

# Survey Paper on Smart Gate Pass System for College Students

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**Abstract**—Smart Gate Pass System is a web-based platform designed to improve the safety, transparency, and operational efficiency of managing students' movement in educational institutions. Traditional gate pass procedures are paper-form or semi-digital-based. These methods are time-consuming, prone to errors, and devoid of real-time verification, which often leads to security lapses and administrative overhead. This project addresses these challenges by implementing a role-based, multi-stakeholder workflow involving students, parents, administrators, and security personnel. The proposed system allows the submission of gate pass requests from students, with details such as the time of exit and the reason. Parents instantly receive notifications to approve or reject requests remotely to ensure parental involvement in movement authorization. Once approved a QR code-based pass by both parent and administrator is generated. Security guards scan the code at entry and exit points, allowing for real-time verification and remain tamperproof logs. Other functionalities include a voice input option to assist visually challenged students face an intelligent recommendation engine. for general reasons, syncing with Google Calendar for tracking approved passes, and an emergency pass override for urgent cases that need expedited approval. By integrating multi-level approval, secure QR-based authentication, and access to SGPMS, with all the features incorporated into a single platform, it surpasses the functionality of current hostel gate pass monitoring systems and RFID-based campus access solutions. The system reduces manual paperwork, accelerates decision-making, and enhances accountability. ability, and improves security on campus as a whole. Its design draws from earlier works on web-based automation of hostel gate passes and RFID-enabled campus access verification, extending them increasingly inclusive, parentally involved, and intelligent automation of a comprehensive, scalable, and reliable the solution for modern educational institutions.

**Index Terms**—Gate Pass Management System, Web-based Automation, QR code Verification, Role-based

access control, Parental Authorization, Voice Assistance, Emergency Pass Override, Intelligent Recommendation Engine

## I. INTRODUCTION

Engineering colleges have strict regulations regarding student movement off-campus during working hours. Many institutions manage gate passes manually using paper slips, log registers, and signatures from the Head of Department (HOD). As a result, students often experience delays in obtaining their gate passes, even in emergencies, due to the unavailability of mentors and the HOD. There are also instances of students forging signatures, which compromises the efficiency of the approval process. Additionally, the manual system lacks transparency regarding issued gate passes, making it challenging to track them effectively. Unlike general gate passes, colleges require parental permission to approve student gate passes, ensuring safety, security, and transparency. Although a few applications digitize the gate pass management process, none adequately incorporate both parental and administrative approvals. Therefore, it is essential to develop a digital gate pass management system for engineering colleges to facilitate efficient issuance and tracking. This study proposes a new model for a role-based application that includes students, administrators, parents, and security personnel. This system will utilize a QR-based gate pass verification method, incorporating the entire college database for role-based authentication. Students can log in with their credentials provided by the college and request a gate pass, specifying the reason and time of exit. Once the request is submitted, a verification call is made to the parent to confirm their awareness of it. If the parent approves the request, it is then forwarded to the administrator for approval. Upon approval, a unique

QR code is generated for the student. The security guard can scan this QR code to retrieve the student’s photograph and other details. The student is then physically verified and allowed to leave the campus. The current manual system poses significant challenges for physically challenged students. Therefore, this new system will include voice input features, facilitating a simpler way for all students to request gate passes.

II. RELATED WORK

In recent years, there has been a wave of numerous developments of digitized gate pass systems, automating and enhancing campus safety and efficiency. These gate pass models are aimed primarily to replace paper-based methods of approving gate passes. Some systems utilized tools like QR codes for pass verification, which reduced the risk of forgery.

Some of them developed systems to simplify maintenance of records of student movement. Certain models used random key generation or RFID and Arduino-based hardware for verification to strengthen the efficiency. However, most of the existing systems lacked a multi-level workflow which ensures transparency by parental involvement and real-time notifications. Additionally, they lack accessibility for visually challenged users and a real-time recommendation engine for students, along with an analytics dashboard, which were not integrated into the existing solutions. The proposed Smart Gate Pass System ensures the integration of a web-based role-wise authentication model with QR code verification, parental approval step, voice-enabled input for increased accessibility and intelligent analytics. Overall, this system is an enhanced framework providing secure, transparent, and scalable product to manage student movement in educational institutions.

