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Digitalization of Forestry Museum Visiting Services Through the Implementation of a Reservation and Scheduling Platform

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This research is motivated by the Forestry Museum's manual reservation process, resulting in irregular schedules and difficulties in managing visitor data. This research aims to build a digital reservation and scheduling platform from scratch using the Prototyping method supported by the Laravel, AJAX, and MySQL frameworks. Functional testing used the Black-Box Testing method, while user experience testing used the System Usability Scale (SUS). The Black Box Testing results showed a 100% success rate. The usability evaluation resulted in an average SUS score of 84.5 placing the system in the Acceptable category. Performance testing resulted in an average visitor form submission time of 0.34 seconds and admin decision execution time of 6.95 seconds, proving the system is capable of processing every data transaction instantly from a technical perspective, thus supporting the smooth flow of overall reservation confirmation. The systems meets the museum's needs and is easy to use.

Keywords: Museum Visits, Laravel, Schedule Management, Digital Reservations, Prototyping, System Usability Scale

INTRODUCTION

Museums are important educational tourism destinations, offering historical and cultural learning as well as recreation (Perdana & Sinaga 2025; Sholehah 2023). Museums serve as centers for information, education, and cultural development (Asmara 2019; Yendra 2019). As centers of information and education, museums have a significant responsibility to provide the best possible service to the public (Amalia *et al*. 2024). To achieve this, the integration of structured service evaluation systems is highly required to ensure precise data transaction mapping and systematic management (Siskandar et al., 2020). However, museum management in Indonesia often faces challenges, particularly in visitor service operations (Hasanah *et al*. 2025). These challenges highlight the need for automated tracking systems and targeted technological frameworks to monitor operational data and optimize structural efficiency (Siskandar et al., 2020).

The main problem with many museums in Indonesia today is their continued reliance on manual methods for administration (Sadikin & Atmawidjaya 2023; Rusdi 2024). Standardizing operational tasks through dedicated software applications and structured computational approaches facilitates precise problem prediction and systematic management (Siskandar et al., 2023). Methods such as recording visitors in physical guest books often result in messy data, are easily lost, and are prone to errors (Salim *et al*. 2025). To prevent these systemic vulnerabilities, modern tracking infrastructures leverage integrated monitoring systems to ensure continuous data control and oversight (Akbar et al., 2019). As a result, museum managers find it difficult to monitor visitor numbers or plan schedules accurately (Gondowijoyo & Soeherman 2019; Sanai *et al.* 2025). To resolve such

challenges, automated scheduling models and computational frameworks are widely utilized to optimize capacity allocation and resource planning across various operational sectors (Santosa *et al*., 2023). Furthermore, today's information technology has changed the way people seek public services, with many seeking convenience and convenience (Hidayatullah *et al.* 2018; Mardiaturrahman & Yulianto 2026). Unless museums quickly transition to digital systems, they will continue to struggle to provide prompt service, ultimately leading to visitor dissatisfaction (Jamil and Firdaus 2025; Selviani *et al.* 2025). Operational bottlenecks can be mitigated through dedicated application designs focused on optimizing structural capacity and operational data transactions (Santosa *et al*., 2021). In this regard, the development of dedicated platform applications plays a critical role in structuring management strategies and balancing operational demand with available structural capacity (Hidayat *et al*., 2023).

A similar problem is experienced by the Ir. Djamaludin Suryohadikusumo Forestry Museum, the current research site. In such environments, relying on systematic data reading tools and digital parameter monitoring is critical to prevent information gaps and optimize administrative workflows (Siskandar et al., 2021). Amidst the rapid development of information technology, the public now expects fast, instant, and transparent public services (Uang & Susniwati 2025). Modern digital architectures frequently leverage integrated application interfaces to facilitate real-time monitoring and operational control for administrators (Akbar *et al*., 2019; Irzaman *et al*., 2022). However, the Forestry Museum's reservation system still relies heavily on a manual process via WhatsApp, preventing prospective visitors from independently checking slot availability and requiring them to wait for an administrator's response. Based on interviews, the total time spent from first inquiring about requirements, requesting availability, submitting required documents, and finally receiving approval from the administrator takes approximately 1 to 3 business days. In terms of schedule management, reservations are still recorded manually in physical books, so administrators lack an automated mechanism to detect slot availability, resulting in potential scheduling conflicts between groups requesting the same date. Integrating predictive detection mechanism within system architectures helps streamline operational data processing and avoids tracking errors found in manual setups (Syafutra *et al*., 2026). Without integrated digitalization, museum operations are hampered and unable to keep up with the demand for information access in today's digital age (Rusdi 2024; Hidayatullah *et al.* 2018; Ndoloe & Sudarmadji 2025; Umar & Miftachuddin 2025). Just as analytical material modeling requires specific computing software to validate structural properties precisely (Irzaman et al., 2025), modern web applications necessitate absolute computational logic to maintain error-free system transactions.

Prior studies have addressed digital reservation systems in various contexts, yet several gaps remain unresolved. Sholehah (2023) developed a museum reservation system using the Prototype method, but the confirmation process remained semi manual and lacked both performance testing and standardized usability evaluation. Umar & Miftachuddin (2025) implemented automatic schedule conflict validation in a laboratory reservation system using Laravel, but adopted the Waterfall method which limits adaptability to changing requirements, and did not measure ease of use with a standardized instrument. Rizky Ariyanto & Syani (2025) successfully eliminated double booking risks in a futsal field reservation system, yet the system was not deployed to a public server and did not include usability testing or response time measurement. Mardiaturrahman & Yulianto (2026) demonstrated the importance of usability evaluation in tourism based reservation systems using UEQ, but did not apply the more standardized SUS instrument or measure system response efficiency quantitatively. Hidayat *et al*. (2025) confirmed that SUS produces objective quantitative data on user acceptance, though the study was limited to evaluation only with merely 7 respondents without developing a new system or measuring response time. None of these studies has specifically developed an integrated reservation and scheduling platform for a forestry museum context that simultaneously addresses slot conflict prevention through database level locking, complete document verification workflow, multi session booking, and automated email notification within a single system

validated through both functional, usability, and performance testing. This study therefore presents a novel contribution by filling this gap through the development of such a platform, designed specifically to meet the operational needs of the Ir. Djamaludin Suryohadikusumo Forestry Museum.

This research, based on these problems, focuses on replacing manual processes with an integrated, precise, and informative online system. While some automated innovations focus on hardware control such as dual-axis tracking algorithms for automated power systems (Siskandar et al., 2024). Dedicated tracking solutions are frequently deployed in automated architectures to continuously monitor slot availability status and minimize manual overhead (Siskandar et al., 2018). This study applies the Prototyping method considering the specific and dynamic operational needs of museums (Purwaningtias 2025). Adhering to structured engineering protocols during the early application design phase ensures that system development remains adaptable and conforms to operational requirements (Siskandar et al., 2022). This method was chosen so that system development can be carried out in stages through a cycle of evaluation and feature improvement with the museum, so that the resulting application is truly relevant and able to meet real needs in the field (Hemawanto *et al*. 2017). Prototyping allows for continuous evaluation of the initial application draft so that changes in needs that often arise when users begin interacting with the system can be accommodated (Virnanda & Mansur 2026). This minimizes the risk of feature incompatibility and ensures that the final product is truly relevant and able to meet real needs in the field. With the development of this digital system, it is hoped that the scheduling process will be more automated and able to streamline overall service operations at the Forestry Museum.

METHODS

The research, entitled "Digitalization of Forestry Museum Visit Services Through the Implementation of a Reservation and Scheduling Platform," was conducted from October 2025 to May 2026. The research took place at the Ir. Djamaludin Suryohadikusumo Forestry Museum, located at Manggala Wanabakti Building, Block 6, Jenderal Gatot Subroto Street, Jakarta 10270, and the Vocational School of the IPB University, located at Kumbang Street No. 14, Babakan, Bogor City. As an institution, IPB University continuously monitors and develops policies to optimize its campus operational activities and infrastructure tracking (Hidayat *et al*., 2024). The research was conducted using three analytical approaches.

The first analytical approach was interviews. These activities were conducted online via Zoom with Forestry Museum administrative staff to identify obstacles encountered in the manual reservation process and formulate the need for a digital scheduling feature. The interviews focused on mapping the administrative workflow, documenting requirements for group visitors, and issues frequently arising from reliance on WhatsApp communication. The information obtained from this interview is the main basis for compiling user stories and system functionality at the communication stage.

The second analytical approach used in this research was observation. This stage involved directly observing the operational flow of visitor services at the Ir. Djamaludin Suryohadikusumo Forestry Museum. Observations focused on how the administrator manages reservation messages via WhatsApp and the process of recording schedules in a manual. This observation aimed to comprehensively understand the factors hindering service efficiency so that appropriate digital solutions could be found.

The third analytical approach was literature review. This approach involved reviewing various academic references, such as scientific journals, books, and technical documents relevant to the topic of museum service digitalization. The study focused on the application of the Prototyping method in software development, the concept of functional testing using Black-Box Testing, and the evaluation of system usability using the System Usability Scale (SUS) and the performance testing of the transaction processing system using Software Performance Engineering.Data Preparation.

The appropriate method based on this approach to map the process and achieve the objectives of this research is the Prototyping method. The Prototyping method is carried out in stages and iteratively through a cycle of evaluation and improvement so that the resulting platform is truly relevant and able to meet real needs in the field (Lisdiyanto *et al*. 2025). This method allows for changes in needs that arise when users begin interacting with the system to be immediately accommodated in each development cycle. After the platform is successfully built through the Prototyping process, the next stage is to conduct system testing to ensure the software quality from various dimensions before being handed over to the museum. This series of evaluations is executed through three testing stages. These three testing methods were chosen because they complement each other: Black Box Testing validates the technical correctness of the system output, SUS measures the level of ease of use from a user perspective, while performance testing ensures the reliability of the system's response time (Hidayat *et al.* 2025). Black Box Testing is implemented as a functional test instrument to verify that key features such as the reservation process, checking slot availability, and the automatic schedule conflict prevention mechanism run according to the designed specifications (Mardiati and Saputra 2025; Rizky Ariyanto and Syani 2025). The System Usability Scale is used to quantitatively measure the level of usability of the platform (Dyatmika *et al.* 2021). This test involved 10 respondents representing all users, including museum administrative staff to evaluate the internal dashboard page and public users to evaluate the reservation form filling flow on the website's front page, representing the role of visitors (Fadilah *et al.* 2024; Prayoga and Kristiana 2024). To ensure the validity of the usability evaluation, respondents were selected using purposive sampling based on two criteria: (1) alignment with the actual user roles of the system, and (2) willingness to complete all task scenarios and questionnaire items. The respondent profile is presented in Table 1.

Table 1. Respondent Profile

Respondents	**Role**	**Age**	**Digital System Experience**	**Evaluated Page**
R1	Museum Administrative Staff	30 Years	Low (limited experience with digital systems)	Admin Dashboard
R2	Museum Administrative Staff	30 Years	Low (limited experience with digital systems)	Admin Dashboard
R3	Prospective Visitor	23 Years	High (frequent internet user)	Public Reservation Page
R4	Prospective Visitor	22 Years	High (frequent internet user)	Public Reservation Page
R5	Prospective Visitor	23 Years	High (frequent internet user)	Public Reservation Page
R6	Prospective Visitor	22 Years	High (frequent internet user)	Public Reservation Page
R7	Prospective Visitor	22 Years	High (frequent internet user)	Public Reservation Page
R8	Prospective Visitor	23 Years	High (frequent internet user)	Public Reservation Page
R9	Prospective Visitor	20 Years	Moderate (occasional internet user)	Public Reservation Page

Table 1. Respondent Profile Part 2

Respondents	Role	Age	Digital System Experience	Evaluated Page
R10	Prospective Visitor	21 Years	Moderate (occasional internet user)	Public Reservation Page

The respondents were selected using purposive sampling based on two inclusion criteria: (1) alignment with the actual user roles of the system, and (2) willingness to complete all task scenarios and questionnaire items. The number of respondents was determined based on two main considerations. First, the number was within the range of 8 to 12 respondents recommended for quantitative SUS testing, where Lewis (2018) stated that the accuracy of the test conclusions had reached 75% with a sample size of 8 respondents. Second, the composition of 10 respondents was designed to reflect the actual users of the system, namely 2 museum administrative staff to evaluate the internal dashboard page and 8 public users to evaluate the reservation form filling flow on the website's front page. The determination of the number 10 also took into account the limitations of actual users, where the number of museum administrative staff only consists of 2 people, making it impossible to add respondents from the admin side. Adding more than 8 visitor respondents did not provide a significant increase in accuracy because the 75% convergence threshold had already been met, while reducing below 8 visitor respondents would actually weaken the representation of public users who make up the majority of system users. Quantitative system performance testing was conducted to measure response time during the public form submission process and admin decision verification (Khalid *et al.* 2025). Measuring the operational efficacy of system iterations is highly essential to evaluate execution stability within the design environment (Sujarnoko *et al*., 2026). Each feature was tested through 40 trials to ensure data transaction stability. The 40 trials per feature were determined based on meeting minimum statistical requirements. Roscoe's Rule of Thumb states that a sample size between 30 and 500 trials is sufficient to produce valid analysis (Alwi 2015). The number 40 was chosen because it falls within this range and also meets the Central Limit Theorem requirement, which ensures a near-normal data distribution, resulting in a representative average response time.

