Indian Journal of Computer Science and Technology
https://www.doi.org/10.59256/indjcst.20260502019
Volume 5, Issue2 (May-August 2026), PP: 171-179.
www.indjcst.com
ISSN No: 2583-5300

To Design Department Management System with WhatsApp Integration by using MEAN Stack

Gulnaj Sayyad[1], Ganesh More[2], Avishkar Kumbhar[3], Rohan Jantre[4], Rushikesh Gaikwad[5]
[1]Professor, SRCOE, Department of Computer Engineering, Pune, Maharashtra, India.
[2,3,4,5] Student, SRCOE, Department of Computer Engineering, Pune, Maharashtra, India.

To Cite this Article: *Gulnaj Sayyad[1], Ganesh More[2], Avishkar Kumbhar[3], Rohan Jantre[4], Rushikesh Gaikwad[5], "To Design Department Management System with WhatsApp Integration by using MEAN Stack", Indian Journal of Computer Science and Technology, Volume 05, Issue 02 (May-August 2026), PP: 171-179.*

Abstract: *Managing departmental activities such as attendance, communication, and academic information is a crucial task in educational institutions. Traditional methods often fail to efficiently handle large volumes of data and lack real-time communication, leading to delays, inaccuracies, and poor coordination between faculty and students. To address these challenges, this paper presents the design and implementation of a web-based Department Management System integrated with WhatsApp communication. The proposed system uses a modern web development approach combining a frontend interface for user interaction and a backend system for data processing and storage. The system incorporates RESTful APIs for seamless communication between components and uses secure authentication mechanisms to ensure data protection. It includes modules for user authentication, attendance management, notice handling, and real-time notification delivery. The system is designed with a user-friendly interface that allows efficient interaction for Admin, Faculty, and Students. It enables real-time attendance tracking, instante notification of updates through WhatsApp integration, and centralized data management. The implementation includes data validation, processing, storage, and notification modules, ensuring reliable and efficient system performance. Experimental results demonstrate that the proposed system improves operational efficiency, reduces manual workload, and enhances communication compared to traditional methods. This system can assist educational institutions in improving administrative processes, ensuring data accuracy, and supporting effective decision-making. In general, the proposed framework highlights the potential of modern web technologies in transforming academic management systems and improving overall institutional efficiency.*

Key Words: *Department Management System, Attendance Management, WhatsApp Integration, Web Application, Notification System, JWT Authentication.*

I. INTRODUCTION

The management of departmental activities such as attendance tracking, communication, and academic record maintenance has become a key focus in modern educational institutions. Because institutions handle large numbers of students and academic processes, traditional methods often lead to inefficiencies, delays, and data inaccuracies. These limitations result in poor coordination between faculty and students, leading to ineffective communication and reduced productivity. With the advancement of web technologies, there is now an opportunity to develop data-driven systems that automate these processes and improve overall efficiency.

Recent studies show that integrating web-based systems with real-time communication platforms is essential for efficient academic management. Different technologies, such as modern frontend frameworks for user interfaces and RESTful APIs for backend communication, have shown great promise. Research indicates that systems combining centralized data management with real-time notification services perform better than traditional systems by improving responsiveness and user engagement. Moreover, integrating messaging platforms like WhatsApp demonstrates how real-time communication can significantly enhance information delivery and coordination among users.

Traditional methods for managing attendance and communication mainly rely on manual registers or basic digital tools. However, these methods often fail to handle the complexity and volume of academic data efficiently. They are prone to human errors, lack real-time updates, and do not provide a centralized system for managing information. Additionally, many existing systems focus only on specific functionalities, limiting their ability to provide a complete solution. To address these issues, modern web technologies have emerged as powerful tools capable of handling complex operations and providing scalable and secure solutions.

In this work, we present a web-based Department Management System integrated with WhatsApp communication. The system uses a structured approach combining frontend interfaces, backend APIs, and database management to automate attendance tracking, notice distribution, and communication processes. It integrates WhatsApp API to deliver real-time notifications, improving interaction between faculty and students. This system aims to enhance efficiency, reduce manual workload, and provide a reliable platform for managing academic activities effectively.

II. PROBLEM STATEMENT

To Design Department Management System with WhatsApp Integration by using MEAN Stack

III. OBJECTIVES

- To design a centralized departmental management system for HOD, faculty, and students.
- To enable HOD to manage faculty registrations, roles, and departmental notices.
- To allow faculty to manage attendance, upload study materials, and send reports.
- To provide students with access to study materials, notices, and attendance records.
- To integrate WhatsApp API for automated attendance alerts and notifications to guardians.

