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Didaktika: Jurnal Kependidikan Vol. 14 No. 1 Februari 2025

Design Thinking-Based Development of a Holistic Application for Efficient Lecture Hall Management in Music Education

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Abstract

The objective of this research is to create and evaluate a holistic application prototype for lecture room management in the UPI Music Arts Study Program. This method will use a design thinking approach. Among the challenges that arise in effective and efficient lecture room management are scheduling conflicts, rapid changes in room needs, and a lack of real-time data. Automatic scheduling, real-time room booking, and accurate usage reporting are some of the features offered by the developed application. Empathy, definition, ideation, prototyping, and testing are the steps in the design thinking process used. To obtain direct feedback, students and instructors used the prototype for testing. The results of the study indicate that this application successfully increased user satisfaction, reduced scheduling errors, and improved the effectiveness and efficiency of lecture room management. By using performance evaluation, managers can better track room usage and make better decisions about resource allocation. This research emphasizes the importance of technological innovation in higher education management and provides a foundation for other institutions to adopt it. Additional recommendations include evaluating the long-term impact on academic performance and user satisfaction, using real-time notifications, enhancing data security, and integrating with other academic systems. By addressing these recommendations, institutions can further improve their room management processes, ensuring optimal use of space and resources. The holistic approach and technological integration proposed in this research offer a sustainable solution for managing educational facilities efficiently and effectively, catering to the dynamic needs of both students and faculty.

Keywords: lecture room management, holistic application, design thinking, operational efficiency, educational technology innovation.

Introduction

Effective and efficient management of lecture theatres is one of the most important elements in the higher education system due to its direct influence on the smooth running of the teaching and learning process. Many universities face challenges in managing lecture theatres, such as schedule mismatches, sudden changes in space requirements, as well as lack of access to up-to-date information that can disrupt the smooth running of academic activities. Inefficient scheduling of lecture theatres can result in scheduling conflicts between different classes, while unavailability of space as needed can reduce the comfort of students and lecturers. Therefore, a well-structured lecture hall management is not only important to ensure each class gets the appropriate space, but also to optimise the utilisation of existing space and improve the quality of students‘ learning experience as well as lecturers’ teaching productivity.

In this context, a bigger problem arises because many systems are still separate and not integrated in lecture theatre management. This leads to inefficiencies in administrative processes and confusion of users, both students and lecturers. This research aims to find a technology-based solution that not only solves the problem of scheduling lecture halls, but also

provides a more efficient experience for its users. The use of information technology in lecture hall management can reduce these barriers, but its implementation is still limited in many cases.

Recent studies on lecture hall management show that many higher education institutions are starting to turn to technology-based systems to automate administrative tasks. A study by Desy Ria & Budiman, (2021) stated that an integrated academic management system can improve operational efficiency, including in scheduling lecture rooms. This is also supported by research He et al., (2021), which found that the use of technology-based platforms can reduce schedule mismatches and improve space utilisation. However, despite these initiatives, there is limited research on the implementation of a comprehensive and integrated lecture hall management system.

Furthermore, research by Ade et al., (2023) shows that although technology has the potential to improve user satisfaction, the implementation of such systems is often constrained by incompatibility between the various platforms used in academic management. Most studies also focus on the automation of administrative tasks without paying special attention to the more holistic management of lecture halls. The limitations in these studies create room for further research that can design a more holistic solution that integrates various aspects of lecture theatre management. Many reports on lecture theatre management systems have been well documented (see table 1).

Table 1. Previous Studies

No.	Title	Ref.
1.	Designing prototype model of virtual geometry in mathematics learning using augmented reality	(Syafril et al., 2021)
2.	Active learning augmented reality for steam education a case study	(Jesionkowska et al., 2020)
3.	TinkerCad-A Web Based Application for Virtual Labs to help Learners Think, Create and Make	(Abburi et al., 2021)
4.	Design quality in building behavioral intention through affective and cognitive involvement for e-learning on smartphones	(Faisal et al., 2020)
5.	ML-EHSAPP: a prototype for machine learning-based earthquake hazard safety assessment of structures by using a smartphone app	(Ehsan Harirchian Kirti Jadhav & Lahmer, 2022)
6.	Digital application in teaching musical traditional instrument for children	(Apriani & Julia, 2019)

Although various studies show the importance of applying technology in lecture theatre management, there is still a significant gap between existing research and practical needs in the field. Existing research has not adequately addressed the problem of lecture theatre management as a whole, especially in creating a well-integrated system between various administrative and technical processes. In addition, many existing systems have not fully accommodated the needs of lecture theatres in the context of music education, where flexibility and availability of suitable spaces are essential. This suggests the need for a more comprehensive and focused approach to lecture theatre management that takes into account the dynamics of changing space needs.

