

An Intelligent Student Scheduling System Based on a Queue Algorithm for Improving Attendance Management

Kodai Kitagawa^{1*}, Edi Ismanto²

¹Mechanical and Medical Engineering Course, National Institute of Technology, Hachinohe College, Hachinohe, Japan

²Department of Informatics, Universitas Muhammadiyah Riau, Pekanbaru, Indonesia

Author's Email: ^{1*}itagawakitagawa156@hachinohe-ct.ac.jp, ²edi.ismanto@umri.ac.id

Article Info

Article history:

Received: March 16, 2026

Accepted: May 12, 2026

Published: May 30, 2026

Keywords:

Student Scheduling System;
Queue Algorithm;
Attendance Management;
Educational Information System;
Vocational Education.

ABSTRACT

Student scheduling and attendance management are essential administrative activities that influence the effectiveness of educational services in vocational institutions. However, many institutions still rely on conventional scheduling methods, resulting in scheduling conflicts, inefficient resource allocation, and difficulties in monitoring student attendance. This study aimed to develop an intelligent student scheduling system based on a Queue Algorithm to improve attendance management. The research employed a Research and Development (R&D) approach involving problem identification, requirement analysis, system design, implementation, testing, and evaluation. The proposed system applies the First-In First-Out (FIFO) principle to process scheduling requests fairly and systematically. Data were collected through observation, interviews, documentation, and literature review. The developed system integrates scheduling management and attendance monitoring within a centralized web-based platform. Black-box testing was conducted to evaluate system functionality and performance. The results demonstrated that the proposed system successfully automated scheduling allocation, minimized scheduling conflicts, improved attendance recording accuracy, and reduced administrative processing time. Furthermore, the implementation of the Queue Algorithm enhanced scheduling efficiency by ensuring equitable schedule distribution among students. The study concludes that the intelligent student scheduling system can effectively support attendance management and improve administrative efficiency in vocational education institutions. The proposed system contributes to the development of educational information systems by integrating scheduling and attendance management into a unified platform that supports data-driven decision-making and service quality improvement.

This work is licensed under a [CC BY-SA](https://creativecommons.org/licenses/by-sa/4.0/) License.



Corresponding Author:

Kodai Kitagawa

Mechanical and Medical Engineering Course,

National Institute of Technology, Hachinohe College, Hachinohe, Japan

Email: itagawakitagawa156@hachinohe-ct.ac.jp

1. INTRODUCTION

The rapid advancement of information technology has significantly transformed educational management practices, particularly in academic administration, learning management, and student services. Educational institutions are increasingly required to adopt digital technologies to improve operational efficiency, data accuracy, and service quality. One of the most important administrative processes in educational institutions is student scheduling management, which directly influences the effectiveness of learning activities and institutional performance. Effective scheduling enables institutions to allocate resources appropriately, manage student participation, and ensure that educational activities are conducted

according to predetermined plans. However, many vocational and training institutions still rely on manual scheduling procedures, resulting in schedule conflicts, inefficient resource allocation, administrative delays, and difficulties in monitoring student participation. These challenges can negatively affect the quality of educational services and hinder institutional efforts to achieve effective academic management.

Student attendance is widely recognized as one of the key indicators of learning engagement and educational success. Attendance records provide valuable information regarding student participation, commitment, and learning behavior, enabling educators and administrators to evaluate educational outcomes and make informed decisions. Recent studies have highlighted the importance of digital attendance systems in improving monitoring accuracy, reducing administrative workload, and supporting real-time educational management (Zhao, 2022; Anzar et al., 2021). Nevertheless, attendance management remains challenging when scheduling processes are not adequately organized. In many educational institutions, attendance recording and scheduling management are treated as separate processes, resulting in data inconsistencies, duplication of records, and limited monitoring capabilities. Consequently, there is a growing need for integrated systems that can manage both scheduling and attendance activities within a unified platform.

