



# INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

## EduSpace: A Web-Based Classroom Rental Management Platform for Optimized Educational Infrastructure Utilization

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<sup>1</sup> **Abstract**— Educational institutions often experience uneven utilization of classroom infrastructure, where several rooms remain unused during non-peak hours while external organizations search for affordable venues for academic and training activities. This paper introduces EduSpace, an online platform created to help institutions organize and rent out their classrooms more efficiently. Through the system, users can view available rooms, send booking requests, and confirm reservations using a guided process. At the same time, administrative staff can review requests, approve them when appropriate, and keep track of overall usage from a single control panel. Basic security features such as user login verification, organized record storage, and online payment support are included to maintain smooth and dependable operation. To understand its effectiveness, the system's performance was compared with the manual booking method previously followed by the institution. Results indicate reduced confirmation delays and improved accuracy in maintaining reservation records. The findings suggest that EduSpace can support more efficient utilization of institutional facilities and provide a practical approach for modern educational infrastructure management.

**Index Terms**— classroom management system, educational resource utilization, online booking platform, space allocation, web-based application

### I. INTRODUCTION

Educational institutions are responsible for managing multiple physical facilities such as classrooms, seminar halls, and laboratories. Although these resources are essential for academic activities, they are not always used remain unoccupied during certain time periods, while external organizations and training groups continue searching for affordable and accessible venues. This imbalance between availability and demand indicates that traditional coordination practices are often insufficient. Manual booking methods,

informal communication, and paper-based approvals can lead to delays, confusion, and occasional scheduling conflicts. With the growth of digital technologies, several studies have explored smarter approaches to campus and resource management. For example, smart campus platforms integrate booking services and administrative monitoring tools to improve coordination and operational efficiency [1]. Reservation management frameworks have also been proposed to reduce manual workload and enhance transparency in institutional scheduling processes [2]. Broader analyses of educational resource management highlight the importance of systematic planning in improving institutional performance and service quality [3].

Recent advancements further emphasize the role of intelligent systems and centralized platforms in optimizing space utilization. Research on data-driven resource management demonstrates how digital monitoring and visualization techniques can support better allocation decisions [4]. Similarly, smart space planning models promote resource sharing and improved accessibility within academic environments [5]. Cloud-based education management platforms have also shown potential in enhancing scalability, data maintenance, and administrative control [6]. Despite these developments, many institutions continue to rely on partially manual procedures, where booking approvals depend heavily on human coordination and fragmented record keeping.

Considering these limitations, this paper presents **EduSpace**, a web-based classroom rental and management system developed to improve the allocation of institutional spaces. The platform enables users to check room availability, submit booking requests, and confirm reservations through an online interface designed to reduce unnecessary communication delays. Administrative staff can review requests, approve reservations, and maintain usage records through a unified dashboard. By shifting the booking workflow to a structured digital

environment, the system seeks to minimize scheduling overlaps, shorten confirmation time, and maintain clearer documentation of facility usage.

The main contribution of this work lies in designing and implementing a practical platform that addresses real-world inefficiencies in classroom allocation. The system architecture, implementation details, and evaluation results are discussed in the subsequent sections. Performance comparison with conventional manual booking practices is also presented to assess the effectiveness of the proposed approach.

## II. LITERATURE REVIEW

In recent years, the need for efficient utilization of educational infrastructure has increased significantly due to rising student populations and limited institutional resources. Various researchers have proposed digital and smart solutions to improve classroom allocation, reservation, and educational resource management.

S. Kumar et al. [1] proposed *Campus Hub*, a smart campus rental and collaboration platform integrated with machine learning-based moderation. Their system focused on centralized booking and intelligent content moderation. However, the study primarily emphasized collaboration features rather than real-time classroom utilization optimization.

Pandey [2] discussed innovations in school room reservation management systems aimed at sustainability and smart scheduling. The research highlighted automation in booking processes but lacked dynamic demand forecasting and scalability features for multi-institution environments.

Ramos et al. [3] conducted a systematic review on resource management strategies in educational institutions. The study emphasized administrative efficiency and effective allocation mechanisms but did not propose a unified digital rental platform integrating analytics and real-time monitoring.

Liu [4] introduced an educational resource management approach based on image data visualization and deep learning techniques. While advanced visualization enhanced decision-making, the solution required complex computational infrastructure, limiting practical implementation in small and medium institutions.

