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IoT Web-Based Student Curfew Management System

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Internet of Things (IoT), Radio Frequency Identification (RFID), Curfew, Universiti Tun Hussein Onn Malaysia (UTHM).

Abstract

This project was developed to address inefficiencies and limitations associated with manual curfew enforcement at Universiti Tun Hussein Onn Malaysia (UTHM). Utilizing Radio Frequency Identification (RFID), PHP, ThingSpeak and MySQL, the system automates student entry and exit logging, real-time monitoring, violation tracking, and permit management. The development followed a structured parallel methodology, enabling concurrent progress on essential modules such as login authentication, profile management, RFID integration, and notification systems. The implemented system demonstrated significant improvements, including enhanced data accuracy, streamlined administrative processes, and real-time reporting capabilities. Feedback from initial user testing indicated positive reception regarding usability and operational efficiency. Despite these successes, limitations such as scalability concerns and the potential need for enhanced data security measures remain. Future work involves addressing these issues through optimization of database management and implementing advanced cybersecurity measures, ensuring high performance even under increased user load and data volume.

1. Introduction

The IoT Web-Based Student Curfew Management System aims to improve curfew enforcement at Universiti Tun Hussein Onn Malaysia (UTHM) by addressing significant challenges in the existing manual system. The current manual process relies heavily on extensive data entry, leading to frequent inaccuracies, delays, and limited real-time tracking of student activities, especially during curfew hours from 12 midnight to 6 am [1]. By integrating Radio Frequency Identification (RFID) technology, this system automates entry and exit logging through student matriculation card scanning, thereby enhancing accuracy and streamlining operations [2], [3]. The web-based platform provides administrators with remote, real-time monitoring capabilities, displaying student details such as matric numbers, residence, and student name, enabling swift responses to curfew breaches [4]. Additionally, the system includes a permit application module, allowing students to request curfew exemptions online, which administrators can efficiently manage. Built using Arduino UNO, ESP8266 WiFi Shield, and technologies like PHP, HTML, CSS, JavaScript, and ThingSpeak, the system comprises several key modules: login authentication, profile management, RFID-based tracking, violation management, scheduling, and notifications. Ultimately, this project aims to reduce administrative burdens, enhance compliance tracking, and significantly reinforce campus security through automation and efficient data management.

2. Related Work

This section discusses the domain background of curfew management systems in educational institutions, highlighting existing challenges and exploring key technologies such as RFID and IoT integrations. Additionally, a brief comparison with current systems is provided, identifying areas for improvement and the unique features offered by the developed IoT Web-Based Student Curfew Management System.

2.1 Domain Background

UTHM prioritizes campus safety and efficient curfew enforcement as essential components in creating a secure and supportive learning environment. Traditionally, curfew management relies on manual logging of student entries and exits by security personnel, which is labour-intensive and prone to errors, delays, and data inaccuracies. This manual approach limits real-time tracking and effective compliance monitoring. Recognizing these limitations, there is a critical need to transition to an automated system utilizing advanced technologies like RFID and IoT, which can streamline processes, enhance accuracy, and significantly improve operational efficiency and campus security.

2.2 Comparison Between Existing Systems and Proposed System

Section 2.2 explains the three existing systems that have been studied and compared with the developed system. The comparison table will outline the strengths and weaknesses of each system relative to IoT Web-Based Student Curfew Management System, highlighting how the proposed system is better suited to meet the unique demands of a university environment. Tables 1 show the comparison of the existing system and proposed system. Yes stands for the feature availability while No stands for feature is not available.

Table 1 *Comparison of the existing system and proposed system*

Features/System	UTHM Student Curfew Management [1]	IoT – UTHM Library Entry System [14]	E-Pass Management System [12]	IoT Web-Based Student Curfew Management System
Web-Based Platform	No	No	Yes	Yes
IoT Implementation	No	Yes	No	Yes
Data Recording and Accuracy	No	No	Yes	Yes
Real-Time Monitoring	Yes	No	Yes	Yes
Entry and Exit Logging	Yes	No	No	Yes
Schedule Management	No	No	No	Yes
Permit Application Management	Yes	No	Yes	Yes
Notification System	No	No	No	Yes
Violation management	No	No	No	Yes
Monitoring System	App-based	Excel-based	Web-based	Web-based

3. Methodology

The development of this system adopted the parallel development methodology due to the modular and independent nature of its components. This methodology was chosen because it allowed simultaneous progress on different parts of the system, such as the RFID-based tap-in/tap-out hardware integration and the web-based administrative platform [13]. Each module had its functionality but shared common technologies, making parallel development efficient and practical. Using this approach enabled the project to reduce development time, ensure seamless integration, and maintain consistent design standards across both hardware and software. The use of technologies such as PHP, MySQL, HTML, JavaScript, and ThingSpeak allowed for smooth coordination between components. As a result, the system was completed and tested, confirming that parallel development was suitable for achieving the project's objectives within the targeted timeframe. Figure 1 show the Software Development Life Cycle of Parallel Development Methodology.

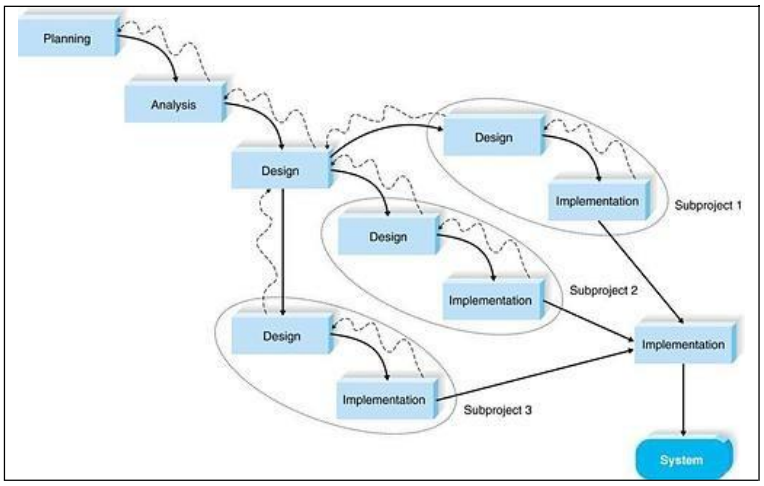


Fig. 1 *Software Development Life Cycle of Parallel Development Methodology [13]*

3.1 System Development Process

This section details the system development process for the complete IoT Web-Based Student Curfew Management System at UTHM, structured according to the parallel development methodology. Each phase of the development was designed to ensure that the project meets the needs of its stakeholders efficiently and effectively. The workflow was broken down into several key phases, each with specific tasks and outputs that contribute to the project's progression from concept to deployment, as shown in Table 2.

Table 2 *System Development Process*

Phase	Task	Ouput	Tools
Planning	Gather Project Requirements and Define System Scope	Specifications and Engagement Reports	Interview, Document Analysis
Analysis	Conduct Literature Review and Requirements Analysis	System Requirements and Gap Analysis	Research Tools, Survey Forms
Design	Create System Architecture and UI/UX Design	Design Documents and System Prototypes	Canva, Lucidchart, Draw.io
Development	Build Complete System with RFID Integration	Fully Integrated System with Core Features	PHP, MySQL, Arduino IDE, ThingSpeak
Testing	Perform System Testing and User Acceptance Testing	Test Reports and User Feedback	UAT Tools, Testing Frameworks
Deployment	Setup Production Environment and System Launch	Operational System and Server Setup	Production Server Environment
Evaluation	Evaluate System Performance and Gather User Feedback	Performance Reports and User Training	Analytics Tools, Training Materials

3.2 System Requirement Gathering

For the IoT Web-Based Student Curfew Management System, the system requirements were meticulously gathered and categorized into functional and non-functional requirements. These were developed through comprehensive discussions with key stakeholders, including UTHM Security Department personnel, university administrators, system coordinators, and students, to ensure the system comprehensively addresses the needs of all users. Table 3 shows Functional Requirements and Table 4 shows Non-Functional Requirements.

Table 3 *Functional Requirements*

No.	Module	Description
1)	User Authentication	Secure system login with role-based access for students, admins, and super admins.
2)	RFID Entry/Exit Logging	Automated tracking of student movements using RFID card scanning technology.
3)	Permit Management System	Tools for students to apply for curfew permits and administrators to approve/reject applications.
4)	Violation Tracking	Automated detection and recording of curfew violations with notification alerts.
5)	Real-time Monitoring	Live dashboard displaying current student status and movement activities.
6)	Reporting and Analytics	Comprehensive reporting capabilities for security personnel and administrators.
7)	Profile Management	User profile creation, editing, and maintenance for all system users.
8)	Notification System	Automated alerts and reminders for permit status, violations, and system updates.
9)	Schedule Management	Administrative tools for managing staff schedules and curfew time settings.
10)	Data Synchronization	Integration between RFID hardware, web platform, and cloud database systems.