IV. LITERATURE REVIEW

Sharma, R. et.al. in the paper (Web-Based Attendance Management System Using Cloud Technology), (2021), proposed a cloud-based attendance system designed to improve efficiency and accessibility in educational institutions. The authors emphasized the importance of centralized data storage, allowing real-time access to attendance records from any location. The system uses web technologies to automate attendance marking and reduce manual errors. Additionally, it incorporates secure authentication mechanisms to ensure data integrity and prevent unauthorized access. The study concludes that web-based solutions significantly enhance transparency, scalability, and ease of use in academic environments, making them highly effective for modern educational institutions. [1]

Singh, P. et.al. in the paper (Performance Analysis of Web Applications Using Load Testing Tools), (2021), analysed the performance and scalability of web-based systems under different workloads. The authors used load testing tools to evaluate system responsiveness and stability when multiple users access the application simultaneously. The study highlights the importance of optimizing backend services and database queries to ensure smooth system performance. It concludes that proper performance testing is essential for building scalable and reliable web applications. [2]

Patel, H. et.al. in the paper (Secure Authentication System Using JSON Web Tokens), (2020), proposed a secure authentication framework using JWT (JSON Web Tokens) to protect web applications. The authors explained that traditional session-based authentication methods have limitations in scalability and security. The JWT-based system provides stateless authentication, ensuring secure data transmission and role-based access control. The study highlights that implementing JWT improves system security, reduces server load, and enhances performance in modern web applications. [3]

Gupta, D. et.al. in the paper (Web-Based Notification System Using Messaging APIs), (2019), explored the use of messaging APIs for real-time communication in web applications. The authors demonstrated how integrating external messaging services can improve user engagement and ensure instant delivery of important updates. The system uses APIs to send notifications based on system events, such as updates or alerts. The study concludes that real-time notification systems significantly enhance communication efficiency and reduce delays in information delivery. [4]

Verma, A. K. et.al. in the paper (Design and Implementation of Student Attendance Management System Using Web Technology), (2018), introduced a web-based system that automates attendance tracking and record management. The authors highlighted that traditional attendance methods are time-consuming and prone to human errors. The proposed system uses database integration and web interfaces to efficiently store and retrieve attendance data. It also provides features such as report generation and role-based access for faculty and administrators. The study demonstrates that such systems improve data accuracy and reduce administrative workload, making them suitable for large-scale academic environments. [5]

V.SOFTWARE/HARDWARE REQUIREMENTS

For End-Users (Admin/Faculty/Students):

The system requires a desktop or laptop or mobile device running on Windows, Linux, macOS, or Android, with a minimum of 4 GB RAM (8 GB recommended), a web browser such as Google Chrome, Mozilla Firefox, or Microsoft Edge, and a stable internet connection for accessing the web application and receiving real-time updates**.**

For Admin/Developer:

The system requires Windows 10 or higher, Linux, or macOS, with an Intel Core i5 or higher processor, 8 GB to 16 GB RAM, at least 256 GB SSD storage, and development tools such as Visual Studio Code, Node.js, Angular CLI, and MongoDB for backend and database management.

For Server/Deployment Environment:

The system can be deployed on cloud platforms such as AWS, Firebase, or Digital Ocean, or on a local server. It requires a runtime environment for Node.js, REST API support, and internet connectivity for handling client requests and real-time communication.

For Database Storage:

The system requires a NoSQL database such as MongoDB for storing user data, attendance records, notices, and logs. The storage requirement may vary depending on the number of users, with a minimum of 100 MB or more recommended for smooth operation.