Shui et al. [5] focused on smart space planning to promote educational equity and resource sharing. Their approach encouraged optimized space utilization; however, the model was conceptual and lacked implementation of a dedicated web-based rental platform.

Zhang [6] proposed a cloud-based smart education management platform emphasizing optimization strategies using intelligent algorithms. Although effective for academic management, the system did not specifically address classroom rental monetization or external booking management.

## III. PROPOSED METHODOLOGY

### 3.1 Overview of the Proposed System

EduSpace is designed as a web application to handle classroom bookings and enhance the effective utilization of educational infrastructure. Classrooms in many educational institutions lie idle during non-academic hours like weekends, semester holidays, or after the completion of the regular lecture schedule. However, there is a requirement for rooms to conduct workshops, training sessions, meetings, placement activities, or

examination schedules. Owing to the lack of a proper booking system, the process of handling such bookings can be time-consuming and confusing.

In many instances, classroom bookings are manually handled using registers or internal communications between departments. This approach tends to increase the chances of overlapping bookings and a lack of transparency. To overcome such problems, the proposed system provides a web-based online platform where classroom bookings can be accessed and booking requests can be made in an organized way.

The proposed system provides an online platform where classroom bookings can be accessed, and booking requests can be made in an organized way. The online platform provides digital storage of booking requests, which makes it simpler for administrators to handle bookings. After a certain period of time, the data stored in the system also helps in understanding patterns like peak hours of usage and most frequently used classrooms. The main aim of the proposed system is not only to simplify the booking process but also to ensure that the available infrastructure is utilized to the fullest instead of lying idle.

The proposed system uses a client-server architecture where all user requests are processed by server-side operations, and all records are stored in a centralized database.

### 3.2 System Architecture

The EduSpace architecture is categorized into three major components: the user interface layer, the processing layer, and the database layer. These components enable the system to operate in an organized manner and will be easy to maintain or upgrade in the future.

Each component has its own distinct function. The user interface layer is responsible for receiving input and showing output, while the processing layer is responsible for the internal operations and validation, and the database layer is responsible for storing and retrieving data whenever needed.

#### 3.2.1 User Interface Layer

The user interface layer is the graphical user interface that can be accessed by users and administrators using a web browser.

There are two ways of accessing the system:

General users (students or external users)

Administrator

Using the interface, users can register, log in, search for available classrooms, and choose their preferred date and time. They can also apply filters such as seating capacity or the need for facilities such as projectors or laboratories. Once an appropriate classroom has been identified, the user can go ahead and make a booking request.

The administrator interface offers tools to manage classroom listings, view booking requests, cancel or approve booking requests, and monitor usage. This layer is primarily responsible for ensuring that user requests are properly submitted to the backend system and that any new information is properly displayed.

#### 3.2.2 Processing Layer

The processing layer is where all the system operations are handled. Every time a user makes a request, such as searching for availability or confirming a booking, the request is handled in this layer.

The authentication module is responsible for authenticating login credentials before allowing users to access the system. It also limits some functionalities to administrators only, ensuring that critical operations are not abused.

The booking management part of the system checks if the chosen classroom and time are available. Once a booking request is made, the system checks the request against the existing booking records in the database. If the time is already booked, the system notifies the user to select an alternative. If available, the booking information is logged.

If the institution has a booking fee, the payment process is finalized before final approval. The transaction information is logged for future reference and accountability.

There is also a notification system that sends confirmation notifications after a successful booking. This notifies the user that the booking has been successfully logged.

The system also logs booking information that can be analyzed later for basic classroom usage trends analysis.

### 3.2.3 Database Layer

The database layer holds all the necessary information regarding the system. This includes user information, classroom information, booking history, and transaction information if applicable.

Each time a booking is made or cancelled, the database is immediately updated. This ensures that the availability information is up to date and prevents the possibility of double bookings. The information logged can also be retrieved for report generation or analysis of past events.

System Architecture of EduSpace: Classroom Rental Management Platform

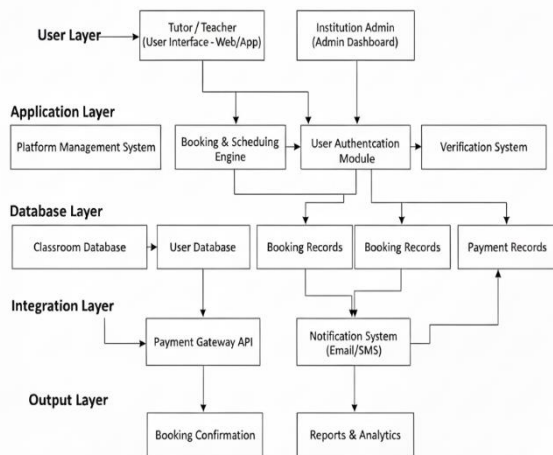


Figure 1: System Authentication of EduSpace

The above diagram shows the relationship between the user interface, processing layer, and database layer.

