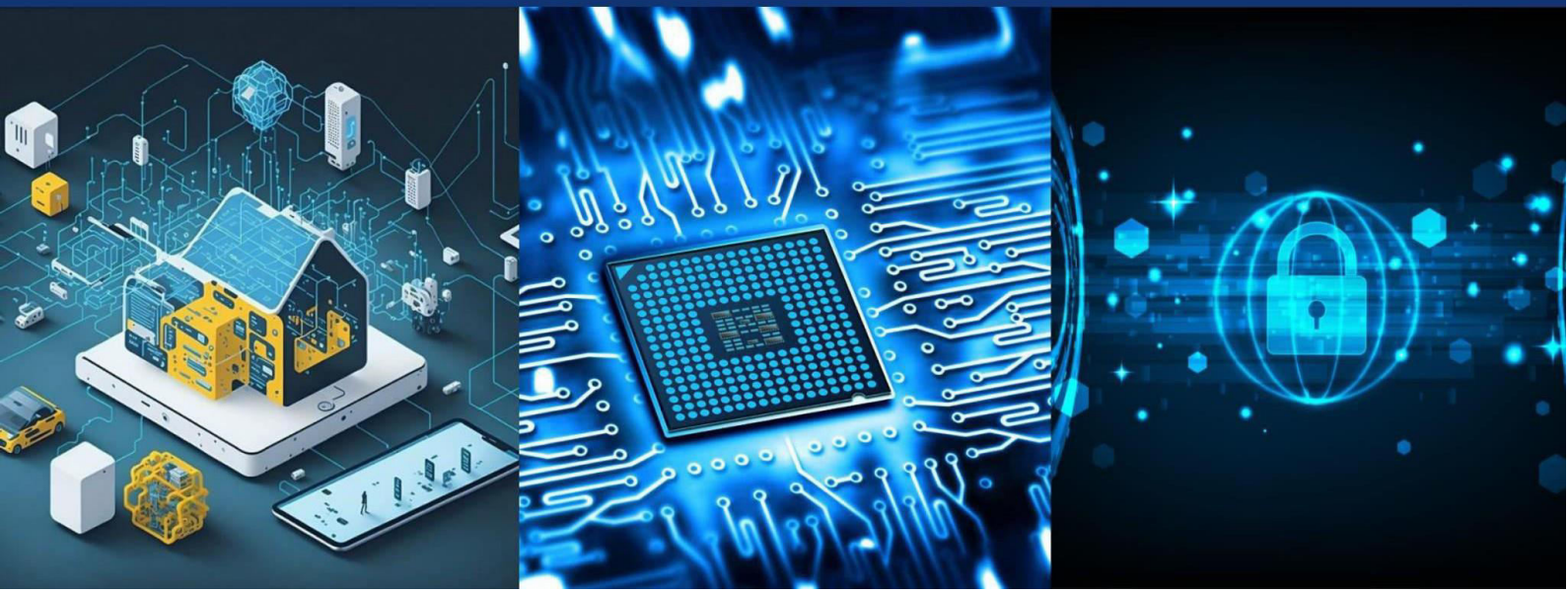
IJIRCCE

ISSN(O): 2320-9801

ISSN(P): 2320-9798



International Journal of Innovative Research in Computer and Communication Engineering