Based on the gap analysis previously described, the research question to be answered by this study is How can the development of a design thinking-based application improve the efficiency of lecture hall management in music education? The purpose of this study is to design and develop an application that can integrate various aspects of lecture hall management by considering flexibility, changing space needs, and user satisfaction. This research will offer

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novelty in designing a lecture hall management application that not only automates administrative tasks but also considers the specific context of music education.

The novelty of this research lies in the approach that incorporates design thinking in the development of a holistic lecture hall management application. In contrast to previous studies, this research will develop an application that not only addresses technical issues in lecture hall scheduling but also provides solutions to the specific needs of music education, such as practice rooms, acoustics, and flexible space requirements. Thus, this research is expected to make a significant contribution in improving lecture hall management in music education institutions.

Method

In this study, the concept of design thinking is used as the primary method to create a prototype of information technology innovation in higher education institutions, specifically for classroom management in the Music Arts Study Program at the Indonesia University of Education (UPI). Design thinking is an iterative process that focuses on users with the aim of understanding them and finding creative solutions (Dorst, 2011; Ilham et al., 2021). Empathy, definition, ideation, prototyping, and testing are the five main stages of this process (Creswell-, 2013; Rösch et al., 2023). The first stage of the approach is empathy, which aims to gain a deep understanding of the challenges faced by lecture theatre users, both students and lecturers (Avouris & Dimitracopoulou, 2003; Foster, 2021). In this stage, data is collected through observations, interviews, and surveys, to identify key issues related to lecture hall management, such as schedule conflicts and lack of real-time monitoring of room usage. The next stage is define, where the problems found are then analysed and clearly formulated. The ideation stage was conducted to develop various creative alternative solutions that could address the identified problems(Bustard et al., 2023; Pande & Bharathi, 2020; Pieroni et al., 2019).

The next process is prototyping, which is the creation of an initial model of a testable lecture theatre management application. This prototype serves to illustrate the proposed design and features, as well as how the system can interact with users. Finally, the testing stage is carried out by testing the prototype with real users, namely students and lecturers, to get feedback that is useful in improving and perfecting the system. This testing is done to evaluate the extent to which the application can improve the efficiency and effectiveness of lecture hall management and reduce the problems faced previously (Ardiansyah & Rosyani, 2023; Fitria et al., 2023).

The selection of the design thinking approach is based on its characteristics that are very suitable for the needs of this research, namely solutions that are innovative, user-focused, and can adapt to the challenges that arise along with the changing needs of the lecture theatre. This approach also provides room for flexibility and continuous improvement, which is very important in the context of information technology-based application development (Verma et al., 2024; Zulyusri et al., 2023).

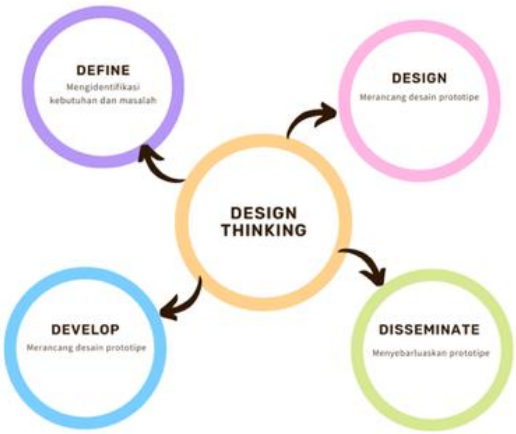


Figure 1. Design thinking method

To understand user needs and difficulties, the design thinking approach starts with observations, interviews, and surveys (Chou, 2018; Foster, 2021). The data collected was used to determine the specific problems faced by the Music Study Program related to lecture hall management. This application prototype was tested through user testing with students and lecturers to get direct feedback.