Prosedur Kerja

The Forestry Museum's reservation and scheduling platform was created using the Prototyping method. This method has several stages, as shown in Figure 1.

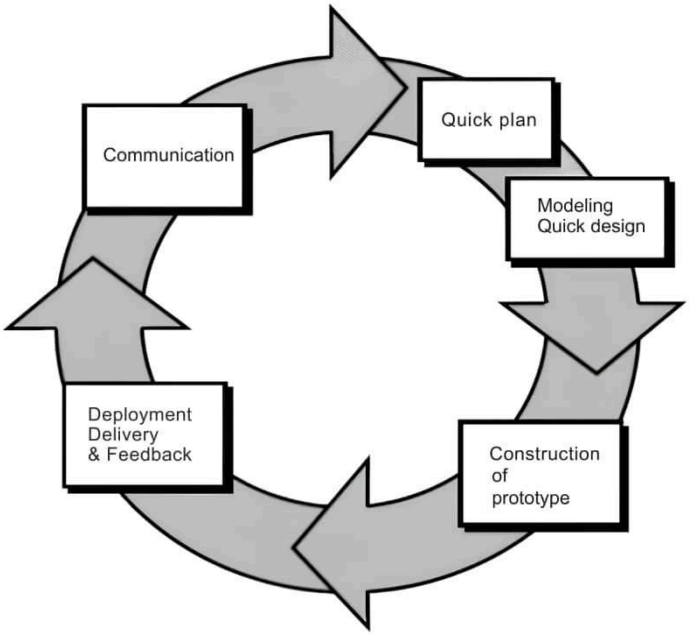

Figure 1. Prototyping method (Rusi *et al.* 2023)

a) Communication

The communication phase was the initial step to deeply understand the Forestry Museum's operational needs. This process was conducted through a combination of online interviews via Zoom and direct observation of the administrative workflow in the field. Observations and discussions focused on how administrators manage reservation messages via WhatsApp, record visit schedules in a manual diary, and the mechanism for handling scheduling conflicts between groups. Observations revealed that reliance on these analog processes resulted in inefficient admin workloads and were prone to data recording errors.

The outcome of this phase was a user story developed based on direct input from administrators. These needs included an automatic quota check feature for each visit session, schedule management by administrators, and a mechanism for uploading official visit request letters in PDF format. Furthermore, the need for an email notification feature to automatically confirm reservation status to visitors was identified. This list of needs then served as the primary reference throughout all stages of system development.

b) Quick Plan

The needs identified in the communication phase were then subjected to rapid planning to compile a concise representation of the system's features. At this stage, the development scope, the priority flow for visitor reservations, and the overall system development schedule were determined. Prioritized features were core features that directly addressed the main challenges, namely schedule management and quota validation per visit session. This plan served as a guideline to ensure system development remained focused on addressing scheduling conflicts and administrative workload.

Planning at this stage included determining the technologies to be used in the system development process. The technologies selected included the Laravel framework with the PHP programming language, a MySQL database, and AJAX to support dynamic interactions in the user interface. This technology selection was based on its suitability to the system's requirements, which required integrated data validation and quota management. This combination of technologies also supported the development of a modular and structured system. In addition to technology determination, the overall scope of system features was also designed at this stage. Features developed included schedule management, reservation approval, regulatory document management, multiple-session reservations, automatic email notifications, and demographic classification and group agency categories. This scope planning ensured that all needs identified in the communication phase could be accommodated within a single, structured development cycle.

c) Modeling Quick Design

The quick design modeling phase focuses on creating a comprehensive technical design for the system before entering the coding phase. System modeling was performed using Unified Modeling Language (UML), which included the creation of Use Case Diagrams to define actor interactions with the system, Activity Diagrams to illustrate functional workflows, and Class Diagrams to design the program code structure. These three diagrams complement each other to provide a comprehensive overview of the system architecture from both a functional and structural perspective. This comprehensive modeling ensures that all user requirements identified in the communication phase can be translated into a structured technical design.

Database design was performed using Entity Relationship Diagrams (ERDs), which map the relationships between entities as the basis for creating key tables in MySQL. The main entities designed include the Schedules table for managing visit time slots, the Reservations table for storing visitor data, the Admin table for managing system access, and the Regulations table for storing official museum regulatory documents. Relationships between entities were carefully designed to ensure data integrity, particularly in the quota validation mechanism, which is the

core of the system. A well-designed database structure is the foundation for the system's ability to automatically prevent schedule conflicts and overbooking.

All design work at this stage aims to ensure the application's data flow and logic are well-developed and structured before entering the coding phase. The resulting design is then consulted with the Forestry Museum to ensure it aligns with previously identified operational needs. This consultation process is crucial to minimize the risk of mismatches between the technical design and user expectations.

d) Construction of Prototype

The approved design was then implemented into program code using the Laravel framework and PHP programming language with a Model-View-Controller architecture. This architecture separates business logic, user interface, and data management in a structured manner so that each system component is modular. At this stage, the system's main functions were built, including quota validation per visit session, an automatic email notification system, PDF document management, and a report export feature in Excel format. System development encompassed all planned features, including an admin login page, dashboard overview, schedule management, reservation approval, visit history, regulatory information management, and a public reservation service page. A dual-session reservation feature that allows visitors to book morning and afternoon sessions in a single transaction, visitor demographic details including the number of men, women, and visitors with disabilities, group agency category classification, and rejection notifications with specific reasons sent automatically via email were also implemented. AJAX integration into the user interface allows the system to display schedule availability information without the need to reload the page. Each feature was developed in stages and tested by museum administrators.

e) Deployment, Delivery, and Feedback

The completed prototype was handed over to the Forestry Museum for live testing to obtain user feedback. At this stage, three types of testing were conducted simultaneously to assess the system's quality from different dimensions: functional testing using Black Box Testing, usability testing using the System Usability Scale (SUS), and system performance testing to measure the speed of the reservation and admin verification systems.

Black Box Testing was conducted by verifying the conformity of the output of all test scenarios based on the use cases defined in the quick design modeling stage. The system's functional success rate was calculated empirically using the following equation (1):

$$Persentase\ validasi = x\,100\% \qquad (1)$$

Usability testing using the System Usability Scale (SUS) involved 10 respondents, including two museum administrative staff and eight prospective visitors. Respondents completed 10 statements on a Likert scale of 1 to 5 after completing a series of task scenarios. The list of SUS statements can be seen in Table 2.

Table 2. List of SUS Statements

No	Task Scenario	Score
Q1	I think I will use this feature again.	1-5
Q2	I think this feature is difficult to use.	1-5
Q3	I find this feature easy to use.	1-5
Q4	I need help from someone else to use this feature.	1-5
Q5	I feel like this feature works as it should.	1-5
Q6	I feel like there are a lot of inconsistencies in this feature.	1-5
Q7	I feel like other people will understand how to use this feature quickly.	1-5
Q8	I find this feature very confusing to use.	1-5
Q9	I felt no obstacles in using this feature.	1-5
Q10	I need to get used to it first before using this feature.	1-5

The System Usability Scale (SUS) standard statement instrument was used to measure the level of system usability. Each respondent provided a subjective assessment of each statement by

selecting a scale of 1 to 5 according to their level of agreement. The scoring scale is divided into five levels, ranging from strongly disagree to strongly agree, as presented in Table 3. This scale was chosen to measure user perceptions in a structured manner so that the assessment results can be further processed into a final SUS score.

Table 3. Score Rating Scale

Answer	Score
Strongly Disagree	1
Disagree	2
Neutral	3
Agree	4
Strongly Agree	5

The resulting score assessment scale is then processed through several conversion stages to produce the final System Usability Scale (SUS) score. The calculation steps are as follows:

1) Odd Statement: For statements number 1, 3, 5, 7, and 9, the score given by the respondent is reduced by 1. Where Px is the score given by the respondent.
   Odd SUS score formula: $\sum Px - 1$ (2)
2) Even Statements: For statements number 2, 4, 6, 8, and 10, the conversion value is obtained by subtracting the number 5 from the score given by the respondent. Where Py is the score given by the respondent.

   Even SUS score formula: $\sum 5 - Py$ (3)

3) Total Respondent Score: The conversion results of the 10 statements are then added together and multiplied by 2.5. This multiplication aims to obtain a final score range between 0 and 100.
   Total score formula: ($\sum skor\ ganjil$ - $\sum skor\ genap$) x 2,5 (4)
4) Average Score: The result of adding up all respondents' scores and dividing it by the total number of respondents. This calculation is done using the formula:

$$X = \frac{\sum x}{n} \quad (5)$$

   Information:
   X = Final average SUS score.
   $\sum x$ = The total number of system usability scale scores for all respondents.
   n = Total respondents

The average SUS score obtained was then interpreted using two classification approaches, namely acceptability range and grade scale, to determine the quality level of ease of use of the system quantitatively. Acceptability range is a classification approach that groups SUS scores into three user acceptance categories, namely not acceptable for a score of 0–50.9 which indicates the system is unacceptable to users, marginal for a score of 51–70.9 which indicates the system is on the threshold of acceptance and acceptable for a score above 71 which indicates the system has been well accepted by users. The acceptability range categories used in this study are presented in Table 4.

Table 4. Acceptability Range

Score SUS	Meaning of Score
0-50,9	Not Acceptable
51-70,9	Marginal
71-100	Acceptable

The second classification approach used is a grade scale to determine the ease of use of the system on a letter scale ranging from A to E based on the range of SUS scores obtained. A rating is given for a score of 80.3 and above, indicating the system has the best level of ease of use, a B rating for a score of 74 to 80.3, a C rating for a score of 68 to 74, a D rating for a score of 51 to

68, and an E rating for a score below 51, indicating the system has very low ease of use. This grade scale approach complements the acceptability range by providing a more granular picture of the position of the system quality in the ease of use spectrum, so that the evaluation results not only indicate whether the system is acceptable or not, but also how good the level of ease of use is achieved relatively. The grade scale classification used in this study is presented in Table 5.

Table 5. Grade Scale

Grade	Keterangan
A	Score >= 80,3
B	Score >= 74 and <80,3
C	Score >=68 and 74
D	Score >= 51 and <68
E	Score <51

System performance testing was conducted quantitatively to measure response times for two key features with the highest database interaction load: the reservation form submission process by public visitors and the reservation decision verification process by admins via the dashboard. The specifications of the testing environment used are presented in Table 6.

Table 6. Test Environment

Component	Specification
Device	Laptop
Prosesor	AMD Ryzen 3
RAM	8,00 GB
Operation System	Windows 11
Web Server	Localhost
Browser	Microsoft Edge
Framework	Laravel
Database	MySQL

Table 6. Test Environment Part 2

Component	Specification
Network	WiFi
Measurement Tools	Laravel Log (laravel.log) and Microsoft Edge DevTools (Network Tab)
Fitur	Reservation form submission by public visitors and reservation decision verification by admins via dashboard
Number of Attempts	40 per feature

RESULTS AND DISCUSSION

a) Communication

The communication phase was conducted through interviews with the Forestry Museum's administrative staff. The interview results can be seen in Appendix 4. Based on these interviews, user stories were formulated as a representation of the system's functional requirements from the perspective of each user role. A user story is a brief description of the features required by each user role and the objectives to be achieved from those features. The results of the user story development are presented in Table 7.