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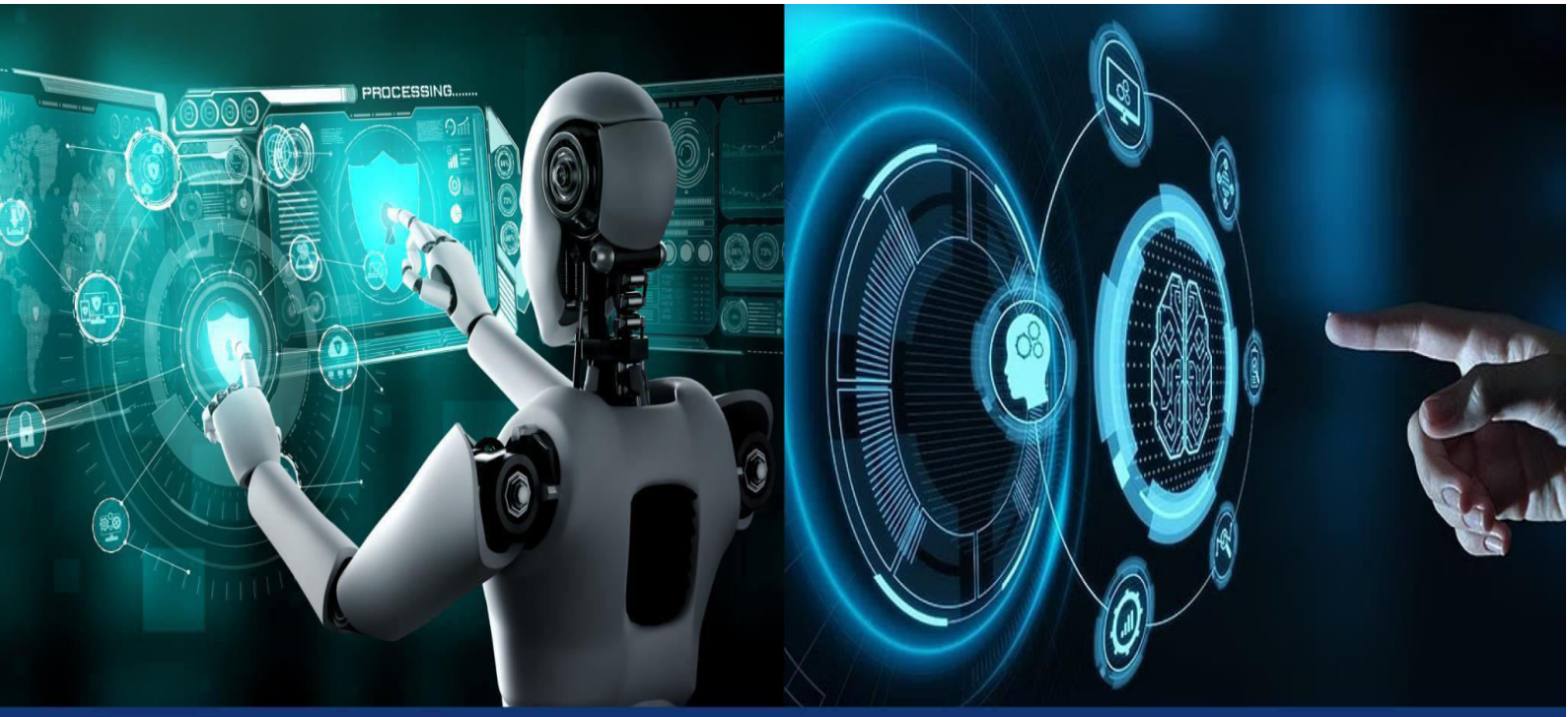

Impact Factor: 8.771

Volume 13, Issue 12, December 2025

© 2025 IJIRCCE | Volume 13, Issue 12, December 2025| DOI:10.15680/IJIRCCE.2025.1312029

www.ijircce.com | e-ISSN: 2320-9801, p-ISSN: 2320-9798| Impact Factor: 8.771| ESTD Year: 2013|

International Journal of Innovative Research in Computer and Communication Engineering (IJIRCCE)

(A Monthly, Peer Reviewed, Refereed, Scholarly Indexed, Open Access Journal)

Agentic AI-Powered Exam Proctor Assignment System

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ABSTRACT: An AI-Driven Proctor Allocation System is proposed to streamline how professors are assigned as invigilators for university examinations. The work addresses persistent issues in manual planning, such as clashing schedules, uneven distribution of invigilation duties, and difficulty reacting to last-minute staff unavailability. In the proposed architecture, Firebase serves as a centralized data store, while a Gemini-based agentic AI module intelligently maps professors to classroom time slots using information from the Admin Module (departments, faculty records, classroom details, and exam schedules) and the Professor Module (personal timetables and declared availability). The system automatically generates conflict-free duty rosters, detects and resolves overlaps, and updates allocations in real time; an Emergency Pool Module further supports continuity by suggesting suitable backup invigilators when a scheduled professor becomes unavailable. By combining centralised data management with AI-driven decision making, the system aims to deliver a more efficient, accurate, and fair approach to proctor assignment in academic institutions.

KEYWORDS: AI-Driven Proctor Allocation, Examination Invigilation, Professor Availability Scheduling, Firebase Realtime Database, Agentic Large Language Model, Automated Resource Allocation, Emergency Proctor Pool.

