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Design and Development of a Web-Based Library Information System at SMP Negeri 221 Jakarta

Muhammad Aditya Firdaus[1]✉, Tuti Haryanti[2*]✉
[1]Sistem Informasi, Universitas Bina Sarana Informatika, Indonesia
[2]Ilmu Komunikasi, Universitas Bina Sarana Informatika, Indonesia

Abstract
The library administration at SMP Negeri 221 Jakarta previously relied on conventional ledger-based records. This practice created difficulties in retrieving data, increased the risk of recording errors and duplication, and delayed report preparation. This study aims to design and develop a web-based library information system to support the management of student records, books, categories, borrowing and returning transactions, user accounts, and borrowing reports. The system was developed using the Rapid Application Development (RAD) method, consisting of requirements planning, user design, construction, and cutover/implementation. Data were collected through observation, interviews, and literature study. The application was built using Laravel, PHP, MySQL, Blade Template Engine, and Bootstrap. Black Box Testing was conducted based on the functional scenarios defined during system design. The testing results achieved a 100% success rate, indicating that all tested scenarios—including user authentication, student and book data management, circulation transactions, and report generation—operated according to the expected results. The system also provides user activity logging and late-return fine calculation. Therefore, the developed system can support the digitalization of library administration by integrating essential management functions into a centralized platform. Future improvements may include self-service borrowing for students, return-date reminders, and more comprehensive analytical reporting features.
Keywords: Library Information System; Website; Rapid Application Development; Laravel; Black Box Testing;

***Corresponding Author:**
Tuti Haryanti, Universitas Bina Sarana Informatika, Indonesia
Email: tuti.tty@bsi.ac.id

1. INTRODUCTION

The school library is one of the learning support facilities that plays a role in providing reading materials and information for both students and teachers[1], [2]. Besides supporting teaching and learning activities, the library also serves as a learning resource center that can strengthen the literacy culture within the school. Along with the development of information technology, library management needs to adapt to the demand for fast, accurate, and structured access to information. Using digital technology in library management can help schools improve administrative quality[3], [4], make it easier to search for collection information, and support more effective library services.

In practice, the administration management at the SMP Negeri 221 Jakarta library, which is the research site, is still done conventionally using a ledger. This recording includes member data, book collections, borrowing and returning transactions, and library activity reports. Using manual recording makes data processing and searching take relatively long. In addition, there is a risk of recording errors, data duplication, lost archives, and delays in report preparation. This situation can also make it difficult for staff to quickly know the availability and borrowing status of books, while students may have trouble finding collections that suit their needs. These problems show the need for a system that can integrate data management and library services into one computerized system.

Several previous studies have discussed the implementation of web-based information systems to support library management. Adwiya [5] developed a web-based book borrowing and returning

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information system to help with the recording of library transactions. Ula and Hasbi [6] discussed the implementation of a web-based library information system as an effort to improve data management and library services. Besides web-based development, Wijaya [7] applied the Rapid Application Development (RAD) method in information system development because this approach allows the system to be built iteratively through user involvement and development in a relatively short time. Previous research results show that web-based information systems and the RAD approach have the potential to support library management digitalization.

Although previous research has shown the benefits of web-based information systems in library management, there is still a gap in their application to school library administration, which mostly relies on manual record-keeping[8]–[10]. Some studies focus more on specific functions, such as borrowing and returning books, or discuss library information systems in general, so the need for a more integrated management approach hasn't always been the main focus. At SMP Negeri 221 Jakarta Library, management needs include not only collection and circulation transaction data but also student data, book categories, user accounts, reports, stock monitoring, and activity logs. Therefore, research is needed that specifically implements an information system based on the operational needs of the school library and ensures that each main function can run according to user needs.

To address this gap, this study developed a web-based library information system using the Laravel framework and MySQL database with a Rapid Application Development (RAD) approach[11], [12]. The RAD approach is used to support an iterative development process so that user needs can be identified and applied gradually during the system development. The developed system includes student data management, book and category data, borrowing and returning transactions, user accounts, collection stock, reports, and activity logs. The novelty of this research lies in the implementation of a system tailored to the administrative needs of SMP Negeri 221 Jakarta Library, which were previously handled conventionally. Therefore, the development is not only focused on digitizing transactions but also on integrating library data and information management into a single system.