Table 7. User Story

Actor	User Story
Admin	As an admin, I want to be able to manage visit quotas and lock schedules for the museum's internal agenda so that slots cannot be booked by visitors on certain dates.
Admin	As an admin, I want to be able to validate and verify group visit application documents so that only reservations that meet the administrative requirements are approved.

Admin	As an admin, I would like to be able to download visit report data to Excel format so that the administrative reporting process can be carried out more efficiently.
Admin	As an admin, I want to be able to manage regulatory documents and decrees that appear on the public page so that information on visit requirements is always up to date.
Admin	As an admin, I want to classify the agency categories and visitor demographics in order to map the segmentation that dominates visits..
Admin	As an admin, I would like to include a specific rejection reason that is automatically sent via email so that visitors are informed about the cancellation.
Visitor	As a visitor, I would like to be able to see the availability of morning and afternoon sessions through an interactive calendar so I can plan my visit without having to contact the admin.
Visitor	As a visitor, I want to be able to register an account and fill out the visit reservation form so that the registration process can be done independently and recorded in the system.
Visitor	As a visitor, I would like to be able to select a visit session and upload an official application letter so that all administrative requirements can be completed in one platform.
Visitor	As a visitor, I would like to make a reservation for both the morning and afternoon sessions in one transaction code to make the registration process for groups visiting all day more practical.

All user stories developed reflect the system's functional requirements from the perspective of each user role in a concrete and measurable way. This list of requirements serves as the primary reference for all subsequent stages of system development, from feature planning and database design to user interface development.

b) Quick Plan

At this stage, initial planning for the reservation platform development is carried out based on the list of user requirements outlined in Table 6. This planning aims to determine the priority features to be created, which is the main cycle of the platform's overall development. In addition to feature determination, a database schema is also planned using MySQL to manage relationships between data and store reservation data to maintain data integrity. Details of the planned features to be created are presented below.

1) Public Reservation Calendar

A homepage for visitors to view the schedule with available or full session status indicators, quickly access official documents, and make reservations. This page allows prospective visitors to check slot availability independently, without having to wait for manual confirmation via WhatsApp.

2) Reservation Form

A form for visitors to register reservations includes data on the person in charge, school or public institution category, details of the number of male, female, and disabled visitors, as well as the option to select a morning, afternoon, or both sessions (morning and afternoon) at once in one transaction.

3) Login and Logout Dashboard

Login is a feature for museum staff to enter the system using registered email and password to ensure data security. Logout is a feature to end access sessions on the admin dashboard to prevent use of the system by unauthorized parties.

4) Forgot Password and Change Password

Forgot Password is a password recovery mechanism that sends a reset link to the registered admin email address. Change Password is a security feature that allows admins to change their passwords periodically to maintain the integrity of their accounts.

5) Operational Dashboard

A feature that displays statistical summaries such as monthly visitor numbers, approval queues, and visitation trends over the past 12 months in graphical form. This data visualization serves as a supporting tool for museum managers in monitoring service effectiveness and planning operational policies.

6) Schedule Management

A feature for setting session open or closed status per date. This feature allows admins to periodically monitor time slot availability according to the museum's internal schedule and ensure there are no scheduling conflicts between groups, even if multiple reservation requests come in simultaneously.

7) Reservation Agreement

A feature for reviewing PDF request files and approving or rejecting incoming reservations. If a request is rejected, the administrator must include a specific reason for the rejection, which will be automatically emailed to the guest. This digital review process replaces physical document validation, speeding up the determination of the group's visit confirmation status.

8) History and Manage Information

Features for providing tables of processed visit data and Excel export for administrative reporting. Information management features allow admins to upload, modify, or delete Decree and Service Information documents displayed on public pages.

c) Modeling Quick Design

The formulated requirements are visualized in a diagram model to illustrate the system's functional architecture, workflow, and data structure in depth. The design process begins with the creation of a use case diagram that maps the interactions between actors and system functionality. The use case diagram can be seen in Figure 2.

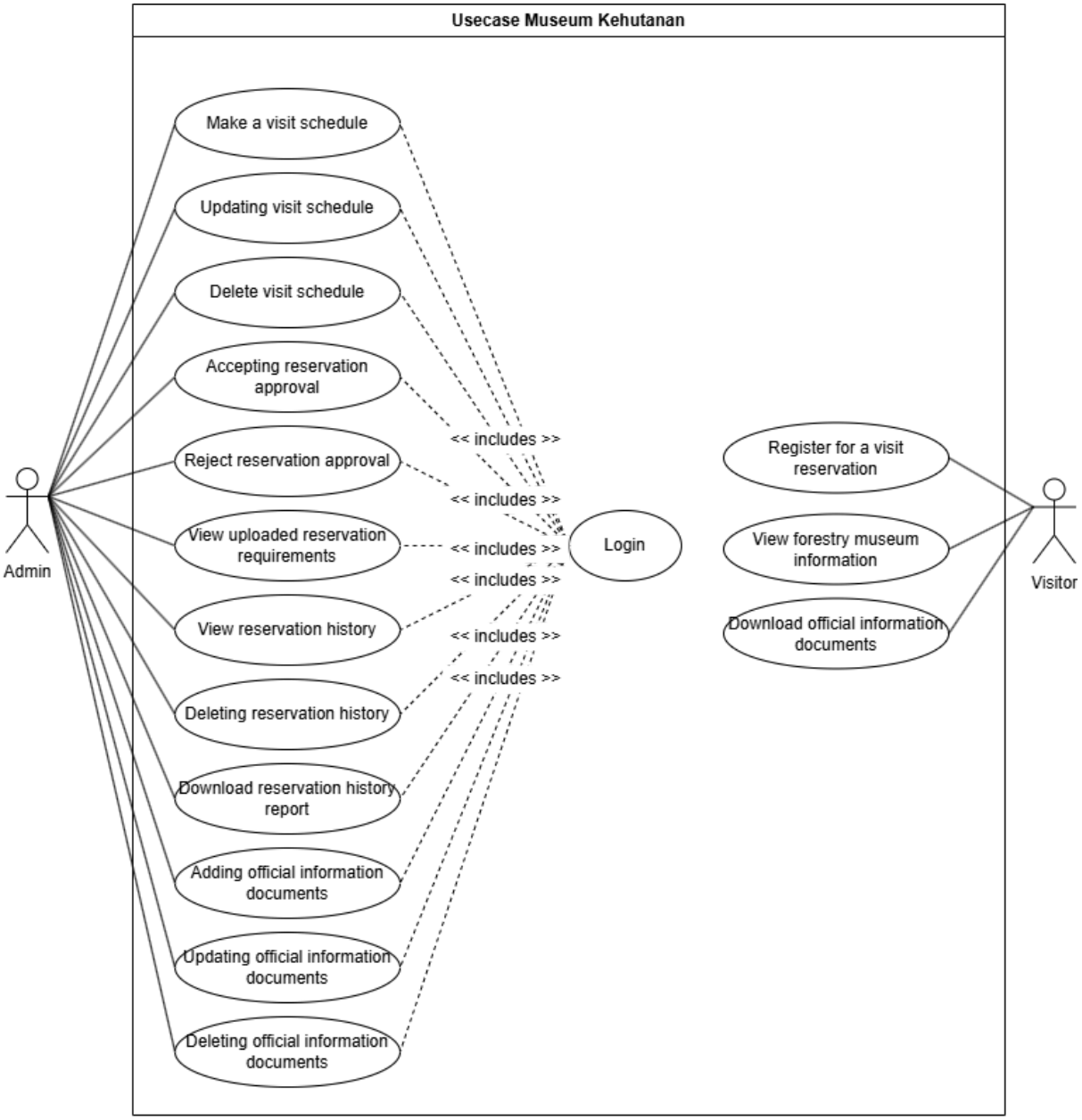

Figure 2. Use Case Diagram

The use case diagram consists of three main actors: Admin, Visitor, and Guest. The Admin actor has full control over operational management, including login and logout authentication features, visit schedule management, reservation validation (accept or reject), and regulatory document management. The Visitor actor interacts with the reservation registration and schedule availability features. This separation of roles is designed to maintain the security of the museum's internal data. Next, a use case description is created to describe each main activity in the system so that the workflow of each feature is clearly defined, as presented in Table 8.

Table 8. Use Case Description

Activity	Description
Create a Visiting Schedule	Admin adds new date slots and visit sessions to the system.
Updating Visiting Schedule	Admin changes information or status on the schedule that has been created.
Deleting Visit Schedule	Admin deletes visit schedule slot data from the system.
Accepting Reservation Approval	Admin gives Approved status to group reservations.

Reject reservation approval	Admin gives Rejected status if the conditions are not met.
Register for Visit Reservation	Visitors fill out a reservation form including details of the number of men, women, disabilities, and school or general institution categories.
Viewing Upload Terms	Admin reviews PDF file of request letter from visitor.
View Reservation History	Admin accesses a list of all visit data that has been processed.
Deleting Reservation History	Admin deletes certain reservation history records from the database.
Download History Report	Admin exports visit history data to Excel or CSV format.
Adding Information Documents	Admin uploads new SK or guide files to the public page.
Updating Information Documents	Admin changes the title or replaces the official document file.
Deleting Information Documents	Admin deletes regulatory document files from the system.

This use case description details the technical functionality of each actor's activity within the system. In the scheduling management cluster, the functions for creating, updating, and deleting visit schedules are used to manage museum operational time slots based on field quotas. In the visitor reservation cluster, the reservation registration and multiple-session reservation functions allow visitors to complete their data, including demographic details and agency categories, for one or two sessions simultaneously. Administrative validation is addressed through the "view upload requirements" feature, which allows administrators to digitally review PDF files of visitor application letters before making a final decision by accepting or rejecting reservation approval, as well as by recording specific reasons for the rejection and sending it automatically via email. The entire decision history is then centrally recorded in the "view history reservations" feature, which is supported by a "download" function history report to Excel format. Next, an activity diagram is created to show the business processes of this system, as shown in Figure 3.

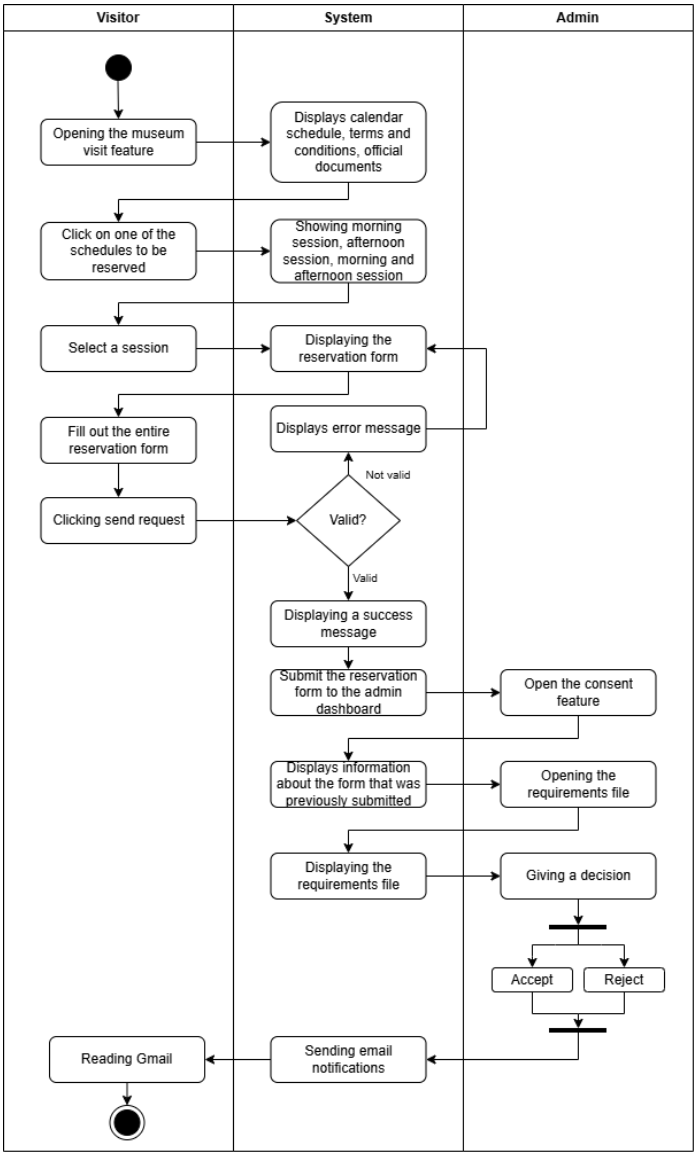

Figure 3. Bisnis Process Activity Diagram

The process begins when a visitor checks the calendar on the public page, to which the system responds by displaying session availability and remaining quota. The visitor then selects a morning, afternoon, or both session schedules, completes a form including demographic data and agency category, and uploads a PDF of the visit request. After the data is submitted, the system validates the session and quota using concurrency locking; if the form is invalid or the quota is full, the flow returns to the filling stage. If it is valid, the data is atomically saved to the database and forwarded to the admin dashboard. The admin then verifies the documents to make a decision (decision node): reject the request with a specific reason or approve it if it meets the requirements. At the end of the flow, the system updates the reservation status and automatically sends a confirmation or rejection notification via email to the visitor.

