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OPTIMIZATION OF THE ROOM INFORMATION MANAGEMENT SYSTEM ON THE SIPERAD WEBSITE USING THE WATERFALL METHOD

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Abstract (10pt)

Room reservation management at Universitas Negeri Jakarta's Dewi Sartika Building faced persistent inefficiencies in the existing SIPERAD (Sistem Informasi Peminjaman Ruangan dan Presensi Perkuliahan) platform, including manual one-by-one data entry, the absence of a data export feature, and uncertainty about whether scheduled classes were actually held, which caused rooms to remain marked as occupied although they were in fact vacant. This study aims to develop and implement a web-based room management system with an integrated automatic notification feature to confirm classroom usage and improve room utilization efficiency. The system was developed using the Waterfall method, covering requirements analysis, system design with UML and Entity Relationship Diagram modeling, backend and frontend implementation using the Laravel framework, and system testing. The developed features include automatic web push notifications sent one day before scheduled classes, a course-in-charge confirmation mechanism, bulk data import via CSV, and report export in Excel and PDF formats. Testing was carried out using Black Box Testing to verify functional requirements and User Acceptance Testing (UAT) to assess user acceptance. Black Box Testing results showed that all 31 test scenarios for the Admin role and all 5 test scenarios for the Student role produced valid outputs, indicating 100% functional validity. UAT results indicated a very high acceptance level, with satisfaction percentages of 95.79% from Admin users and 89.69% from Student users, both categorized as "Very Good". These results demonstrate that the developed system successfully addresses the identified limitations of the existing SIPERAD platform and effectively supports real-time, transparent, and efficient room management at Universitas Negeri Jakarta.

INTRODUCTION

The development of digital technology over the past two decades has transformed the way organizations operate, including in higher education. Digitalization drives automation and efficiency, enabling organizations to operate faster and more accurately [1], and leads toward integrated, data-driven systems [2]. In higher education institutions, digital transformation has been shown to improve operational efficiency and the quality of academic services [3], [5].

One form of information system implementation in higher education is a room reservation or booking system, which plays an important role in addressing schedule overlaps, difficulty tracking usage history, and inefficient communication in manual processes. Previous studies have shown that web-based room booking systems can improve administrative efficiency and the transparency of room availability [6], [7].

Nevertheless, these systems generally provide only one-way informative notifications, such as booking-status alerts without a confirmation option from the user [8], or rely on SMS channels with limited reach and interactivity [9]. In other words, previous studies have not presented a two-way confirmation notification mechanism that specifically involves the participation of the student in charge of a course to ensure the

certainty of class implementation before the scheduled time. This is the gap that the present study seeks to address.

Universitas Negeri Jakarta, specifically the 5th and 6th floors of the Dewi Sartika Building, already has a facility management system called SIPERAD (Sistem Informasi Peminjaman Ruangan dan Presensi Perkuliahan, or Room Booking and Lecture Attendance Information System) used by administrators to centrally manage room data, usage schedules, and facility booking processes. However, interviews and re-testing conducted with the administrator revealed that the existing system does not yet fully meet operational needs, including the absence of a report export feature (Excel/PDF) and a data-entry process that is still performed manually one record at a time, making it inefficient for managing large volumes of data.

Another major problem identified is the uncertainty of room usage. Although the class schedule has been set, its implementation is often dynamic due to changes from offline to online delivery or rescheduling by lecturers, so that rooms that are actually not used remain recorded as occupied and cannot be utilized by other parties. Active participation from the student in charge of a course in confirming class implementation is an important factor in ensuring accurate room availability. The use of push notifications has been shown to significantly increase user participation compared to conventional communication methods such as email [10], [11], while Progressive Web App (PWA) technology enables push notifications to be delivered in real time and across platforms without requiring the installation of an additional application [12].

To manage the development process in a structured manner, this study uses the Waterfall method, considering that the system requirements had been clearly identified through interviews and observation, making the specifications stable from the outset, in line with the characteristics of information system development projects whose scope is limited to refining specific modules [13], [14]. Based on the above, this study aims to develop and implement a web-based room management system with an integrated automatic notification feature on the SIPERAD website in the Dewi Sartika Building, Universitas Negeri Jakarta, in order to address the existing system's technical limitations while optimizing room utilization.

METHODS

Research Type and Location

This study uses a system development method aimed at refining the existing SIPERAD system, with development focused on integrating a web push notification feature and a room-usage confirmation mechanism. The research was conducted at Universitas Negeri Jakarta, specifically on the 5th and 6th floors of the Dewi Sartika Building, during the period of February–June 2026, using one laptop unit (Intel Core i7-7500U, 8 GB RAM) with the Laravel framework, Visual Studio Code as the IDE, and the database of the existing SIPERAD system.