Based on these problems and gaps, this study aims to analyze the ongoing library administration process, design and build a web-based library information system using Laravel and MySQL with a RAD approach, and test the main functions of the system using Black Box Testing. Practically, this study is expected to produce a system that can help staff manage library data, speed up information searches, monitor book availability and loan status, handle circulation, and create reports in a more structured way. For library users, the system is expected to make it easier to get information about the library's collections and services. The results of the system's implementation and testing will then serve as the basis for discussion on the development process, system functions, and test results in the following section.

This study aims to analyze the existing library administration processes at SMP Negeri 221 Jakarta, develop a web-based library information system using the Laravel framework and MySQL database with the Rapid Application Development (RAD) methodology, and evaluate its core functionalities through Black Box Testing. The main contribution of this research is the development of an integrated system tailored to the operational needs of the school library, encompassing student data management, book collections, categories, user accounts, borrowing and returning transactions, stock monitoring, overdue fine calculations, report generation, and activity logging. Unlike approaches that focus primarily on specific library functions, the proposed system integrates these administrative components into a centralized platform to support more structured data management and facilitate information retrieval. The results are expected to provide a practical solution for supporting library staff in managing routine administrative activities while offering a foundation for future improvements in digital library services. Furthermore, the functional testing results provide evidence of whether the implemented features operate according to their specified requirements, although the system's impact on operational efficiency requires further quantitative evaluation.

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2. RESEARCH METHODOLOGY

2.1. Data Collection

To get an accurate picture of the actual conditions regarding the activities and workflow at the SMP Negeri 221 Jakarta Library, this study uses several data collection techniques. Research information was obtained through direct observation of library activities, interviews with relevant parties, and exploring various relevant library sources. Observations were carried out to understand library administration activities, including things like book collection recording, membership processes, loan services, and book return procedures. Interviews were conducted to gather information about library management needs from the relevant parties. The literature study was carried out by reviewing various sources that are related to this thesis topic and are used as a foundation for discussion. The study materials for this research were collected through searches of relevant literature, such as books, articles in scientific journals, and various publications discussing library information system management, software development, and system modeling techniques. The diversity of references used serves as a basis to strengthen the research concepts and theories, while also providing comparative perspectives that support the stages of system design and development.

2.2. System Development Method

The Rapid Application Development (RAD) method is a system development approach that emphasizes rapid application development through prototyping, intensive user involvement, and iterative development[13], [14]. This method enables developers and users to communicate directly to identify requirements, design the system, conduct testing, and refine the application based on feedback. RAD generally consists of four main phases: Requirements Planning, User Design, Construction, and Cutover, allowing systems to be developed in a relatively short time while ensuring that the final application meets user requirements. The development of a web-based Library Information System at SMP Negeri 221 Jakarta is carried out using the Rapid Application Development (RAD) approach. The RAD stages are explained through four phases:

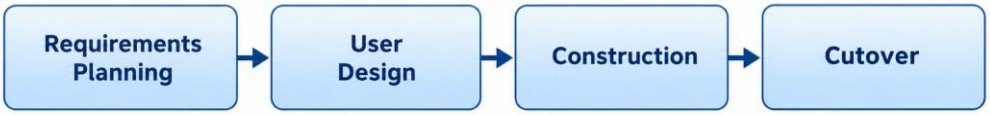


Figure 1. RAD Methodology

The Rapid Application Development (RAD) method in this study consists of four stages: Requirements Planning, User Design, Construction, and Cutover. The Requirements Planning stage is carried out to identify and formulate system requirements based on the conditions and problems in managing the library at SMP Negeri 221 Jakarta, which are obtained through data collection. Next, the User Design stage includes designing the system flow, use case diagram, activity diagram, Entity Relationship Diagram (ERD), Logical Record Structure (LRS), class diagram, sequence diagram, as well as the user interface design. In the Construction stage, the library information system starts to be developed based on the established design, using Laravel as the framework, MySQL as the database management system, and Blade Template Engine and Bootstrap to build the interface; this stage also involves creating the database, models, and controllers. The final stage, called Cutover, is the process of transitioning from the old system to the new system that has been fully developed. This includes testing functions using Black Box Testing, making improvements based on the test results, and preparing the system implementation so it can actually be used in managing the library at SMP Negeri 221 Jakarta.