The next step is to transform the data flow logic into an organized storage structure. To define a centralized database structure capable of supporting business process automation, an Entity Relationship Diagram (ERD) is designed, as shown in Figure 4.

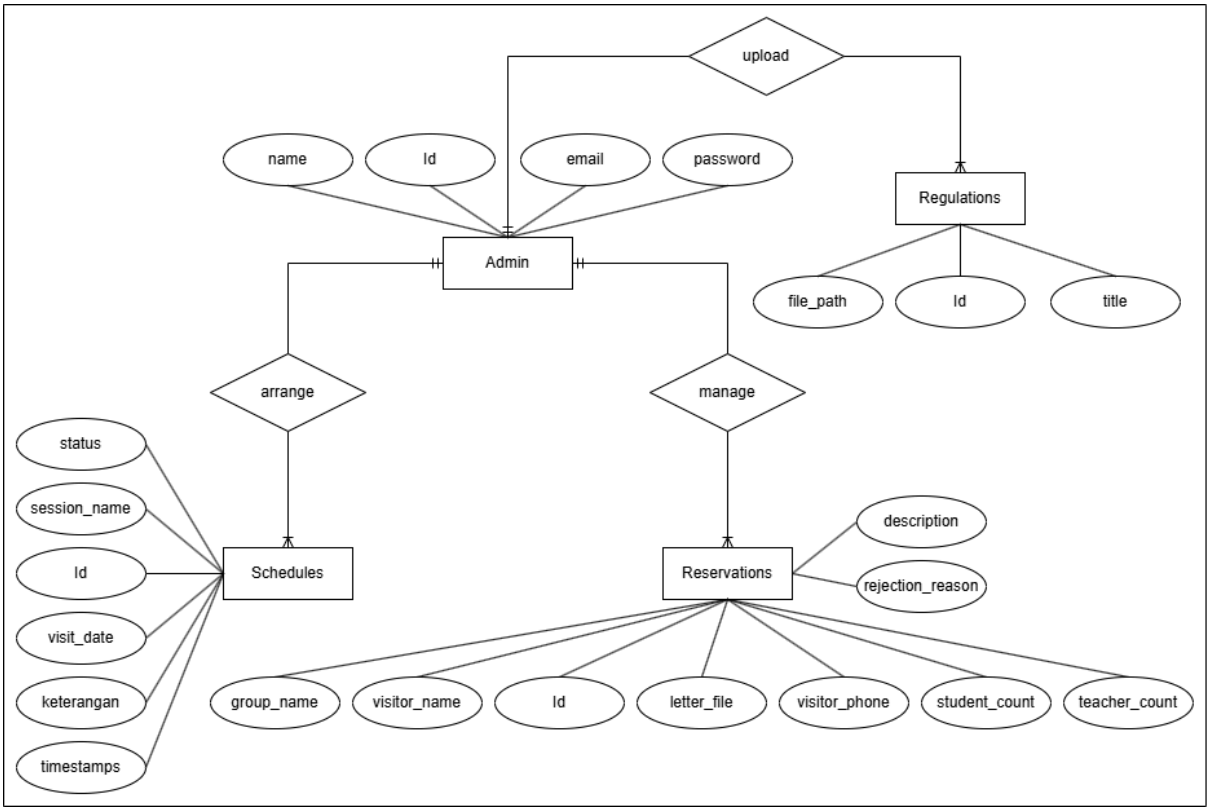

Figure 4. Entity Relationship Diagram

This ERD consists of four main, interconnected entities: Admin, Schedules, Reservations, and Regulations. The Schedules entity serves as the core manager of the museum's operational quota and has a one-to-many relationship with the Reservations entity. This relationship indicates that a single date slot and visit schedule session opened by the admin can be selected and contain multiple group reservation request data simultaneously. The Reservations entity is equipped with additional attributes in the form of school or public institution categories, demographic details consisting of the number of men, women, and disabilities, and a note on the reason for rejection to support the need for service transparency. On the other hand, validation control and data management within the system are represented through the Admin entity that holds managerial access rights to visit schedule configuration, reservation status processing, and official document updates in the Regulations entity. Through this centralized relational schema design, data consistency can be maintained and the risk of overbooking can be minimized, which is then reinforced at the application level through database transaction mechanisms and row-level locking to prevent simultaneous reservation conflicts. The next stage is to transform these static data components into a dynamic program object architecture. This design stage ends with the creation of a class diagram in Figure 5.

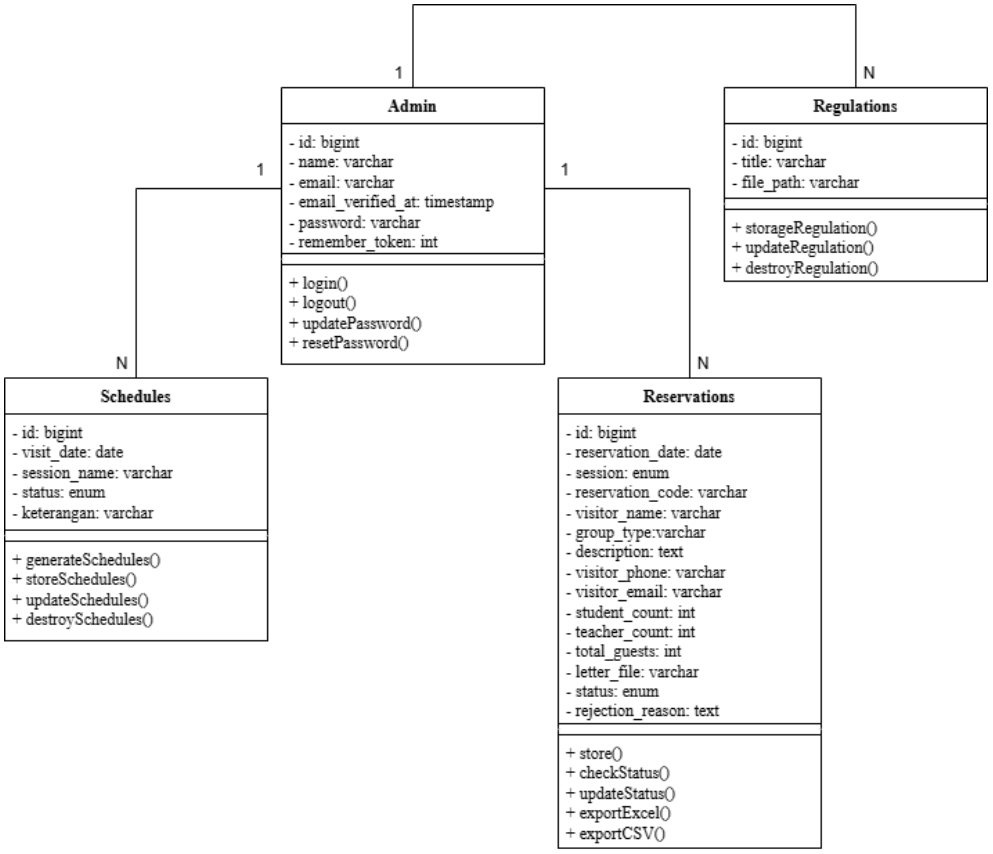

Figure 5. Class Diagram

The class diagram in Figure 5 illustrates the structure of the main entities in the system, namely admin, schedules, reservations, and regulations, along with attributes that represent the data structure in the database and the main operations that can be performed on each entity. This class diagram serves as a conceptual depiction of the relationships between entities before the system is implemented. The admin entity relates to schedules and reservations in a one-to-many relationship, meaning one admin can manage many schedules and reservations, while the regulations entity stands alone and is managed directly by the admin. Each operation shown on each entity represents the core functionality implemented in the system to support the museum's reservation and scheduling flow.

d) Construction of Prototype

All designs established during the quick design modeling stage are implemented into a functional prototype during the prototype construction stage. Seven key features are developed during this stage, as presented below.

1) Public Reservation Service Page

This feature is the primary interface used by general visitors to begin the process of booking a visit to the Forestry Museum. Before this system was developed, prospective visitors could not directly check slot availability and had to contact the administrator via WhatsApp, resulting in a confirmation process that could take up to 1–3 business days. A screenshot of the public reservation service page is shown in Figure 6.

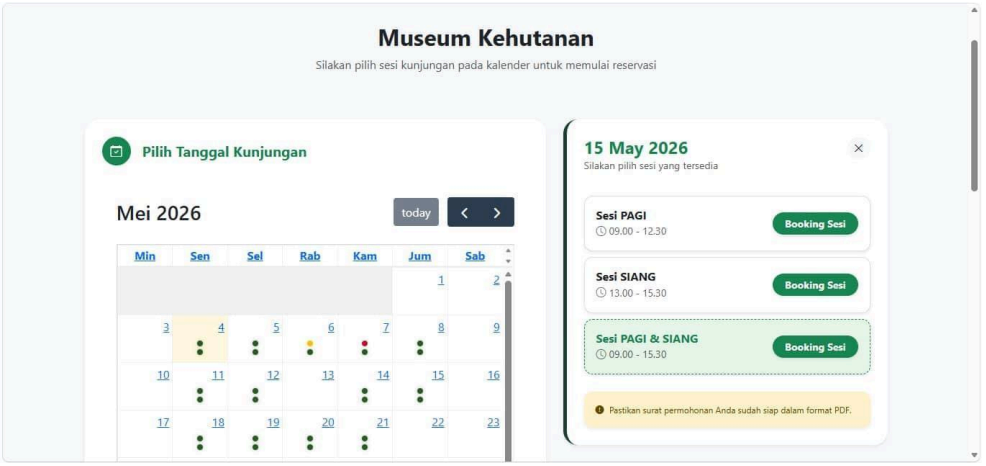

Figure 6. Public Reservation Service Page

This interactive calendar features left and right arrow navigation that allows users to navigate between months to view schedule availability for the desired period. Each date on the calendar can be clicked to view details of session availability for that day, eliminating the need for prospective visitors to contact the admin via WhatsApp to inquire about schedule availability. The terms and conditions panel on the right side of the page displays important information regarding visitation rules that prospective visitors should be aware of before making a reservation, ensuring they understand all reservation requirements before proceeding.

