# Enhanced Resource Allocation System Using IoT, Feedback-Driven Optimization and Collision Resolution for Sustainable Event Management

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## ABSTRACT

Resource allocation using IoT and Feedback-Driven Optimization introduces a new way to transform existing halls into smart, sustainable and intelligent environments through the implementation of IoT sensing, machine learning and automated scheduling for event management. Halls that are used in a traditional way often face problems of underutilization, bottlenecks associated with manual scheduling, and inefficiencies in energy consumption. This paper's approach solves those problems by retrofitting existing infrastructure with IoT sensors to capture real-time data for occupancy (measured with carbon dioxide concentration), lighting, temperature, humidity, and other parameters representing the environment. The data is used by a regression machine learning model that has been trained to predict lighting needs based on conditions and occupancy of the hall, and the model continues to retrain itself until it achieves an accuracy of 0.9 or higher. By connecting to a central dashboard and ERP system, the hall can now be equipped to handle automated scheduling, energy-saving lighting, and role-based approvals, thus reducing the human element and enhancing transparency. By turning the conventional hall into a data-enabled smart space, the system offers potential for real-time resource optimization, an enhanced user experience, and seamless integration of green practices. The outcome of this research emphasizes the ease with which facilities already in place can be retrofitted on a scalable and controllable basis to meet the event management imperatives of sustainability.

*Keywords:* Optimization, IoT, Smart Event Management

## I. INTRODUCTION

Effective space management is of utmost concern to institutions, conference centers, and organizations that schedule different events, lectures, and meetings. Conventional methods of hall


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allocation are handled through manual scheduling practices, which are inefficient, inaccurate, and time-consuming. Such systems tend to generate conflict scheduling, inefficient utilization of available space, and resistance to last-minute bookings. Furthermore, the absence of real-time monitoring renders administrators incapable of making well-informed decisions, leading to suboptimal resource utilization. To address these problems, the application of Internet of Things (IoT) technology presents an innovative solution to hall allocation. Employing IoT sensors, real-time occupation can be captured and processed to maximize space utilization. This system supports automated scheduling to eliminate conflicts, promote fair allocation, and reduce the administrative load of manual booking. The system also incorporates a feedback system to allow users to provide input on hall conditions, availability, and experience. This continuous feedback loop optimizes future allocations such that the system learns over time in terms of user needs and preferences.

Apart from its focus on effective scheduling, sustainability is also a significant focus area of the proposed system. The problem of wastage of energy through over-lighting, air conditioning, and operation of machinery in empty halls is common among most institutions. By the inclusion of smart energy management, the system is able to adapt lighting and climate control based on real-time occupancy, thereby significantly minimizing power consumption. Not only does it save on operational expenses but also contributes to an eco-friendly infrastructure thus ensuring sustainable event management practices.

In addition, the system increases transparency and accountability. Administrators, academics, and event organizers are given access to a centralized dashboard providing information regarding hall availability, usage trends, and energy usage. Real-time visibility allows better planning, avoids unauthorized use, and ensures maximum utilization of resources. The system also allows for easy booking, cancellation, and rescheduling through the automation feature, thus minimizing the need for human intervention and event planning. By combining IoT-based monitoring, automatic scheduling, and feedback-based optimization, this smart hall allocation system significantly improves space usage, resolves conflicts, and promotes energy efficiency. The data-driven approach ensures that decision-making is more precise, leading to a well-organized and environmentally friendly process of event management. Overall, this system not only enhances the user experience but also creates a sustainable and technologically sound platform for resource allocation across institutions and organizations.

## II. Literature Review

This section reviews the existing studies and solutions and provides an overview of works related to hall allocation systems, IoT integration, and feedback-based optimization. The objective here is to determine research gaps and how these technologies have been used across the fields to optimize space management and resource allocation.