2.3. System Testing

Testing was done using a Black Box Testing approach. The testing focused on whether the inputs and outputs of each function matched the specified requirements, without checking the internal code structure[15], [16]. The testing process involved preparing test scenarios based on the system's functional requirements, providing inputs under predefined conditions, observing the resulting

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outputs, and comparing the actual results with the expected results. The tested functionalities included user authentication, student data management, book data management, borrowing transactions, book return transactions, and report generation. Authentication testing was performed to verify the system's ability to validate user credentials and provide access according to the applicable conditions. Student and book data management were tested to ensure that data could be added, viewed, updated, and deleted as required. Borrowing and return transactions were examined to verify the accuracy of transaction processing and the updating of book availability. In addition, report generation was tested to ensure that the information displayed corresponded to the recorded transaction and master data. Each test scenario was evaluated based on whether the actual output matched the expected output, with the results documented in the testing tables presented in the thesis. These results provide a basis for determining whether the implemented functions satisfy the defined functional requirements and identifying any discrepancies that require correction. The evaluation is limited to functional verification using Black Box Testing; therefore, performance indicators, such as response time, system throughput, and load capacity, are not included unless supported by the original testing data.

3. RESULT AND DISCUSSION

The research focuses on the design and development of a web-based library information system at SMP Negeri 221 Jakarta to improve the efficiency and accuracy of library management. The system is developed to address challenges in conventional library administration, particularly in managing book data, student records, borrowing and returning transactions, and report generation. The development process applies the Rapid Application Development (RAD) method, which consists of four phases: Requirements Planning, User Design, Construction, and Cutover. This approach supports rapid system development through user involvement, iterative design, and continuous evaluation. The system is tested using the Black Box Testing method to verify that each function operates according to the specified requirements, including user authentication, data management, circulation transactions, and report generation. The resulting system is expected to facilitate library staff in managing library activities, improve data organization, and provide more accessible and reliable library services for students and staff at SMP Negeri 221 Jakarta.

3.1. Analysis and System Design

The system that was developed is intended for internal use within the library of SMP Negeri 221 Jakarta and does not include integration with other schools' academic systems. The main modules include student data, book data, book categories, borrowing transactions, system users with Admin and Staff roles, and borrowing reports. Students haven't been borrowing on their own through the website yet; transactions are recorded by the Staff based on student requests.

The database design uses six main tables, namely users, students, activity_logs, categories, books, and borrowings. The activity_logs table is related to users to store user activities. The books table is linked to categories, while the borrowings table connects data from students and books. This structure supports the relationships between member data, collections, transactions, and user activities.

Tabel 1. Core Data Structures of a Library Information System

Components	Functions in the system
Users	Stores user accounts and Admin/Staff roles.
Students	Stores student identities as library members.
Categories	Groups book collections by category.
Books	Stores information on books, categories, and stock.
Borrowings	Records borrowing/return transactions along with status and fines.
Activity logs	Tracks user activity in the system.

The library information system consists of six main components: Users, Students, Categories, Books, Borrowings, and Activity Logs. The Users component manages user accounts and defines access roles, including Admin and Staff, while the Students component stores student identification data for library

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membership. The Categories component organizes book collections into specific classifications, and the Books component maintains book information, category associations, and stock availability. The Borrowings component records book borrowing and returning transactions, including transaction status and overdue fines, enabling staff to monitor library circulation activities. Finally, the Activity Logs component tracks user activities within the system to support operational monitoring and accountability. Together, these components are integrated to facilitate structured data management, streamline library administration, and maintain consistency across the system's core functions.

The web-based library information system proposed for SMP Negeri 221 Jakarta is designed to support the process of managing library data in an integrated way, from user authentication, recording student and book borrowing transactions, data storage, to processing and presenting information. This system involves users with different access rights, especially the admin or library staff, so that every activity can be carried out according to their roles and permissions. With a web-based system, the data management process is expected to be more structured, documented, and easy to monitor through dashboards and reports generated by the system shown in Figure 2.