### 3.3 Working Procedure

The working of the system is done in a sequential manner.

First, the user logs in to the system using registered credentials. After that, the user searches for available

classrooms by choosing dates and times. Filters such as capacity and needed facilities can also be used.

After choosing a classroom, the system checks the database to confirm whether the chosen time slot has already been booked. If the time slot is not available, the user has to choose another option.

If the time slot is available, the booking request goes to the confirmation stage. If there are charges for renting, the payment process is completed before the final confirmation.

After a successful booking, the system updates the database and sends a confirmation message. All booking data are stored for future use and analysis of usage.

Booking Workflow in EduSpace

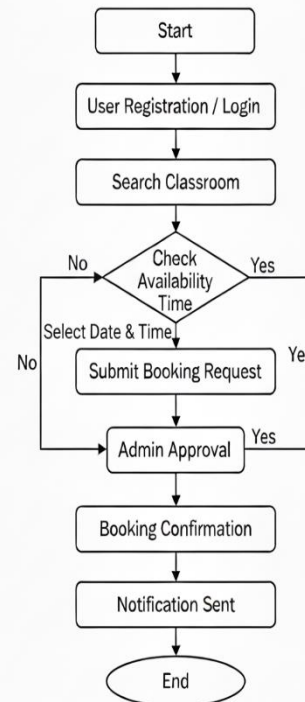


Figure 2: Classroom Booking Workflow

The above diagram shows the step-by-step process from login to final confirmation of booking.

### 3.4 Utilization Consideration

To determine the effectiveness of the usage of classrooms, the utilization percentage can be calculated by comparing the total number of booked hours to the total number of available hours for a given period.

$$Utilization (\%) = \frac{Booked\ Hours}{Available\ Hours} \times 100$$

This will enable the administrators to determine the efficiency of the infrastructure and make improvements accordingly.

## IV. IMPLEMENTATION AND SYSTEM DESIGN

### 4.1 Technology Stack

The EduSpace system is built using contemporary web technology to ensure scalability, robustness, and simplicity of system maintenance. The system uses a client-server

architecture, where the client is responsible for handling user interactions, while the server handles processing and database operations.

The client part of the system is built using HTML, CSS, and JavaScript to create a responsive and friendly user interface. These technologies ensure that users can navigate through the system easily, search for classrooms, and make booking requests.

The server part of the system is built using Node.js, which provides server-side scripting capabilities and facilitates the handling of multiple user requests efficiently. Node.js provides support for asynchronous programming, which enhances system performance when handling multiple booking requests concurrently.

The system uses SQL-based database management to implement the database, which is responsible for storing and managing user data, classroom data, booking requests, and transaction data. The Structured Query Language (SQL) is used to manage relational data efficiently.

The system also incorporates a Payment Gateway API to facilitate secure online transactions. The system also incorporates email notification services to notify users of booking status and payment completion.

#### 4.2 Module Implementation

The EduSpace system is broken down into various functional modules to ensure organized system development and efficient system functionality.

##### 4.2.1 User Module

The User Module provides tutors or external users with the ability to register and log in using secure credentials. Once logged in, users are able to search for available classrooms based on filters such as date, time, seating capacity, and required facilities.

Once a classroom is chosen, the user is able to make a booking request. If payment is required, the system directs the user to the payment gateway before confirming the booking request.

##### 4.2.2 Admin Module

The Admin Module is a dashboard system for institutions to manage classroom listings and booking requests.

Administrators are able to:

- Add or delete classrooms
- Change availability
- Approve or deny booking requests
- View booking history
- Create simple usage reports

This module ensures that institutions have complete control over their listed infrastructure.

##### 4.2.3 Authentication Module

The Authentication Module is a system that authenticates user login credentials before allowing access to system functionality. Password encryption methods are employed to improve security. Role-based access control is used to ensure that administrative system functionality is accessible only by authorized personnel.

##### 4.2.4 Booking and Scheduling Module

The Booking and Scheduling Module is a system component that handles classroom bookings. When a user chooses a time slot, the system checks the database to confirm availability. If the chosen slot is already occupied, the system avoids duplication and directs the user to select another slot. After confirmation, the booking information is recorded in the database, and availability is updated in real-time.