The increasing number of students and educational programs has further intensified the complexity of scheduling management. Educational administrators are required to coordinate multiple schedules, manage participant registration, allocate learning resources, and monitor attendance simultaneously. Traditional scheduling approaches often depend on manual coordination, which is time-consuming and prone to human error. Previous studies have reported that ineffective scheduling practices can lead to overlapping schedules, inefficient classroom utilization, and reduced student participation in learning activities (Chen et al., 2021; Kutty Mammi & Ying Ying, 2021). Furthermore, the inability to process scheduling requests efficiently can reduce institutional responsiveness and negatively impact student satisfaction. Therefore, educational institutions need intelligent scheduling mechanisms capable of automating administrative tasks while ensuring fairness and efficiency in schedule allocation.

The development of intelligent information systems has emerged as an effective solution to address educational administration challenges. Intelligent systems utilize computational techniques to automate decision-making processes, improve operational performance, and enhance data management capabilities. In educational settings, intelligent scheduling systems have been implemented to optimize timetable generation, minimize scheduling conflicts, and improve resource allocation. Research has demonstrated that algorithm-based scheduling approaches can significantly improve scheduling accuracy and reduce processing time compared to conventional methods (Nguyen & Nguyen, 2021; Amrulloh & Sela, 2021). Additionally, intelligent systems provide educational institutions with real-time information that supports strategic planning and administrative decision-making. As a result, the adoption of intelligent scheduling technologies has become increasingly important in supporting modern educational management.

Among various scheduling approaches, the Queue Algorithm represents a practical and efficient method for managing sequential requests and service allocation. The Queue Algorithm operates based on the First-In First-Out (FIFO) principle, ensuring that requests are processed according to their order of arrival. This mechanism promotes fairness, transparency, and consistency in scheduling operations. Queue-based approaches have been widely applied in service management systems because they effectively reduce waiting times, improve resource utilization, and simplify operational procedures. Recent studies indicate that queue-oriented systems can enhance organizational efficiency by ensuring systematic request processing and equitable service distribution (Dalmia et al., 2022; Nurdiansyah et al., 2021). In educational environments, the Queue Algorithm can be utilized to manage student scheduling requests, allocate available learning sessions, and regulate participation in educational activities according to predefined criteria.

Vocational education and training institutions present unique scheduling challenges due to the diversity of educational programs, varying participant capacities, and dynamic learning schedules. Administrators must continuously monitor student registrations, schedule availability, instructor assignments, and attendance records. The complexity of these activities often increases as the number of participants grows, making manual scheduling increasingly difficult to manage. Several studies have shown that technology-driven educational management systems contribute significantly to improving institutional efficiency and service quality (Li & Wong, 2022; Rashid, 2024). Furthermore, smart educational systems provide enhanced capabilities for monitoring educational activities, facilitating communication, and supporting data-driven decision-making processes. Therefore, integrating intelligent scheduling and attendance management functionalities into a single system offers substantial benefits for vocational institutions seeking to improve their administrative performance.

Recent developments in educational technology have also emphasized the importance of smart attendance systems in supporting sustainable educational management. Technologies such as QR codes, facial recognition, mobile applications, and Internet of Things (IoT)-based platforms have been increasingly adopted to improve attendance monitoring and data collection processes (Lateef & Kamil, 2023; Agustiyar et al., 2025). These technologies enable educational institutions to collect attendance data more efficiently while

reducing opportunities for fraud and human error. Moreover, studies have demonstrated that student attendance is positively associated with academic performance and learning outcomes, highlighting the importance of accurate attendance management systems (Lu & Cutumisu, 2022). Despite these advancements, many existing attendance solutions focus primarily on attendance recording without addressing scheduling-related challenges that influence student participation.

Although previous studies have explored scheduling optimization and attendance management independently, limited research has integrated both functions within a unified intelligent platform based on queue management principles. Existing scheduling systems frequently utilize optimization algorithms such as genetic algorithms and heuristic approaches, while attendance systems focus primarily on monitoring and reporting activities (Chen et al., 2021; Amrulloh & Sela, 2021). Consequently, there remains a research gap regarding the development of an integrated educational management system that combines intelligent scheduling and attendance management using a Queue Algorithm. Addressing this gap is essential for improving administrative efficiency and ensuring that educational institutions can manage student participation effectively in increasingly complex learning environments.