Hall allocation plays a significant role in institutions, corporate offices, and conference centers where multiple events need to be scheduled daily. Traditional hall booking methods often depend on manual processes, which are time-consuming and prone to errors, resulting in scheduling conflicts, inefficient space utilization, and increased administrative workload as specified in [2], [3]. Automated booking platforms have attempted to address these issues by enabling digital reservations and centralized schedule tracking [11]. L. D. Tran et al [3] implements an automated room booking platform with real-time occupancy sensing to support ad-hoc meetings, illustrating the advanced (IoT-enhanced) booking scenario. Similarly, Alam et al. [2] investigated these proposed resource allocation techniques and the parameters considered for improvement in resource allocation for IoT networks. Alongside challenges and issues of Cloud-based resource

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allocation for IoT environment. Lalitha et al. [11] also proposed an online college event-hall booking system that streamlined reservations but similarly lacked adaptive resource utilization features.The result of these studies is that even though automation reduces the manual burden, the absence of real-time monitoring and sustainability factors causes inefficiencies. There is therefore research space in the design of smart hall allocation systems with live occupancy data supplemented with energy-saving measures.

Internet of Things (IoT) has emerged as a revolutionary technology for resource management in many industries, including smart infrastructure, health care, and logistics. IoT-enabled devices like motion sensors, temperature sensors, and smart cameras enable real-time observation of resource consumption and therefore enable data-based decisions [4], [5]. Azizi et al. [5] investigated IoT-based sensor networks in the context of university environments and demonstrated that incorporation of occupancy sensors into a centralized control system reduced scheduling conflicts and improved usage. A. Masoumzadeh et al [4] extended this idea further in smart building environments, where IoT-based automation continuously ranged lighting and HVAC usage based on real-time occupancy, yielding rational energy savings. These studies indicate the potential of IoT to enhance efficiency and sustainability. Most of the current work, however, applies IoT at the building level and not in combination with event scheduling systems. This indicates the potential of IoT-based hall allocation systems that incorporate occupancy monitoring, resource control, and automated scheduling.

Feedback mechanisms are increasingly acknowledged as instrumental in enhancing user-centered systems. Within the context of hall allocation, user feedback serves to inform administrators regarding hall conditions, facility-related concerns, and overall satisfaction levels, thereby facilitating iterative enhancements in allocation policies. Feng et al. [6] demonstrated how resource allocation can be continuously adjusted based on real-time feedback—an essential component in user-feedback–driven booking systems. Their results showed improved facilities management and higher user satisfaction. Alqithami [1] emphasized the value of sentiment analysis in allocation strategies and proposed the use of AI models to mine user feedback to enable continuous optimization. Yet, even with these developments, feedback systems are not prevalent in hall management, where most platforms consider booking to be a static process. This is a reflection of the need for dynamic hall allocation systems incorporating user feedback in an adaptive scheduling and decision-making paradigm.

Heating, Ventilation, and Air Conditioning (HVAC) systems consume about 40% of the energy consumed in commercial buildings [7]. Traditional HVAC operation is usually founded on static controls or delayed manual adjustments and, as a result, less sensitive to changing occupancy levels. Some more recent research has utilized machine learning for forecasting energy demand and HVAC operation optimization. Zhou et al. [7] gave a broad overview of machine learning in HVAC and suggested its potential to enhance both energy efficiency and user comfort. Predictive models can optimize lighting and thermal control adaptively by learning the patterns of occupancy and environmental conditions. Most of the existing research, however, is oriented toward large-scale smart building management, and there are few studies that transfer these methods to event-driven hall environments. There is therefore scope for further research into machine learning–based HVAC optimization coupled with hall allocation systems.

## III. PROBLEM STATEMENT

Traditional hall allocation systems in institutions and organizations face significant challenges, including inefficient scheduling, resource under-utilization, and administrative burden. Manual


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booking methods often result in scheduling conflicts, overlapping reservations, and difficulties in accommodating last-minute changes. Additionally, the absence of real-time occupancy monitoring leads to improper space utilization, with some halls remaining underused while others are overcrowded. Another critical concern is excessive energy consumption caused by ineffective resource management. Halls that are not used often have unnecessary lighting and air conditioning running, leading to increased operational costs and environmental impact. Moreover, the lack of a feedback mechanism means that users cannot report issues or suggest improvements, making the allocation process rigid and nonadaptive.
Another major concern that is meant to be addressed is the conflicts that occur when a new event is scheduled. For conflict resolution in scheduling and fair allocation of resources, our system uses a collision resolution algorithm using priority queuing and time-slot negotiation. In case there are conflicting requests in terms of a common hall and time slot, the system ranks each of them based on pre-defined parameters such as event priority, approval status, request time, and user role (e.g., faculty member vs. student). A weighted score is determined, and the slot is allocated to the highest scoring request. Low- priority requests are automatically rescheduled based on available slots or forwarded to alternative appropriate venues by way of constraint satisfaction logic, ensuring fairness and optimal utilization of halls.