I. INTRODUCTION

Examination invigilation is a critical administrative task in higher education, as it ensures fairness, integrity, and smooth conduct of assessments. In many institutions, proctor allocation is still managed manually through spreadsheets or paper-based schedules, which becomes increasingly difficult as the number of courses, classrooms, and faculty members grows. Manual planning often produces overlapping duties, inconsistent workload distribution across departments, and limited flexibility when last-minute changes occur. These shortcomings not only increase the burden on administrative staff but also create dissatisfaction among professors who may receive too many or poorly timed invigilation assignments. Furthermore, handling sudden absences or timetable revisions typically requires reworking large portions of the schedule, leading to delays and communication gaps. With universities moving toward more data-driven and digital workflows, there is a strong need for an automated mechanism that can generate and maintain reliable invigilation rosters. This research presents an AI-Driven Proctor Allocation System that automates the process of assigning professors to examination rooms based on their availability and institutional constraints. The proposed system integrates centralized data storage with an intelligent allocation engine capable of generating conflict-free schedules, balancing faculty workload, and dynamically suggesting replacements in case of unexpected unavailability. By combining real-time data management with agentic AI decision-making, the system aims to reduce manual effort, improve scheduling accuracy, and offer a transparent and equitable framework for managing proctor duties in academic institutions.

II. LITERATURE SURVEY

The allocation of invigilation duties has long been recognized as an important component of examination management and resource scheduling in academic institutions. Earlier research consistently highlights the challenges associated with manual invigilation planning, including the high probability of scheduling overlaps, disproportionate duty distribution among faculty members, and the administrative burden required to coordinate last-minute changes. These limitations have encouraged institutions to adopt automated or semi-automated scheduling systems that leverage computational, algorithmic, or AI-based methods to produce reliable exam duty rosters.Penchalaiah et al. proposed one of the notable early solutions through their Smart Invigilation Duty Allocation System, which employed Google OR-Tools as the backbone of a rule-based scheduling engine. Their approach showed that deterministic algorithms could incorporate faculty availability, room capacity, duty limits, and fairness constraints to create schedules that significantly reduced

clashes compared with traditional manual processes. The study demonstrated the value of objective-rule enforcement in minimizing human biases and improving operational reliability of exam scheduling processes [1].Similarly, Ramzan et al. developed an Intelligent Examination Staff Allotment System, offering a web-based interface that allowed exam administrators to manage staff assignments centrally. Their work emphasized transparency and ease of access, enabling staff to view their duties online. The system also automated the mapping of invigilators to exam sessions based on predefined rules, substantially cutting down the time required to publish duty lists. This contributed to improved communication and accountability within academic departments [2].In contrast to purely scheduling-focused models, certain studies have adopted a more integrated perspective. A work titled "A Framework for Invigilation Scheduling" combined invigilator assignment with biometric authentication for check-in/check-out, enabling real-time monitoring of duty compliance. While this approach enhanced invigilator verification and record keeping, it relied mainly on conventional rule-based scheduling and did not utilize advanced optimization or AI-driven techniques for allocation, limiting its flexibility during dynamic changes [6].

More optimization-driven research includes Taha's thesis, which applied the Artificial Bee Colony (ABC) meta-heuristic to the proctor assignment problem. The thesis formulated invigilation scheduling as a multi-objective optimization problem, prioritizing conflict minimization, fairness, and distribution of workload. The study demonstrated that meta-heuristic algorithms could outperform traditional optimization methods by exploring a broader solution space and generating more balanced schedules, particularly for large datasets with complex constraints [3].Another notable contribution is the study on the "Examination Invigilator's Schedule Problem", where authors used systematic, programming-based sequential methods to assign invigilators to exam sessions without conflicts. This approach proved that even simple algorithmic structures, when properly implemented, can drastically reduce overlapping duties and minimize the need for manual correction during schedule finalization [5].Recent academic works have begun integrating invigilation scheduling with broader examination management processes, such as hall allocation, timetable generation, and student seating arrangements. These systems are typically built on database-driven web applications designed for operational efficiency. However, they still rely largely on procedural or algorithmic logic rather than leveraging modern generative AI or agentic techniques. Hence, while these systems improve scalability and reduce administrative workload, they lack adaptive decision-making capabilities, especially in handling sudden changes such as unexpected faculty absences.The present research differentiates itself by incorporating Agentic AI using a Large Language Model (LLM) into the invigilation scheduling workflow. This approach enables dynamic reasoning over constraints, real-time adaptation, and conflict resolution—capabilities not addressed in earlier works. By merging centralized data management with AI-driven decision-making, the proposed system positions itself as an evolution of existing scheduling tools, offering a more adaptive, intelligent, and robust solution to examination invigilation challenges [4].