TABLE I  
LITERATURE REVIEW

Ref.	Title	Findings	Drawbacks
[5]	Gate Pass Security Management System using Random Key Generation (IJCSMC,2021)	Introduced random key-based security for authentication of passes.	Absence of scalability and no role-based access control.
[2]	SMART GATEPASS Solutions Leveraging Technology (IJIRCCE,2024.)	Improved efficiency in data management and record tracking for student movements.	Did not ensure tamper-proof verification and lacked accessibility features.
[3]	DiG-Pass: Enhance and Secure Solution for Gate Pass Using QR Code ((IRJET,2024)	Used QR code-based generation and verification for secure and tamperproof gate passes.	No real-time notification or accessibility support for users.
[4]	Hostel Gate Pass Management System (IJSREM,2024.)	Streamlined hostel permission approval and record management through automation.	Limited external integration; lacked scalability and analytics.

[8]	Gate Pass Management System Using Arduino and RFID (IJERT,2024.)	Used Arduino and RFID for automatic student identity verification at gates.	Dependent on hardware setup; lacked remote accessibility and parental involvement.
[1]	Smart Digital Gate Pass System (IJETA,2025.)	Automated gate pass generation using a centralized web-based system to replace manual processes.	Lacked multi-level authentication and real-time parental involvement.
[6]	Automated Gate Pass Management System (IJARCC,2025.)	Web-based automation for gate pass approval and tracking.	No parental approval workflow; lacked analytical monitoring.

### III. METHODOLOGY / PROPOSED SYSTEM

The proposed Smart Gate Pass System develops a real-time solution to the inefficiencies and limitations of the traditional manual paper-based system by providing a web-based application that runs on a role-based access with a QR-verified pass approval process. The methodology involves the development of an integrated system for Students, parents, Institution administrators, and Security personnel, providing a transparent workflow. The proposed system scores a great mark by providing an awesome accessibility with voice input for visually impaired Students. The proposed system also showcases intelligent analytics to the users, highlighting the peak hours of pass generations, and the probability of approval of passes based on the frequency of already approved passes during that time. The methodology includes 6 phases, which are listed as follows:

1. System Design and Architecture Development,
2. Gate Pass Workflow,
3. Integration of multiple features
4. Data Analytics
5. Security and Testing
6. Deployment and Scalability

#### A. System Design and Architecture

The proposed system is developed as a 3-tier architecture focusing on-  
**Frontend Layer:** Development of an interactive, component-based UI design using React.js.

**Backend Layer:** Implementation of core logic using Python, connecting backend to the frontend using Flask, providing RESTful APIs for communication, JWT for authentication.  
**Database Layer:** PostgreSQL is used with normalised tables for reduced redundancy and indexing for faster experiences on tables such as Users, Students, Parents, Requests, Approvals, and Logs.

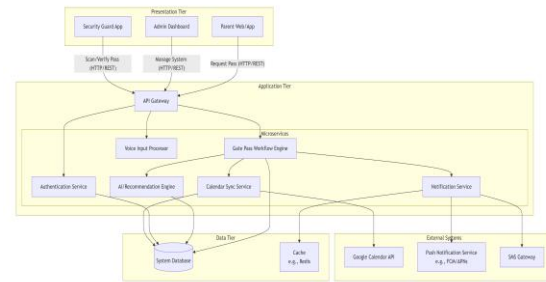


Fig. 1. Smart Gate Pass System Architecture Overview

#### B. Gate Pass Workflow

1. Users log in to the system using their credentials according to the institutional database. The role-based dashboard is logged in to the users, differentiating Students, Parents, Admin, and Security.
2. The student can submit a request for a gate pass through his dashboard with a reason and exit time. A student can request an emergency pass by clicking the emergency pass check box.
3. An instant SMS/email notification is triggered to the Parents to approve or reject the gate pass remotely.