VI.SYSTEM ARCHITECTURE

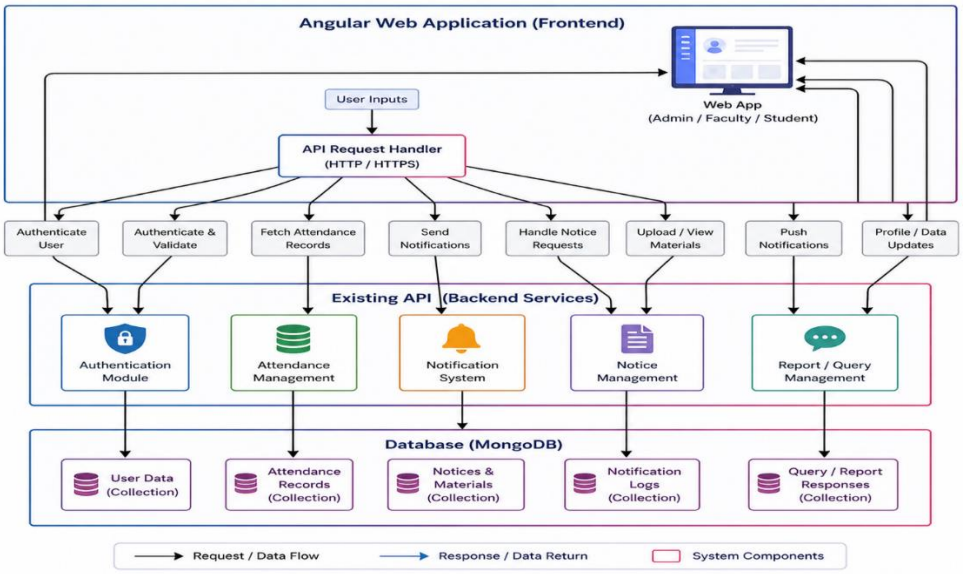

Fig 1: - System Architecture Diagram for Department Management System

The system architecture of the Department Management System is designed using a multi-tier structure consisting of frontend, backend, database, and external communication services. The architecture ensures efficient data flow, secure communication, and real-time updates across all modules. The frontend layer is developed using Angular, which provides an interactive and user-friendly interface for Admin, Faculty, and Students. It follows a component-based architecture that improves code reusability and maintainability. The frontend communicates with the backend using RESTful APIs and handles user interactions such as login, attendance management, notice viewing, and report access. It also performs client-side validation to ensure data accuracy before sending requests to the server. The backend layer is implemented using Node.js and Express.js, which manages the core business logic of the system. It processes incoming API requests, performs authentication using JWT tokens, and ensures role-based access control for different users. The backend also handles operations such as attendance processing, notice management, and report generation. Middleware functions are used for request handling, security checks, and error management, ensuring reliable and secure communication between system components. The database layer uses MongoDB, a NoSQL database, to store structured and unstructured data such as user details, attendance records, notices, and system logs. MongoDB provides high scalability, flexible schema design, and fast data retrieval. It supports indexing and efficient querying mechanisms, which improve system performance when handling large volumes of data. The system also integrates WhatsApp API as an external communication service to enable real-time notifications. Events such as attendance updates, important announcements, and alerts trigger automated messages sent to users. This integration enhances communication efficiency and ensures that users receive timely updates. Additionally, the architecture incorporates security mechanisms such as encrypted communication (HTTPS), token-based authentication, and input validation to protect sensitive user data. It also supports scalability by allowing deployment on cloud platforms, enabling the system to handle increasing numbers of users without performance degradation.

Data Flow Diagram

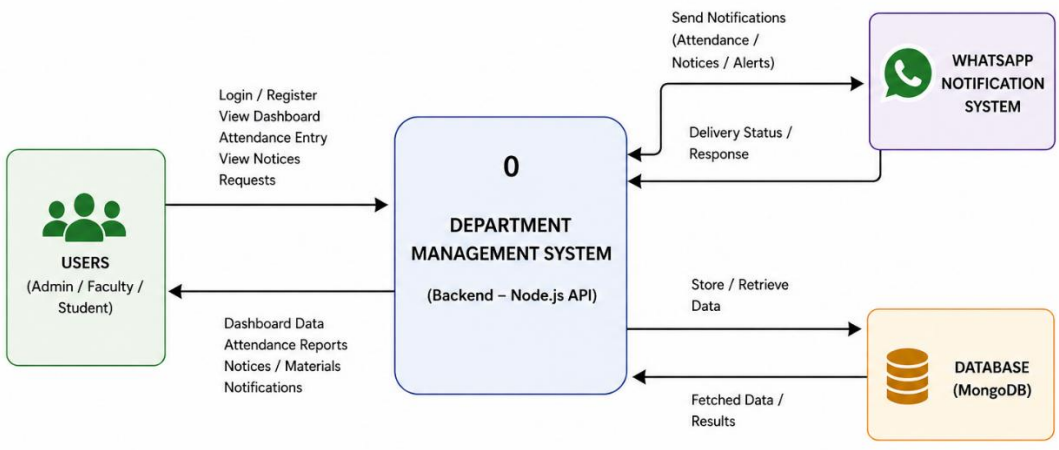

Fig 2: - Data Flow Diagram of Department Management System

The Data Flow Diagram represents how data moves through different stages of the Department Management System. It starts with data collection from users such as Admin, Faculty, and Students through the web application, followed by processing steps such as validation, authentication, and data handling. The processed data is then sent to the backend for storage and further operations like attendance management, notice handling, and report generation. The system also integrates real-time communication where events such as attendance updates or notice uploads trigger notifications through the WhatsApp API. The DFD clearly shows how user input is transformed into meaningful outputs by passing through various processes and data stores such as the MongoDB database.