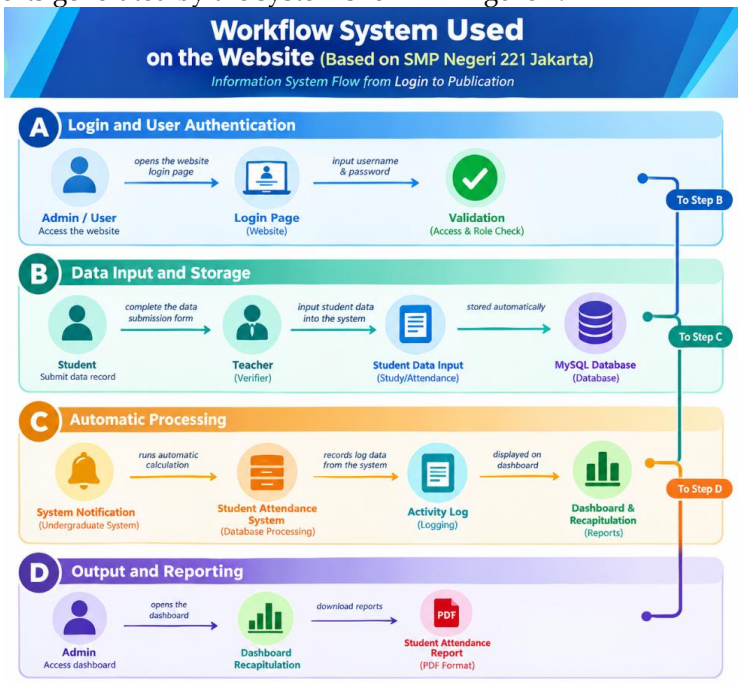


Figure 2. Design System

The picture shows the workflow of a library information system consisting of four main stages. Stage A, Login and User Authentication, shows users accessing the login page, entering their username and password, and then the system validating the account and access rights. Stage B, Data Input and Storage, depicts students requesting to borrow books and staff entering transaction data into the system, which is then stored in a MySQL database. Stage C, Automatic Processing, shows the system automatically detecting delays, calculating fines, recording activities in the log, and updating the dashboard and summaries. Finally, Stage D, Output and Reporting, shows the admin accessing the dashboard to monitor information and download borrowing reports in PDF format. This flow shows that each stage is connected, so the data entered at the beginning can be processed and produce information that can be used for library monitoring and reporting.

3.2. System Implementation

The application is built using Laravel as the framework, PHP as the programming language, and MySQL as the database management system. The Blade Template Engine is used to build the views, while Bootstrap helps with the interface layout. The development environment uses Visual Studio Code and Composer. The database is implemented through Laravel migrations and can be checked via

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phpMyAdmin. The authentication feature checks the username and password and directs users to the dashboard according to their role. Admins and Staff can manage student and book data. Book management includes adding, updating, deleting, and adjusting stock quantities. Admins also have account management functions and can view borrowing summaries through the dashboard.

In a borrowing transaction, the staff selects the student and the requested book. The system checks stock availability; if it's available, the transaction is saved and the book stock decreases. During the return process, the system checks the return date against the deadline. If there's a delay, the system calculates and records a fine. The system also provides borrowing reports that can be filtered by date range and status, and then downloaded in PDF format. Activity logs help the admin review actions taken by users.

The login page is the initial view of the SMP Library information system, serving as the access gateway for users before entering the main application page. This page is designed with a simple and easy-to-understand interface, so users can enter their account information to authenticate. The presence of the login page aims to limit system access to users with the appropriate credentials, while also supporting the security of library data management, as shown in Figure 3.

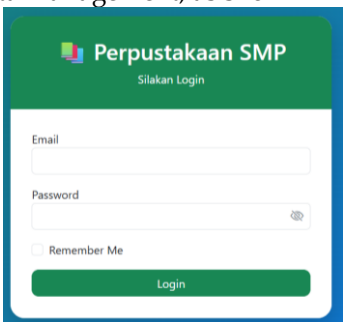


Figure 3. Implementation Login Page

Based on the login page image, the system displays the identity of the SMP Library at the top of the page with green as the dominant color. The login form provides two input fields, namely Email and Password, along with a Remember Me option to keep the user logged in. In addition, there are icons to show or hide the password and a Login button to process authentication. The compact and structured layout is expected to make it easier for users to access the system conveniently.