The system displays three session options: morning (9:00–12:30), afternoon (1:00–3:30), and morning & afternoon (9:00–3:30) in a single transaction. The system automatically validates the availability of quotas for both sessions before allowing visitors to proceed to the form filling stage; if one of the sessions is full, the double session option cannot be automatically selected to maintain quota data accuracy. The reservation form includes data on the person in charge, school or public institution category via a dropdown, and a number input column to record the number of male, female, and disabled visitors to prepare appropriate service facilities on site.

```php
$sessionsToCheck = ($request->session == 'pagi_siang') ? ['pagi', 'siang'] : [$request->session];

$errorMessage = null;

try {
    DB::transaction(function () use ($request, $sessionsToCheck, &$errorMessage) {
        foreach ($sessionsToCheck as $sess) {

            $isTaken = \App\Models\Reservation::where('reservation_date', $request->reservation_date)
                ->where(function ($q) use ($sess) {
                    $q->where('session', $sess)
                    ->orWhere('session', 'pagi_siang');
                })
                ->whereIn('status', ['pending', 'approved'])
                ->lockForUpdate()
                ->exists();
```

Figure 7. Row-level locking implementation code snippet

The system implemented conflict prevention as a solution to the previously unsynchronized manual booking process, as conveyed by the administrator in the interview. The system shifted the entire reservation process to a centralized database, allowing conflict prevention to be implemented through two complementary mechanisms. First, quota validation per session ensures that slots that have reached their maximum capacity cannot be selected by other visitors, as indicated by the red session button labeled full on the interactive calendar. Second, race condition prevention at the database level through concurrency locking, as implemented using a combination of DB::transaction() and lockForUpdate() in Figure 8. This mechanism works by locking the data row being validated during the slot availability check process. This allows two

visitors to submit reservation forms simultaneously for the same slot, only one transaction can complete the validation and storage process, while the second transaction is automatically rejected by the system. Properly evaluating potential transaction losses and defining strict constraint parameters ensures continuous data stability during recovery phases (Sujarnoko *et al*., 2025). This approach ensures that conflict prevention not only applies under normal conditions but also prevents reservation conflicts entirely at the database level.

2) Login Page

This feature is the initial interface that administrators must access before entering the Forestry Museum reservation dashboard system. This authentication feature is built as an access security mechanism to ensure that only authorized museum administrative staff can manage schedule data, verify reservation documents, and make visit approval decisions. Without this mechanism, all museum operational data could potentially be accessed or modified by unauthorized parties. Admins authenticate using the email address and password registered in the system, and a password reset feature is available if the admin forgets their access credentials. This page provides a login form interface designed centered on the screen to increase administrator focus during authentication. The authentication form itself consists of two main input fields: the email address field and the password field. The Email Address field serves as a medium for inputting user credentials equipped with system validation, where the entered email address must use the @gmail.com domain format and must be officially registered in the system database. Meanwhile, the password field displays hidden characters by default to protect password confidentiality from the risk of visual surveillance. Both of these columns have the required attribute implemented as a form of initial client-side validation, preventing the system from submitting empty data until the admin presses the green login button. The admin login page is shown in Figure 8.

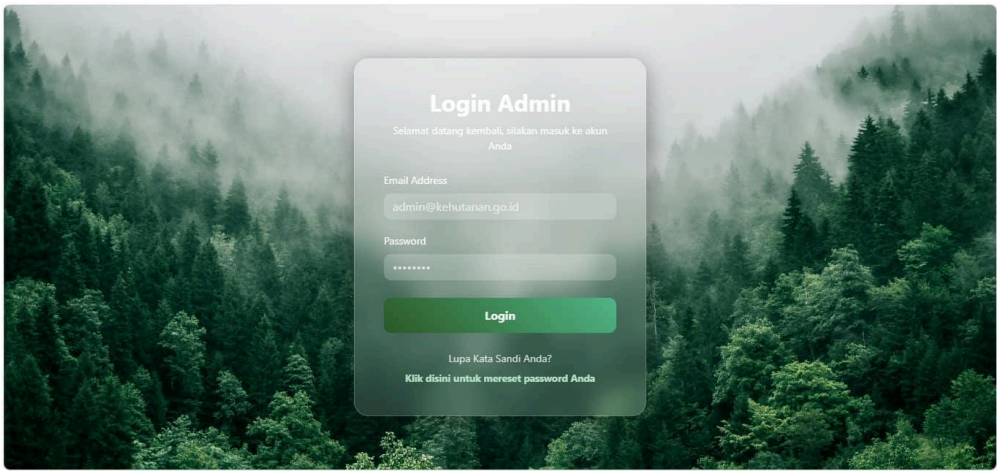

Figure 8. Login Page

3) Dashboard Overview Page

This feature is the main display that appears after the admin successfully logs into the system. This page is designed as an operational information center, presenting a summary of the latest data at a glance in a single, integrated view, allowing admins to monitor the status of museum reservations without having to navigate to other pages. The dashboard overview is shown in Figure 10.

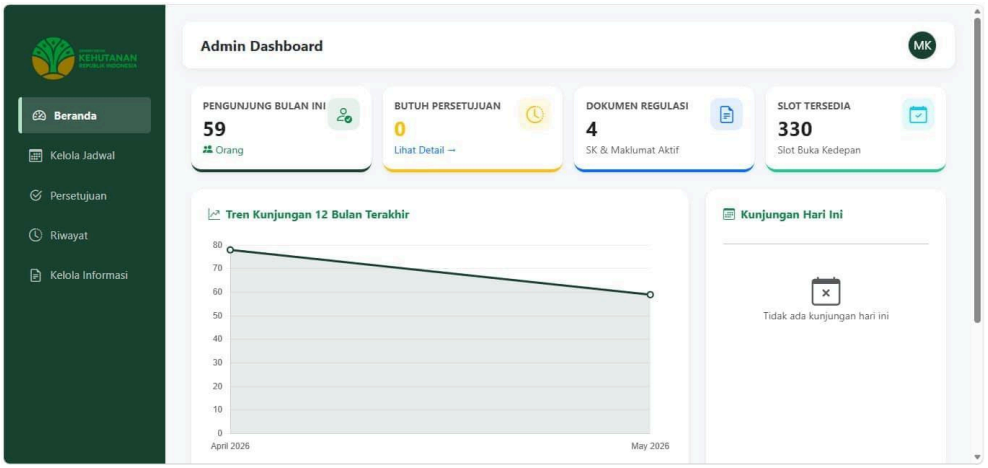

Figure 9. Admin Dashboard Overview Page

The information displayed includes four main indicators: the number of visitors this month, the number of reservations requiring approval, the number of active regulatory documents, and the number of available slots. Furthermore, the dashboard displays a 12-month visit trend graph, allowing admins to regularly monitor visitor developments, as well as a current visit panel that displays visits scheduled for the same day. Utilizing longitudinal monitoring data over specific temporal variations provides a granular overview for systematic tracking and auditing (Irzaman *et al*., 2025). This feature replaces the manual recording function in a physical book that admins previously used to monitor reservation status, allowing all operational information to be accessed digitally on one centralized page.

4) Manage Schedule Page

This feature is an interface used by admins to manage the availability of museum visit sessions on any specified date. Through this feature, admins have full control to flexibly change the operational status of open or closed sessions to align public visit slots with internal agendas or quota restrictions at the Forestry Museum. The schedule management page is shown in Figure 10.

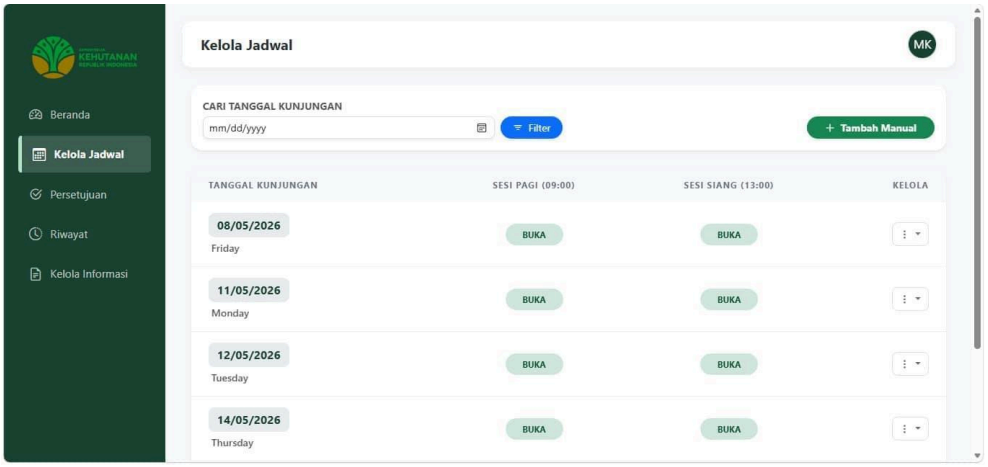

Figure 10. Admin Schedule Management Page

Admins can manually add visit schedules by specifying the dates and availability status for morning sessions (9:00–12:30) and afternoon sessions (1:00–3:30). Each added schedule is displayed in a table format, showing the visit date and the status of each session, allowing admins to monitor all upcoming schedule availability in a single, structured view. The manage column on each row is equipped with a dropdown button that allows admins to change the session status to closed or delete schedule data if necessary. This feature also includes a date search feature located at the top of the table to make it easier for admins to quickly find schedules on specific dates.

5) Consent Page

This feature is the main interface used by admins to verify and make decisions on all visit requests received into the system. Before this system was built, the verification process was done manually via WhatsApp, requiring admins to check each incoming message individually, check schedule availability in a physical book, and then manually respond to confirmations. Through this feature, all incoming reservation requests are displayed in a centralized table format that presents complete information for each group, including the reservation code, group name, person in charge, contact, selected date and session, participant composition, and current approval status. Admins can view the required documents uploaded by visitors via the View button in the requirements column, then make a decision to approve or reject directly via the action buttons available on each reservation entry. The system automatically sends email notifications to visitors after verification, so visitors receive immediate confirmation of the reservation status without having to wait for a manual response from the admin, which previously took 1–3 business days. The approval page display is shown in Figure 11.

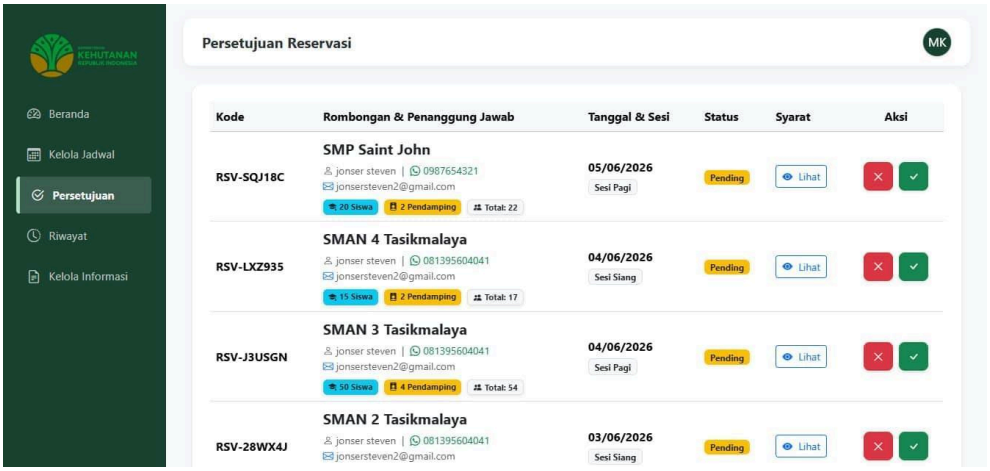

Figure 11. Admin Approval Page

The system displays a reservation rejection confirmation modal component that requires the administrator to enter a specific reason for the rejection in the provided text area before the reservation status is updated. The rejection reason modal component display is shown in Figure 12.

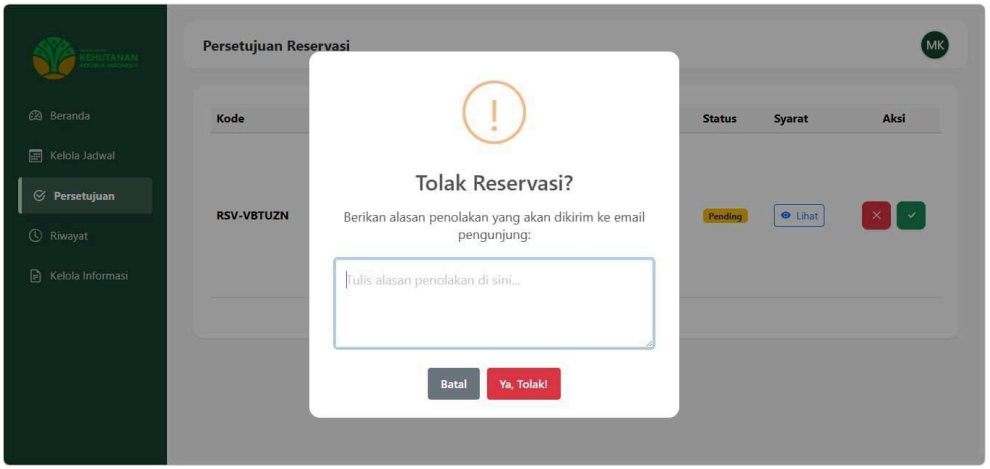

Figure 12. Capital Reasons for Rejection

The reason for rejection entered by the admin in the modal has been integrated with an automated email delivery service. After the admin presses the "Yes, Reject!" button, the backend system processes a notification to the visitor's email address, complete with the reason provided. This implementation addresses the need for service transparency while minimizing visitor confusion regarding the status of their reservation.