Therefore, this study proposes the development of an intelligent student scheduling system based on a Queue Algorithm for improving attendance management. The proposed system integrates scheduling and attendance functionalities into a centralized platform capable of processing student scheduling requests, allocating learning sessions, and monitoring attendance in real time. By implementing queue-based scheduling mechanisms, the system is expected to improve scheduling accuracy, minimize schedule conflicts, optimize administrative workflows, and enhance attendance management effectiveness. Furthermore, this research contributes to the growing field of educational information systems by providing an innovative approach that combines intelligent scheduling and attendance monitoring within vocational education environments. The findings of this study are expected to provide practical benefits for educational institutions seeking to improve operational efficiency, strengthen student participation management, and support data-driven educational decision-making.

2. LITERATURE REVIEW

2.1 Student Scheduling System

A student scheduling system is an information system designed to organize, allocate, and manage educational schedules efficiently. The primary objective of a scheduling system is to ensure that educational activities are conducted systematically while optimizing the utilization of available resources, including classrooms, instructors, and learning facilities. In educational institutions, scheduling plays a crucial role in supporting academic administration because it directly affects the effectiveness of learning activities and student participation.

Traditional scheduling methods often rely on manual processes, which are prone to scheduling conflicts, duplicate allocations, and administrative inefficiencies. As the number of students and educational programs increases, manual scheduling becomes increasingly difficult to manage. Therefore, intelligent scheduling systems have been developed to automate schedule generation, improve allocation accuracy, and reduce administrative workloads. Modern scheduling systems utilize computational algorithms to process scheduling requests, allocate available resources, and generate optimized schedules that satisfy institutional requirements.

The implementation of scheduling systems has demonstrated significant benefits in educational environments, including improved operational efficiency, reduced scheduling conflicts, and enhanced student satisfaction. Furthermore, intelligent scheduling systems provide real-time information that supports educational planning and decision-making. Consequently, the adoption of scheduling technologies has become an important strategy for educational institutions seeking to improve service quality and administrative effectiveness.

2.2 Attendance Management

Attendance management refers to the process of recording, monitoring, and evaluating student participation in educational activities. Attendance information is an essential component of academic administration because it provides indicators of student engagement, learning commitment, and academic performance. Educational institutions utilize attendance records to monitor learning activities, evaluate participation levels, and support academic decision-making processes.

Conventional attendance management methods generally involve manual recording procedures that require substantial administrative effort and are susceptible to human error. The emergence of digital attendance systems has transformed attendance management by enabling automated data collection, real-time monitoring, and centralized data storage. Technologies such as QR codes, facial recognition, mobile

applications, and Internet of Things (IoT)-based systems have been increasingly adopted to improve attendance monitoring accuracy and efficiency.

Recent studies indicate that effective attendance management contributes positively to educational performance by providing accurate participation data and facilitating timely intervention for students with attendance issues. Additionally, integrated attendance systems improve administrative efficiency by reducing paperwork, minimizing recording errors, and supporting data-driven educational management. Therefore, attendance management systems have become a fundamental component of modern educational information systems.

2.3 Queue Algorithm

The Queue Algorithm is a data processing technique based on the principle of First-In First-Out (FIFO), where the first request entering the queue is processed before subsequent requests. Queue-based mechanisms are widely used in computer systems, service management applications, and scheduling environments because they provide fairness, transparency, and operational efficiency.

In a queue structure, new requests are inserted at the rear of the queue and processed sequentially from the front. This mechanism ensures that all requests receive equal treatment according to their arrival order. The Queue Algorithm is particularly effective in situations involving high volumes of requests, limited resources, and sequential service allocation.