## IV. Research Objectives

The objectives of this study are to explore the potential of IoT technology in enhancing real-time monitoring and data collection for efficient hall allocation, reduce the chances of collision and to resolve those collisions using an efficient priority-based technique, and analyze the influence of feedback-driven optimization in improving decision-making processes for hall management. To evaluate how these technological advancements, contribute to the development of a more sustainable, efficient, and user-friendly hall allocation system.

## V. Methodology

This section outlines the methodology employed to investigate the enhancement of the hall allocation system. The developed hall allocation system leverages ERPNext, a robust open source ERP framework built on Frappe. As cited in [8], the system is seamlessly integrated into the ERPNext environment, aligning with institutional workflows for event scheduling, approvals, and resource management.

*a) Core Functional Modules:* The hall allocation system (Fig. 1) is structured around custom DocTypes that define the key data models and relationships: Event Request that stores event metadata including title, organizer details, number of participants, preferred date and time, and resource requirements. Hall Management which is about maintaining a registry of available halls with attributes like capacity, facilities (e.g., projector, AC), and current booking status. Booking Request is involved in handling hall assignment, availability checking, and conflict resolution. Approval Workflow does the tracking of event approvals across roles such as IQAC, HOD, Dean, Principal, and Resource Approvers.


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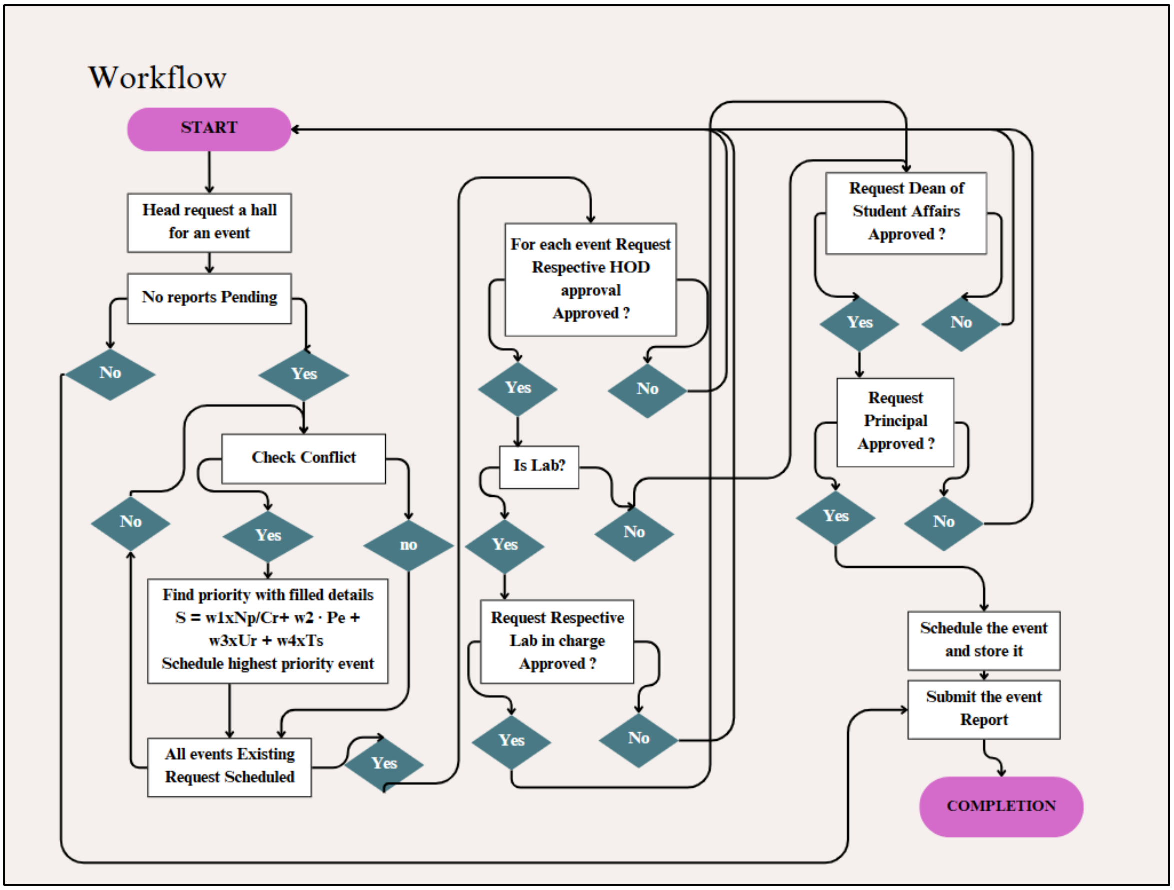