VII. ENTITY RELATIONSHIP DIAGRAM

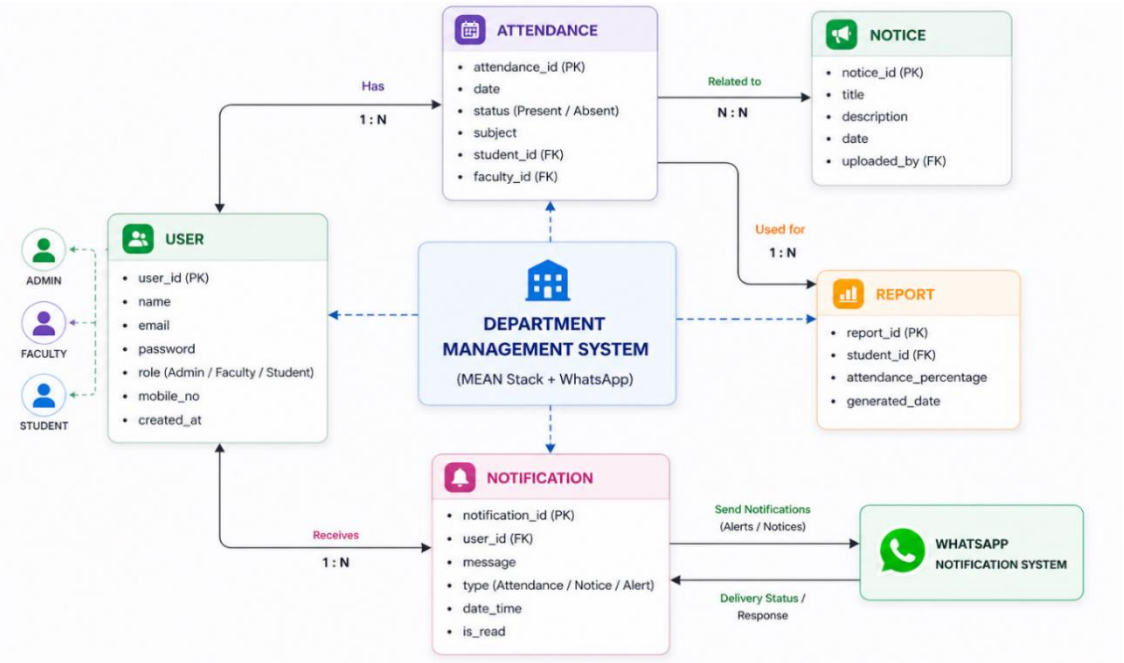

Fig 3: - Entity Relationship Diagram of the System

The Entity Relationship Diagram represents the database structure of the Department Management System. It shows the main entities such as Users (Admin, Faculty, Students), Attendance, Notices, and Reports, along with their attributes and relationships. The diagram explains how different data elements are connected and stored in the system. For example, users are linked with attendance records, and faculty can manage notices and student data. This structure ensures proper organization of data and maintains data integrity. It also helps in efficient data retrieval, updates, and management within the system.

VIII. USE CASE DIAGRAM

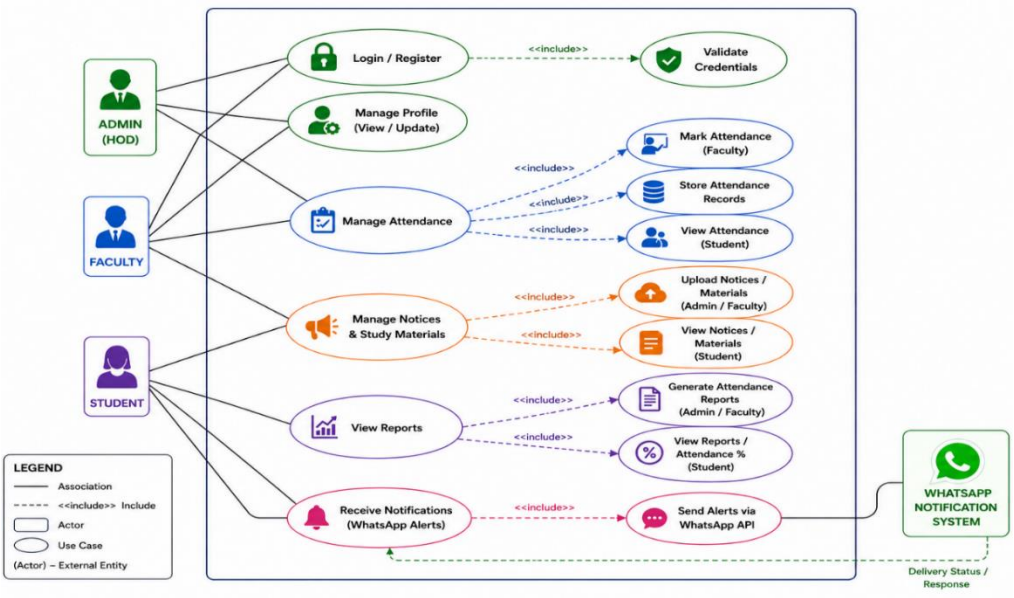

Fig 4: - Use Case Diagram of the System

The Use Case Diagram represents the interaction between users and the Department Management System. It illustrates how different users such as Admin, Faculty, and Students interact with the system functionalities. Admin can manage users, monitor system activities, and handle notices. Faculty can mark attendance, view reports, and upload notices. Students can view attendance, receive notifications, and access academic information. The diagram provides a clear understanding of system functionalities and user roles, helping in defining system behavior and improving system design.