Within educational scheduling systems, the Queue Algorithm can be utilized to manage student registration requests, allocate available schedules, and regulate participation in educational activities. By processing scheduling requests according to the order of registration, the algorithm helps prevent scheduling conflicts and ensures equitable schedule distribution among students. Furthermore, the simplicity of the FIFO approach makes it suitable for implementation in educational institutions that require efficient and transparent scheduling mechanisms.

The operational process of the Queue Algorithm can be represented through the following steps:

- a. Student registration request is submitted.
- b. Request is inserted into the queue.
- c. System checks schedule availability.
- d. Request at the front of the queue is processed.
- e. Available schedule is allocated.
- f. Attendance information is recorded.
- g. Process continues until all requests are completed.

The use of queue-based scheduling mechanisms has been shown to improve service efficiency, reduce waiting times, and optimize resource utilization in various organizational environments.

2.4 Intelligent Information Systems in Education

Intelligent information systems integrate computational techniques, automation technologies, and data processing capabilities to support organizational decision-making and operational activities. In educational institutions, intelligent systems are increasingly utilized to improve academic administration, learning management, student services, and performance evaluation.

The application of intelligent information systems enables educational institutions to automate routine administrative processes, improve data accuracy, and provide real-time information for decision-making purposes. Intelligent systems can process large volumes of educational data efficiently and generate insights that support institutional planning and management activities.

Several studies have demonstrated that intelligent educational systems contribute to improved operational performance, enhanced service quality, and increased user satisfaction. Furthermore, the integration of intelligent technologies into educational administration supports digital transformation initiatives and promotes the development of smart educational environments.

In the context of this study, the intelligent student scheduling system integrates scheduling management, queue-based allocation mechanisms, and attendance monitoring functionalities within a centralized platform. This integration enables educational institutions to manage student participation more effectively while improving administrative efficiency and service quality.

2.5 Conceptual Framework

This study is based on the assumption that ineffective scheduling management contributes to attendance management problems and administrative inefficiencies. The implementation of an intelligent scheduling

system utilizing a Queue Algorithm is expected to improve scheduling accuracy, reduce schedule conflicts, and enhance attendance monitoring effectiveness..

3. RESEARCH METHOD

3.1 Research Design

This study employed the Research and Development (R&D) approach to develop an intelligent student scheduling system based on a Queue Algorithm for improving attendance management. The research focused on designing, implementing, and evaluating a scheduling system capable of managing student scheduling requests and attendance records within a centralized platform. The development process consisted of several stages, including problem identification, requirement analysis, system design, algorithm implementation, system testing, and evaluation.

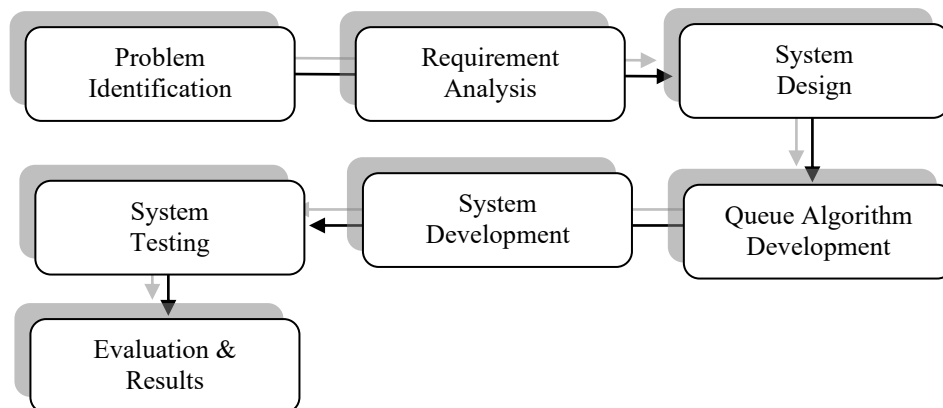


Figure 1. Research framework for developing the intelligent student scheduling system.

The proposed system was designed to automate scheduling activities by applying the First-In First-Out (FIFO) principle of the Queue Algorithm. This approach ensures that scheduling requests are processed fairly and systematically according to their registration order. Furthermore, the system integrates attendance monitoring functionality to support efficient educational administration..

