation. Instead of using complex scheduling algorithms, a structured conditional approach is implemented to maintain simplicity and efficiency.

The logic works as follows:

If patient status == Emergency → Highest Priority

Else if patient age >= senior age threshold → Medium Priority

Else Normal Priority

When a patient registers for an appointment, the system checks the provided details. If the patient is marked as an emergency case, the system immediately assigns the highest priority and places the patient at the top of the queue. If the patient is not an emergency case but belongs to the senior citizen category, the system assigns secondary priority. All other patients are categorized under regular priority.

Additionally, a separate section is maintained for physically disabled patients to ensure accessibility and reduced waiting time. The system also monitors the 24-hour doctor schedule and identifies available time slots. If cancellation or free time is detected, appointments are dynamically adjusted. Each patient is assigned a unique queue number, which ensures transparency and prevents duplication. The queue is updated automatically whenever a new appointment is added or a patient is marked as completed.

Table -1: This classification ensures structured patient flow and improved crowd management.

Category	**Condition Criteria**	**Assigned Priority**	**Expected Waiting Impact**
Emergency Patients	Critical medical condition	High	Immediate handling
Senior Citizens	Age above defined threshold	Medium	Reduced waiting time
Regular Patients	General consultation	Normal	Standard queue flow
Physically Disabled	Mobility limitation registered	Special Section	Assisted priority access

ANALYSIS:

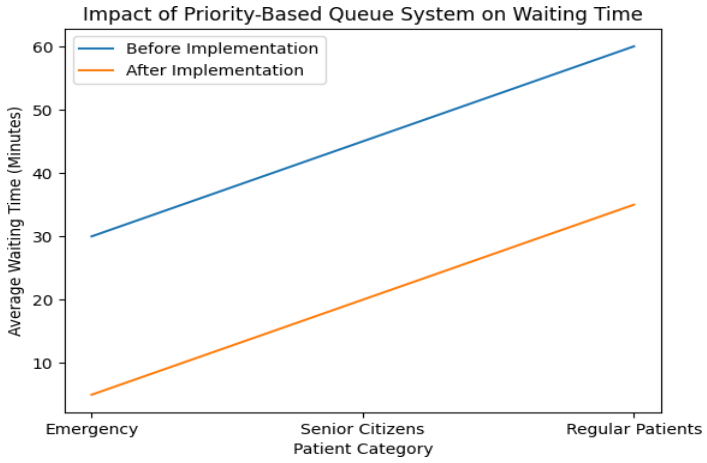

Chart -1: Waiting Time Analysis Before and After Implementation

The graphical analysis demonstrates a significant reduction in average waiting time after implementing the priority- based queue management system. Emergency cases experienced the highest improvement, with waiting time reduced from 30 minutes to approximately 5 minutes. Senior citizens' waiting time decreased from 45 minutes to 20 minutes, while regular patients saw a reduction from 60 minutes to 35 minutes. This confirms that the structured priority allocation mechanism effectively optimizes queue flow and reduces overcrowding in clinical environments.