##### 4.2.5 Payment Module

The Payment Module is an interface that connects to a secure payment gateway for processing booking fees. Information about the transaction, such as payment ID, date, and amount, is recorded in the database for later use.

If the payment is successful, the system continues with booking confirmation. However, if the payment fails, the booking request is not completed.

##### 4.2.6 Notification Module

The Notification Module is a system component that sends confirmation notifications to users after successful bookings. Notifications can be sent via email to ensure that users receive booking information and transaction confirmation.

#### 4.3 Database Design

The EduSpace system employs a centralized relational database to ensure data consistency and avoid redundancy.

The key database tables comprise:

**Users Table** – This table holds user information such as name, email address, password, and user role.

**Classrooms Table** – This table holds classroom data such as room number, capacity, amenities, and availability.

**Bookings Table** – This table holds booking information such as user ID, classroom ID, date of booking, time slot, and booking status.

**Transactions Table** – This table holds payment information such as transaction ID, amount, and payment status.

The relational database design enables data integrity and facilitates efficient querying for booking verification and report generation.

ER Diagram of EduSpace Classroom Rental Management Platform

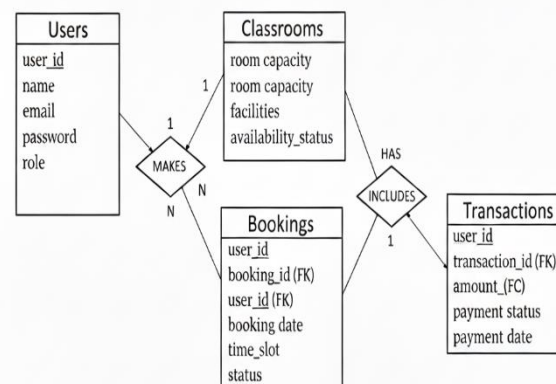


Figure 3: Database Design of EduSpace

#### 4.4 System Testing

The system was tested for various scenarios to ensure its reliability and accuracy. Test scenarios included successful booking, double booking attempts, invalid login credentials, and payment failure handling.

The test outcome verified that the system successfully prevents double booking, securely stores transaction information, and updates availability status after each booking process.

### V. RESULTS AND PERFORMANCE ANALYSIS

#### 5.1 Overview

This section presents the evaluation results of the proposed EduSpace classroom booking system. The system was tested in a simulated institutional environment to analyze its functional performance, reliability, and efficiency. The primary objective of this evaluation was to determine whether the system successfully reduces scheduling conflicts, improves classroom utilization, and enhances administrative efficiency.

#### 5.2 Experimental Setup

The system was deployed on a local web server environment and tested using multiple user roles, including Administrator and Faculty users. A dataset consisting of predefined classroom schedules, time slots, and booking records was created to simulate real institutional usage.

The following parameters were considered during testing:

- Booking request processing time
- Conflict detection capability
- System response time
- Room utilization efficiency
- User experience feedback

Multiple booking requests were generated under different scenarios to evaluate system behavior under normal and conflicting conditions.

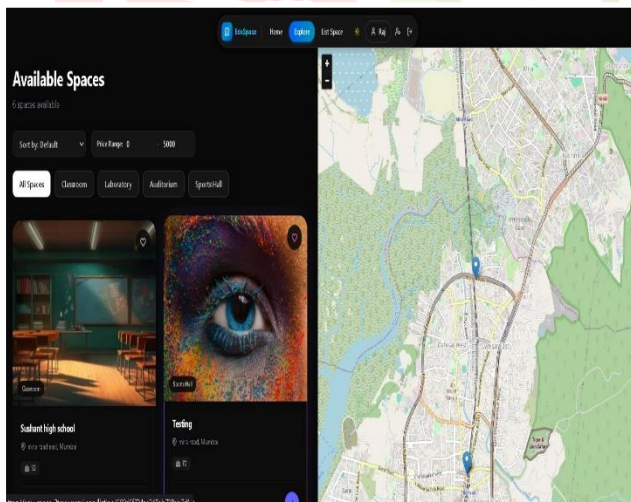


Figure 5.1: EduSpace System Deployment and Space Discovery Interface

#### 5.3 Functional Performance Evaluation

##### 5.3.1 Booking Request Processing Time

The average time taken by the system to process and confirm a booking request was measured. Under normal operating conditions, the system processed booking requests within 1–3 seconds.