III. PROPOSED SYSTEM

Current examination duty planning in many institutions still depends on manual spreadsheets and informal communication between the examination cell and faculty coordinators. Administrators must repeatedly cross-check professor timetables, room availability, and exam schedules, which is slow, error-prone, and difficult to scale when the number of subjects and classrooms increases. Manual allocation also struggles to maintain fairness, often giving some professors heavier invigilation loads while others receive very few duties, and it provides little support for handling sudden unavailability or timetable changes during the exam period. As a result, there is a clear gap between the need for accurate, real-time invigilation schedules and the limited capabilities of traditional planning methods.

The proposed system, an AI-Driven Proctor Allocation Platform, addresses this gap by integrating a centralized data layer with an agentic AI allocation engine and an emergency replacement mechanism. Instead of requiring examination staff to calculate and revise duty charts by hand, the system lets admins configure departments, professor profiles, classroom details, and exam schedules through a web-based Admin Module. Professors interact with the Professor Module to log in securely, submit their teaching timetable, and mark availability or constraints for specific dates and sessions. All information is stored in Firebase, which maintains a unified, up-to-date view of exam sessions and available proctors.

At the core of the platform, the Agentic AI Module powered by Gemini interprets this data and automatically generates duty rosters that map professors to classrooms for every exam slot. The allocation logic considers multiple factors simultaneously, including availability, maximum duties per day, distribution across departments, and avoidance of consecutive or overlapping sessions. The AI-generated schedule is validated and then written back to the database, where

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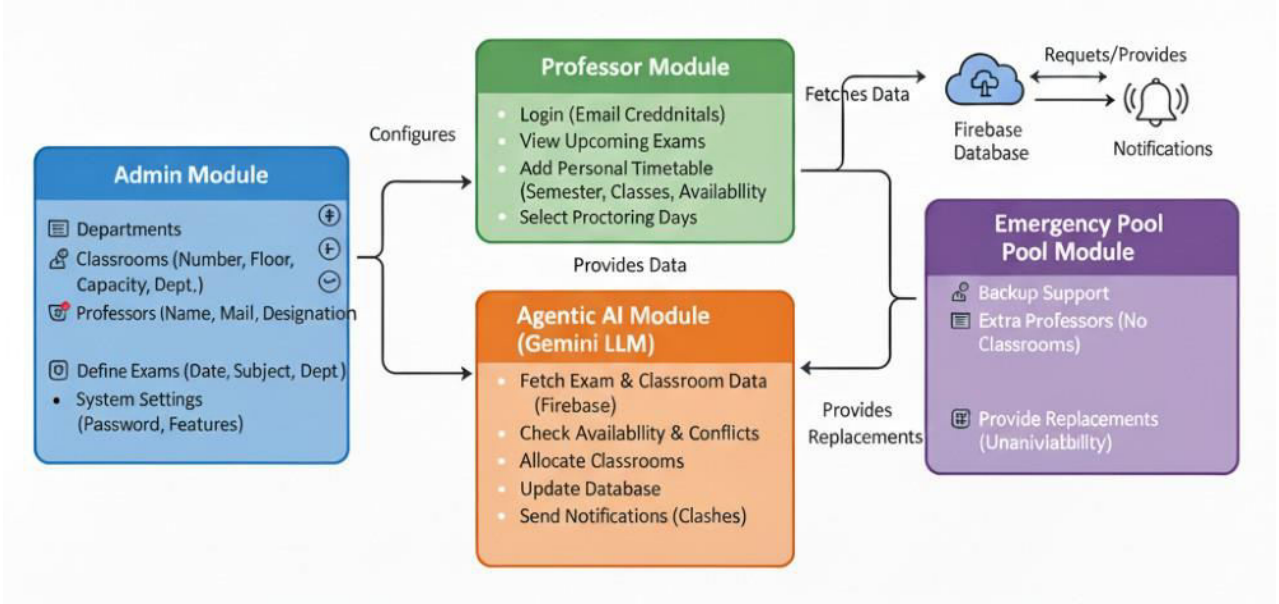
it can be viewed by admins and faculty members along with clear details of room, time, and role. When a professor becomes unavailable at short notice, the Emergency Pool Module identifies suitable backup professors flagged as free for that session and requests a localized re-allocation from the AI engine, ensuring that affected rooms still receive adequate invigilation.