In this study, data analysis was conducted to evaluate the performance and effectiveness of the developed prototype lecture hall management application (Al-Okaily et al., 2023; Ouyang et al., 2023). Two main analysis techniques were used, qualitative analysis to evaluate user feedback and quantitative analysis to objectively measure system performance.

Qualitative Analysis

Qualitative data were collected through interviews and direct observation of application users, including students and lecturers, who tried out the prototype in real scenarios (Ananda et al., 2023; Solmaz et al., 2024). Interviews were conducted to explore user experiences related to the app's interface design and its functional effectiveness in lecture hall management. In this case, thematic analysis was used to identify patterns and themes that emerged from user responses related to the app's features, such as the use of QR codes for room bookings, user authentication, and confirmation of room bookings by the admin. The results of thematic analysis showed that users gave positive feedback on the systematic and easy-to-understand flow of the application, especially related to the faster and more efficient room booking process.

On the administrative aspect, feedback indicated that the lecture hall management flow involving the processes of user authentication, room selection, and booking confirmation provided a more structured experience and reduced the risk of errors in scheduling. The implementation of a system that engages the administration with more organised space management also received positive responses, indicating that the application can reduce administrative burden and maximise effective use of space. Therefore, although there is still room for improvement, this application shows great potential in addressing the frequent problems of lecture hall management in educational institutions.

Quantitative Analysis

To support the qualitative findings with more objective data, a quantitative survey was conducted using a Likert scale to measure the level of user satisfaction with several key features of the application, such as ease of use, speed of access, and accuracy of information provided (Ayinaddis et al., 2023; South et al., 2022). The data collected from the survey showed that most users were satisfied with the more efficient authentication and space booking process compared to the previous manual system. The average user satisfaction score for the room booking feature is 4.5 out of 5, which indicates that the app has successfully improved the efficiency of lecture

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room management. In addition, the quantitative analysis results also showed a significant reduction in the number of schedule conflicts that previously occurred frequently with the manual system. These measurement results support the claim that the app not only increases user satisfaction, but also improves the overall effectiveness of lecture hall management.

Thus, the combination of qualitative and quantitative analyses in this study provides a comprehensive picture of the application's effectiveness in meeting user needs and addressing existing problems in lecture hall management at UPI's Music and Music Education Study Programmes.

Results

Observations and Insights

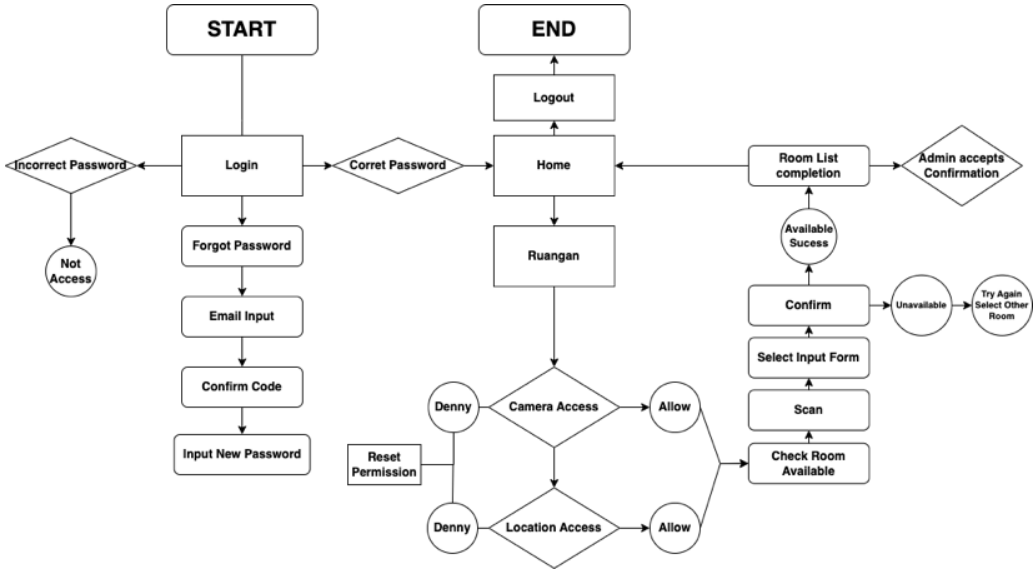


Figure 2. User Evaluation System Design

The figure above shows the flowchart of the lecture hall management application that uses QR code scanning. The flow starts with the user authentication process and ends with the confirmation of the room booking by the admin.