Research Stages

System development was carried out using the Waterfall method, which consists of four sequential stages: requirements analysis, system design, implementation, and testing, as shown in FIGURE 1. The requirements analysis stage was carried out through interviews, observation, and a literature study to obtain a comprehensive picture of the existing room booking system. The system design stage was carried out by creating Unified Modeling Language (UML) diagrams in the form of use case diagrams, activity diagrams, and class diagrams, as well as an Entity Relationship Diagram (ERD) as a technical reference for implementation. The implementation stage is the application of the design results into an operable system, covering database, backend, and frontend development. The testing stage was carried out to ensure the system functions according to user requirements.

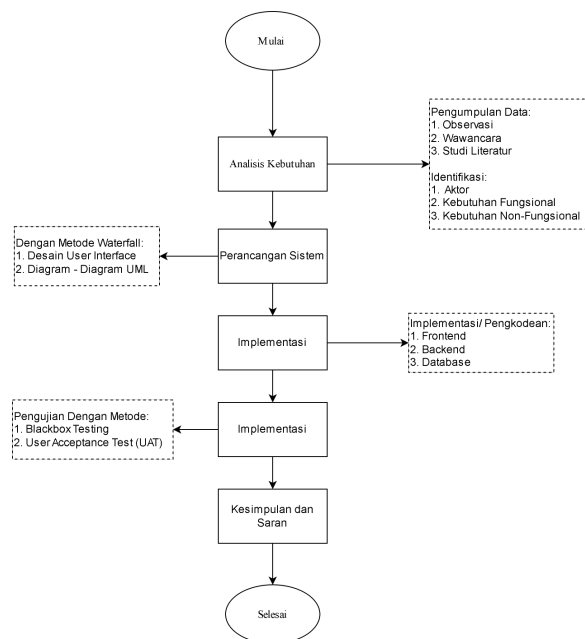


FIGURE 1. Research Stages Using the Waterfall Method

Requirements Analysis

The requirements analysis process began with direct interviews with two informants: one room administrator from the 5th floor of the Dewi Sartika Building and one student acting as the person in charge of a course, in order to explore the existing room booking process, the obstacles encountered, and the system development requirements. Before the interview was conducted, the administrator was first given the opportunity to test the existing SIPERAD system, since the system had previously experienced performance issues and had, as a result, been managed manually again. Observation was carried out directly on the existing SIPERAD system, a Laravel- and MySQL-based system developed using an incremental model that manages room bookings, equipment bookings, and lecturer attendance monitoring within the Mathematics Cluster of UNJ, in order to identify the functional limitations in the existing request, recording, and room-usage workflow. The results of the interviews and observation were supplemented with a literature study.

The analysis results show that the main problem lies in the absence of a mechanism to confirm class implementation before the scheduled day, so that rooms that have been scheduled but are not used remain recorded as occupied, along with the absence of data import and export features. Based on these findings, 12 functional requirements (KF-01 to KF-12) and 7 non-functional requirements referring to the ISO/IEC 25010:2011 software quality standard were formulated, as summarized in TABLE 1.

TABLE 1. Summary of the System's Main Functional Requirements

Code	Functional Requirement
KF-01–KF-03	Management of room data, class schedules, and room usage status by the admin
KF-04, KF-09, KF-10	Sending web push notifications and confirming class implementation (Held/Not Held) by students
KF-05, KF-06	Report recap and dashboard data export to Excel/PDF format
KF-07	Bulk data import via CSV upload
KF-08	Approval (accept/deny) of room booking requests
KF-11, KF-12	Real-time access to room availability information via the web

System Design and Implementation

System design refers to the requirements analysis results and is translated into UML diagrams and an ERD as a technical reference. Implementation was carried out using the PHP-based Laravel framework with a Model-View-Controller (MVC) architecture, covering database construction according to the ERD design, backend and frontend development, and the integration of a Service Worker and Push API to send automatic web push notifications one day (H-1) before the scheduled class.

System Testing

System testing was carried out using two methods. First, Black Box Testing was used to verify the compliance of all functional requirements (KF-01–KF-12) through the AT-KF test scenarios for the Admin actor and UT-KF for the Student actor. The validity percentage was calculated using the validation-percentage formula referring to [15], as follows:

$$\text{Validation Percentage} = (\text{Number of Valid Test Cases} / \text{Total Number of Test Cases}) \times 100\%$$

The higher the validation percentage obtained, the better the functional quality of the developed system [15].

Second, a User Acceptance Test (UAT) was conducted using a 5-point Likert-scale questionnaire (1 = Strongly Disagree to 5 = Strongly Agree) consisting of 19 statements for Admin respondents and 13 statements for Student respondents, developed based on the functional requirements and the ISO/IEC 25010 quality aspects, including satisfaction, functionality, reliability, usability, and efficiency. Example statements for the three main aspects are shown in TABLE 2.