3.2 Data Collection

The data used in this study consisted of student registration data, scheduling information, attendance records, and administrative requirements obtained from the educational institution. Data collection was conducted through observation, interviews, and documentation analysis.

Table 1. Data Collection Techniques

Technique	Description	Purpose
Observation	Direct observation of scheduling activities	Identify existing scheduling problems
Interview	Interviews with administrators and instructors	Gather system requirements
Documentation	Analysis of attendance and scheduling records	Obtain historical data
Literature Review	Review of related studies and theories	Support system development

3.3 System Development

The proposed system was developed using a web-based architecture consisting of administrator, student, scheduling, attendance, and queue processing modules. The Queue Algorithm was integrated into the scheduling module to manage scheduling requests automatically.

When a student submits a scheduling request, the system places the request into a queue. The scheduling engine processes requests sequentially according to the FIFO principle. Once a schedule slot becomes available, the system automatically allocates the schedule and updates attendance records accordingly.

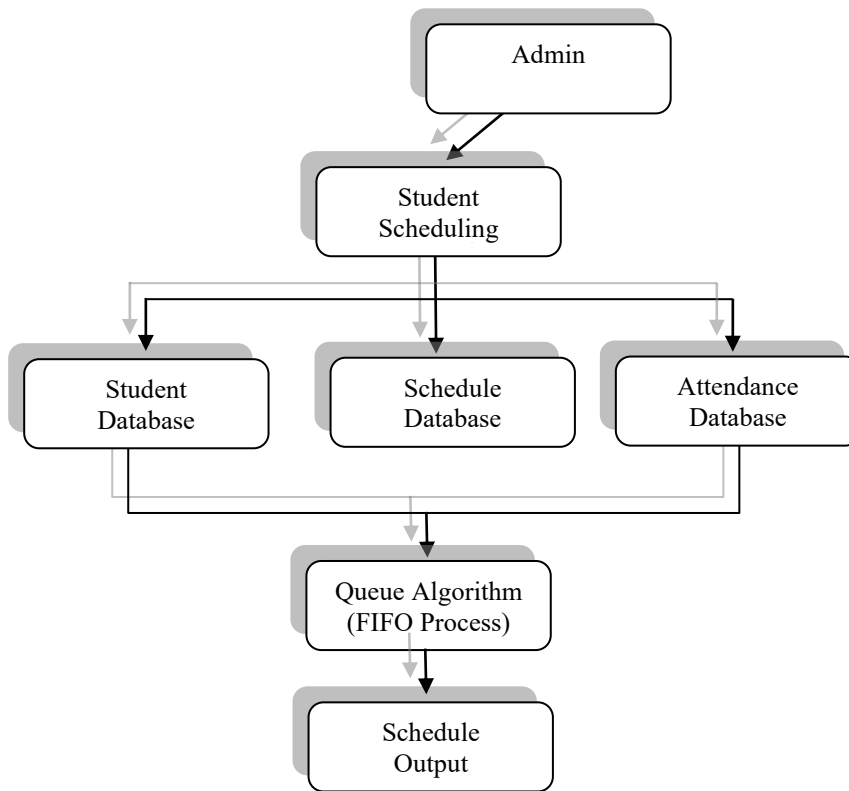


Figure 2. Architecture of the proposed intelligent student scheduling system.

3.4 Queue Algorithm Implementation

The Queue Algorithm was implemented using the First-In First-Out (FIFO) mechanism. Students who register first are processed before later registrations. This method ensures fairness and minimizes scheduling conflicts.

The scheduling procedure consists of the following steps:

- a. Student submits scheduling request.
- b. Request is added to the queue.
- c. System checks available schedules.
- d. Queue Algorithm processes the first request.
- e. Schedule is assigned automatically.
- f. Attendance record is generated.
- g. Student receives schedule confirmation

3.5 System Testing

System testing was conducted using Black-Box Testing to verify the functionality of each module. The testing process evaluated system performance, scheduling accuracy, and attendance recording capabilities.