The student data page is one of the main features in the junior high school Library information system, which functions to manage student information as users of the library services. This page is designed to help staff in recording, monitoring, and maintaining student data in an organized way. With the student data management feature, information related to students' identities and contacts can be stored in one system, making administrative processes easier and supporting library service activities as shown in Figure 4.

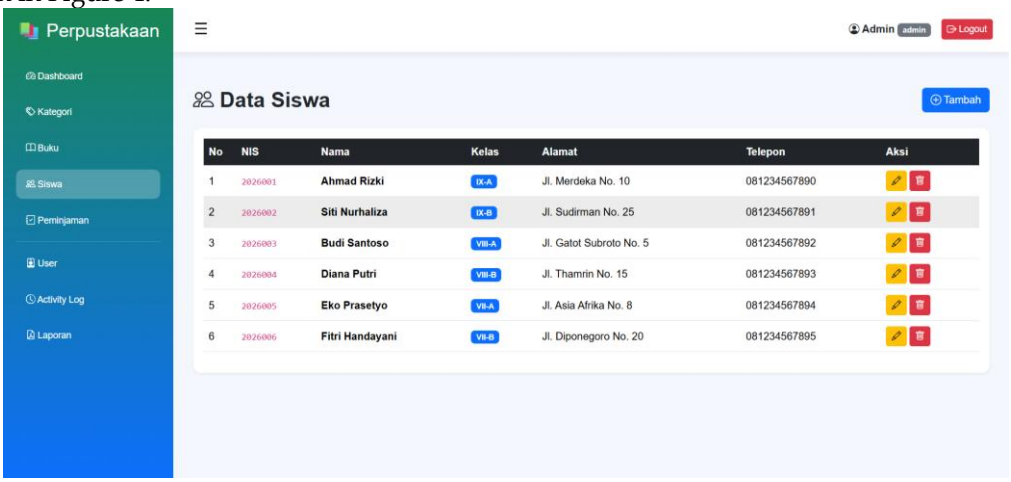


Figure 4. Implementation Student Data Page

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Based on the student data page image, the system displays a table containing several pieces of information, namely the serial number, Student Identification Number (NIS), student name, class, address, phone number, and an action column. The data is presented in a table format to make it easy for staff to read and navigate. In the top right corner of the page, there's an Add button to add new student data, while the action column provides edit and delete buttons to update or remove selected data. Additionally, the navigation menu on the left side gives access to various other features, such as Dashboard, Categories, Books, Borrowing, Users, Activity Log, and Reports.

The book data page is a feature used to manage the collection of books available in the Junior High School Library. This feature supports the process of recording and monitoring the collection, from noting the book's identity to grouping it based on categories and stock quantity. Centralized book data management is expected to help staff maintain orderly collection administration and make it easier to find the information needed by students and other library users. Figure 5.