Table 4 *Non-Functional Requirements*

No.	Category	Requirements
1)	Performance	Ensure fast loading times and responsive interaction.
2)	Security	Robust data protection and secure user authentication.
3)	Usability	Intuitive user interface and easy navigation.
4)	Reliability	Dependable performance with minimal downtime.
5)	Scalability	Ability to accommodate increasing numbers of users and events.

4. Analysis and Design

This section describes the comprehensive system design, including the use case diagram, system architecture, class diagram, database design, and interface design. The designs and diagrams illustrate how the system components interact to meet user requirements and ensure a functional, secure, and user-friendly solution.

4.1 System Architecture Design

Figure 2 shows the system architecture showcases a comprehensive multi-layered framework that seamlessly integrates RFID-based hardware with a dynamic web-based platform to efficiently manage student curfews. The process begins when students scan their RFID cards at the main gate using RFID-RC522 readers, which are connected to Arduino microcontrollers. These devices capture critical data such as student identification and timestamps, which are then transmitted to the ThingSpeak IoT platform for real-time monitoring and analysis. This data is subsequently stored in a centralized MySQL database, serving as the primary repository for student profiles, entry and exit logs, permit applications, and violation records. The system's web application, built using PHP, provides user-friendly, role-based access where students can view and update their profiles, apply for permits, and check application statuses. Staff members have tools to register students, issue violations, manage schedules, and generate analytical reports. Administrators are responsible for configuring system settings, reviewing and approving permits, assigning staff duties, and maintaining overall system operations. The architecture ensures smooth and synchronized communication between hardware events and web interface updates, enabling real-time data accuracy and responsiveness. Designed with modular components, the system supports future scalability and enhancement while ensuring secure, consistent data transmission across all layers of operation.

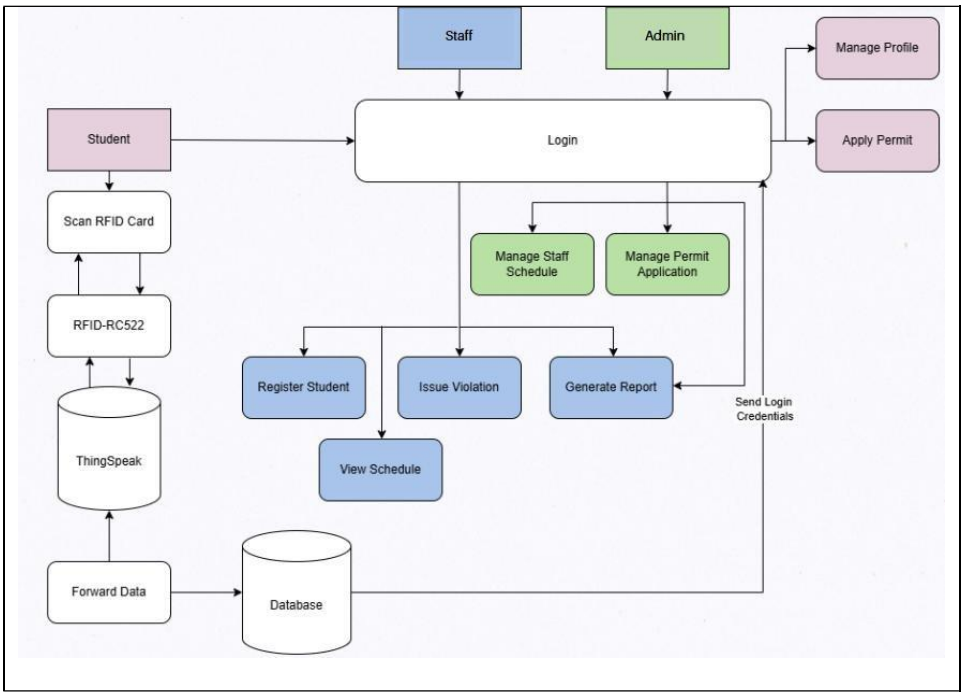


Fig. 2 *System Architecture Diagram*

4.2 Class Diagram

The class diagram in figure 3 illustrates the structural design and relationships among the core entities in the IoT Web-Based Student Curfew Management System. At the center, the Schedule class manages scheduling information, including schedule ID, name, date, and time ranges. It connects with both Staff and Shift_Types, enabling the assignment of staff members to specific duty periods. The Students class stores essential student information such as ID, name, contact details, residential status, and RFID card linkage. It supports login functionality, permit application, profile updates, and status checks, and is directly associated with RFID scans, permits, and violations. The Staff class is responsible for day-to-day administrative functions, including student registration, violation issuance, report generation, and schedule viewing. The Users class governs login credentials and roles for all user types, including admins and staff, with role-based access control.

The Admin role (represented through the Users class with an admin role type) has elevated privileges to manage system-wide settings, approve or reject permit applications, and oversee staff scheduling. Hardware interactions are captured through the RFID_Cards, RFID_Scans, and RFID_Readers classes, which work together to log RFID events with accurate timestamps and reader locations, and link them to the correct student records. The Permits class facilitates curfew exemption processes, storing reasons, supporting documents, approval status, and timestamps. The Violations class tracks rule infractions and manages details such as violation type, status, penalties, and issuer information. Supporting synchronization between the system and the IoT platform, ThingSpeak_Sync_Logs records communication logs, while ThingSpeak_Config and ThingSpeak_Field_Mapping handle configuration and data mapping. Together, these classes establish a robust and scalable framework that integrates physical RFID scanning with real-time web-based curfew monitoring and administrative management.

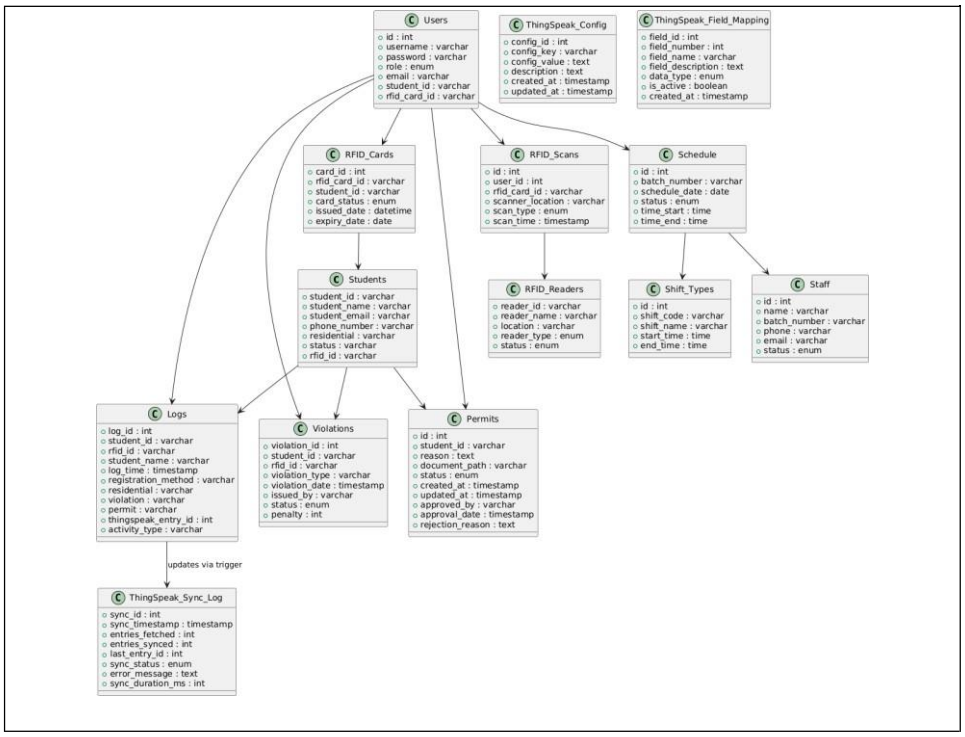


Fig. 3 *Class Diagram*

4.3 Use Case Diagram

The use case diagram in figure 4 illustrates the core functionalities of the IoT Web-Based Student Curfew Management System and the interactions of its three primary user roles: Student, Staff, and Admin. Students interact with the system to perform essential actions such as logging in, managing their profiles, submitting permit applications, and viewing their curfew entry and exit logs. Staff members are responsible for reviewing permit applications, issuing curfew violations, generating reports, and managing their assigned schedules. Admins hold the highest level of access, overseeing the overall system operations. Their responsibilities include assigning staff schedules, adding new student records, generating analytical reports, issuing violations, and managing all submitted permit requests. Each actor's access is defined based on their role, ensuring proper authorization and streamlined task execution. This use case diagram serves as a high-level representation of system functionality, clearly defining how each user interacts with various system features, and provides a foundation for further system design and development.