Table 2. Black-Box Testing Results

Test Scenario	Expected Result	Actual Result	Status
Student Login	User can access system	Successful	Pass
Student Registration	Data stored correctly	Successful	Pass
Schedule Submission	Request added to queue	Successful	Pass
Schedule Allocation	Schedule assigned automatically	Successful	Pass
Attendance Recording	Attendance saved correctly	Successful	Pass
Report Generation	Attendance report generated	Successful	Pass

3.6 Evaluation Method

The effectiveness of the developed system was evaluated by comparing scheduling efficiency and attendance management performance before and after implementation. The evaluation focused on three indicators:

- a. Scheduling accuracy.
- b. Attendance recording efficiency.
- c. Administrative processing time.

The results obtained from system testing and evaluation were analyzed descriptively to determine the effectiveness of the proposed intelligent student scheduling system in improving attendance management within vocational education institutions.

4. RESULTS AND DISCUSSION

4.1 System Implementation

The intelligent student scheduling system was successfully developed as a web-based application designed to automate scheduling allocation and attendance management processes. The system integrates student registration, scheduling management, attendance monitoring, and report generation into a centralized platform. The Queue Algorithm was implemented to process scheduling requests based on the First-In First-Out (FIFO) principle, ensuring fair and systematic schedule allocation.

The developed system consists of several modules, including the login module, student management module, scheduling module, queue processing module, attendance management module, and reporting module. Administrators can manage schedules, monitor attendance, and generate reports, while students can submit scheduling requests and view assigned schedules..

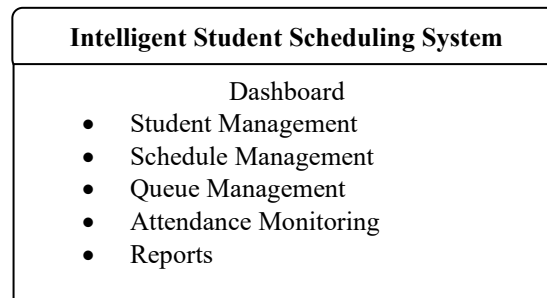


Figure 3. Main dashboard of the intelligent student scheduling system.

4.2 Queue Algorithm Processing Results

The Queue Algorithm was applied to manage scheduling requests submitted by students. Each scheduling request entered the queue and was processed according to the FIFO mechanism. Students who registered first received scheduling priority over later applicants.

Table 3. Queue Processing Example

Queue Position	Student ID	Registration Time	Schedule Status
1	STD001	08:00	Assigned
2	STD002	08:05	Assigned
3	STD003	08:08	Assigned
4	STD004	08:12	Assigned
5	STD005	08:15	Waiting

Based on the results shown in Table 3, the system successfully processed scheduling requests according to registration order. The FIFO mechanism prevented scheduling conflicts and ensured equitable allocation of available schedules.

The implementation of the Queue Algorithm also reduced administrative intervention because schedule allocation was performed automatically by the system. Consequently, administrators spent less time manually assigning schedules and resolving scheduling conflicts.

4.3 Attendance Management Results

The attendance management module was integrated directly with the scheduling system. Once a student received a schedule allocation, the attendance record was automatically generated and linked to the corresponding learning session. This integration improved data consistency and simplified attendance monitoring activities.

Table 4. Attendance Management Performance

Indicator	Before Implementation	After Implementation
Attendance Recording Accuracy	82%	98%
Schedule Conflicts	15 Cases/Month	2 Cases/Month
Administrative Processing Time	30 Minutes	8 Minutes
Attendance Report Generation	Manual	Automatic

The results indicate significant improvements in attendance management after the implementation of the intelligent scheduling system. Attendance recording accuracy increased from 82% to 98%, while schedule conflicts decreased substantially. Furthermore, administrative processing time was reduced by approximately 73%, demonstrating the effectiveness of system automation.