TABLE 2. Example UAT Statements Based on ISO/IEC 25010 Aspects

Aspect	Example Statement
Usability	The interface navigation is easy to understand
Reliability	The system runs stably without errors
Functionality	The features meet the requirements

The ideal highest score (maximum score) was determined using the formula referring to [16], as follows:

$$\text{Maximum Score} = \text{Number of Statements} \times \text{Highest Score} \times \text{Number of Respondents}$$

The user acceptance level was then calculated by comparing the respondents' total score to that maximum score, using the formula:

$$\text{Percentage} = (\text{Respondents' Total Score} / \text{Maximum Score}) \times 100\%$$

The resulting percentage was interpreted into five rating categories: 0%–20% Very Unsatisfactory, 21%–40% Poor, 41%–60% Fair, 61%–80% Good, and 81%–100% Very Good, referring to the rating categories used in [17], to determine the level of user acceptance of the system.

RESULTS AND DISCUSSION

System Implementation

The system was developed based on the analysis and design results using the Waterfall method, with the database realized according to the ERD design. The main features implemented include: (1) management of room data and class schedules by the admin; (2) a room-usage confirmation mechanism through a "Held"/"Not Held" confirmation card sent via web push notification to the student in charge of the course H-1 before the schedule (FIGURE 2); (3) an approval (accept/deny) feature for incidental room booking requests; (4) bulk data import via CSV upload; and (5) data export on every admin dashboard feature to Excel/PDF format. FIGURE 2 shows the room confirmation page interface along with the confirmation card received by the student.

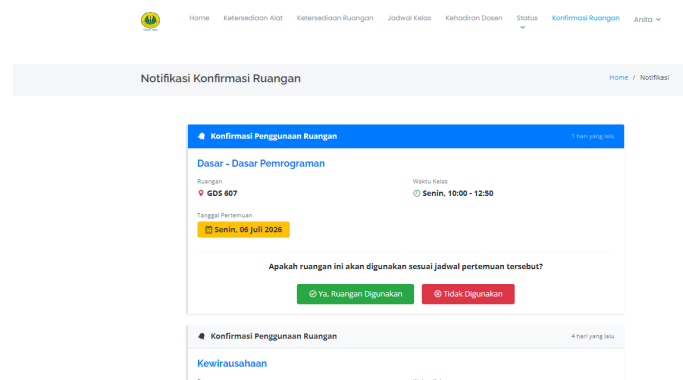


FIGURE 2. Room Confirmation Page and Room-Usage Confirmation Card

In addition to the confirmation feature, the implementation results also include an admin dashboard that centrally summarizes room and equipment booking history (FIGURE 3), as well as a data import page that allows the admin to upload data in bulk via a CSV file according to the provided template (FIGURE 4), thereby replacing the manual, one-by-one data-entry process used previously.

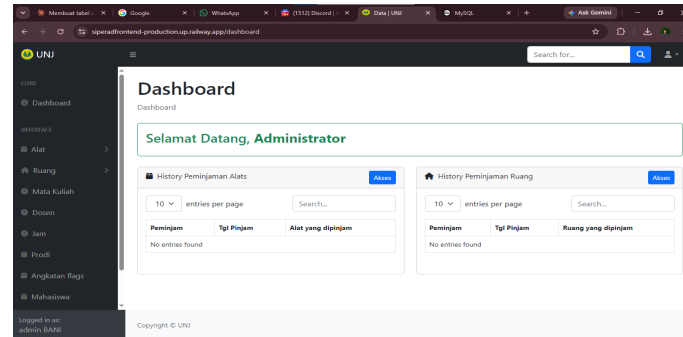


FIGURE 3. SIPERAD Admin Dashboard

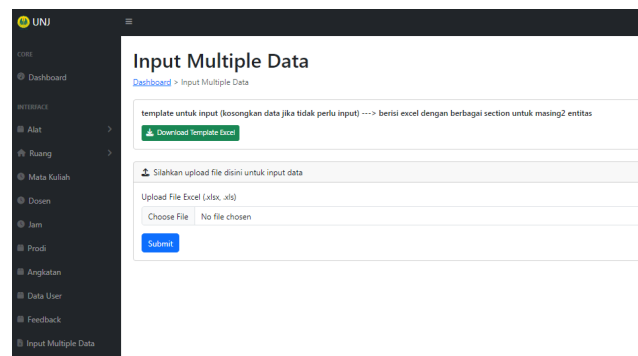


FIGURE 4. Bulk Data Import Page via CSV File

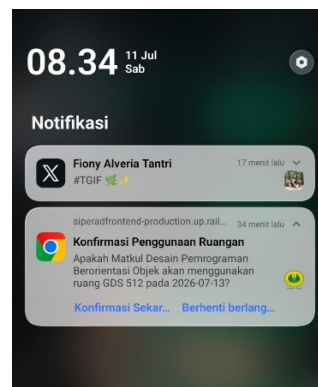


FIGURE 5. Sent Notification

Black Box Testing Results

The results of Black Box Testing on all functional requirements (KF-01–KF-12) are summarized in TABLE 3.