6) History Page

This feature is an interface that displays a list of all visit data processed by the admin. This feature was developed to address the limitations of the manual system, which previously relied solely on records in physical books and sheets of paper, making it difficult for admins to quickly and accurately track past reservation records. The reservation history page is shown in Figure 13.

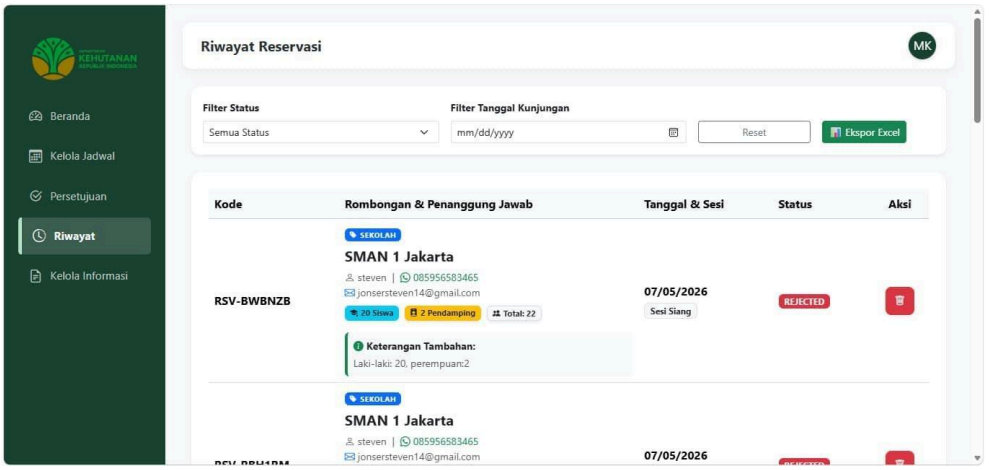

Figure 13. Admin Reservation History Page

This feature allows admins to monitor all reservation history and complete details, including reservation codes, group names, person in charge, visit dates and sessions, participant demographics, and the reservation's final status. The action column provides a red delete button that allows admins to delete unnecessary reservation data to maintain system data cleanliness and tidiness. All detailed demographic data and agency categories are also integrated with filter and report export features to support accurate monthly visit statistics. The combination of filter features, demographic information, status badges, and action buttons on this page ensures admins can manage all visit history efficiently and well-documented.

7) Manage Information Page

The information and regulations management page is an interface used by admins to manage various official documents and visiting conditions that are accessible to the public. Before this system was available, museum regulatory documents such as visiting conditions, service hours, service announcements, and service standards were not publicly available on any digital platform, preventing potential visitors from viewing them directly. Through this feature, admins can add, edit, or delete regulatory documents that will be displayed to the public, allowing information updates to be made independently without requiring developer assistance. Every document managed on this page will be automatically available for download by potential visitors through the public page, allowing potential visitors to independently meet their needs for information on visiting requirements without having to contact the admin first. The information and regulations management page display is shown in Figure 14.

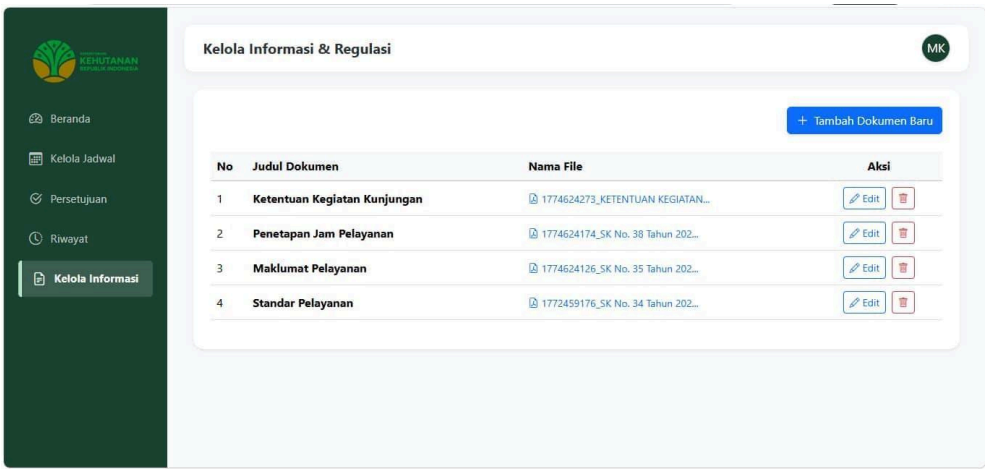

Figure 14. Admin Information Management Page

e) Deployment, Delivery, and Feedback

The developed features were then tested using the Black Box Testing method to ensure that each feature produced output that met the requirements. This functional testing was conducted by researchers and the Forestry Museum administration. The testing scope covered five main system modules: the authentication module, session schedule status management, reservation file validation process, historical data management, and public pages. Each test scenario was evaluated based on the suitability between the input entered and the output generated by the system. The test results are presented in Table 9.

Table 9. Black Box Testing

Test Code	Test Scenario	Expected Results	Status
TC-01	Login with the correct email and password	Displaying the Dashboard Overview	Succeed
TC-02	Login with an incorrect email or password	The system displays the message “wrong email or password”	Succeed
TC-03	Login without filling in email or without filling in password	The system displays the message “please fill out this field”	Succeed
TC-04	Do forgot password with registered email	The system sends a password reset link to the admin email.	Succeed
TC-05	Doing forgot password with unregistered email	The system displays the message “This email address is not registered in our system!”	Succeed
TC-06	Create a new visit schedule	Schedule data is saved and appears on the public calendar.	Succeed
TC-07	Create a new visit schedule without filling in the date	The system displays the message “please fill out this field”	Succeed
TC-08	Change the schedule status to open to closed	Session slots on that date cannot be booked by visitors.	Succeed
TC-09	Change the schedule status from closed to open	Session slots on that date can be booked by visitors.	Succeed

Table 9. Black Box Testing Part 2

Test Code	Test Scenario	Expected Results	Status
TC-10	Admin filters by selected date on manage schedule	The system only displays the selected date data.	Succeed
TC-11	Deleting visit schedule data	Schedule data deleted from the system	Succeed
TC-12	Visitors fill out the reservation form completely	The system saves the data and displays the message "Reservation Successful"	Succeed
TC-13	Visitors fill out the reservation form with one of the inputs left blank.	The system displays the message “please fill out this field”	Succeed
TC-14	Visitors upload required files (PDF) > 2MB	The system displays the validation "The letter file field must not be greater than 2048 kilobytes."	Succeed
TC-15	Visitors try to make a reservation during a session that is already full.	The "Book a Session" button is red and displays the label "Full"	Succeed
TC-16	Admin presses the accept button on the login request	Reservation status changes to Approved and sends email notification	Succeed
TC-17	Admin views the requirements file on approval	Displays the requirement files uploaded by visitors	Succeed
TC-18	Admin downloads the requirements file on approval	The file was successfully downloaded and saved.	Succeed
TC-19	Admin downloads reports via Excel export feature	The system downloads an .xlsx file containing historical data.	Succeed
TC-20	Admin filters approved status on reservation history	Displays only approved reservation data	Succeed
TC-21	Admin filters rejected status on reservation history	Displays only rejected reservation data	Succeed
TC-22	Admin filters visit dates in reservation history	Displays data for the selected visit date only	Succeed
TC-23	Admin uploads new information or regulatory documents	Display documents and can be downloaded on the public service page	Succeed

Table 9. Black Box Testing Part 3

Test Code	Test Scenario	Expected Results	Status

TC-24	Admin logout from dashboard	The system ends the session and returns to the login page.	Succeed
TC-25	Visitors choose the morning & afternoon session options	The system validates the quotas of both sessions and stores the data in one transaction code.	Succeed
TC-26	Admin fills in the reason for rejection column when rejecting a reservation.	The system stores the reason and sends it via email notification.	Succeed
TC-27	Admin leaves the reason column blank when rejecting	The system displays a validation message that the reason for rejection must be filled in.	Succeed

The results of the Black Box Testing test showed that all 27 designed test scenarios were successful. This success rate was calculated by comparing the number of valid scenarios (test cases) with the total number of scenarios tested to ensure system reliability before being handed over to users. The calculation results showed a success rate of 100%, indicating that all 27 test scenarios covering the five system modules had functioned optimally according to the expected functional specifications. This 100% success rate proves that the Forestry Museum reservation and scheduling platform has met all functional requirements identified in the communication stage, starting from the feature for checking schedule slot availability independently by visitors, validating quotas per session to prevent schedule conflicts, uploading and verifying required documents, to an automatic email notification mechanism for visitors after a decision is made by the admin. In addition to functional testing, the deployment stage also included a live demonstration session for the management of the Ir. Djamaludin Suryohadikusumo Forestry Museum. This session aimed to obtain feedback on the prototype that had been built before the system was declared final. The feedback obtained from the demonstration session became the basis for refining the prototype, which is further described in the sub-chapter Prototype Refinement Based on Feedback.

Prototype Refinement Based on Feedback

A demonstration session was conducted for the management of the Ir. Djamaludin Suryohadikusumo Forestry Museum after the initial prototype was completed and functionally tested with the aim of obtaining direct feedback on the developed prototype. The demonstration session resulted in three major revision notes to the features that had been built, as presented below.

f) Reservation Form

The initial reservation form contained only general information about the person in charge and the total number of visitors without further details. The appearance of the reservation form before the revision is shown in Figure 15.

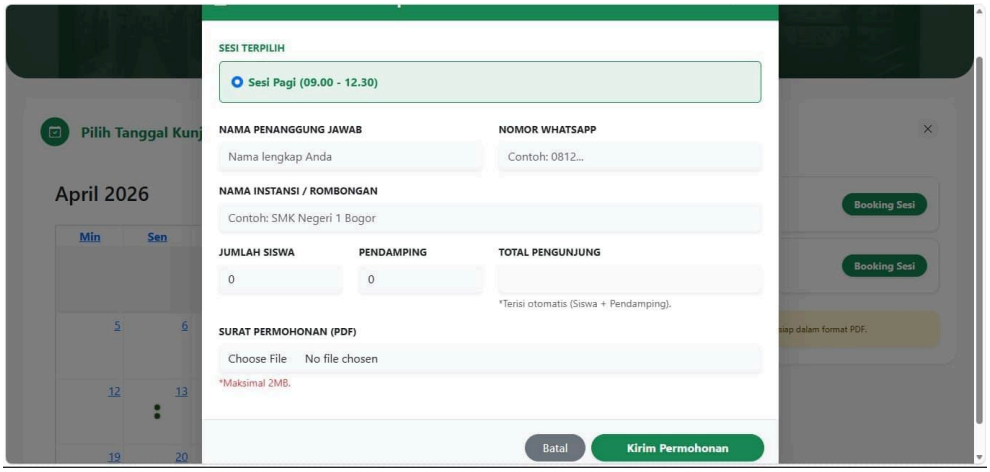

Figure 15. Reservation Form Before Revision

The museum stated that the data was insufficient for operational purposes in the field because management needed to know the classification of school groups or general institutions for mapping visitor segmentation, as well as details of the number of male, female, and disabled visitors in order to prepare appropriate service facilities, such as accessibility and group division of visits. The reservation form was then revised by adding a dropdown column for agency categories and three number input columns for visitor demographic data. The appearance of the reservation form after revision is presented in Figure 16.