*Fig. 1. Workflow*

Feedback and Issue Reporting – Allows users to report post- event feedback and facility-related concerns.

*b) Frontend and User Interface:*

The UI is rendered through ERPNext's web forms and desk interface, supporting both desktop and mobile access. Dynamic dropdowns populate fields like club name, faculty in-charge, and halls. Calculated fields display automatically generated IQAC Event Numbers, ensuring traceability. Customized forms provide real-time validation, auto-fill based on selected data, and conditional visibility of fields based on roles or status. The Workflow Engine of ERPNext is used to create a sequential approval process. Transitions are role-based and visible on the event request page. Email notifications are triggered automatically on submission, approval, or rejection using Notification Rules. The system supports status tracking and real-time updates via the dashboard (Fig. 1).

*c) Data Storage and Integration:*

The backend runs on MariaDB, the default for ERPNext, with structured tables linked via Frappe ORM. Relationships are enforced using Link Fields between DocTypes. Event logs and booking history are permanently stored that can be used for audit and analytics.

*d) Intelligent Hall Suggestion:*

On entering the number of participants, the system queries the Hall database and suggests top 3 most suitable halls based on capacity, availability, and required facilities. Booking conflicts are auto-checked by querying overlapping events in the selected time slot. In future updates, this can be extended to use Python server scripts within ERPNext for more advanced recommendation logic.

*e) Security and Access Control:*

Role-based access permissions are defined at the DocType level. Only authorized users can perform actions such as submission, approval, or booking. User authentication is managed through built-in feature of ERPNext like Role Permission Manager and log-in sessions. Activity logs ensure the traceability of all actions within the system.

*f) Scalability and Maintainability:*

As part of the ERPNext ecosystem, the module can be scaled across departments or campuses with minimal code changes. Admins can modify forms, workflows, and reports using the low-code customizer, reducing development overhead. The system is hosted either on-premise or on cloud (bench-managed), allowing flexibility in deployment.

The proposed hall allocation system is a web-based, role driven event and resource management platform developed using the Frappe framework for the backend and MySQL as the database engine. The frontend is designed to be user friendly and intuitive, with a Google Forms-inspired interface to ensure ease of use for non-technical stakeholders.

## VI. Analysis and Discussion

This section mainly discusses data analysis, focusing on the potential improvements observed by integrating IoT and feedback-driven optimization. To address these challenges, there is a need for a smart and efficient hall allocation system that takes advantage of IoT- based monitoring, automated scheduling, and feedback driven optimization. By integrating real-time data collection, intelligent space allocation and energy-efficient mechanisms, the proposed system aims to improve transparency, minimize conflicts, optimize resource utilization, and promote sustainability in event management.