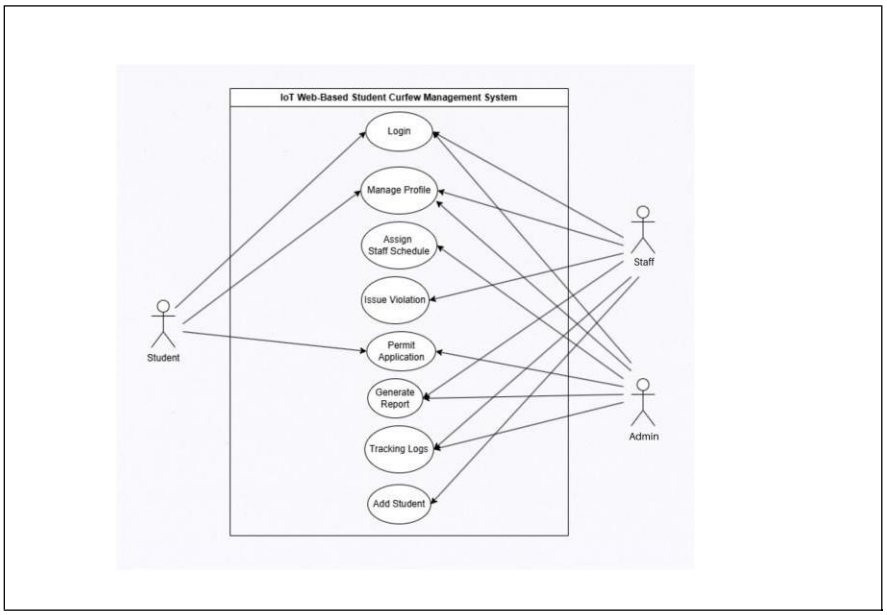
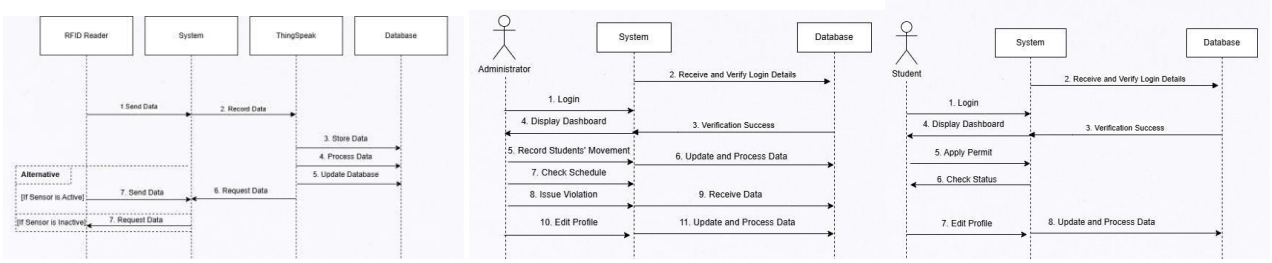


Fig. 4 *Use Case Diagram*

4.4 Sequence Diagram

A sequence diagram in figure 5 illustrates the flow of interactions and messages between components in the IoT Web-Based Student Curfew Management System using RFID technology. The process begins with the RFID reader capturing data when a student scans their matric card, which is then sent to the system for recording and forwarded to the database for storage. The database processes the data to verify compliance with curfew rules and updates its records accordingly. This real-time interaction between the RFID reader, system, database, and administrative components ensures accurate and up-to-date logs of student movements. The sequence diagram visually represents these processes, highlighting the system's efficiency and reliability in managing curfew enforcement.



(a) **(b)** **(c)**

Fig. 5 *Sequence Diagram*

(a) Overall system (b) Administrator Perspective (c) Student Perspective

4.5 Activity Diagram

The activity diagram outlines the workflow of the RFID-based curfew management system, starting with students scanning their RFID cards at the main gate. Once the ID is detected, the system verifies the student's permit status. If a valid permit is present, the system emits a green light and a short beep, granting approval. Conversely, if the permit is invalid, a red light and a long beep are triggered to indicate a violation. The system then records the data to cloud storage for future monitoring and displays the student's personal details for verification. This process ensures accurate, real-time logging and enhances security by automating compliance checks and providing immediate feedback on curfew status. The activity diagram is provided in Appendix B.

4.6 Database Design

Figure 6 shows the entity-relationship diagram (ERD) that provides a comprehensive overview of the data structure and interrelationships within the IoT Web-Based Student Curfew Management System. It visually outlines how key entities interact to support functions such as student monitoring, permit processing, schedule management, and violation tracking. The core entities include Users, Students, RFID_Cards, RFID_Scans, RFID_Readers, Permits, Violations, Logs, Schedule, and Staff. The system begins with students scanning RFID cards, where RFID_Cards are assigned to individual students and managed through the RFID_Scans entity, which records scan time, type, and location. These scans are linked to specific users and stored in the Logs entity for tracking entry and exit activities. Students may submit permit applications stored in the Permits entity, while any curfew violations are recorded in the Violations entity, with information about the violation type, issuer, and timestamp. Schedules are managed through the Schedule entity, which connects to Staff and references Shift_Types for defining duty periods. The Users entity holds login credentials and role definitions, enabling role-based access for students, staff, and administrators. Integration with the ThingSpeak IoT platform is managed through the ThingSpeak_Config, ThingSpeak_Field_Mapping, and ThingSpeak_Sync_Log entities, ensuring real-time synchronization of scan data with the system database. Overall, the ERD illustrates the structured flow of information and responsibilities within the system, enabling accurate curfew enforcement, data logging, and administrative control through clearly defined relationships and database normalization.

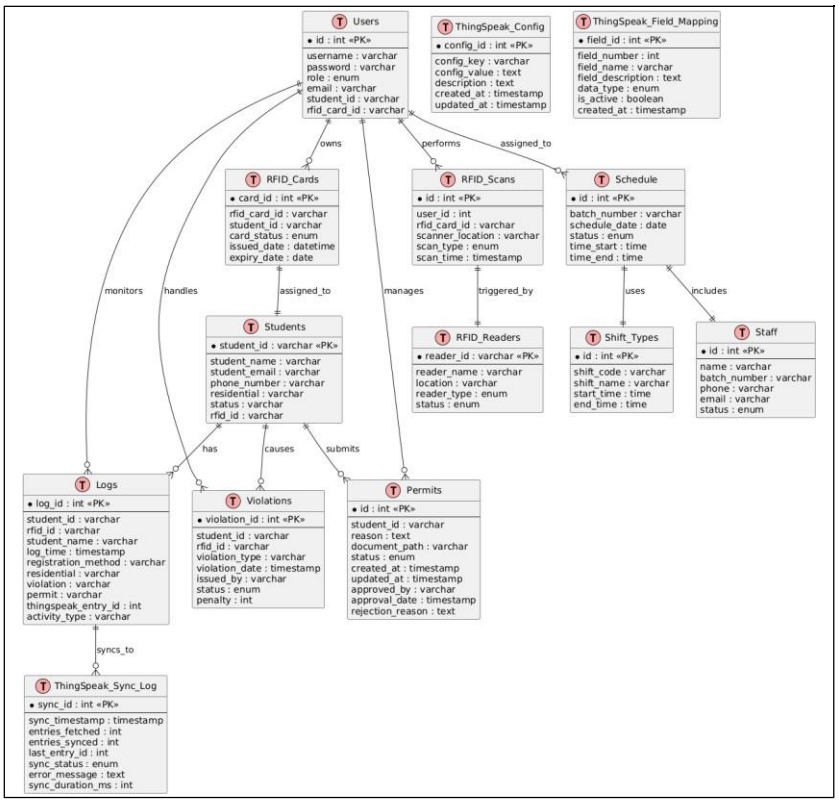


Fig. 6 *Entity-Relationship Diagram (ERD)*

4.7 System Interface

The interface design focuses on providing a user-friendly experience for all system users with role-based access and streamlined functionality. The design incorporates responsive layouts and intuitive navigation to enhance accessibility and usability. Key interfaces include:

- Admin Dashboard Interface: Provides comprehensive system overview with total student count, real-time monitoring capabilities, and quick access to administrative functions.
- Student Permit Application Interface: Enables students to submit curfew permit requests and view application status (Approved/Pending) through an intuitive form and status tracking system.
- Admin Permit Management Interface: Allows administrators to review, approve, or reject student permit applications with dropdown status updates and detailed permit information display.
- Staff Schedule Interface: Displays security staff scheduling with time slots, duty assignments, and date ranges for effective workforce management during curfew hours.
- Student Registration Interface: Facilitates student enrollment with personal details, matriculation numbers, and contact information, including update, remove, and check-in/out monitoring capabilities.
- Staff Violation Interface: Enables documentation and tracking of curfew violations with student information, violation types, timestamps, and additional notes for comprehensive violation management.

Figure 7-12 shows all interface design for Admin Dashboard, Permit Management, Staff Schedule, Student Registration and Staff Violation.