IX. RESULTS

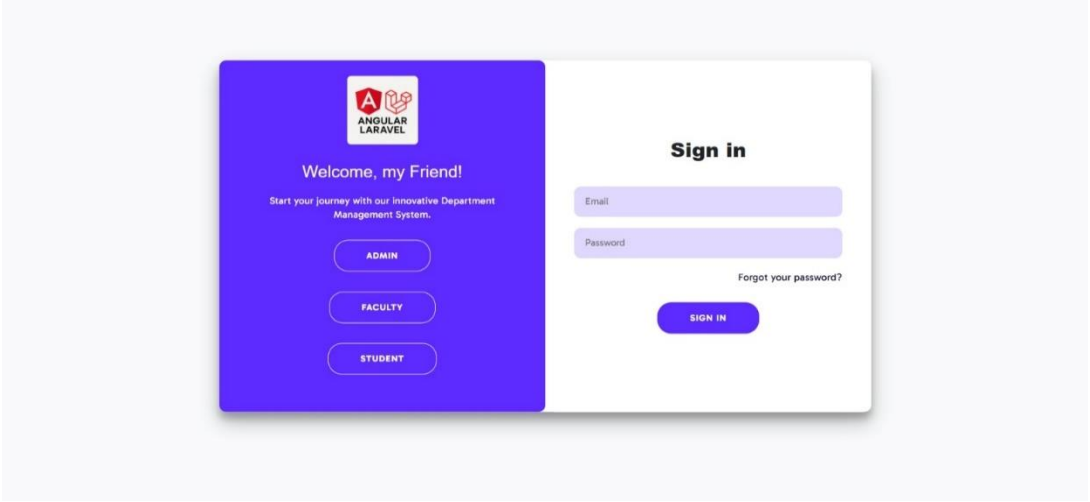

Fig 5: - Sign In Page of the System

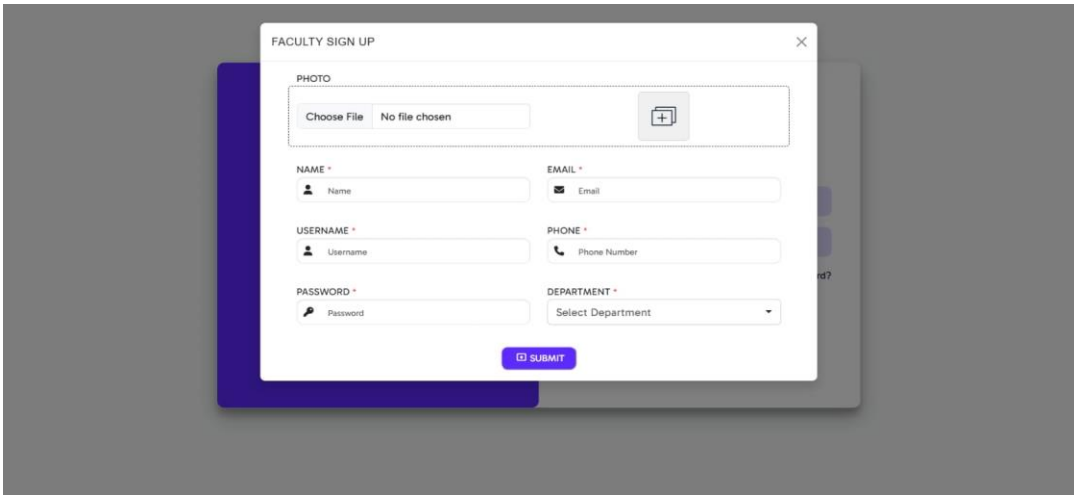

Fig 6: - Signup Page of the System

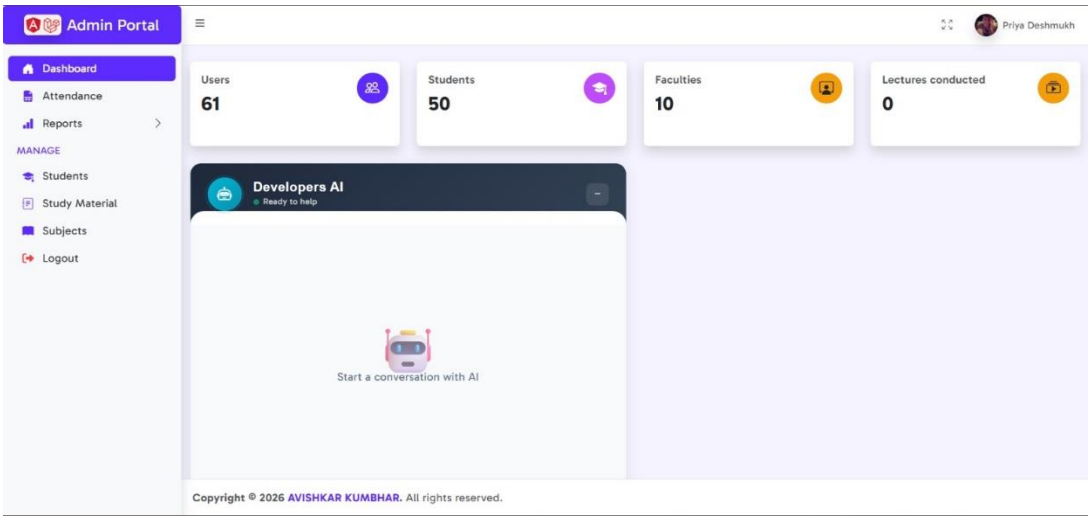