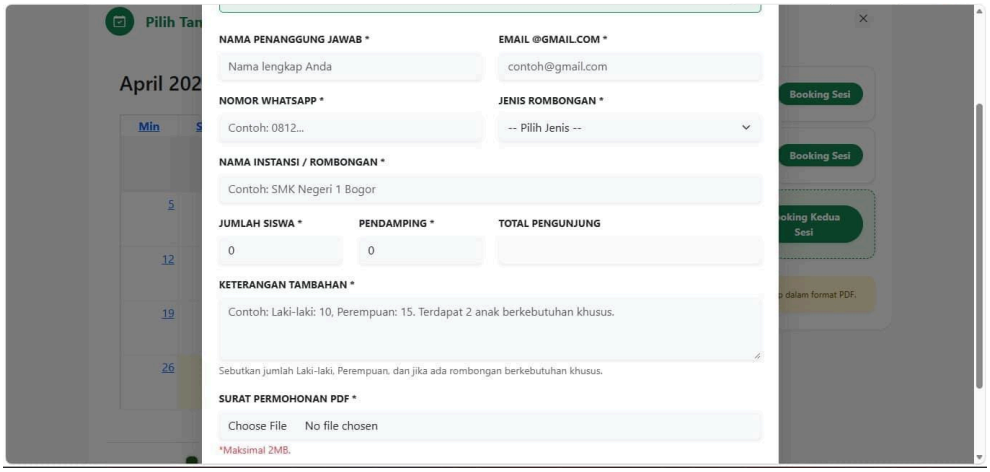

Figure 16. Reservation form after revision

g) Admin Approval Page

The system, in its initial state, immediately updates the reservation status to rejected without requesting additional information from the admin when the reject button is pressed. The reservation rejection process before revision is shown in Figure 17.

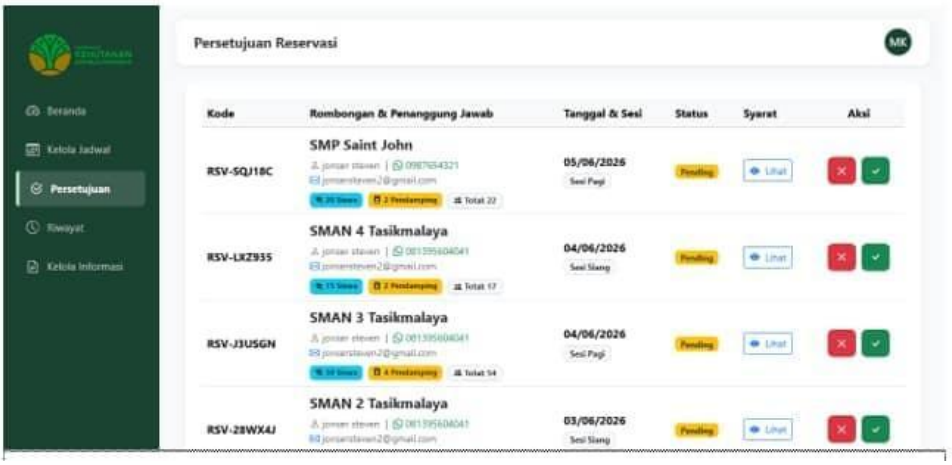

Figure 17. Reservation Rejection Before Revision

The museum stated that unexplained rejections prevented visitors from understanding the reasons for their requests being rejected, potentially leading to repeated inquiries to the administrator via WhatsApp. The rejection process was subsequently revised by adding a confirmation modal component that requires the administrator to provide a reason for the rejection, which is then automatically sent via email notification to the visitor. The revised reservation rejection process is shown in Figure 18.

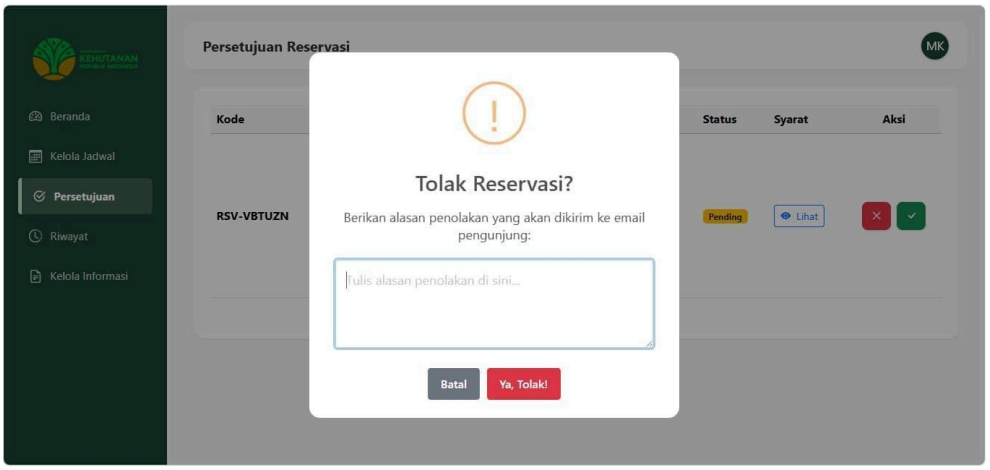

Figure 18. Reservation Rejection After Revision

h) Selection of Visit Session

The system initially offered only two separate session options: a morning session or an afternoon session, requiring groups wishing to spend a full day to complete two separate reservation transactions when selecting a date on the calendar. The session selection screen before the revision is shown in Figure 19.

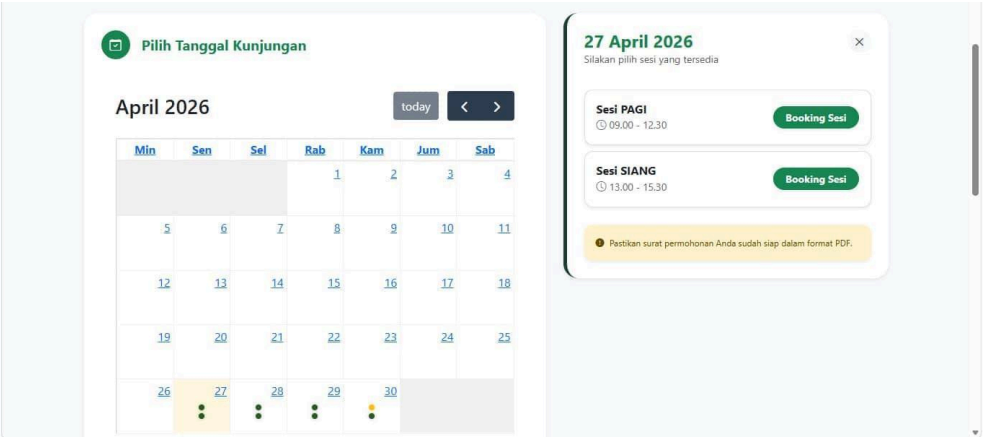

Figure 19. Selection of Visit Sessions Before Revision

The museum stated that there were prospective group visitors who wanted to visit for a full day that included both morning and afternoon sessions, but the system initially required the group to register twice in two separate transactions to get both sessions. The session selection display was then revised by adding a third option, namely morning & afternoon sessions, which allows groups who want to visit for a full day to only register once in one transaction code. The session selection display after the revision is presented in Figure 20.

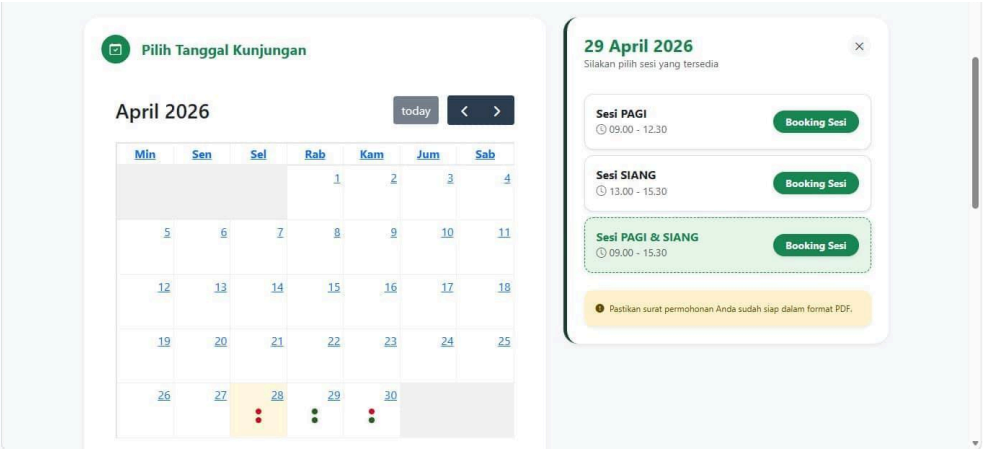

Figure 20. Selection of Visit Sessions After Revision

The three revisions were the result of a direct evaluation process with the management of the prototype that had been built so that all operational needs of the museum could be fully

accommodated before the final prototype was submitted. The final prototype of the Ir. Djamaludin Suryohadikusumo Forestry Museum reservation system was then submitted to the management and was declared accepted without further revision notes, indicating that the system built was in accordance with user needs.

Evaluation of Usability Level

The System Usability Scale testing involved 10 respondents from two different user groups. Respondents R1 and R2 were museum administrative staff evaluating the ease of use of the admin dashboard page, while respondents R3 to R10 were prospective visitors evaluating the flow of filling out the reservation form on the website's public page. Each respondent provided a rating on a scale of 1 to 5 for each statement after running a series of task scenarios on the system accessed through a temporary public tunnel link. The results of all respondents' answers are presented in Table 10.

Table 10. Respondents' Answers

Respondents	Q 1	Q 2	Q 3	Q 4	Q 5	Q 6	Q 7	Q 8	Q 9	Q 10
R1	5	3	5	4	4	4	5	4	3	4
R2	5	1	5	1	5	1	5	1	5	3
R3	5	1	5	1	5	3	5	1	5	3
R4	5	1	5	1	5	1	5	1	5	1
R5	4	2	4	2	4	2	4	2	3	4
R6	5	1	5	2	5	1	5	1	5	2
R7	5	1	5	1	5	1	5	1	5	1
R8	5	1	5	1	5	1	5	1	5	1
R9	4	2	4	2	4	3	4	2	4	3
R10	4	2	4	2	4	2	4	2	4	4

The consistent pattern of responses between high scores on positive statements and low scores on negative statements indicates that respondents understood and completed the questionnaire well without any response bias. Each respondent's answer was then processed using the SUS accumulation score formula, where the answer to the odd statement is subtracted by 1 and the answer to the even statement is used to subtract 5. The total score of all statements is then multiplied by 2.5 to produce a final SUS score for each respondent ranging from 0 to 100. The results of the determination of all respondents are presented in Table 11.

Table 11. Determination of SUS score

Respondents	Total	Score SUS
R1	23	57,5
R2	38	95
R3	36	90
R4	40	100
R5	27	67,5
R6	38	95
R7	40	100
R8	40	100
R9	28	70
R10	28	70

The final SUS scores from all respondents were then grouped by user role to obtain a more representative picture of ease of use per group. The admin group consisting of R1 and R2 obtained an average score of 76.25, which is included in the Acceptable category. The visitor group consisting of R3 to R10 obtained an average score of 86.56, which is included in the Excellent category. The

combined average score of all respondents reached 84.5, which is also included in the Acceptable category. The results of the calculation of the average SUS score per group are presented in Table 12.

Table 12. Calculation of the Average SUS Score

Group	Respondents	Score SUS	Category
Admin	R1-R2	76,25	Acceptable
Visitor	R3-R10	86,56	Excellent
SUS Avarage Score		84,5	Acceptable

The average score for the admin group of 76.25 was derived from the difference in perception between R1, who scored 57.50, and R2, who scored 95.00. The admin group's average score of 76.25, while lower than the visitor group's 86.56, remains in the Acceptable category. This score gap is consistent with the respondent profile shown in Table 1, where both administrative staff (R1 and R2), aged 30 years with low prior experience with digital systems, found the dashboard interface comparatively more demanding to navigate than the public reservation form. In contrast, the visitor group (R3–R10), aged 20–23 years and predominantly categorized as high-frequency internet users, demonstrated greater familiarity with web-based interfaces, which is reflected in their higher average score of 86.56. This pattern aligns with Prayoga and Kristiana (2024), who found that users with limited digital system familiarity tend to produce lower SUS scores on dashboard-type interfaces compared to general users accessing simpler public-facing pages.