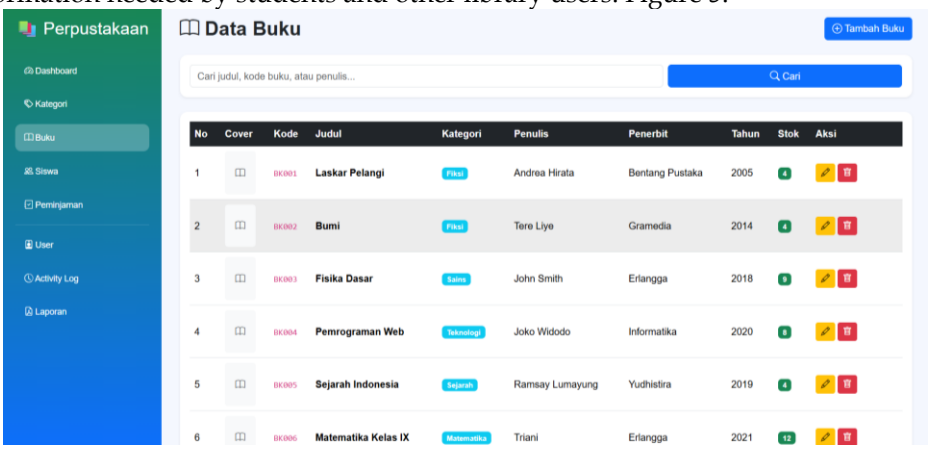


Figure 5. Implementation Book Data Page

Based on the image of the book data page, the system shows the collection in a table that includes the serial number, book cover, book code, title, category, author, publisher, publication year, stock, and an action column. At the top of the page, there's a search bar that can be used to look for books by title, book code, or author, along with a Search button to run the search. There's also an Add Book button to enter new collections into the system, while the edit and delete buttons in the action column are used to update or remove book data. Stock information is also displayed so staff can easily and efficiently see the quantity of each collection.

The loan data page is part of the library transaction management module used by staff to manage all book borrowing and returning data. This feature serves as a transaction recording hub, so staff can know the status of each loan, monitor overdue returns, and take action on ongoing transactions. By presenting data in table form, the transaction management process can be done more systematically and is easier to monitor, as shown in figure 6.

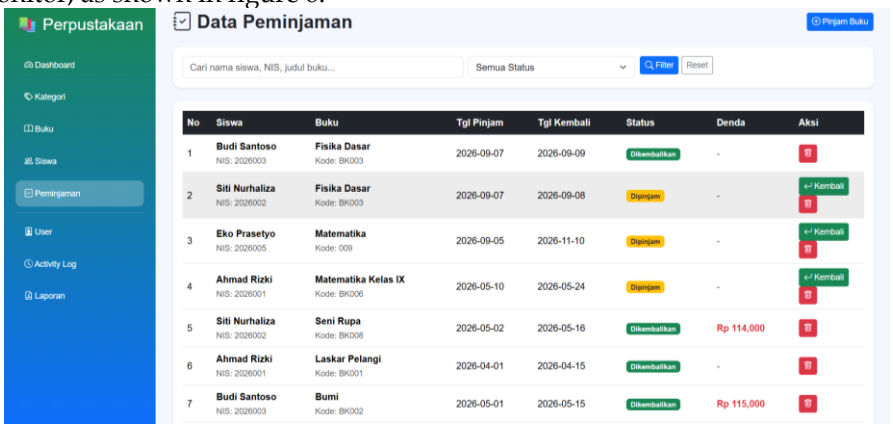


Figure 6. Implementation Book Loan Data Page

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In the picture, the Loan Data page comes with a search feature based on student name, NIS, or book title, as well as filters based on transaction status. The loan table shows information like transaction number, student name and NIS, book title and code, loan date, return date, status, fines, and actions. Ongoing transactions are marked with the status Borrowed and include a Return button that staff can use to record the book return process. Meanwhile, completed transactions are shown with the status Returned, and if there's a fine, the amount is displayed in the available column. Staff can also delete transaction data through the action button provided. Besides managing transactions, this page also has a Borrow Book button to add a new loan transaction.

The loan report page is designed as one of the system's output features, used to present a summary of book borrowing activities in a concise and structured way. This page makes it easier for library admins or staff to monitor the number of borrowing transactions, total fines, return status, and borrowing history over a certain period. The information displayed can be used as a reference for evaluating library management and administrative documentation, as shown in Figure 7.