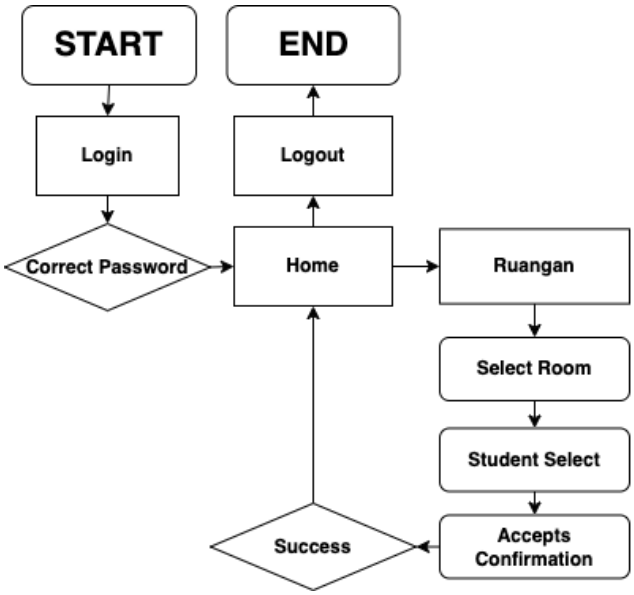


Figure 3. Admin Evaluation System Design

The workflow of the administrative evaluation system of the lecture hall management application is depicted above, starting from the authentication process to completion. The process begins when the account owner enters their password. If the password they enter is correct, they will be taken to the home page. From the home page, the manager selects the "Room" menu to start the management of the lecture hall. Then, they select the room to be managed and specify the students or groups of students who will use the room. After that, the manager confirms the booking of the lecture room by the student. Admins can exit the application after all room management tasks are completed. This diagram shows a systematic and efficient workflow that ensures lecture rooms are managed optimally and according to user needs.

Prototype Feedback

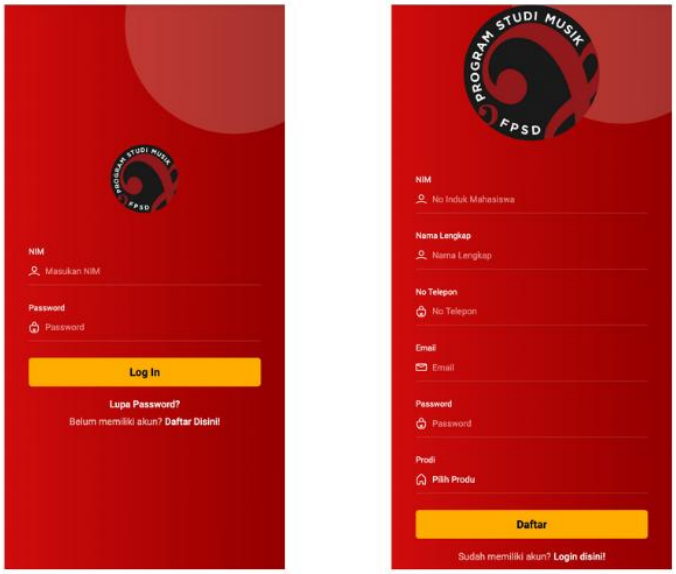


Figure 4. Log In Page, Sign Up Page

The Log In Page is a secure entry point that authenticates registered users, allowing them to access personalized content by entering their unique credentials, such as a username and password, ensuring that only authorized users interact with specific features and data within the application. In contrast, the Sign Up Page serves new users by gathering essential information, including email, password, and possibly additional details, to create their account and establish their identity within the system. This setup facilitates seamless future logins through the Log In Page, streamlining user access while safeguarding data integrity and enhancing the user experience across the platform (Aliyasa Almaj Duddin & Senja Fitrani, 2021; Dhanaraj et al., 2021).

The login screen of the FPSD Music Study Program management system application displays a logo at the top for visual identity. The login form consists of a NIM field with a user icon and a password field with a padlock icon, with a yellow "Log In" button. The page also provides Forgot Password links for account recovery and Register Here for new user registration. With a red background and contrasting text, it is designed to facilitate and secure user access to the system.