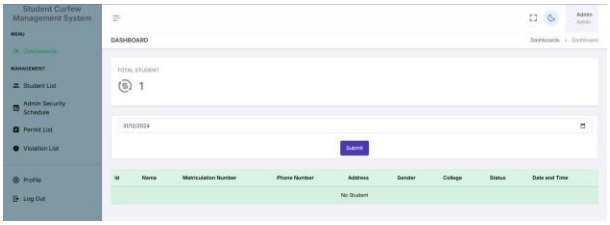


Fig. 7 *Admin Dashboard*

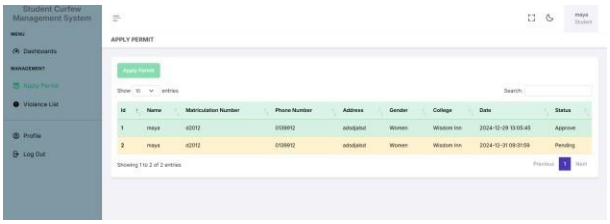


Fig. 8 *Student Permit Application*

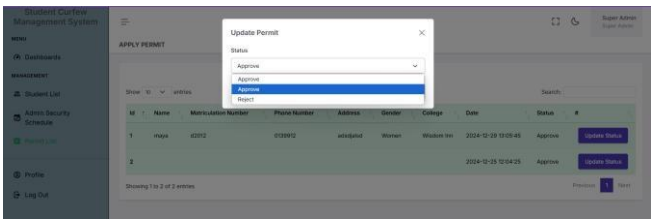


Fig. 9 *Super Admin Permit Management*

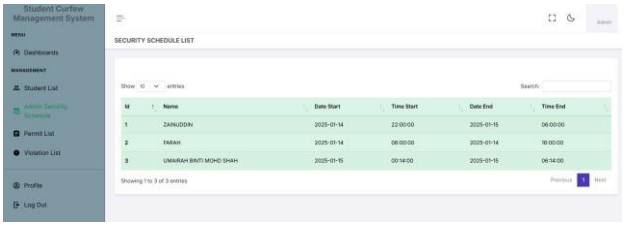


Fig. 10 *Staff Schedule Interface*

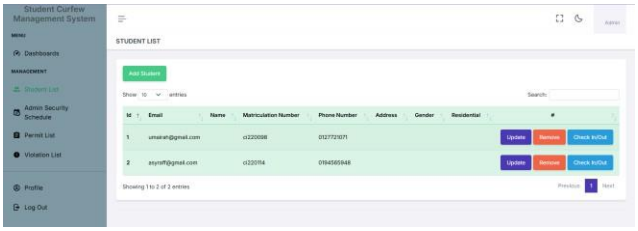


Fig. 11 *Student Registration Interface*

Fig. 12 *Staff Violation Interface*

5. Implementation and Testing

This section outlines the implementation and testing of the IoT Web-Based Student Curfew Management System. These phases play a vital role in the system development process, as they help determine whether the system's features meet user requirements. Ensuring a smooth system flow is also important so that all modules developed during the design and analysis stages operate efficiently. To verify that the system functions as expected, the IoT Web-Based Student Curfew Management System is thoroughly developed and tested in this phase.

5.1 Implementation Phase

Figure 13 presents the prototype of the IoT Web-Based Student Curfew Management System positioned for entry/exit monitoring simulation. The RFID-RC522 module is strategically positioned to capture student matriculation card data when scanned at campus gates. The system utilizes an Arduino UNO microcontroller connected to various components including LED indicators for visual feedback, a buzzer for audio alerts, and an LCD display for showing student information. The hardware setup demonstrates the integration of RFID technology with real-time processing capabilities, where the Arduino collects scanning data and transmits it wirelessly through the ESP8266 WiFi module to ThingSpeak for cloud processing. The system is designed to provide immediate feedback through LED status indicators and buzzer alerts while simultaneously logging all entry/exit activities to the centralized database, enabling administrators to monitor student compliance with curfew regulations in real-time and ensure campus security.

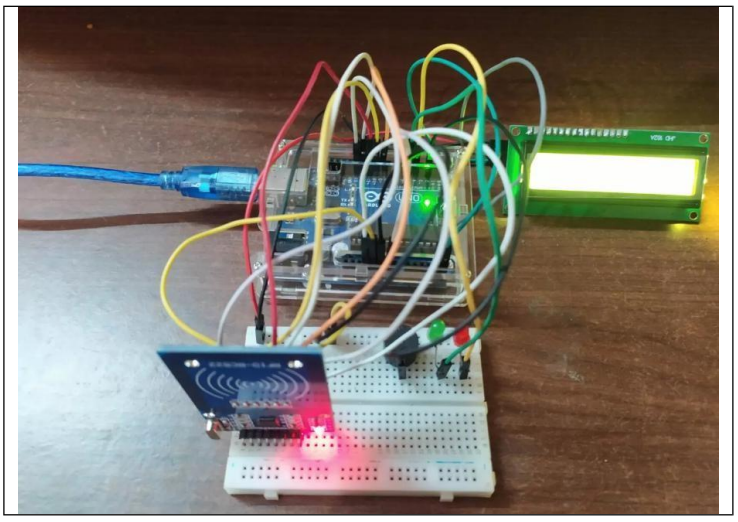


Fig. 13 *Wiring Diagram*

The login page of this system in figure 14 serves as the primary access point for all user roles, including students, staff, and administrators. This page authenticates users by requiring a valid username and password, ensuring that only authorized individuals can access system functionalities. Once authenticated, users are redirected to their respective dashboards, where features are tailored based on their role. For instance, students can view their activity logs and submit permit applications, staff can manage student records and issue violations, while administrators have full control over schedules, permit approvals, and system reports. The login system also includes a "Forgot password?" feature that allows users to recover their credentials through a secure process. Additionally, SSL encryption is implemented to protect user data during transmission, reinforcing the system's commitment to secure and confidential access. This login mechanism ensures a controlled and role-based workflow across all modules of the system.

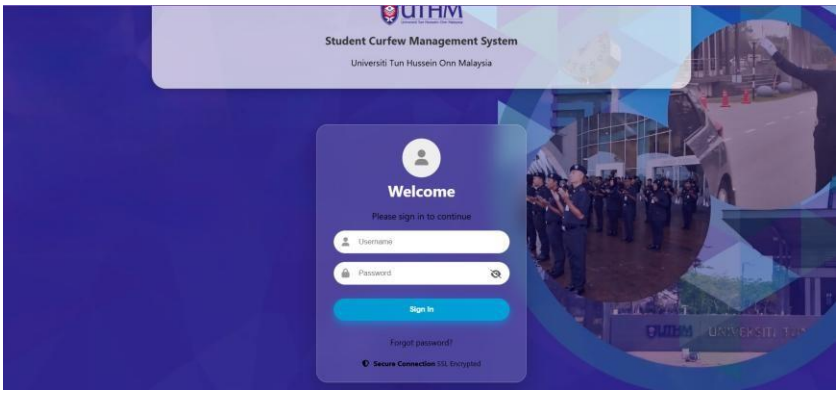
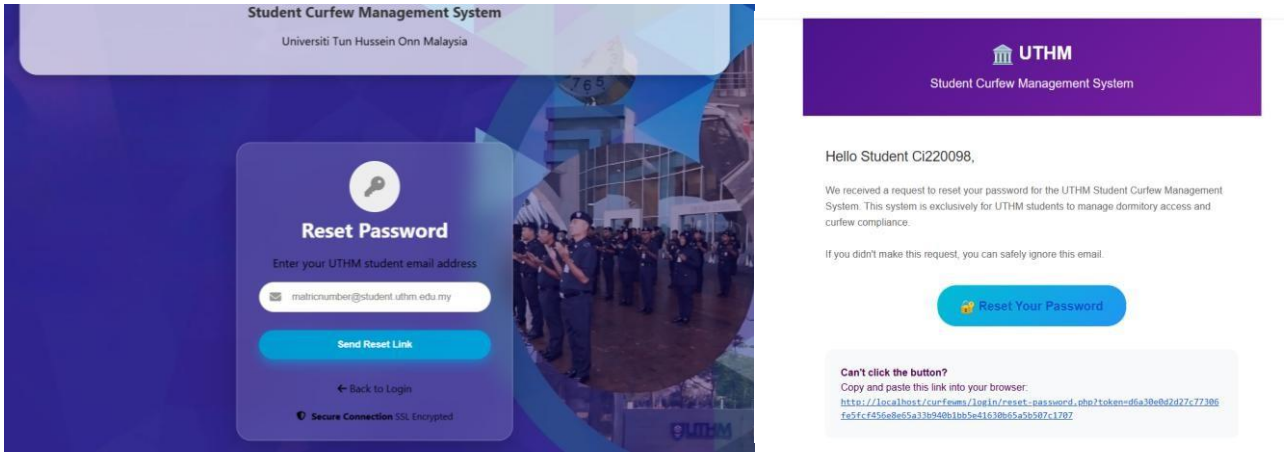


Fig. 14 *login page*

Figure 15 shows that the password recovery feature ensures that users who have forgotten their login credentials can securely regain access to the IoT Web-Based Student Curfew Management System. The process begins on the "Reset Password" page, where users are prompted to enter their official UTHM student email address in the format "matricnumber@student.uthm.edu.my". Once submitted, the system generates a secure reset link and sends it to the user's email. A "Back to Login" option is available for convenient navigation, and SSL encryption is applied to all password recovery requests to maintain security and privacy.