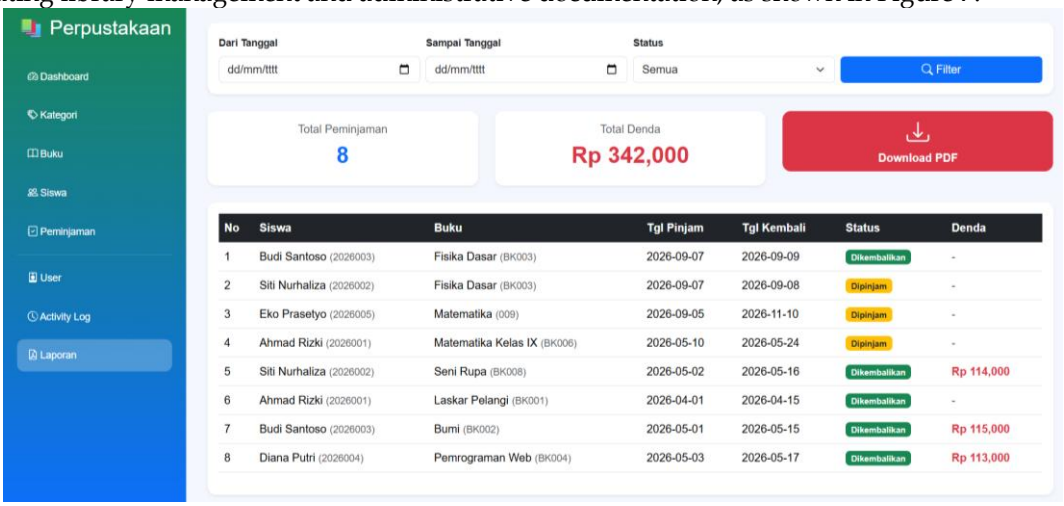


Figure 7. Implementation Report Data Page

In figure 7, the report page provides data filtering features based on start date, end date, and loan status, so that staff can display data as needed. The summary section shows the Total Loans and Total Fines calculated from the available transaction data. Below that, there is a table containing the transaction number, student name along with student ID, book title along with book code, loan date, return date, transaction status, and fine amount. The Returned and Borrowed statuses are shown using different color markers to make it easier to identify the transaction condition. Additionally, there's a Download PDF button that allows staff to generate reports in PDF format for documentation or reporting purposes.

3.3. System Testing

The test results in the thesis show that the function scenarios listed in the Black Box Testing table matched the expected outcomes. Authentication testing included logging in with registered accounts and rejecting incorrect credentials. Student data testing checked adding entries, required field validation, updates, and deletions. Book data testing involved recording collections, updating stock, and removing books from the list.

In the circulation module, testing covers recording loans, updating stock after transactions, and managing returns. Report testing checks filter selection and PDF file creation. Based on the compliance marks in the thesis testing table, the functions tested work as designed. Since the thesis does not include measurements of process duration, quantitative comparisons before and after implementation, or load testing, this article does not provide a numerical figure for performance improvement as shown in Table 2.

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Tabel 2. Summary of Functional Testing Results

Testing Area	Checked Scenarios	Result
Login	Correct credentials are directed according to role; wrong credentials are denied.	Success
Student data	Add, validate required fields, edit, and delete data.	Success
Book data	Add collections, update information/stock, and delete data.	Success
Borrowing	Record transactions and reduce stock when a transaction is successful.	Success
Returning	Update status and calculate late fees.	Success
Reports	Filter data and download reports in PDF format.	Success

Based on the testing results of the library information system, the tests were carried out in six main areas: Login, Student Data, Book Data, Borrowing, Returning, and Reports. Each area was tested based on functional scenarios that included user credential and access rights validation, management of student and book data, recording borrowing transactions, handling returns and calculating late fees, as well as filtering and downloading reports in PDF format. All test scenarios showed a Success result, so out of 6 testing areas with 6 scenarios, there were 6 successes and 0 failures, giving a success rate of 100%. These results indicate that the main functions of the system are working according to the set requirements and all tested features can be used as intended.

3.4. Discussion

The implementation of the web-based library information system addresses several key challenges identified in the manual management of library operations, particularly those related to data storage, transaction recording, stock monitoring, and report generation. By centralizing library data within an integrated system, information about students, books, categories, borrowing transactions, and user activities can be managed in a more structured and consistent manner. This centralized approach reduces dependence on physical records and helps minimize the potential for data duplication, recording errors, and difficulties in retrieving previously stored information. Furthermore, the use of a web-based interface provides a more accessible environment for administrative tasks, allowing authorized users to manage library information through a single application. These features demonstrate how the proposed system can support the digitalization of routine library activities and improve the organization of information compared with conventional record-keeping practices.