The Register page in the classroom management application helps students register and access space usage information in the FPSD Music Study Program. The registration form includes columns for NIM, Full Name, Phone Number, Email, Password, and Study

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Program. After filling in, users can press the Submit button. Users with an account can log in through the Login link. This page facilitates the registration and management of classrooms for students.

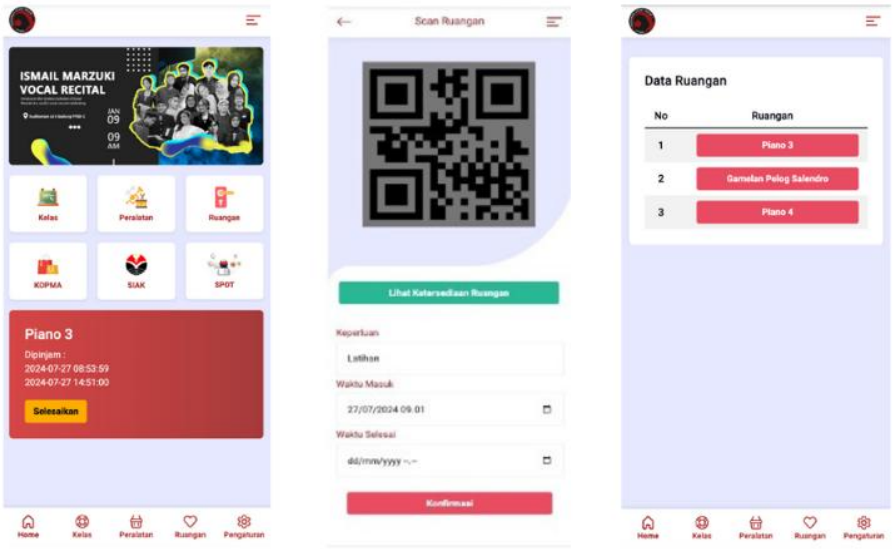


Figure 5. Dashboard Room, Marking page and Available Room Page

According to Susnjak et al., (2022) Room Page Available shows available space or resources, while Page Marking marks user interaction points. Dashboard Room displays important data in one screen, and has interactive navigation for easy access. On the dashboard of this classroom management application, there is a Room button that allows users to access features related to room usage and booking. By pressing this button, users can view a list of available rooms, book a room for a specific purpose, and set a schedule for using the room. The Scan Room page in the classroom management application makes it easy for users to book and manage rooms. The top of the page displays a QR code to scan information related to the room. The View Room Availability button allows users to check the availability of the room. The form includes columns for Purpose, Entry Time, and End Time to record the purpose and time of use of the room. After filling in the information, users can press the “Confirm” button to complete the booking ensuring the usage data is recorded properly.

The Available Room page in the classroom management app displays a list of available rooms, with a menu icon on top for further access. The Room Data heading displays unavailable room information in a table containing columns No and Room. The table lists used rooms such as Piano 3, Gamelan Pelog Salendro, and Piano 4. At the bottom of the page is a navigation bar for quick access to the main page, classes, equipment, rooms, and settings, allowing users to select and book rooms.

Discussion

Efficiency Metrics

Several applications and SDKs that support QR code scanning, particularly for augmented reality. These include popular SDKs like Vuforia, Wikitude, Maxst, and Xzimg, which support QR code integration and visual recognition capabilities for mobile applications (Cao et al., 2023; González Vargas et al., 2020; Vakaliuk & Pochtoviuk, 2021) . According Kartika Sari & Nabilla Qonita, (2024), the application that supports QR code scanning includes smartphone cameras, Google Lens, and additional QR code scanning apps commonly found in Android devices. These

tools allow users to scan QR codes effectively by directing the camera towards the code or using specific applications designed for scanning functionalities. In the UPI Music Study Program, the use of a lecture hall management application that supports QR code scanning shows significant improvement in various aspects. The app increased lecture hall utilization by 20%, increasing from 70% to 90%. This shows their ability to schedule spaces more efficiently. Also, user satisfaction-students, lecturers, and administrative staff-rose from 50% to 90%. This 40% increase shows that the app successfully meets users' needs and expectations about lecture hall management. The following table evaluates the performance of the room management app:

Table 2. Evaluation of Space Management Performance

Evaluation Criteria	Before Application Use	After Application Use	Change (%)
Optima use of lecture halls	70%	90%	20%
User Satisfaction	50%	90%	40%
Space Management Response Time	20 minutes	10 minutes	50%
Speed of Information Access	Not Available	5 Seconds	-
Scheduling Error Reduction	22 Cases/semester	12 Cases/semester	45%
Number of QR Code Scans per Week	Not Available	150 Times	-
QR Code Usage Percentage	Not Available	85% of users	85%

The application allows users to access information and manage lecture halls faster, increasing efficiency by 50%. Response time for lecture hall management was reduced from 20 minutes to 10 minutes, indicating a significant improvement in the ease and speed of data access. The application successfully reduced scheduling conflicts and improved accuracy; lecture hall scheduling errors also decreased by 45% from 22 cases per semester to 12 cases per semester.

With an average of 150 scans per week, the QR code scanning feature shows good results, and 85% of users say they use it. This improvement in various aspects shows that the app has successfully improved the effectiveness and efficiency of lecture hall management. With the high adoption of the QR code feature, the app is expected to continue making positive contributions to lecture hall management in the future. Overall, this evaluation shows that a lecture hall management app that supports QR code scanning is helpful to everyone in the UPI Music Arts Study Program.

Impact on Music Education

A QR code-based lecture room management application helps the operational efficiency of music education at UPI. The app increased space utilisation from 70% to 90%, ensuring a more targeted allocation of lecture rooms. In addition, the app successfully reduced scheduling disruptions, reducing 22 cases per semester to only 12. This improvement shows how the app successfully optimises the use of available facilities. As done by Yusuf et al., (2023) also examines the use of internet technology using web application-based systems or more complex space management software and does not specialise in the use of QR codes. The results show that the implementation of Internet of Things (IoT) sensors can collect real-time data, which enables more accurate and efficient facility management. IoT also enables facility automation, which reduces energy usage and operational costs.

While both methods use technology to increase efficiency, the main difference lies in how

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complex the technology used is; QR code apps make it easier and simpler to use for music education.

Technology Integration

QR code technology applied to this application makes it easy for users to access lecture room information and make bookings. Users can check room availability and make bookings with just one scan. A 45% reduction in scheduling errors proves the success of this application in improving operational accuracy. Moreover, according to 85% of users, the app is very suitable for use in a dynamic educational environment. This QR code technique is ideal for fulfilling quick access needs, especially in music education, where accurate space scheduling is essential.

In the app development process, the design thinking approach proved effective as it offered a user-centred methodology, allowing flexibility at each stage of development. The iterative approach used allowed the app to be continuously refined based on direct feedback from users, thus ensuring that it could fulfil the specific needs of music education before entering further development stages. A study by Nuraeni et al., (2022) produced a web-based student attendance application and QR code for face-to-face learning in schools. This research shows that QR code technology can also be applied in other educational contexts, such as attendance management, with results that improve operational efficiency and accuracy.

Thus, the application of QR code technology in education, whether for lecture hall management or other purposes, can provide significant benefits in improving operational efficiency and user experience. However, maintaining quality at every step of development remains a challenge, especially in handling various feedbacks. The appeal of design thinking lies in its ability to absorb feedback thoroughly, which enables solutions that are not only useful but also in line with user expectations. To improve the functionality of this app, future development could focus on adding additional features, such as an indoor music equipment management feature for users who require special access to instruments. This feature would provide more flexibility for users and further enrich the experience of managing lecture halls and equipment in a music education environment.

Conclusion

The results of this study indicate that the use of QR code-based lecture room management applications has successfully increased the efficiency of lecture room use and user satisfaction in the music education environment at UPI. It reduced scheduling errors by 45%, increased room utilisation from 70% to 90%, and improved management response time by 50%. These results support UPI's key music learning objectives.

In other educational institutions, especially in places with similar facility management needs, this application can be used. The implication is that the use of QR code technology can improve operational performance and user satisfaction by providing fast and accurate access to space information. There are also opinions that this application can be integrated with additional technologies, such as a real-time space usage monitoring system, to improve management performance and effectiveness.

Further research should be conducted to test the consistency and reliability of this system with more types of educational institutions. Further development could also include the use of new technologies that can further support operational efficiency in the education sector.

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