The next step in the process is illustrated through the system-generated email, which is automatically sent to the user upon requesting a password reset, like in figure 15. This email identifies the recipient using their matric number (e.g., CI220098) and confirms that a password reset was initiated for the Student Curfew Management System. The email includes a direct "Reset Your Password" button to guide users to the password reset page. For added reliability, it also provides a fallback URL that users can copy and paste into their browser if the button fails to function due to email client limitations. This comprehensive recovery process ensures accessibility, data protection, and a seamless user experience for all authorized system users.

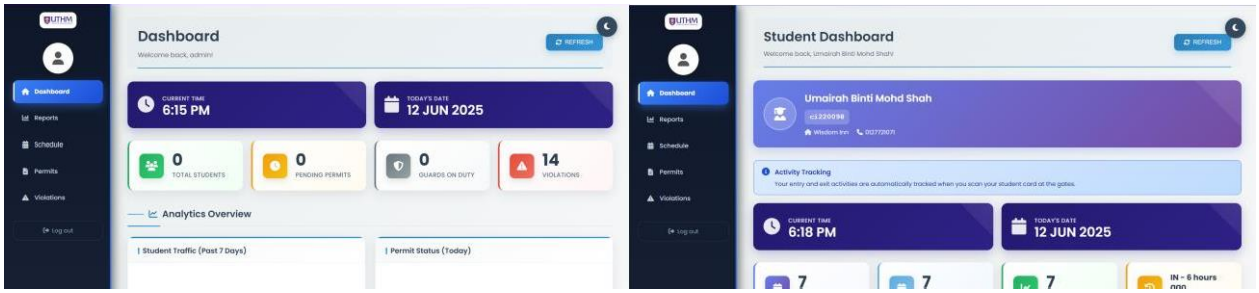


(a) (b)

Fig. 15 *Login Interface (a) reset password; (b) reset password notification*

Figure 16 shows the dashboard interfaces of this system provide tailored access and functionalities based on user roles. The Admin Dashboard delivers a centralized view for administrators to monitor system activity in real time. It includes a welcome message, displays the current time and date, and presents critical status indicators such as the total number of students, pending permit requests, guards currently on duty, and recorded violations. These metrics are shown using color-coded cards for quick reference. An "Analytics Overview" section enhances administrative decision-making by visualizing data trends through charts, including student movement patterns over the past week, and permit status updates for the current day.

The Student Dashboard offers a personalized interface where each student can view their profile details, including their matric number, residential college, and contact information. The system also provides an activity tracking notice, informing students that their entry and exit logs are automatically recorded through RFID scans at the campus gates. The dashboard includes real-time displays of the current time and date, along with summary cards showing entry frequency, duration inside campus, and other relevant statistics. This setup allows students to monitor their curfew compliance and access patterns, promoting awareness and accountability. Both dashboards are designed to support smooth system navigation and ensure that users receive information relevant to their responsibilities and privileges within the system.



(a) (b)

Fig. 16 *Dashboard (a) Admin/Staff; (b) Student*

The Student Registration modal in figure 17 facilitates manual registration for students who are unable to present their matriculation cards during entry or exit. A prominently displayed notice informs administrators that this method will generate a violation record and synchronize the data with ThingSpeak. This feature is intended for exceptional cases such as forgotten or lost cards, ensuring that access is still recorded without compromising system integrity. The form requires two key inputs: the Student ID, where the administrator enters the student's identification number (e.g., DK220001), and the RFID ID, which is used to associate the manual entry with the student's registered RFID information. Upon submission via the "Register & Sync" button, the system records the student's entry or exit in the local database and simultaneously updates the ThingSpeak IoT platform. A violation is automatically issued to indicate non-compliance with the standard RFID scanning procedure. This process ensures that all student movements are consistently tracked, whether via automatic or manual methods. It supports accountability by discouraging repeated non-compliance, while still allowing flexibility for legitimate situations where students may not have their cards. This maintains the system's balance between enforcement of curfew policies and consideration for student welfare.

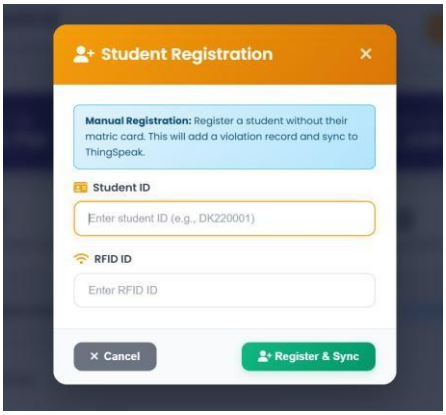
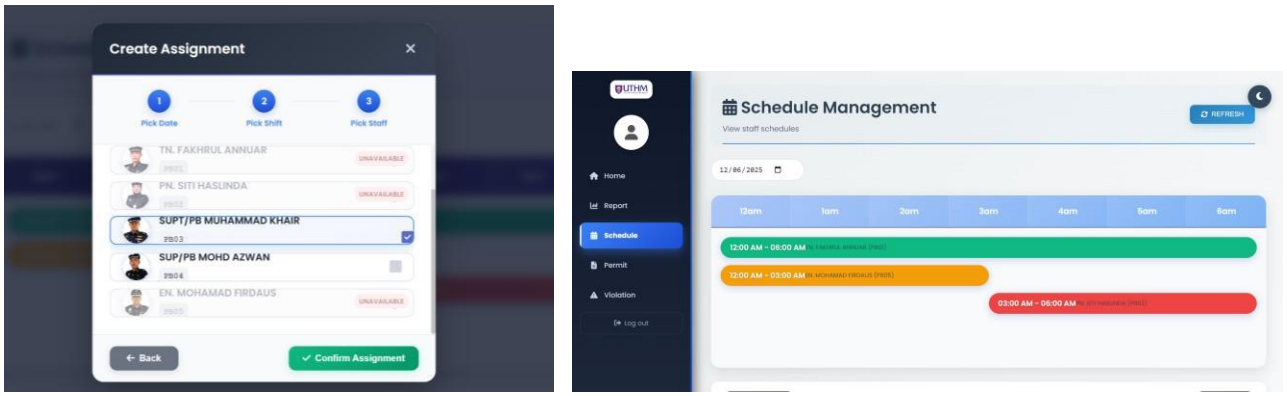


Fig. 17 *Student registration*

The schedule management module in figure 18 streamlines the process of assigning staff to curfew shifts through a structured three-step interface: selecting a date, choosing a shift, and assigning available staff. The system clearly displays real-time availability, allowing administrators to make quick and informed decisions. Profile photos, names, and statuses help verify selections, and the process can be easily confirmed or adjusted using navigation controls. Once assignments are made, the Schedule Management view presents all staff schedules using a visual timeline. Color-coded shift blocks help administrators and staff identify duty periods, overlaps, and gaps briefly. The date selector enables quick access to any scheduled day, improving planning and coordination. This feature ensures that security personnel are effectively scheduled to maintain campus safety during curfew hours, while providing staff with clear visibility of their assigned responsibilities.



(a) (b)

Fig. 18 *Dashboard(a) Admin/Staff; (b) Student*

Figure 19 shows that the Reports & Analytics module delivers detailed insights and statistical analysis tailored to each user role in the curfew management system. Users can select a specific date using the calendar picker and generate reports using the "VIEW REPORT" button, enabling flexible access to daily summaries and trends for administrative monitoring or personal review. The Daily Summary provides a quick overview of curfew activity, highlighting key indicators such as total entries and exits, the number of students with permits, and those without. These metrics help administrators assess compliance levels and monitor enforcement effectiveness. The Data Visualization section presents trends and distributions through charts that support deeper analysis, including entry/exit activity and permit usage patterns. Administrators and staff have access to system-wide reports, allowing them to monitor campus-wide statistics, analyse permit and violation data, and print reports for documentation or security audits. Students, on the other hand, are granted access only to their personal records. They can view and download reports showing their entry/exit logs, permit history, and any violations issued. This role-based access ensures data privacy while promoting accountability and transparency for all users.