Fig 7: - Faculty Dashboard

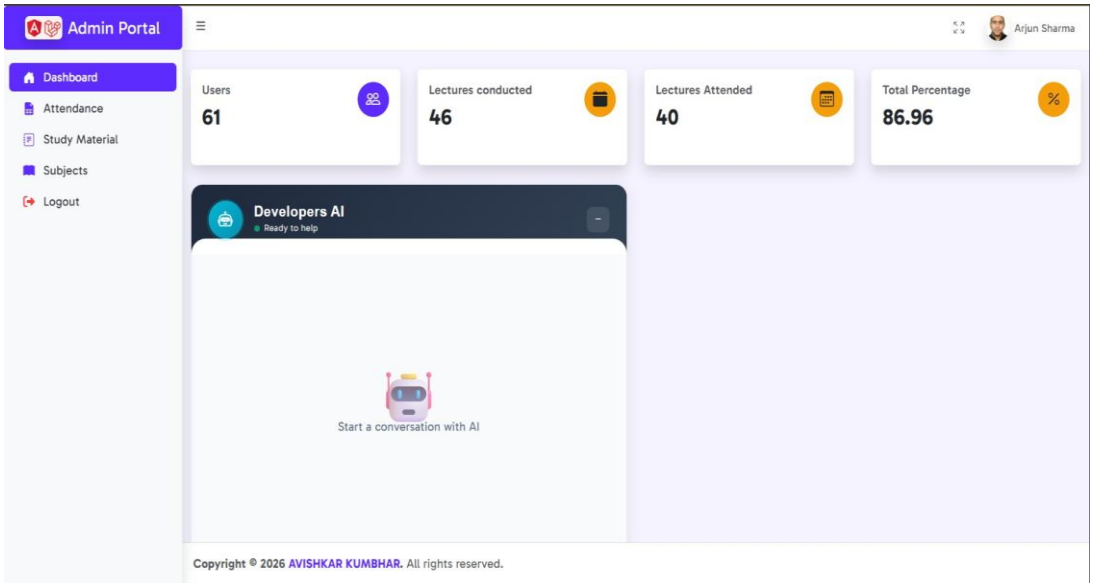

Fig 8: - Students Dashboard

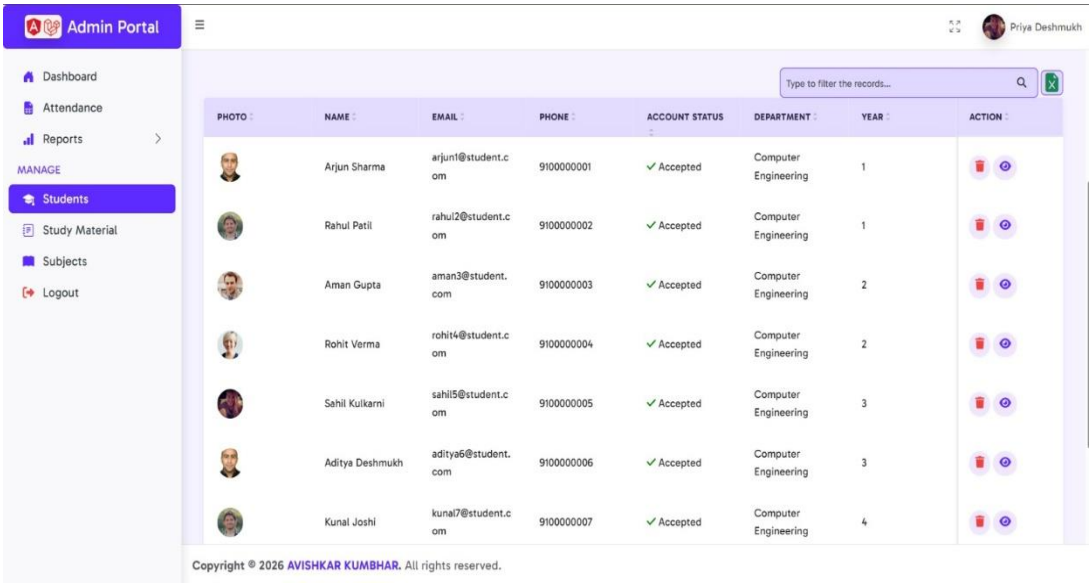

Fig 9: - No. of Students Page

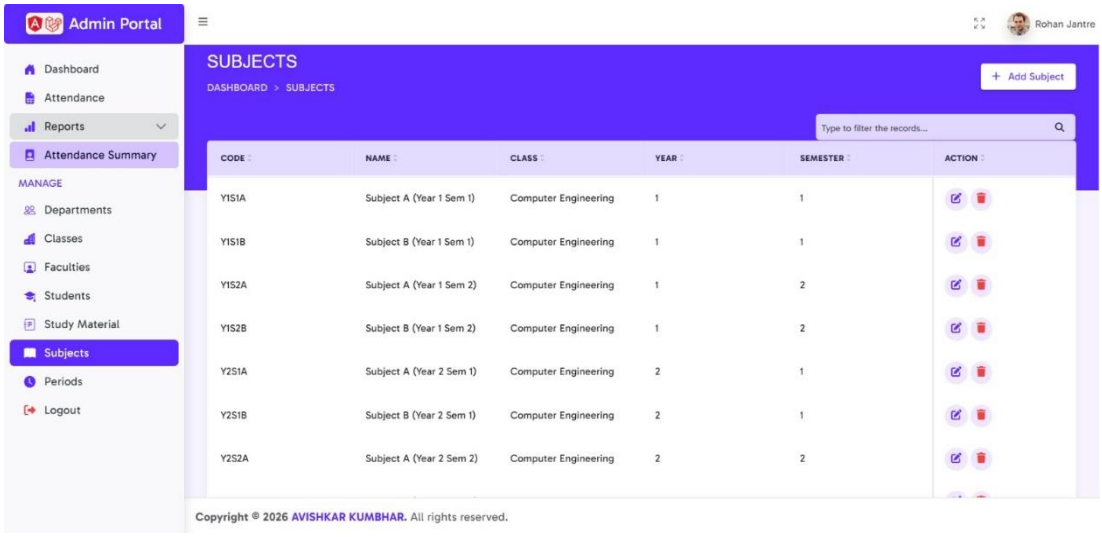