TABLE 3. Summary of Black Box Testing Results

Actor	Number of Scenarios	Valid	Percentage
Room Admin	31	31	100%
Student (User)	5	5	100%

TABLE 3 shows that all 31 test scenarios for the Room Admin actor and all 5 test scenarios for the Student actor were declared valid, resulting in a system validity percentage of 100% for both actors. These results confirm that all features — from room data management, schedule updates, real-time room-status monitoring,

and web push notification delivery, to data export, CSV data import, and room booking-request management, functioned according to specification without errors.

User Acceptance Test Results

The UAT results for the Room Admin and Student respondents are summarized in TABLE 4.

TABLE 4. Summary of User Acceptance Test Results

Respondent	Statements	Total Score	Maximum Score	Percentage	Category
Room Admin	19	182	190	95.79%	Very Good
Student (User)	13	583	650	89.69%	Very Good

TABLE 4 shows that the system acceptance level reached 95.79% among Room Admins and 89.69% among Students, both falling into the "Very Good" category. The maximum score in TABLE 4 is consistent with the number of respondents actually involved in each testing group: the Admin maximum score of 190 was obtained from 19 statements $\times$ a highest score of 5 $\times$ 2 respondents, namely the administrators of the 5th- and 6th-floor rooms, while the Student maximum score of 650 was obtained from 13 statements $\times$ a highest score of 5 $\times$ 10 respondents, namely active students from the Mathematics Cluster, Faculty of Mathematics and Natural Sciences, UNJ. Accordingly, the UAT percentage calculation in TABLE 4 is consistent with the number of respondents involved and indicates that the developed features have met users' needs and expectations in supporting the room management and confirmation process.

Discussion

The testing results show that the developed system successfully addressed the limitations identified in the previous SIPERAD system. The problem of manual, one-by-one data entry was addressed through the CSV data-import feature (KF-07), while the absence of a reporting feature was addressed through the data-export feature to Excel/PDF (KF-06). The uncertainty of room usage, which was the main problem highlighted in the background of this study, was addressed through the web push notification mechanism and class-implementation confirmation (KF-04, KF-09, KF-10), which proved valid in Black Box Testing and received very good user acceptance in UAT.

These findings are consistent with those of Tang & Hew [10], who showed that instant-messaging-based notifications can significantly increase user engagement compared to conventional communication, as reflected in the high level of student acceptance of the web push notification feature in this study (89.69%). This finding further reinforces the results of Mumcu & Çebi [11] regarding the role of notifications in encouraging student self-regulation and engagement, as well as those of Wu [18], who showed that a real-time, notification-based learning system can improve user responsiveness. On the other hand, this study extends the work of Sukmana et al. [7] and Utami et al. [6], who developed web-based room booking systems without integrating an automatic notification mechanism, by adding a two-way confirmation feature that proved valid and was very well received by users. This study also complements the work of Imron et al. [8] and Khasbi et al. [9], who applied one-way notifications to facility booking systems, by presenting a participatory confirmation mechanism based on Progressive Web Apps specifically designed to address the uncertainty of class implementation caused by changes between offline and online delivery modes. Accordingly, the integration of the automatic notification feature in this study proved effective in supporting the optimization of room utilization in the Dewi Sartika Building, Universitas Negeri Jakarta.

CONCLUSION

Based on the results of the analysis, design, implementation, and testing, it can be concluded that the development and implementation of a web-based room management system with an integrated automatic notification feature in the Dewi Sartika Building, Universitas Negeri Jakarta, was successfully carried out through the development of the SIPERAD website using the Waterfall method. The developed system is able to support real-time room booking and availability management, integrate an automatic web push notification feature H-1 before the class schedule, provide a room-usage confirmation mechanism to minimize rooms being recorded as occupied when vacant, and support administrative management through a booking approval feature, CSV data import, and report export in both Excel and PDF formats. The Black Box Testing results show that all functional requirements of the system performed as expected (100% validity), while the User Acceptance Test results show a very high level of user acceptance, with satisfaction percentages of 95.79% from Room Admins and 89.69% from Students. Further development is recommended to expand the system's scope to the equipment-booking and lecturer-attendance modules, extend the implementation scope to other buildings or faculties, and analyze network security and server performance aspects in greater depth.

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