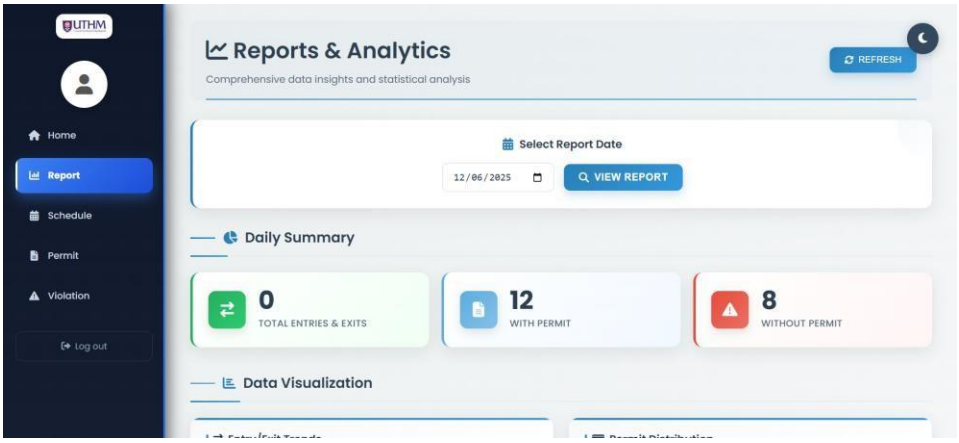
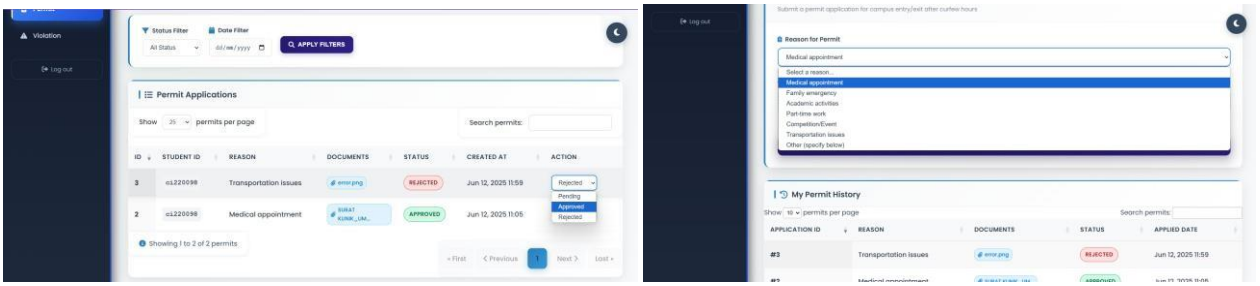


Fig. 19 *Report and Analytic*

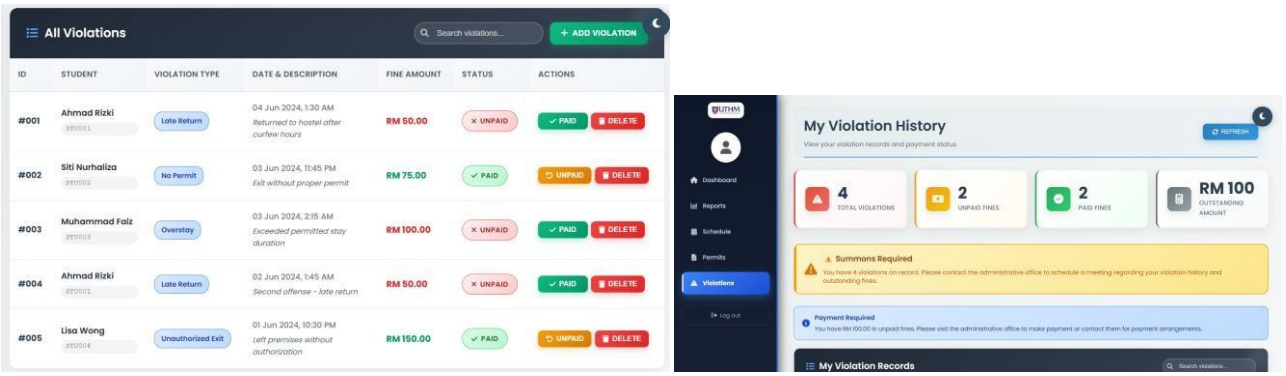
The permit management system in figure 20 facilitates a structured and transparent workflow for handling curfew exemption requests between students and administrators. The admin interface presents all permit applications in a tabular format with filter options by status and date, allowing administrators to narrow down results for efficient review. Each application record includes student details, reason for the request, attached documents, status, and timestamps. Administrators can review uploaded documents and update application statuses via an action menu offering options such as "Pending," "Approved," and "Rejected." This ensures a controlled and traceable decision-making process. On the student side, the permit application form includes a dropdown list of standardized reasons such as medical appointments, family emergencies, academic activities, part-time work, and others. Students can upload supporting documents and submit their requests for consideration. All past applications are displayed in the "My Permit History" section, which logs the reason, document, status, and application date. This promotes transparency, enabling students to track the progress and outcome of their submissions while maintaining a complete record of their curfew exemption history.



(a) (b)

Fig. 20 *Permit Management (a) Admin; (b) Student*

Figure 21 shows that the violation management system allows effective tracking and handling of curfew-related offenses for administrators and students. The "All Violations" page gives administrators an overview of recorded violations, including student details, violation type, date and time, fine amount, and payment status. Common violation types include "Late Return," "No Permit," "Overstay," and "Unauthorized Exit." Admins can update payment status, delete records, and use filters or search to manage entries efficiently. The admin dashboard also highlights key statistics, such as total violations, paid and unpaid fines, and students with multiple offenses. Repeat offenders are flagged for further action through the "Students with Summons" section, showing unpaid fines and recent violation history. Students can view their violations through the "My Violation History" page, which shows total infractions, payment status, and outstanding amounts. Notifications alert students when action is required, such as paying fines or attending a meeting. A searchable history helps students stay informed and accountable for their curfew compliance.



(a) (b)

Fig. 21 *Permit Management (a) Admin; (b) Student*

5.2 System Testing

To ensure that the system functions well and has no significant issues, it has to complete proper evaluation before being made available for usage. Therefore, to ensure that the system operates as intended, this stage is important. A thorough test strategy and User Acceptance Testing (UAT) were used to test the system in order to verify this.

5.2.1 Test Plan

The purpose of this test plan is to ensure that the system functions as expected. All parts of the system have undergone testing to ensure that it performs as wanted. Testing ensures that the system is ready for usage and helps identify any issues. Table 5-14 shows all test plan for all the modules.

Table 5 *User Authentication Module*

Test	Expected Results	Actual Result
Student login	Student can log in successfully with valid credentials	Pass
Staff login	Staff can log in successfully with valid credentials	Pass
Admin login	Admin can log in successfully with valid credentials	Pass
Password reset request	Reset link sent to registered email successfully	Pass
Role-based access control	Users access appropriate interfaces based on their roles	Pass

Table 6 *RFID Entry/Exit Logging Module*

Test	Expected Results	Actual Result
RFID card scanning	System reads student matriculation card successfully	Pass
Entry/exit data recording	Scanning events logged with timestamp and student ID	Pass
Manual registration	Staff can register students without cards and create violation	Pass
LED and buzzer feedback	Visual and audio indicators work for valid/invalid scans	Pass

Table 7 *Permit Management System Module*

Test	Expected Results	Actual Result
Student permit application	Students can submit permit requests with reasons and documents	Pass
Admin permit approval	Administrators can approve permit applications	Pass
Admin permit rejection	Administrators can reject permit applications	Pass
Permit status tracking	Students can view their permit application status and history	Pass

Table 8 *Violation Tracking Module*

Test	Expected Results	Actual Result
Automatic violation creation	System creates violations for curfew breaches	Pass
Payment status management	Admin can mark violations as paid or unpaid	Pass
Violation deletion	Admin can delete violation records	Pass
Student violation history	Students can view their personal violation records	Pass
Summons generation	System identifies students requiring disciplinary action	Pass

Table 9 *Real-time Monitoring Module*

Test	Expected Results	Actual Result
Live dashboard updates	System statistics update in real-time	Pass
Current system status	Dashboard displays accurate current student counts	Pass
Entry/exit activity tracking	Real-time display of student movements	Pass

Table 10 *Reporting and Analytics Module*

Test	Expected Results	Actual Result
Daily summary generation	System generates accurate daily reports	Pass
Data visualization	Charts and graphs display correctly	Pass
Role-based report access	Users see appropriate data based on their access level	Pass
Date-filtered reports	Reports can be generated for specific date ranges	Pass

Table 11 *Profile Management Module*

Test	Expected Results	Actual Result
Profile information editing	Users can update their profile information	Pass

Table 12 *Notification System Module*

Test	Expected Results	Actual Result
Email password reset	Password reset emails sent successfully	Pass

Table 13 *Schedule Management Module*

Test	Expected Results	Actual Result
Staff assignment creation	Admin can create duty assignments using 3-step process	Pass
Schedule visualization	Staff schedules displayed in timeline format	Pass
Availability checking	System shows staff availability status	Pass
Schedule viewing by staff	Staff can view their assigned schedules	Pass

Table 14 *Data Synchronization Module*

Test	Expected Results	Actual Result
ThingSpeak integration	RFID data successfully transmitted to ThingSpeak	Pass
Database synchronization	Data consistency maintained between systems	Pass
Real-time data updates	Changes reflected across all system components	Pass

5.2.2 User Acceptance Testing (UAT)

The aim of User Acceptance Testing (UAT) was to determine that the system was functional to the requirements of the users and that it performed well under real life conditions, particularly within a restaurant setting. The system was tested with real users to assess the functionality, the ease of use as well as the performance. The users also gave their feedback which indicated that the system was realistic, convenient, and functional as anticipated. The results of the UAT, presented in Table 15 and Figure 22, provide a clear overview of the system's performance and indicate that it sufficiently meets user requirements.