The main objectives of this proposed system are:

- To eliminate manual conflict checking by automatically generating proctor assignments that respect professor availability, classroom capacity, and institutional rules.
- To promote fairness and transparency by distributing invigilation duties evenly across eligible professors while allowing them to view their schedules through a unified interface.
- To support real-time adaptability by offering an emergency replacement workflow that can quickly reassign duties without regenerating the entire timetable.
- To provide examination branches with a scalable, cloud-based tool that reduces administrative workload and improves reliability of invigilation planning for both regular and supplementary examinations.

In the proposed approach, examination staff and professors interact with the system through a single, integrated platform rather than multiple disconnected tools. Admins configure exams and resources once, professors update their availability as needed, and the AI allocation engine continuously uses this shared dataset to produce and refine schedules. By combining data management, intelligent scheduling, and dynamic replacement in one environment, the AI-Driven Proctor Allocation Platform is designed to make the end-to-end invigilation planning process faster, more accurate, and better aligned with the operational realities of modern academic institutions.

IV. METHODOLOGY



A. Requirement Analysis

In the first phase, functional and non-functional requirements were collected from examination branch staff and faculty coordinators. The key functional needs identified were: maintaining a central repository of professor, classroom, and exam data; capturing professor availability; automatically generating non-overlapping invigilation schedules; and suggesting replacements when a professor becomes unavailable. Non functional requirements such as scalability, real-time updates, secure access control, and ease of use were also defined to guide the design of the system.

B. System Architecture and Design

Based on the requirements, a modular architecture was designed with four main components: Admin Module, Professor Module, Agentic AI Module, and Emergency Pool Module. The system adopts a client–server model where a web or

mobile front end communicates with a cloud-hosted backend using Firebase as the real-time database and authentication service. Entity–relationship diagrams were prepared to model departments, professors, classrooms, exam sessions, availability slots, and proctor assignments. Data flow diagrams and sequence diagrams were used to describe how information moves between the modules during configuration, scheduling, and re-scheduling.

C. Admin Module

The Admin Module is responsible for configuring all base data required for allocation. Administrators create department records, register professors with their contact details and designations, define classrooms along with capacities and locations, and upload or enter the examination timetable. They also specify global constraints such as maximum invigilation duties per professor, preferred department-wise distribution, and rules for morning/afternoon session loads. All these parameters are stored in Firebase so that any change is reflected instantly across the system.

D. Professor Module

The Professor Module provides an interface for faculty members to authenticate using institutional credentials and manage their availability. Professors can enter their teaching timetable, research commitments, and days or slots when they are free to invigilate. They may optionally indicate preferences, such as avoiding consecutive sessions or specific time windows. The module validates entries to avoid inconsistent data (for example, marking a professor as both busy and available in the same slot) and synchronizes the final availability map with the centralized database.

E. Agentic AI Allocation Workflow

At the core of the methodology is the Agentic AI Module powered by a large language model (Gemini) orchestrated through a rule-driven controller. The allocation workflow begins by fetching exam sessions, classroom requirements, and professor availability from Firebase. The controller transforms this raw data into a structured prompt containing: list of sessions, required number of proctors per room, availability matrix, and institutional constraints. The LLM is then guided to generate candidate proctor assignments that satisfy the constraints and aim for a balanced distribution of workload. The returned assignment is parsed and validated by the controller. It checks for clashes (a professor assigned to two rooms at the same time, or assigned during an unavailable slot), violation of maximum-duty limits, and missing rooms. If any violations are detected, the controller automatically asks the model to revise the allocation with additional constraint hints. This loop continues until a conflict-free schedule is obtained or a predefined iteration limit is reached. The final allocation is then written back to Firebase and linked to each professor's account so they can view their duties.

F. Emergency Pool and Dynamic Re-Scheduling

To handle last-minute changes, the methodology includes an Emergency Pool Module that maintains a list of professors flagged as "backup available" for specific dates and sessions. When a professor reports unavailability or an administrator cancels a duty, the system triggers a re-allocation procedure only for the affected slot. The AI module receives the current assignment, the cancelled professor ID, and the list of eligible backups and generates a replacement suggestion that maintains fairness and avoids new clashes. The updated assignment is saved to the database and notification messages are sent to the replacement proctor and concerned administrators.