Another important aspect of the system is the integration of transaction management and inventory control. In a manually operated library, recording borrowing and returning activities often requires staff members to update transaction records and book availability separately. This process can increase the risk of inconsistencies between borrowing records and the actual number of available books. The implemented system addresses this issue by incorporating stock updates into the designed transaction workflow, allowing changes in book availability to be processed in accordance with borrowing and return activities. In addition, the system provides a mechanism for calculating overdue fines based on the configured transaction rules, thereby reducing the need for repetitive manual calculations. The availability of structured borrowing records also enables library staff to review transaction information more efficiently. Nevertheless, the reliability of these functions depends on the correctness of the implemented business rules, the accuracy of the data entered by users, and appropriate handling of exceptional situations, such as overdue returns, cancelled transactions, or discrepancies in book records.

The separation of administrative and operational responsibilities through the Admin and Staff roles also contributes to more organized system management. By assigning different permissions according to user responsibilities, the system can restrict access to particular functions and reduce the likelihood of unauthorized changes to important library data. The relationships established among the database tables further support data consistency by connecting student records, book information, categories, borrowing transactions, and activity logs. This relational structure allows transaction records to be associated with the relevant students and books, while activity logs can support the monitoring of actions performed within the application. In comparison with a paper-based ledger, the system also offers web-based search facilities and downloadable reports, which can simplify information retrieval

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and support administrative decision-making. However, the practical effectiveness of role-based access control and activity logging depends on the implementation of appropriate authorization checks, secure authentication, and reliable log management. Therefore, these features should be considered important foundations for operational control rather than definitive evidence that all security risks have been eliminated.

Despite these advantages, several limitations should be considered when interpreting the system's contribution. The current application is primarily designed for internal use by administrators and library staff, meaning that students cannot independently access the system to search for books, check availability, or initiate borrowing requests. The benefits identified at this stage are therefore associated mainly with the organization and support of internal library operations, rather than with demonstrated improvements in student access or overall service performance. In addition, the effectiveness of the system has not yet been established through quantitative measurements of processing time, transaction accuracy, user satisfaction, or operational efficiency under real-world conditions. Future evaluation should involve library staff and students, use actual transaction data where appropriate, and compare service performance before and after implementation. Security testing, usability assessment, and reliability testing should also be conducted to examine the system's robustness and suitability for routine use. Further development could include student-facing catalog access, online borrowing requests, automated notifications, and more comprehensive analytical reports. These improvements would provide a stronger basis for assessing the system's practical value and extending its functionality to meet broader library service requirements.

4. CONCLUSION

This study successfully developed a web-based library information system for SMP Negeri 221 Jakarta using the Rapid Application Development (RAD) methodology. The system was implemented using Laravel, PHP, and MySQL to support the management of student records, books, categories, user accounts, borrowing and returning transactions, PDF reports, overdue fine calculations, and user activity logs. The implementation integrates these functions into a centralized platform designed to support more structured and organized library administration.

The reported results of Black Box Testing indicate that the tested functional scenarios operated according to their expected outcomes. These findings suggest that the system's implemented features function as intended within the scope of the testing performed. The system also provides facilities for searching and managing library data, monitoring book availability, processing transactions, and generating reports, which have the potential to simplify routine administrative activities. However, improvements in operational efficiency have not yet been quantified through measurements such as transaction processing time, error rates, or user satisfaction. Therefore, the system's practical benefits should be further evaluated through real-world implementation and systematic user assessment.

Future development should focus on expanding the system's functionality and improving the overall user experience. Recommended enhancements include self-service borrowing requests, automated return-deadline reminders through WhatsApp or email, more comprehensive analytical reports, book-shelf location information, and improvements to the transaction interface. Further evaluation should also examine usability, security, reliability, and operational performance under actual library conditions. These developments could strengthen the system's contribution to library management and provide a more accessible, efficient, and sustainable digital library service.

CRediT AUTHORSHIP CONTRIBUTION STATEMENT

Muhammad Aditya Firdaus: Writing – original draft, Validation, Software, Methodology. **Tuti Haryanti**: Writing – review & editing, Formal analysis, Data curation, Conceptualization, Supervisor.

DECLARATION OF COMPETING INTEREST

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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The authors used Generative AI to improve the writing clarity of this paper. They reviewed and edited the AI-assisted content and take full responsibility for the final publication.

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