Fig 10: - Assigned Subjects Page

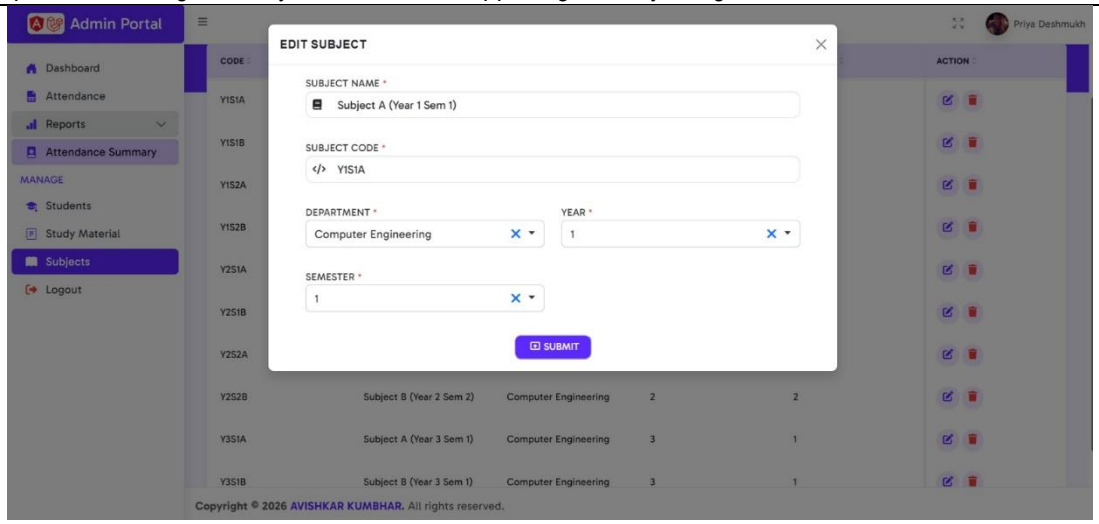

Fig 11: - Edit Subjects Panel

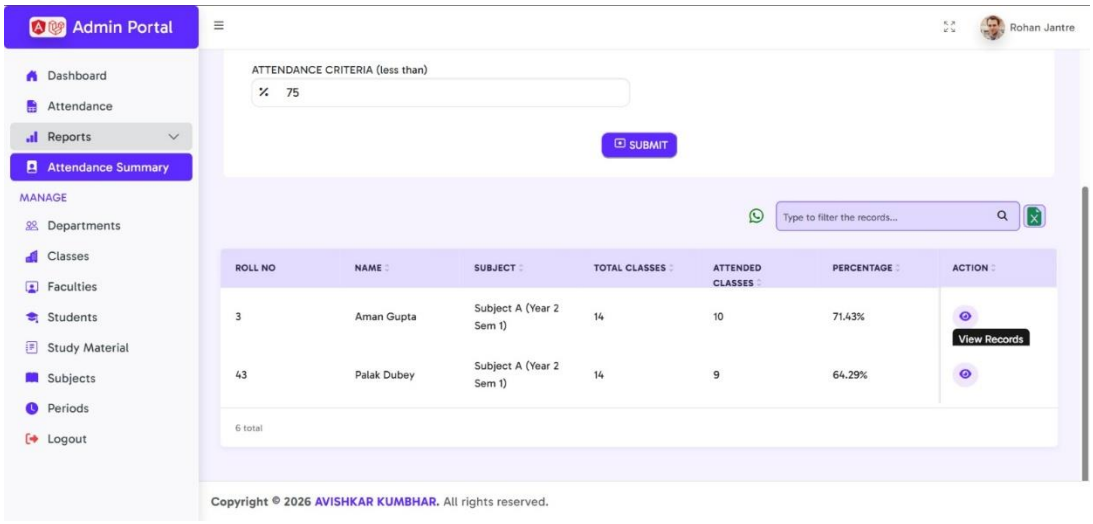

Fig 12: - Attendances Summary (Criteria)