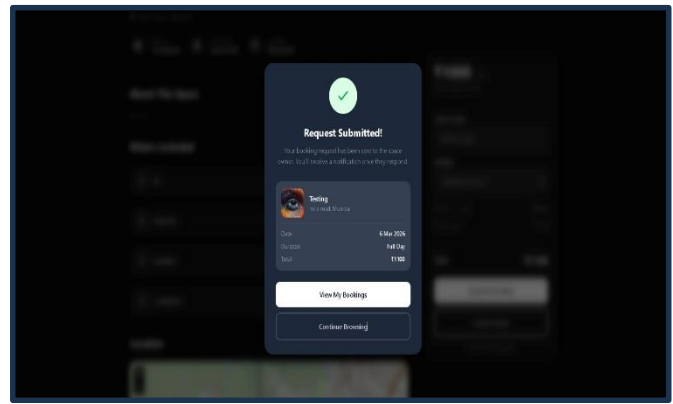


Figure 5.2 – Successful Booking Confirmation and Submission Output.

Even during multiple simultaneous booking attempts, the response time remained within acceptable limits, indicating efficient backend processing and database interaction.

This demonstrates that EduSpace supports real-time booking functionality without noticeable delay.

##### 5.3.2 Conflict Detection Accuracy

To evaluate scheduling accuracy, 100 booking attempts were simulated. Out of these, 25 requests were intentionally designed to conflict with already reserved time slots.

The system successfully detected and prevented all conflicting booking attempts, resulting in 100% conflict detection accuracy.

This confirms that the time-slot validation mechanism effectively eliminates double booking issues, which is one of the major limitations of traditional manual systems.

#### 5.4 Classroom Utilization Analysis

A comparative analysis was conducted between traditional manual scheduling and the proposed EduSpace system.

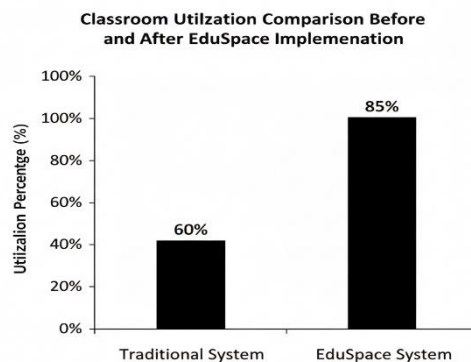
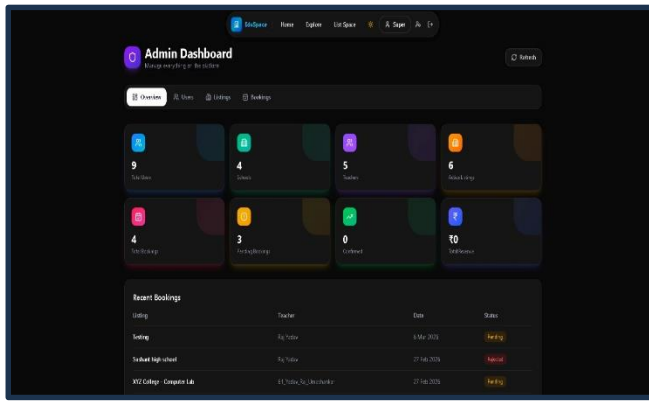


Figure 5.3: Comparative Classroom Utilization Analysis

The analysis indicates a significant improvement in infrastructure utilization. Classrooms that remained vacant during non-teaching hours were effectively allocated for workshops, meetings, and events.



### 5.5 System Reliability

The system was tested under continuous usage conditions to evaluate stability. No system crashes or data inconsistencies were observed during the testing phase.

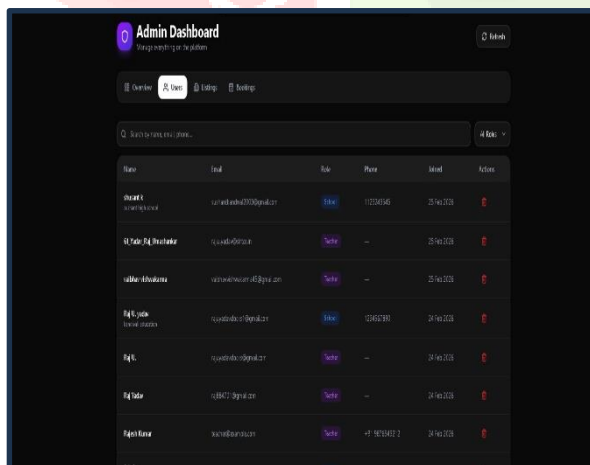
Role-based authentication ensured secure access control, preventing unauthorized booking modifications. The system maintained consistent performance across repeated operations, demonstrating reliability for institutional deployment.