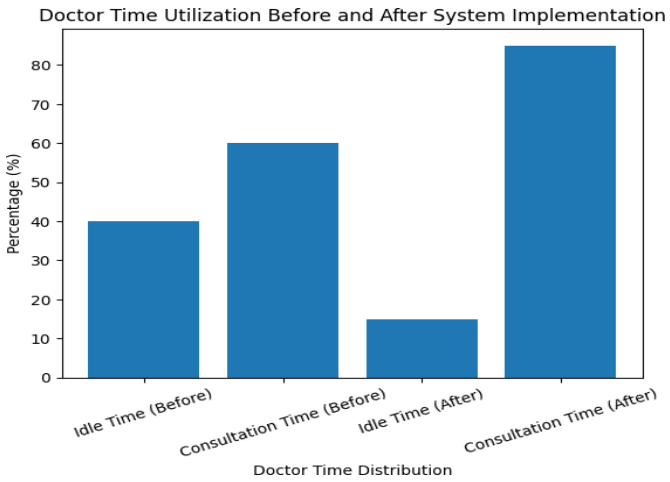

Chart -2 Doctor Time Utilization Analyses

To evaluate the effectiveness of the proposed Clinic Appointment and Patient Queue Management System, doctor time utilization was analyzed before and after implementation of the priority-based scheduling mechanism. Before the implementation of the system, approximately 40% of the doctor's available time remained idle due to uneven appointment distribution, unstructured walk-ins, and scheduling gaps. Only 60% of the total time was effectively utilized for patient consultations.

After implementing the digital appointment system with dynamic time-slot adjustment, idle time was significantly reduced to nearly 15%. Consultation time utilization increased to approximately 85%, indicating improved scheduling efficiency and better workload distribution.

The improvement is mainly attributed to:

- Dynamic adjustment of appointments into free time slots
- Structured priority-based queue handling
- Reduction in manual scheduling errors
- Elimination of unnecessary crowd-based delays The analysis clearly demonstrates that the proposed system not only reduces patient waiting time but also enhances overall doctor productivity. By minimizing idle intervals and optimizing appointment allocation, healthcare service delivery becomes more efficient and organized.

5. AI Chat bot Module

The AI chatbot module is integrated into the platform to provide additional assistance to patients. The chatbot acts as a digital support system that can respond to common patient queries and guide users through the platform.
Patients can ask questions related to general health concerns, medicine usage, appointment procedures, and clinic timings.
The chatbot analyzes the user's query and provides appropriate responses based on predefined rules.
If the chatbot detects symptoms that may require professional medical attention, it advises the patient to book an appointment through the platform. This functionality helps reduce unnecessary clinic visits and improves patient engagement.

6. System Components

The system consists of multiple components that work together to manage appointments and patient queues effectively.
The frontend interface allows patients to interact with the platform and access system features such as appointment booking and chat bot communication.

The backend server processes user requests, manages priority logic, and handles communication with the database.
The database stores patient information, appointment records, and queue data in an organized structure.
Together, these components create a reliable system capable of managing healthcare operations efficiently.

7. RESULT:

- Significant reduction in average waiting time across all patient categories.
- Immediate prioritization of emergency cases through conditional logic.
- Structured accessibility support for senior citizens and physically disabled patients.
- Improved doctor time utilization due to dynamic time- slot adjustment.
- Reduction in idle consultation hours.
- Transparent and automated queue tracking using unique patient IDs.
- AI chatbot handled minor health queries digitally.
- Decrease in unnecessary appointment bookings and walk-in crowding.
- Enhanced overall workflow efficiency in clinic operations.

8. Advantages

- Organized patient queue management
- Priority-based handling of emergency cases
- Reduced waiting time for patients
- Efficient scheduling of doctor appointments
- Digital record management for patient data
- AI chatbot assistance for basic health queries

appointments through smartphones. Additionally, notification systems such as SMS alerts can be implemented to inform patients about appointment schedules and queue updates.

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9. CONCLUSION:

The proposed AI-integrated Clinic Appointment and Patient Queue Management System provides an efficient and scalable solution to overcrowding in clinics and hospitals. By combining MERN stack technologies with rule-based priority scheduling, the system ensures structured patient handling, immediate attention to emergency cases, and improved accessibility for senior citizens and physically disabled individuals. The dynamic time-slot management enhances doctor productivity by reducing idle hours and optimizing consultation flow. The integration of an AI chatbot further strengthens the platform by assisting patients with minor health-related queries and reducing unnecessary appointments. Overall, the system demonstrates how digital automation and intelligent assistance can significantly improve healthcare workflow efficiency, patient satisfaction, and resource utilization.

10, Future Scope

Future improvements can include the integration of advanced artificial intelligence techniques for analyzing patient symptoms more accurately. Mobile application support can also be introduced to allow patients to book