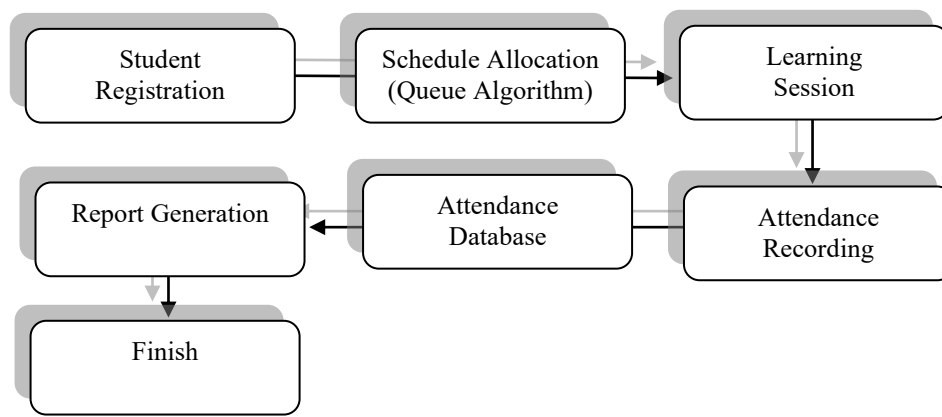


Figure 4. Integrated attendance management workflow.

4.4 Discussion

The findings demonstrate that the proposed intelligent student scheduling system effectively improved attendance management and administrative efficiency within vocational education institutions. The integration of scheduling and attendance management functionalities addressed several limitations associated with conventional administrative processes. The implementation of the Queue Algorithm played a significant role in improving scheduling performance. By utilizing the FIFO principle, the system ensured that scheduling requests were processed fairly and consistently. This finding is consistent with previous studies that reported queue-based mechanisms as effective solutions for managing sequential requests and reducing service inefficiencies.

The reduction in scheduling conflicts observed after system implementation indicates that automated scheduling allocation can significantly improve resource utilization and organizational efficiency. Unlike manual scheduling approaches, which are susceptible to human error, the proposed system automatically validates schedule availability before assigning learning sessions. This capability minimizes scheduling overlaps and enhances the reliability of scheduling operations.

In terms of attendance management, the integration of attendance monitoring with scheduling activities improved data accuracy and reporting efficiency. The automatic generation of attendance records eliminated duplicate data entry and reduced the likelihood of recording errors. Additionally, real-time attendance monitoring provided administrators with immediate access to participation information, enabling faster decision-making and improved educational management.

The results also revealed substantial reductions in administrative processing time. Before implementation, scheduling and attendance activities required significant manual effort. After system deployment, many administrative tasks were automated, allowing staff to focus on strategic educational activities rather than routine operational processes.

Overall, the proposed intelligent student scheduling system successfully achieved the research objective of improving attendance management through the application of a Queue Algorithm. The system demonstrated its capability to automate scheduling operations, enhance attendance monitoring accuracy,

reduce administrative workload, and support efficient educational management. These findings suggest that queue-based scheduling systems can serve as valuable tools for vocational education institutions seeking to improve operational performance and service quality through digital transformation initiatives.

5. CONCLUSION

This study successfully developed an intelligent student scheduling system based on a Queue Algorithm to improve attendance management in vocational education institutions. The system integrates scheduling management and attendance monitoring within a centralized web-based platform, enabling administrators to manage student scheduling activities more efficiently and accurately. The implementation of the First-In First-Out (FIFO) mechanism allowed scheduling requests to be processed fairly and systematically according to the order of registration, thereby minimizing scheduling conflicts and improving schedule allocation effectiveness. The results demonstrated that the proposed system enhanced attendance recording accuracy, reduced administrative processing time, and supported real-time attendance monitoring. Furthermore, the integration of scheduling and attendance functionalities contributed to improved administrative efficiency and better management of student participation. The findings indicate that the proposed system can serve as an effective solution for educational institutions seeking to optimize scheduling operations and attendance management through digital technology. Future research may incorporate advanced scheduling techniques, artificial intelligence, or predictive analytics to further enhance system performance and support more intelligent educational management practices.