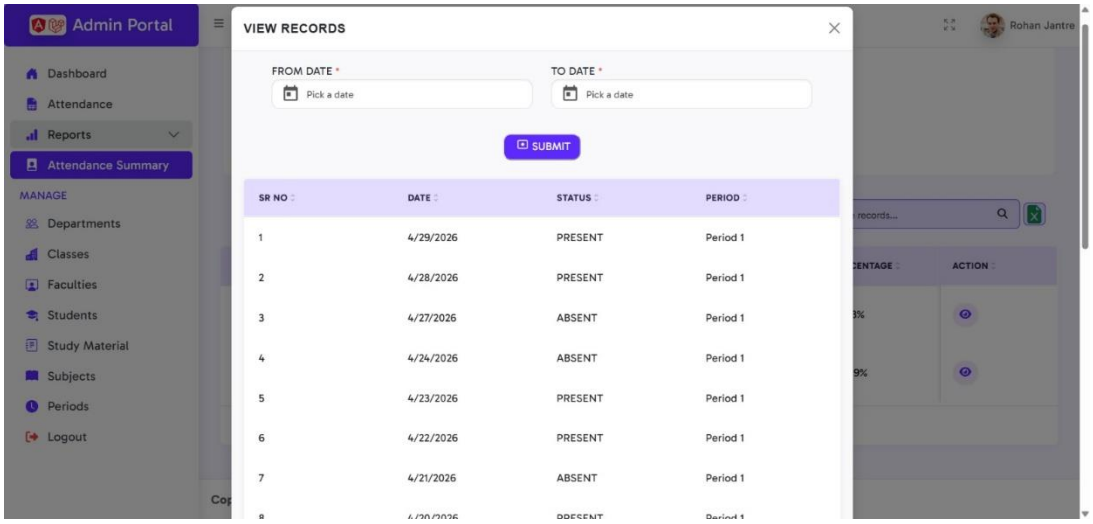

Fig 13: - Attendance Records

X. ADVANTAGES

- Real-Time Updates: Provides instant updates for attendance, notices, and system activities.
- Automated Management: Reduces manual work by automating attendance and data handling processes.
- Improved Communication: Enables real-time notifications through WhatsApp integration.
- User-Friendly Interface: Easy to use for Admin, Faculty, and Students with minimal technical knowledge.
- Scalable System: Can be easily expanded with new features and increased number of users.

XI. DISADVANTAGES

- Internet Dependency: The system requires a stable internet connection for real-time updates and notifications.
- Initial Setup Complexity: Setting up the backend, database, and API integration requires technical expertise.
- Performance Issues: System performance may degrade under heavy user load without proper optimization.
- Security Risks: Improper implementation of authentication and APIs may lead to data security issues.
- Dependency on External Services: Reliance on WhatsApp API may affect notification delivery if the service is unavailable.

XII. APPLICATIONS

- Educational Institutions: The system can be used in colleges and universities to manage attendance, notices, and academic records efficiently.
- Department Management: Helps departments automate daily operations such as attendance tracking and communication.
- Student Information Systems: Can be integrated to manage student data, reports, and academic performance.
- Real-Time Notification Systems: Enables instant communication using WhatsApp for alerts and announcements.
- Administrative Management: Assists administrators in monitoring activities, generating reports, and managing users effectively.

XIII. LIMITATIONS

- Limited Offline Support: The system cannot function fully without an internet connection, limiting usability in offline scenarios.
- Dependency on Network Quality: Slow or unstable internet may affect system performance and real-time updates.
- Scalability Constraints: Performance may decrease if the system is not properly optimized for a large number of users.
- Third-Party Dependency: The system relies on external services like WhatsApp API, which may impact functionality if unavailable.
- Basic Feature Scope: The current system focuses mainly on attendance and notifications, with limited advanced academic features.

XIV. CONCLUSION

The proposed Department Management System with WhatsApp integration presents an effective and intelligent solution for managing academic activities in educational institutions. By leveraging modern web technologies such as Angular, Node.js, and MongoDB, the system is capable of automating key processes such as attendance management, notice distribution, and data handling. This approach enhances the overall efficiency of academic operations by reducing manual work, minimizing errors, and improving data accuracy. The system demonstrates strong potential in improving communication between faculty and students through real-time notifications using WhatsApp integration. It ensures timely updates, better coordination, and improved user engagement. The implementation of secure authentication mechanisms further enhances system reliability by protecting sensitive user data and enabling role-based access control. The integration of modern technologies ensures efficient handling of large volumes of data, making the system suitable for real-world academic environments. Furthermore, the future scope of this project includes developing mobile applications, integrating advanced analytics for performance tracking, and enhancing communication features with additional platforms such as email and SMS. The adoption of emerging technologies such as AI-based analytics and cloud deployment can further improve system scalability and usability.

XV. FUTURE SCOPES

The proposed Department Management System has significant potential for further enhancement and expansion. One of the key future improvements includes the development of a mobile application, which can provide easier and more convenient access for students and faculty to manage attendance and receive notifications anytime and anywhere. Integrating advanced analytics and reporting features can also provide deeper insights into student performance and attendance patterns, helping institutions make data-driven decisions. Another important direction is the incorporation of artificial intelligence techniques for predictive analysis, such as identifying students at risk based on attendance trends.

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