G. Implementation Details

The front-end interface is implemented using standard web technologies (such as HTML, CSS, and JavaScript or a modern framework) to support responsive access across devices. The backend integrates Firebase Authentication for secure login, Firebase Realtime Database or Firestore for data storage, and cloud functions or an application server to call the Gemini API and run allocation logic. Role-based access control ensures that only admins can modify exam schedules and system parameters, while professors can edit only their own availability and view their duty lists.

H. Testing and Evaluation

The system is evaluated using both functional and performance testing. Functional tests verify scenarios such as: creating exams and classrooms, entering availability, generating the first schedule, handling conflicting inputs, and performing replacements through the emergency pool. Test cases are designed to include edge situations like professors with zero availability or rooms with multiple sessions in a day. For performance evaluation, metrics such as time taken to generate a complete schedule, number of conflicts before and after automation, average number of duties per professor, and user satisfaction feedback from administrators and faculty are recorded. Comparative analysis against the previous manual method is used to demonstrate reductions in scheduling time, conflicts, and workload imbalance.

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V. RESULTS

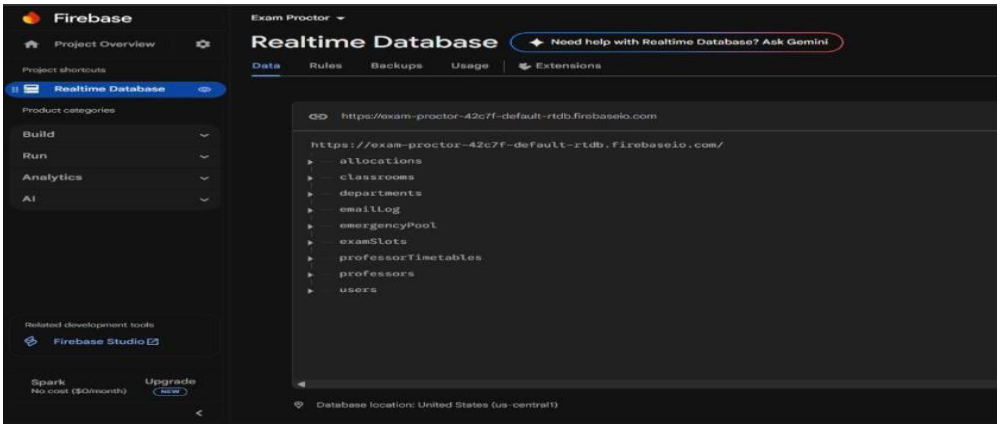

Figure 1: Firebase Realtime Database structure for the system

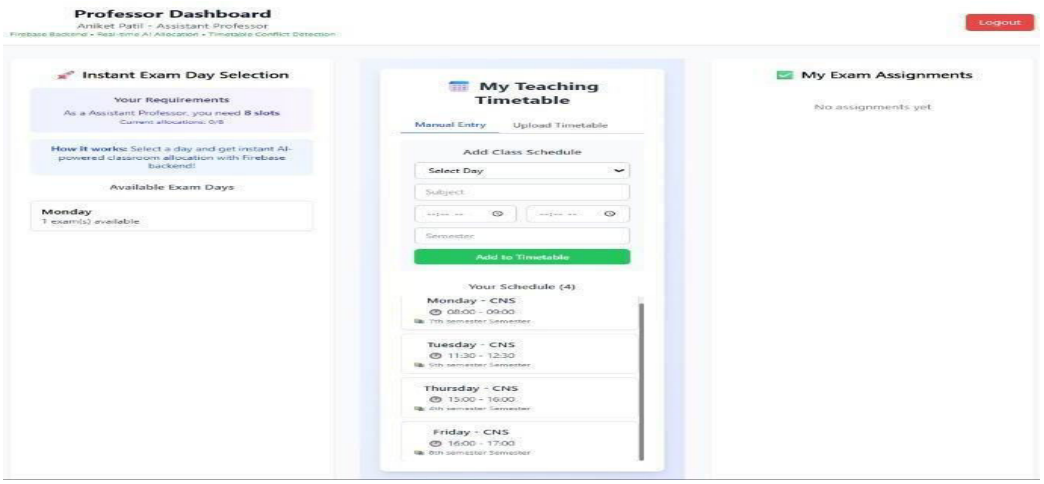

Figure 2: Professor dashboard to manage teaching timetable.