System Speed Evaluation

System performance evaluation is conducted through quantitative response time measurements as an integral part of the overall system quality assessment. Response time is a non-functional parameter in the Software Performance Engineering (SPE) methodology that measures the duration required for a system to complete one data transaction cycle, from the time the user submits input to the browser successfully rendering the output.

Testing was conducted on two key functionalities with the highest database interaction load: the reservation form submission process by public visitors and the reservation decision verification process by the admin via the dashboard. Response time recordings were obtained from the system log, which was executed 40 times repeatedly to generate a statistically valid average value.

```
1  [2026-04-23 04:46:32] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 4.8881 detik.
2  [2026-04-23 04:47:23] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2176 detik.
3  [2026-04-23 04:48:15] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1881 detik.
4  [2026-04-23 04:48:57] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.226 detik.
5  [2026-04-23 04:49:40] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2034 detik.
6  [2026-04-23 04:50:22] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1879 detik.
7  [2026-04-23 04:51:04] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2381 detik.
8  [2026-04-23 04:51:54] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1987 detik.
9  [2026-04-23 04:52:43] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1937 detik.
10 [2026-04-23 04:53:22] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.213 detik.
11 [2026-04-23 04:54:04] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2016 detik.
12 [2026-04-23 04:54:48] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1936 detik.
13 [2026-04-23 04:55:25] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2551 detik.
14 [2026-04-23 04:56:03] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1895 detik.
15 [2026-04-23 04:56:41] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2134 detik.
16 [2026-04-23 04:57:23] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2027 detik.
17 [2026-04-23 04:58:02] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.201 detik.
18 [2026-04-23 04:58:39] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2365 detik.
19 [2026-04-23 04:59:20] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2007 detik.
```

Figure 21. Test visitor form submission speed

```
20 [2026-04-23 04:59:58] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1925 detik.
21 [2026-04-23 05:00:33] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2057 detik.
22 [2026-04-23 05:01:11] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2144 detik.
23 [2026-04-23 05:01:48] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1855 detik.
24 [2026-04-23 05:02:27] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1892 detik.
25 [2026-04-23 05:03:02] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2051 detik.
26 [2026-04-23 05:03:42] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2226 detik.
27 [2026-04-23 05:04:22] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1934 detik.
28 [2026-04-23 05:05:00] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1921 detik.
29 [2026-04-23 05:05:40] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2837 detik.
30 [2026-04-23 05:06:28] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.1941 detik.
31 [2026-04-23 05:07:12] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2618 detik.
32 [2026-04-23 05:07:53] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2366 detik.
33 [2026-04-23 05:08:35] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2055 detik.
34 [2026-04-23 05:09:18] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2093 detik.
35 [2026-04-23 05:10:01] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2139 detik.
36 [2026-04-23 05:10:46] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.3886 detik.
37 [2026-04-23 05:11:37] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2695 detik.
38 [2026-04-23 05:12:21] local.INFO: Uji Kecepatan - Kirim Formulir Pengunjung | Durasi: 0.2318 detik.
```

Figure 21. Visitor form submission speed test part 2

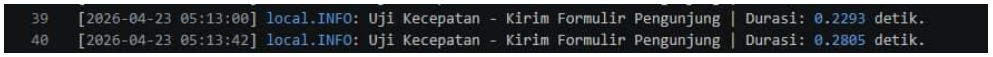

Figure 21. Visitor form submission speed test part 3

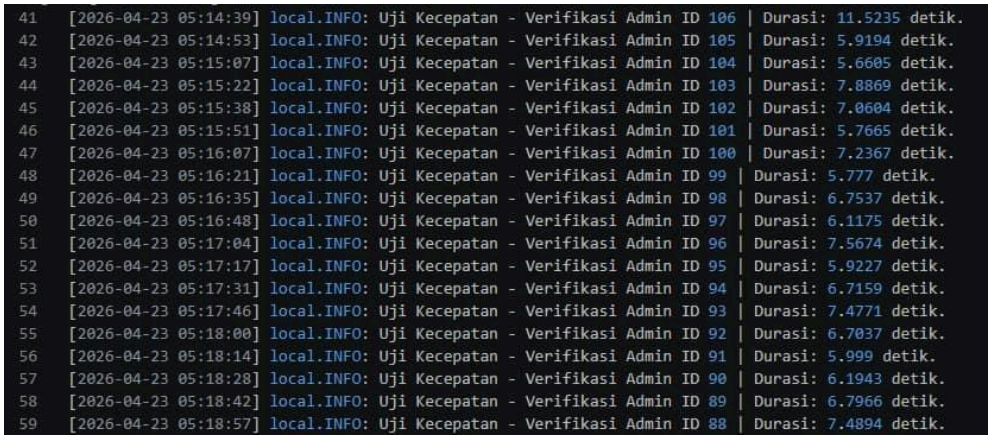

Figure 22. Admin Verification Speed Test

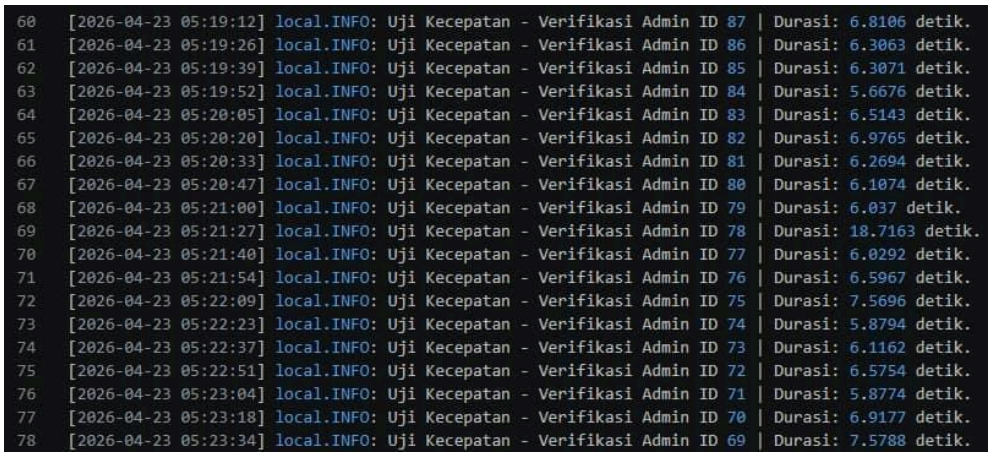

Figure 22. Admin Verification Speed Test Part 2

Figure 22. Admin Verification Speed Test Part 3

The test results were then used to calculate the average (mean) value for each functionality to obtain a representative picture of system performance. The interpretation of the test results refers to three response time thresholds set by Nielsen (1993): 0.1 seconds as the instant response limit, 1.0 seconds as the limit for uninterrupted user thought flow, and 10 seconds as the maximum limit for maintaining user attention. For the visitor reservation form submission feature, the system recorded an average response time of 0.34 seconds. This value is below the 1.0 second threshold set by Nielsen (1993), meaning that the user's thought flow is still uninterrupted when submitting the reservation form. This achievement is supported by the simplicity of the executed process, which only involves validating input parameters and writing data directly into the local MySQL database. For the decision verification feature on the admin dashboard, the average response time recorded was 6.95 seconds. This value is below the 10-second threshold set by Nielsen (1993) as the maximum limit for maintaining user attention, so the system is still in the acceptable performance category. The longer duration compared to the form submission feature is due to the complexity of the processes executed simultaneously, namely updating the reservation status in the database, recalculating the remaining visit quota, and network communication with an external SMTP server to send a confirmation email notification to the visitor. Thus, these two features produce a response time that is within the Nielsen (1993) threshold and supports a smooth overall reservation confirmation flow.

Comparison with Prior Studies

The functional testing result of 100% using the Black Box Testing method across 27 test scenarios is consistent with findings from comparable reservation system studies. Rizky Ariyanto & Syani (2025) similarly achieved a complete functional test pass rate in their web based futsal field reservation system using Laravel, and Umar & Miftachuddin (2025) also reported that their laboratory reservation system successfully passed all functional validation scenarios. These consistent results across different application domains indicate that the Prototyping method, when paired with iterative evaluation between developers and end users, is effective in producing systems that meet their designed functional specifications. However, the 100% functional success rate in this study carries additional significance because the test scenarios covered concurrency sensitive features such as row level locking and race condition prevention through the combination of DB::transaction() and lockForUpdate(), dimensions not reported in any of the prior reservation system studies reviewed.

The average SUS score of 84.5 obtained in this study exceeds both the general industry benchmark and scores reported in prior related studies. Based on data compiled from nearly 500 studies, the average SUS score across all systems is 68 (Lewis 2018), placing the present system's score comfortably above the 80th percentile and within the Grade A classification (≥80.3). This result is notably higher than the SUS score of 52.1 reported by Hidayat *et al*. (2025) in their usability evaluation of a village tourism information application, which fell in the Marginal category and indicated that the system was not yet fully accepted by users. The difference in scores reflects not only the difference in system complexity but also the methodological contribution of this study: by involving actual end users museum administrative staff and prospective visitors as respondents rather than general evaluators, the SUS scores obtained more accurately represent real world usability conditions. Furthermore, Mardiaturrahman & Yulianto (2026) evaluated their tourism reservation system using the User Experience Questionnaire (UEQ) and reported positive impressions on attractiveness, clarity, and efficiency dimensions, but did not produce a standardized comparable score. The SUS score of 84.5 in this study provides a more universally comparable benchmark that positions the Forestry Museum reservation platform above average in the broader landscape of web-based reservation and information systems.

From a performance testing perspective, neither Sholehah (2023), Rizky Ariyanto & Syani (2025), nor Hidayat *et al*. (2025) measured system response time quantitatively, while Umar & Miftachuddin (2025) and Mardiaturrahman & Yulianto (2026) similarly did not report response time efficiency as part of their evaluation. This study therefore addresses a gap in the existing literature by providing empirical response time data for two key transactional features. The average response time of 0.34 seconds for the visitor form submission process is well within Nielsen's (1993) 1.0 second threshold for maintaining uninterrupted user thought flow, confirming that the system is capable of processing reservation data submissions without disrupting the user experience. The 6.95 second average response time for the admin decision verification process, while higher, remains below Nielsen's (1993) 10 second maximum attention limit. The longer duration reflects the structural complexity of the admin verification workflow, which simultaneously executes three operations: database status update, session quota recalculation, and SMTP based email notification delivery to the visitor. Academically, this finding highlights an important practical implication: for reservation systems that integrate automated communication workflows, the standard 1.0 second benchmark is not an appropriate threshold for administrator-facing features with multi operation loads, and future studies in similar contexts should consider differentiating performance benchmarks based on the underlying operational complexity of each transactional feature.

CONCLUSION

The Ir. Djamaludin Suryohadikusumo Forestry Museum's digital reservation and scheduling platform was successfully built using the Laravel framework and prototyping. This resulted in an interactive calendar feature on the public page displaying morning and afternoon session availability. Prospective visitors can check slot availability and make reservations independently without having to contact the administrator via WhatsApp. The platform includes seven integrated key features: a public reservation calendar, admin authentication, an operational dashboard, schedule management, reservation approval with automatic email notifications, history and report export, and information document management. The reservation data management system was successfully implemented with an automatic quota validation mechanism per visit based on a centralized database. It incorporates

database transactions and row-level locking through a combination of DB::transaction() and lockForUpdate() in the Laravel framework, completely preventing scheduling conflicts between groups, including reservation conflicts, at the database level. Functional testing using black box testing across 27 test scenarios demonstrated a 100% success rate, proving that all features operate according to the designed functional specifications. Usability evaluation using the System Usability Scale (SUS) involving 10 respondents resulted in a combined average score of 84.5 which places the platform in the Acceptable category with a Grade A rating, indicating the system is easy to use by all user groups. System performance testing based on the Nielsen (1993) response time threshold shows an average response time of 0.34 seconds for the reservation form submission process by visitors which is below the 1.0 second limit so that the user's thought process is not disturbed, and 6.95 seconds for the decision verification process by the admin which is below the 10 second limit so that user attention can still be maintained, proving the system is able to process every data transaction and support the smooth flow of reservation confirmation as a whole.

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