### A. Collision Resolution in Hall Allocation

Hall allocation systems often encounter scheduling conflicts due to overlapping reservations or simultaneous booking requests. To mitigate this, our system introduces a collision resolution mechanism based on a weighted scoring model that evaluates each booking request against key parameters. Let the score $S$ for a booking request be calculated as:

$$S = w_1 . \frac{N_p}{C_r} + w_2 . P_e + w_3 . U_r + w_4 . T_s$$

Where:

- $N_p$ = Number of expected participants (registrations)
- $C_r$ = Capacity of the requested room
- $P_e$ = Event priority (scale: 1 to 5, where 5 is highest, e.g., external seminar)
- $U_r$ = User role weight (higher weight, more preference)
- $T_s$ = Time since the request was made (in hours)
- $w_1$, $w_2$, $w_3$, $w_4$ =Weighting coefficients that reflect institutional policies

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TABLE I
**EVENT PRIORITY SCALE ($P_e$)**

| Priority Value | Event Type |
|---|---|
| 1 | Informal Meetings or Practice Sessions |
| 2 | Intra-college Events or Club Activities |
| 3 | Inter-college Competitions or Workshops |
| 4 | National/International Seminars or Conferences/Placement Sessions |

TABLE II
**USER ROLE WEIGHT ($U_r$)**

| Weight Value | User Role |
|---|---|
| 1 | IQAC or Principal |
| 2 | Faculty Coordinator or Dean of Student Affairs |
| 3 | Club Head |

The term $\frac{N_p}{C_r}$ captures the efficiency of space utilization (how well the room fits the participant count). Higher values are preferred, provided they do not exceed capacity. A room is allocated only if the value of the ratio $\frac{N_p}{C_r}$ falls between an optimum range. The inverse time factor $T_s$ prioritizes early submissions.

*Conflict Resolution Workflow:*

The conflict resolution workflow ensures fair and efficient allocation of resources. For each time slot and hall, all competing requests are evaluated using the scoring function SS, with the request obtaining the highest score being allocated the slot. The remaining requests are addressed by either redirecting them to alternative available halls with sufficient capacity or offering adjacent time slots, in accordance with institutional constraints and preferences. All users are subsequently notified of the decision along with a justification, thereby maintaining transparency in the allocation process. This method ensures a fair, data-driven, and adaptive allocation process that considers both institutional policies and real-time usage constraints.