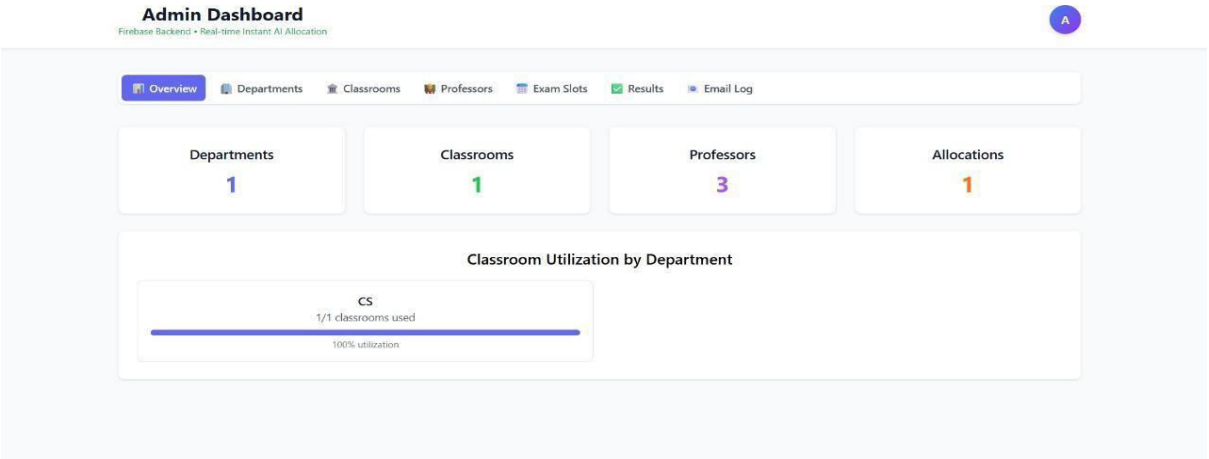

Figure 3: Admin dashboard showing overall exam statistics.

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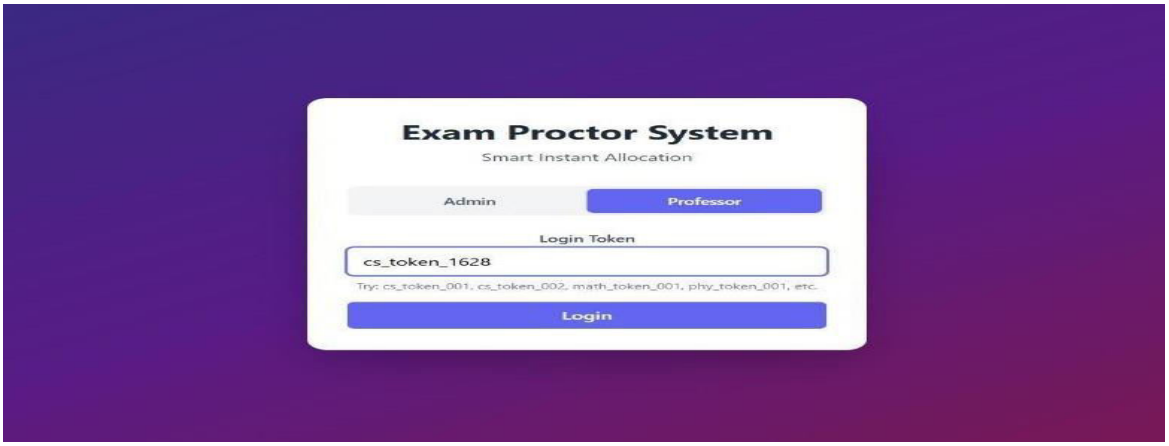