5.2.3 Result

The user acceptance test results show that most users were satisfied with the system's features and design. Key functions such as login, RFID logging, permit handling, and schedule management received high scores. The interface was also rated positively for being easy to use and visually clear. However, a few areas like the notification system and violation management had slightly lower ratings, suggesting room for improvement. Overall, the system was well received and considered effective for curfew monitoring and management.

Table 15 *Result of User Acceptance Testing*

No	Acceptance Requirement	Actual Result (Ranking)				
		1	2	3	4	5
User Interface						
I	Easy to understand				✓	
II	Navigation				✓	
III	Interface (e.g., color, background, font)					✓
System Function						
IV	Login/Registration function				✓	
V	RFID entry/exit logging capabilities				✓	
VI	Permit application and approval process				✓	
VII	Violation tracking and management functionalities				✓	
VIII	Real-time monitoring features				✓	
IX	Schedule management capabilities					✓
X	Report generation and analytics features				✓	
XI	Notification system effectiveness				✓	
XII	Admin panel interface for managing student accounts and curfew enforcement				✓	
XIII	Dashboard effectiveness in providing real-time updates and insights					✓

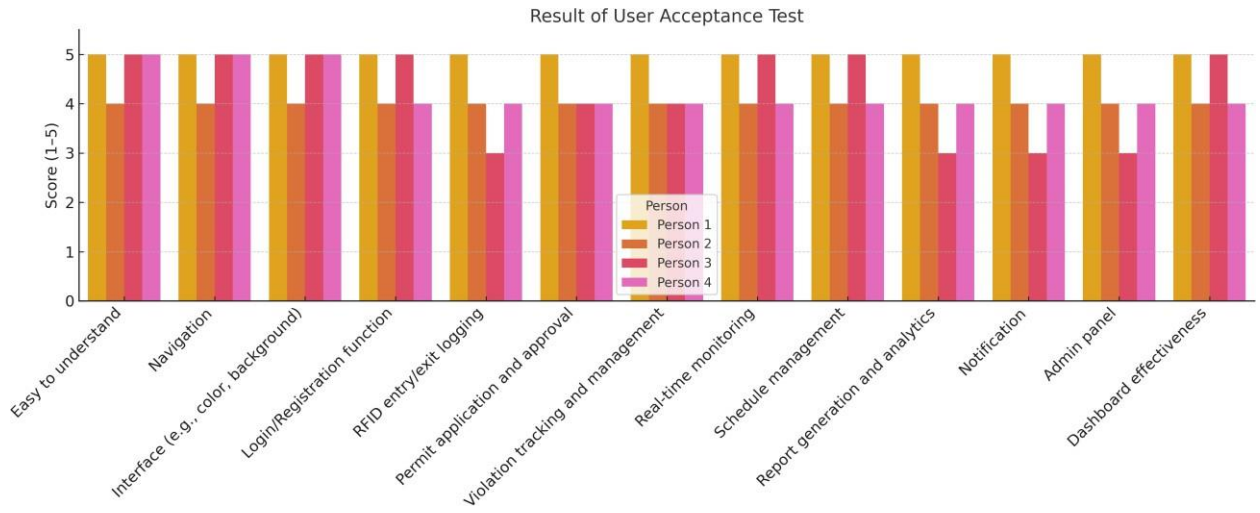


Fig 22 *Result of User Acceptance Testing*

6. Conclusion

The IoT Web-Based Student Curfew Management System has successfully demonstrated its ability to automate curfew tracking and management by integrating RFID card scanning, real-time monitoring, and web-based administrative control. The system improves accuracy in student movement records, streamlines permit and violation handling, and enhances coordination among staff and administrators. However, the system does have several limitations. It relies heavily on a stable internet connection and continuous operation of the ThingSpeak IoT platform, which may affect real-time synchronization during network outages. Additionally, the system currently supports only one type of RFID hardware, limiting hardware flexibility. The lack of biometric or facial recognition as a secondary verification method may also pose risks in cases of lost or shared RFID cards. Furthermore, reporting functions are limited to basic visualizations and do not yet support advanced analytics or predictive insights.

For future work, the system can be improved by expanding compatibility with other RFID modules or IoT platforms, incorporating biometric authentication for higher security, and enhancing the analytics module with advanced data processing tools. Integration with mobile applications could also provide students with real-time notifications and permit status updates. Finally, implementing multi-language support and accessibility features would help broaden the system's usability across a more diverse user base. These enhancements aim to strengthen the system's reliability, scalability, and user experience in future deployments.

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Conflict of Interest

Authors declare that there is no conflict of interests regarding the publication of the paper.

Author Contribution

This journal requires that all authors take public responsibility for the content of the work submitted for review. The contributions of all authors must be described in the following manner:

The authors confirm contribution to the paper as follows: ***study conception and design:*** *Umairah Mohd Shah, Nayef Abdulwahab Mohammed Alduais;* ***data collection:*** *Umairah Mohd Shah;* ***analysis and interpretation of results:*** *Umairah Mohd Shah, Nayef Abdulwahab Mohammed Alduais;* ***draft manuscript preparation:*** *Umairah Mohd Shah, Nayef Abdulwahab Mohammed Alduais. All authors reviewed the results and approved the final version of the manuscript.*

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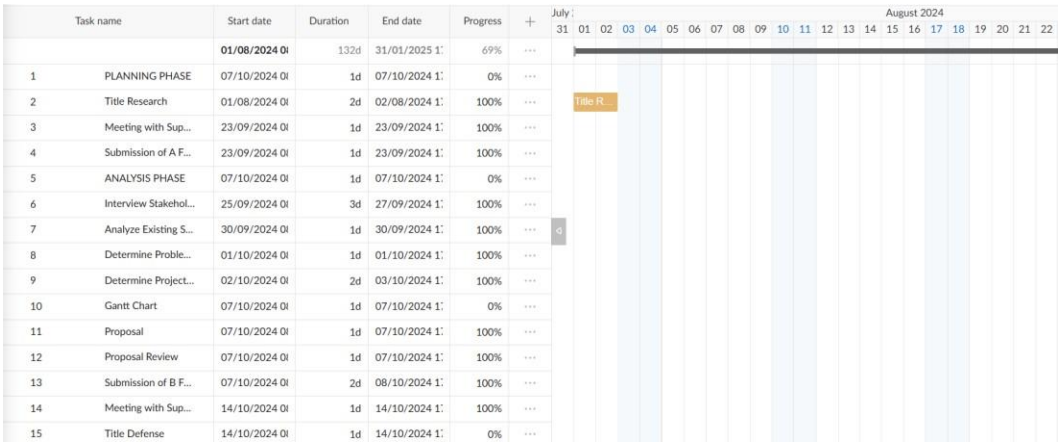
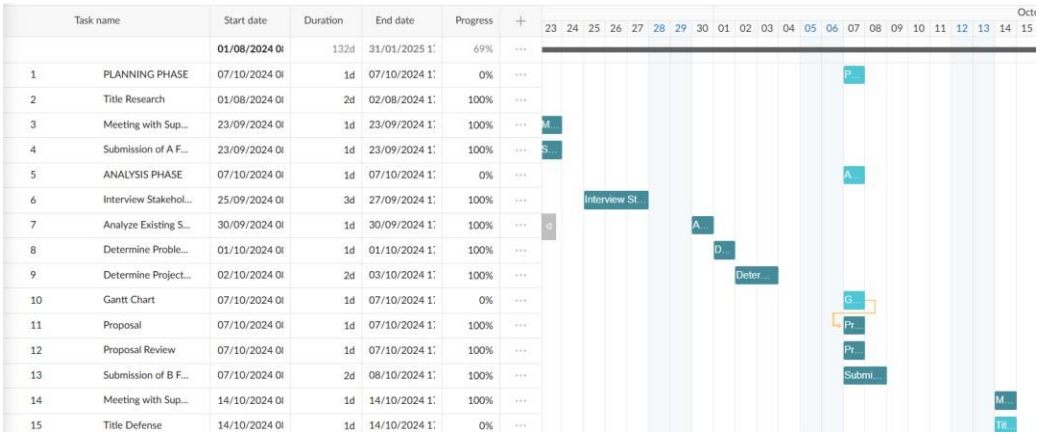
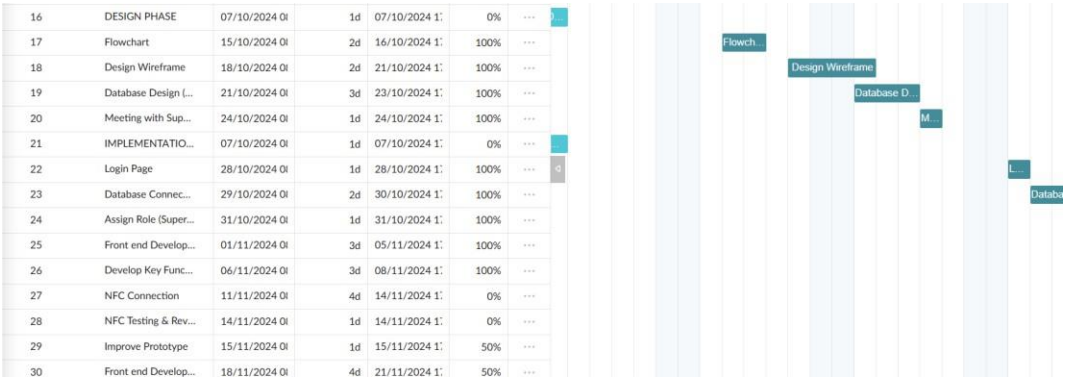
Appendix A: Gantt Chart