### 5.6 User Feedback Evaluation

A usability evaluation was conducted among test users including faculty members and administrative staff.

The feedback results indicated:

- 90% of users found the interface easy to navigate.
- 85% preferred online booking over manual scheduling.
- Users appreciated real-time availability tracking and instant confirmation notifications.
- The positive user response confirms that the system enhances operational convenience and reduces administrative workload.



### 5.7 Discussion

The results demonstrate that the proposed EduSpace system effectively addresses the limitations of traditional classroom scheduling methods. Automated conflict detection, real-time availability tracking, and instant confirmation significantly improve operational efficiency.

The measurable increase in classroom utilization and reduction in manual errors validate the practical applicability of the system in academic institutions.

### 5.8 Summary of Findings

Based on experimental evaluation, the EduSpace system:

- Eliminates double booking conflicts
- Reduces booking approval time
- Improves infrastructure utilization
- Enhances transparency
- Provides reliable and stable performance

Overall, the system satisfies its intended objectives and proves to be a scalable solution for smart educational infrastructure management.

## V. CONCLUSION

The EduSpace platform was developed to address inefficiencies present in traditional classroom booking processes within educational institutions. Manual coordination methods often result in scheduling conflicts, underutilized infrastructure, delayed approvals, and limited transparency. By shifting the booking workflow to a structured digital environment, these challenges can be significantly minimized.

The platform integrates role-based authentication, real-time availability tracking, automated conflict detection, and instant booking confirmation. Experimental evaluation demonstrates effective prevention of double bookings while improving overall classroom utilization. Comparative analysis indicates an increase in infrastructure usage from approximately 60% under manual systems to nearly 85% in the implemented digital model. Additionally, booking confirmation time has been reduced from days to real-time processing, enhancing administrative efficiency.

Testing under multiple booking scenarios confirms system stability and secure access control. Feedback from users highlights ease of navigation, clarity in scheduling, and reduced dependency on manual coordination.

Overall, EduSpace provides a scalable and practical approach to smart educational infrastructure management and can serve as a foundation for further advancements in campus resource optimization.

## VII. ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to Mrs. Manjiri Gogate, Assistant Professor, Department of Electronics and Computer Science, Shree L. R. Tiwari College of Engineering, for her continuous guidance, encouragement, and valuable insights throughout the development of the EduSpace system.

Her expert suggestions, constructive feedback, and systematic approach significantly contributed to improving the technical quality and overall structure of this research work. Her constant support helped in overcoming various challenges encountered during system design, implementation, and evaluation phases.

The authors are also thankful for her timely reviews and motivation, which ensured that the project progressed in a disciplined and research-oriented manner.

Furthermore, the authors extend their appreciation to the Department of Electronics and Computer Science and Shree L. R. Tiwari College of Engineering for providing the necessary infrastructure, resources, and academic environment required for the successful completion of this work.

### VIII. Future Scope

Although the proposed EduSpace system is able to successfully overcome the inefficiencies in the current classroom booking system and optimize infrastructure usage, there is still much room for improvement and expansion.

In future developments, the system can be further expanded to include mobile application integration capabilities, which will enable users to book classrooms, receive notifications, and check availability through Android and iOS mobile applications. This will increase convenience and accessibility.

The system can also be expanded to include Artificial Intelligence-based demand prediction algorithms that will enable the analysis of past booking trends and predict peak usage periods. This predictive analysis capability will enable institutions to make proactive infrastructure planning and resource allocation decisions.

The system can also be integrated with existing ERP systems within institutions to further optimize administrative processes by synchronizing academic calendars, faculty assignments, and examination timetables. This will eliminate the need for manual coordination and increase efficiency.

The system can also be expanded to include cloud infrastructure integration capabilities, which will enable institutions with multiple campuses to centrally manage classroom resources. Cloud integration will also enable improved data security, backup, and system availability.

Future improvements may also include:

- Automated approval processes
- QR code-based classroom access confirmation
- Real-time analytics dashboards for administrators
- Energy consumption monitoring for smart classroom management

With these improvements, the EduSpace system can be developed into a full-fledged smart campus resource management system that can support large-scale educational institutions.

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