Figure 4: Professor token-based login screen

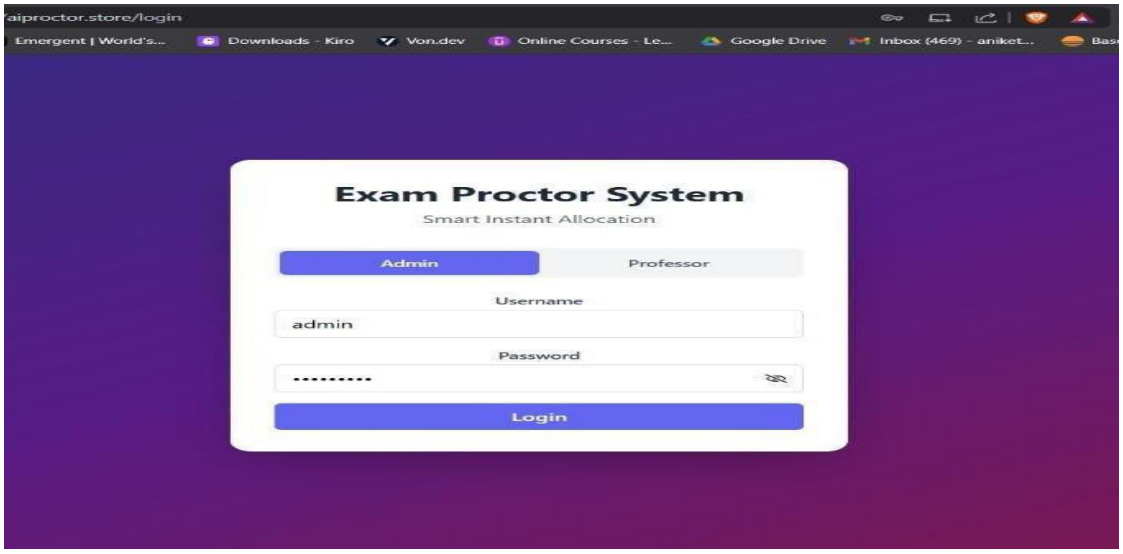

Figure 5: Admin login screen for the Exam Proctor System

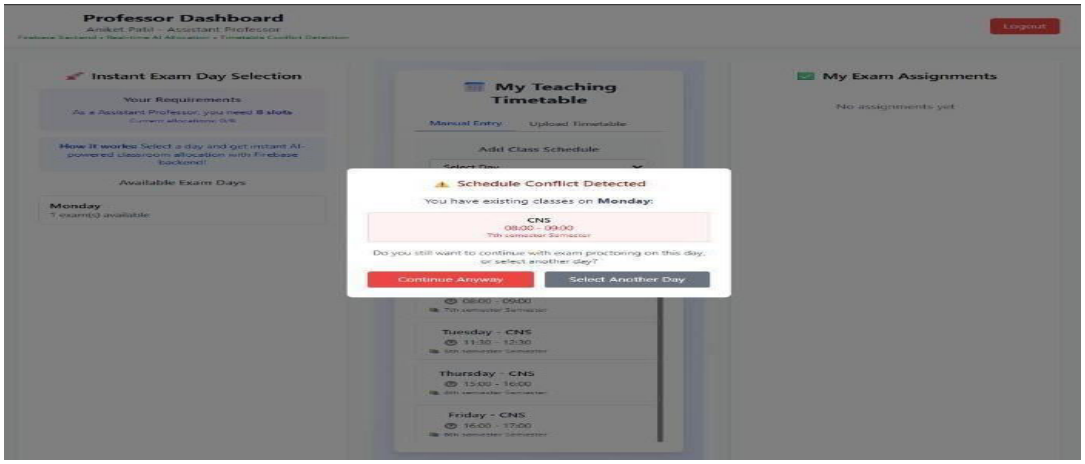

Figure 6: Conflict Detection in Professor Dashboard

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VI. CONCLUSION AND FUTURE WORK

The AI-Driven Proctor Allocation System presented in this work demonstrates that invigilation scheduling can be transformed from a manual, error-prone activity into a structured, automated process. By integrating centralized data management with an intelligent allocation engine, the system successfully generates conflict-free duty rosters using professors' availability, classroom requirements, and institutional constraints. The Emergency Pool mechanism further strengthens operational reliability by enabling rapid reallocation when sudden unavailability occurs, thereby minimizing last-minute disruptions. Overall, the proposed solution improves efficiency for examination administrators, ensures a more balanced workload for faculty, and enhances transparency in how proctoring responsibilities are assigned. Several extensions can further enhance the capabilities and applicability of the system. First, optimization techniques such as integer programming or meta-heuristic algorithms can be combined with the current AI workflow to produce provably near-optimal schedules for very large institutions. Second, analytics dashboards may be added to visualize historical duty distribution, identify over or under-utilized staff, and support evidence-based policy decisions. Third, integration with existing university ERP and timetable systems would reduce data duplication and allow end-to-end automation from timetable generation to invigilation and result processing. Finally, future work can explore adaptive learning within the allocation engine so that the system gradually incorporates user feedback, departmental preferences, and fairness metrics to produce increasingly acceptable schedules across successive examination cycles.

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