4. The administrator can review and finalize the approval of the pass.

5. Upon approval, a unique QR code is generated which is linked to the request ID and accessible to the student in the respective dashboard.

6. Security personnel scan the QR code at exit point for verification ensuring transparent workflow.

#### C. Integration of multiple features

1. QR code Verification, ensures validity of pass via backend API calls for real-time tracking of student movement from the college premises. Implemented using python libraries where the pass is linked to the request ID generated by the student. 2. Voice Assistance, implemented on the fronted using Web Speech API where users can submit gate pass requests through speech commands.

3. Email/SMS Notifications, the system triggers email using Node Mailer and SMS using Twilio API upon successful submission of pass request from the backend. The triggered notification includes request details, approve/reject buttons promoting remote parental authorization with transparency.

4. Analytics Dashboard, Python-based machine learning models like scikit-learn, Pandas, Matplotlib are implemented in the backend to determine the peak hours, movement trends.

5. Emergency pass approval, a separate API endpoint ensures approval of gate pass instantly without parental confirmation during emergencies.

#### D. Data Analytics

All the relevant data generated from user activities is collected from the proposed system.

1. Data Collection, storing data from database tables like Gate pass Request, Approvals, Logs, and users with timestamps for every request, approval and QR Scan.

2. Data Preprocessing, cleaning of data by normalisation and scaling using Python Pandas and NumPy libraries to handle missing data.

3. Pattern Detection, using descriptive analysis, development of statistical graphs highlighting daily and weekly request trends with average approval times along with most frequent request reasons.

4. Analytics Dashboard, using Python Matplotlib library, displaying Bar charts for student request frequency, and Pie charts for reason distribution.

#### E. Security and Testing

To ensure security, the proposed system incorporates the usage of

1. Hashed Passwords.

2. JWT for authenticated API calls  
3. HTTPS protocol for encrypted Communication. System is tested by unit testing, integration testing, and usability testing to ensure reliability and performance across devices.

#### F. Deployment and Scalability

The web-based Smart Gate Pass System is deployed on a secure cloud infrastructure as it is easy to scale in the future for implementing advanced features and handle huge user traffic. Hence deployment is done for scalable and secure model development which involves containerizing, using continuous integration and continuous delivery (CI/CD).

### IV. EXPERIMENTAL SETUP

Therefore, the Smart Gate Pass System was implemented and then evaluated in a controlled experimental environment in order to test its functionality, performance, and usability for multiple user roles. The setting includes the software and hardware environments, the datasets, configurations, and test scenarios used for its validation.

#### A. Hardware configuration

Implementation and testing had been performed on the standard computing infrastructure, whose settings are as follows: Processor: Intel Core i5, 11th Gen @ 2.8 GHz

RAM: 16 GB DDR4

Storage: 512 GB SSD

Operating System: Windows 11 / Ubuntu 22.04 LTS

Network: 100 Mbps LAN / Wi-Fi connection

Mobile Device (for testing QR): An Android 13 phone with a 12 MP camera for scanning QR passes

#### B. Software Environment

The complete system was developed using a three-tier web architecture composed of:

Frontend: React.js (JavaScript, HTML5, CSS3, TailwindCSS)

Backend: Python Flask framework with RESTful APIs

Database: PostgreSQL (on localhost and also hosted on Azure PostgreSQL for cloud testing) Tools Libraries:

1. QR Codes Generation: qrcode, pyqrcode (Python)
  2. Notifications: NodeMailer (Email), Twilio (SMS)
  3. Voice input: Web Speech API
  4. Analytics: Pandas, NumPy, Matplotlib, Scikit-learn
  5. Deployment: Docker
- Version Control: GitHub

### C. Datasets

Since Smart Gate Pass System represents a customized institutional system, a synthetic dataset was created containing sample student and staff records:

Total Users: 200 - 150 students, 30 parents, 15 admins, 5 security personnel

Requests Generated: 500 gate pass requests simulated over 30 days

Request Parameters: Student ID, reason for exit, timestamp, approval status, QR code ID

The test scenarios will include normal requests, rejected requests, emergency overrides, and invalid QR scanning.