	Task name	Start date	Duration	End date	Progress
		01/08/2024 0	132d	31/01/2025 1	69%
1	PLANNING PHASE	07/10/2024 0	1d	07/10/2024 1	0%
2	Title Research	01/08/2024 0	2d	02/08/2024 1	100%
3	Meeting with Sup...	23/09/2024 0	1d	23/09/2024 1	100%
4	Submission of A F...	23/09/2024 0	1d	23/09/2024 1	100%
5	ANALYSIS PHASE	07/10/2024 0	1d	07/10/2024 1	0%
6	Interview Stakehol...	25/09/2024 0	3d	27/09/2024 1	100%
7	Analyze Existing S...	30/09/2024 0	1d	30/09/2024 1	100%
8	Determine Proble...	01/10/2024 0	1d	01/10/2024 1	100%
9	Determine Project...	02/10/2024 0	2d	03/10/2024 1	100%
10	Gantt Chart	07/10/2024 0	1d	07/10/2024 1	0%
11	Proposal	07/10/2024 0	1d	07/10/2024 1	100%
12	Proposal Review	07/10/2024 0	1d	07/10/2024 1	100%
13	Submission of B F...	07/10/2024 0	2d	08/10/2024 1	100%
14	Meeting with Sup...	14/10/2024 0	1d	14/10/2024 1	100%
15	Title Defense	14/10/2024 0	1d	14/10/2024 1	0%



	Task name	Start date	Duration	End date	Progress
		01/08/2024 0	132d	31/01/2025 1	69%
1	PLANNING PHASE	07/10/2024 0	1d	07/10/2024 1	0%
2	Title Research	01/08/2024 0	2d	02/08/2024 1	100%
3	Meeting with Sup...	23/09/2024 0	1d	23/09/2024 1	100%
4	Submission of A F...	23/09/2024 0	1d	23/09/2024 1	100%
5	ANALYSIS PHASE	07/10/2024 0	1d	07/10/2024 1	0%
6	Interview Stakehol...	25/09/2024 0	3d	27/09/2024 1	100%
7	Analyze Existing S...	30/09/2024 0	1d	30/09/2024 1	100%
8	Determine Proble...	01/10/2024 0	1d	01/10/2024 1	100%
9	Determine Project...	02/10/2024 0	2d	03/10/2024 1	100%
10	Gantt Chart	07/10/2024 0	1d	07/10/2024 1	0%
11	Proposal	07/10/2024 0	1d	07/10/2024 1	100%
12	Proposal Review	07/10/2024 0	1d	07/10/2024 1	100%
13	Submission of B F...	07/10/2024 0	2d	08/10/2024 1	100%
14	Meeting with Sup...	14/10/2024 0	1d	14/10/2024 1	100%
15	Title Defense	14/10/2024 0	1d	14/10/2024 1	0%



	Task name	Start date	Duration	End date	Progress
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17	Flowchart	15/10/2024 0	2d	16/10/2024 1	100%
18	Design Wireframe	18/10/2024 0	2d	21/10/2024 1	100%
19	Database Design (...	21/10/2024 0	3d	23/10/2024 1	100%
20	Meeting with Sup...	24/10/2024 0	1d	24/10/2024 1	100%
21	IMPLEMENTATIO...	07/10/2024 0	1d	07/10/2024 1	0%
22	Login Page	28/10/2024 0	1d	28/10/2024 1	100%
23	Database Connec...	29/10/2024 0	2d	30/10/2024 1	100%
24	Assign Role (Super...	31/10/2024 0	1d	31/10/2024 1	100%
25	Front end Develop...	01/11/2024 0	3d	05/11/2024 1	100%
26	Develop Key Func...	06/11/2024 0	3d	08/11/2024 1	100%
27	NFC Connection	11/11/2024 0	4d	14/11/2024 1	0%
28	NFC Testing & Rev...	14/11/2024 0	1d	14/11/2024 1	0%
29	Improve Prototype	15/11/2024 0	1d	15/11/2024 1	50%
30	Front end Develop...	18/11/2024 0	4d	21/11/2024 1	50%

Appendix B: Diagram

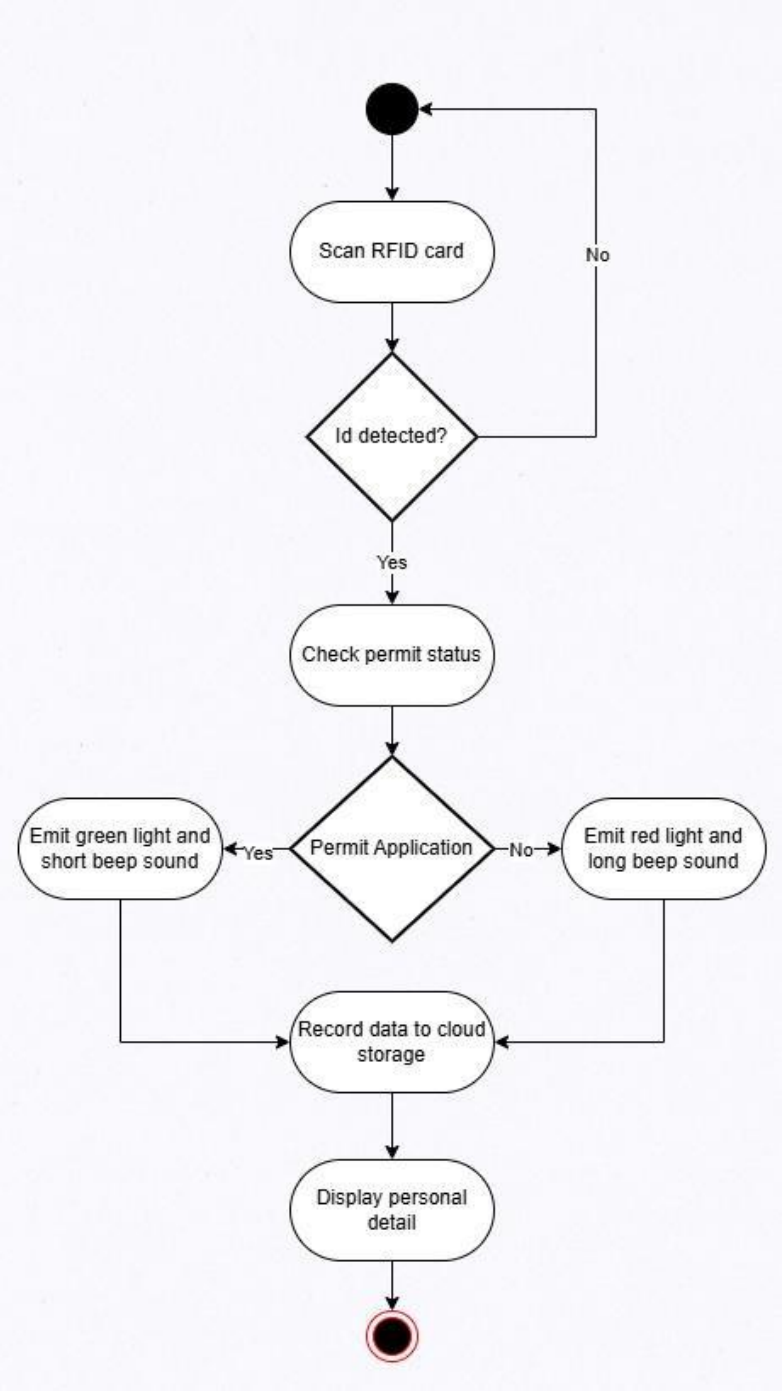

Fig. 23 *Activity Diagram*