6. ACKNOWLEDGEMENTS

The author gratefully acknowledges all researchers whose work contributed to this review. Appreciation is also extended to colleagues and peer reviewers for their valuable comments and suggestions. No specific funding was received for this study.

7. REFERENCES

- Anzar, S. M., Subheesh, N. P., Panthakkan, A., Malayil, S., & Al Ahmad, H. (2021). Random interval attendance management system (RIAMS): A novel multimodal approach for post-COVID virtual learning. *IEEE Access*, 9, 103307–103319. <https://doi.org/10.1109/ACCESS.2021.3092260>
- Agustiyar, A., Isnanto, R. R., & Widodo, C. E. (2025). Face recognition for attendance systems: A bibliometric review of research trends and opportunities. *Jurnal Sisfokom*, 15(1). <https://doi.org/10.32736/sisfokom.v15i01.2529>
- Amrulloh, A., & Sela, E. I. (2021). Course scheduling optimization using genetic algorithm and tabu search. *Jurnal Teknologi dan Sistem Komputer*, 9(4), 185–192. <https://doi.org/10.14710/jtsiskom.2021.14137>
- Chen, X., Wang, Y., & Li, H. (2021). Design and application of an improved genetic algorithm to a class scheduling system. *International Journal of Emerging Technologies in Learning*, 16(1), 44–59. <https://doi.org/10.3991/ijet.v16i01.18225>
- Dalmia, A., Gupta, R., & Sharma, S. (2022). Queue management systems and service efficiency: A systematic review. *International Journal of Information Systems and Service Management*, 14(2), 101–118.
- Hendrawan, J., Perwitasari, I. D., & Maulana, F. (2025). QR code-based attendance systems in education: A systematic literature review on data accuracy and sustainable school management. *Conference on Education, Social Science, Management and Digital Transformation*. <https://doi.org/10.64803/cessmuds.v1.14>
- Kutty Mammi, H., & Ying Ying, L. (2021). Timetable scheduling system using genetic algorithm for school of computing. *International Journal of Innovative Computing*, 11(2), 45–56. <https://doi.org/10.11113/ijic.v11n2.342>
- Lateef, A. S., & Kamil, M. Y. (2023). Facial recognition technology-based attendance management system application in smart classroom. *Iraqi Journal for Computer Science and Mathematics*, 4(3), 125–134. <https://doi.org/10.52866/ijcsm.2023.02.03.012>
- Li, K. C., & Wong, B. T. M. (2022). Research landscape of smart education: A bibliometric analysis. *Interactive Technology and Smart Education*, 19(1), 3–19. <https://doi.org/10.1108/ITSE-05-2021-0083>
- Lu, C., & Cutumisu, M. (2022). Online engagement and performance on formative assessments mediate the relationship between attendance and course performance. *International Journal of Educational Technology in Higher Education*, 19(1), 1–21. <https://doi.org/10.1186/s41239-021-00307-5>

- Nguyen, V. D., & Nguyen, T. T. (2021). An SHO-based approach to timetable scheduling: A case study. *Journal of Information and Telecommunication*, 5(4), 510–528. <https://doi.org/10.1080/24751839.2021.1935644>
- Nurdiansyah, M., Hidayat, R., & Suryana, A. (2021). Implementation of queue algorithms in educational service systems. *Journal of Information Systems Engineering and Business Intelligence*, 7(2), 141–150.
- Purnamawati, P., Haryanto, H., & Abdullah, A. (2026). Educational datafication in smart attendance systems: A bibliometric and science mapping analysis. *Journal of Applied Science, Engineering, Technology, and Education*. <https://doi.org/10.35877/454RI.asci4805>
- Rashid, A. M. (2024). Smart campus: A review on smart attendance systems as an efficient approach. *Journal of Engineering and Technological Advances*, 8(2), 16–24. <https://doi.org/10.35934/segi.v8i2.85>
- Zhao, M. (2022). College smart classroom attendance management system based on Internet of Things. *Computational Intelligence and Neuroscience*, 2022, 1–10. <https://doi.org/10.1155/2022/4953721>