### D. Implementation and Integration

Local Development Phase: Each module, such as authentication, gate pass workflow, notifications, and analytics, is independently designed and tested in the local environment created by Flask's integrated development server and React's Node environment.

Integration Phase: Integrated REST APIs between frontend and backend; connected PostgreSQL via SQLAlchemy ORM.

Cloud Deployment Phase: The entire application was containerized with Docker and then deployed onto Azure Container Instances with SSL-enabled endpoints for access. Testing Tools: APIs were validated using Postman. Selenium and Jest were used to write tests for the frontend. Database performance was monitored using pg Admin.

E. Evaluation Metrics The system performance was gauged with respect to the following: Response Time: Average latency between submission of a request and confirmation of approval. QR Verification Speed: Less than 2 seconds for code scan and verification. System Uptime: Monitored by Azure. Usability: Feedback will be solicited from test users (students and staff). Security Testing: Role-based authentication, session management, unauthorized access prevention shall be tested.

F. Outcome This experimental setup

successfully demonstrated the end-to-end functionality of the Smart Gate Pass System, proving its efficiency, scalability, and real-time functionality. The testing environment confirmed that the system maintains fast response times, secure authentication, and reliable communication for all roles under realistic conditions within an institution.

## V. FUTURE WORK

While the Smart Gate Pass System System addresses issues related to the current pass system, there are still numerous opportunities for improvements and scalability. Future improvements will hopefully be smarter, more engaged in the institutional ecosystem, and more universally accepted.

### A. Mobile Application Integration

The next step for improving accessibility and convenience will be to build a separate" mobile application" for Android and iOS mobile devices. The application would allow students, parents, and administrators to fully operate gate passes from the application. Push notifications would be added for quick notifications, and if the campus security personnel will need to scan the QR code on the day, their mobile phone's camera could be used. The mobile application will allow users to cache data offline, so the use of the application does not need a constant internet connection to view emergency/critical information on passes if they do not have constant access to the internet.

### B. Introduce Biometric/Face ID Verification

In order to add more safety to the campus and authentication of identity, biometrics (fingerprint, face ID, etc.) will be a way to improve the safety of using QR codes.

### C. Auto-Generated Reports

In future updates, automated report generation will be added to provide a condensed overview of information relevant to the institution's leadership. Weekly and monthly reports will provide a summary of trends in student movement, exit reasons, and metrics by department. The reports will generate automatically via Python-based analytics scripts and distributed by email to administrators. The reporting dashboard will

allow for CSV and PDF document exports for maintaining records and policy evaluations.

#### D. Visitor Management Module

An extension of functional Visitor Management Module will be implemented to manage entry and exit of parents, guests, vendors, and outside visitors. Visitors will receive digital passes via QR codes, and approvals can occur via the same multi-level workflow as student approval. The log will also record history of visits and estimated duration, along with purposes of entry. Biometric verification applications and calendar scheduling options will allow for coordination efforts and improved campus security during events and busy periods.

## VI. CONCLUSION

The suggested Smart Gate Pass System presents an intelligent and secure solution for modernizing and digitizing the orthodox gate pass method used in education institutions. Smart Gate Pass System implementation of web-based role authentication and QR code verification, provides for the ability to eliminate forgery/alteration and manual reliance while improving accountability and efficiencies in tracking students' movements.

The multi-role architecture unites students, parents, administrators, and safety personnel in a single digital workflow allowing communication in real-time along with instant authorization. Multiple roles within the system benefit since parents instantaneously receive notifications to approve requests, administrators can observe the approvals, and safety personnel can perform checks utilizing QR passes at entry/exit points. The end-to-end digitization enhances speed-of-operation while providing accountability for multiple stakeholders.

Smart Gate Pass System's multi-platform operational awareness allows users to engage with the system transparently via both desktop and mobile. The system's built-in AI-empowered analytics module provides meaningful insights into movement behaviours, facilitating administrator accountability and communication, while easily alerting them of deviations from expected activity. Moreover, built-in voice recognition and screen reader inclusivity functions ensure the visually impaired platform users

can easily participate in the Smart Gate Pass System engagement process.

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