### B. *Extension: Predictive Lighting Control Using Environmental Sensor Data*

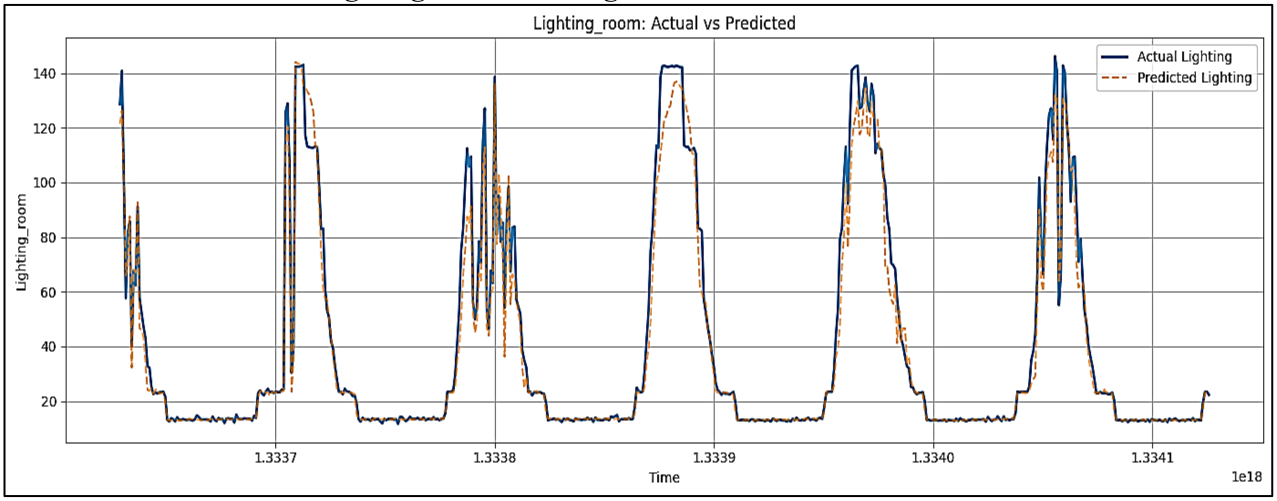


*Fig. 2. Final $R^2$ Score (Lighting_room prediction): 0.9687*

To enhance the automation capabilities of the hall allocation and management system, we incorporated a machine learning-based predictive model using sensor data to accurately forecast room lighting conditions. The dataset used includes environmental and contextual features such as room ID, timestamp, indoor CO levels (representing the number of people occupied in a room), relative humidity, solar irradiation values from different building facades, and meteorological conditions like wind and sunlight exposure. A supervised regression model was trained to predict the Lighting of room value (Fig. 2 representing real-time lighting intensity requirements) based on these input features. The model was designed to automatically retrain until it achieved a performance threshold of 0.9, ensuring high prediction accuracy. This component not only validates the feasibility of responsive lighting systems in indoor environments but also demonstrates the practical impact of sensor fusion and AI in reducing manual energy interventions and improving occupant comfort.

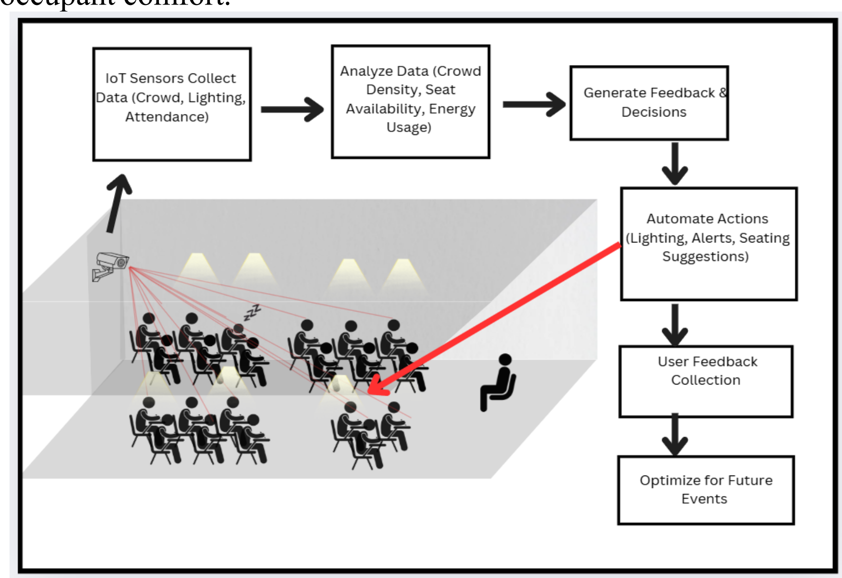


*Fig 3. Workflow of the IOT based Smart Event Management System, illustrating data collection, real-time analysis, automated decision making and continuous optimization for enhanced event conduction and sustainability*

### C. *Data Collection and Analysis*

The study will utilize data from existing IoT-enabled hall allocation systems (if available) or simulate such data. This will include real-time data on hall usage, occupancy, environmental factors, and equipment status (Fig. 3). Additionally, user feedback will be collected from event organizers and participants through surveys and rating systems. Machine Learning can be integrated into this part of the system to study the pattern of responses obtained in the survey. The data collected can be used to classify the type of events into different categories [9]. These details can be used in generating enhanced feedback for future event planning. Collecting real-time data for attendance tracking through machine learning techniques minimizes manual intervention, and delivers instant, reliable updates [10].

### D. *System Architecture Analysis*

An analysis of the system architecture, including IoT integration and feedback loops, will be conducted to understand how these technologies are being employed in hall allocation systems. This will involve studying existing models and their components such as sensor networks, cloud-based processing platforms, and user interfaces.

## VII. CONCLUSION AND FUTURE WORK

In conclusion, the study will summarize the findings related to the enhancement of hall allocation systems using IoT and feedback-driven optimization and efficiently managing collisions in event venue bookings. It will emphasize the advantages of these technologies in improving space utilization, user satisfaction, and system responsiveness. Future work will focus on exploring more advanced optimization algorithms, expanding the study to larger-scale systems, and investigating the further integration of AI for predictive scheduling and resource allocation.

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## Conflict of interest:

The authors state that they have no conflict of interest.

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