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The Implementation of a Web-Based Library Management Information System Using Barcodes at Al-Islam Vocational High School Surakarta: A Research and Development (R&D) Approach

Reza Dani Wijaya [1]*, Nendy Akbar Rozaq Rais [2], Siti Rokhmah [3]

[1]ITB AAS Indonesia

rezadanimujahid17@gmail.com[1]*, ab.terate@gmail.com[2], sitirokhmah.itbaas@gmail.com[3]

Abstract

This study discusses the implementation of a web-based Library Management Information System utilizing barcode technology at Al-Islam Vocational High School in Surakarta. The system was developed to enhance efficiency in managing book data as well as borrowing and returning transactions in a digital environment. Built using the Laravel framework, the system ensures structured and secure web application development. The Research and Development (R&D) method was applied through stages of needs analysis, system design, development, validation, and evaluation. The implementation results indicate that the system accelerates library services, minimizes data entry errors, and facilitates user access to collection information and transaction history. Testing was conducted by involving librarians as the primary users, and evaluation results revealed a high level of satisfaction regarding the system's ease of use and functionality. In conclusion, the system functions effectively and can serve as an efficient and user-friendly solution for digital library management in educational institutions.

Keywords: *Management Information System, Digital Library, Laravel, Barcode, R&D*

1. Introduction

School library management that still relies on manual systems often faces various challenges, such as inaccurate data recording, time-consuming book searches, and difficulties in report generation. These issues can hinder the efficiency of library services and reduce students' interest in utilizing library facilities optimally. With the advancement of information technology, the need for computerization in library management has become increasingly urgent to improve service quality and operational efficiency. The implementation of a web-based library management information system supported by barcode technology can serve as an effective solution to address these problems. This system enables faster and more accurate book borrowing and returning processes, as well as easier data management and report generation. The application of a web-based library information system can significantly enhance efficiency and accuracy in school library management. Therefore, the development and implementation of a web-based library management information system integrated with barcode technology is expected to make a positive contribution to improving the quality of library services in educational settings [1]. By incorporating barcode technology into the web-based library system, the management of member data, books, and transactions becomes more structured, and librarians are assisted in data entry, monitoring availability, and conducting borrowing/returning processes in real time, thereby accelerating operational decision-making [2].

As an educational institution based on information technology, Al-Islam Vocational High School Surakarta, located at Jalan Honggowongso No. 28A, Laweyan District, Surakarta City, is a private vocational high school with a "B" accreditation operating under the Al-Islam Foundation. The school has approximately 132 students (116 male, 16 female) and 22 teachers and educational staff who support the daily teaching and learning process. The school's vision and mission emphasize the formation of a superior generation that is morally upright and competent in the field of computer and network engineering, supported by a library facility consisting of a dedicated room and managed by a full-time administrator. Currently, the library's management is semi-IT based, still relying on Microsoft Excel, with a collection that has reached 2,792 copies but is not yet systematically structured. Consequently, a number of problems have arisen, including data entry prone to errors, slow book searches, out-of-date collection reports, and a decline in student interest due to suboptimal availability and access to information. This situation underscores the urgency of developing a web-based Library Management Information System with the integration of barcode technology, using the Research and Development (R&D) method. The goal is to make the book borrowing and returning process faster and more accurate, and to facilitate the administrator's monitoring of the collection and routine reports [3]. It is hoped that the implementation of this system will not only improve operational efficiency and data accuracy but also

encourage an increase in literacy and user satisfaction, as well as have a positive impact on the reading culture within the Al-Islam Vocational High School Surakarta environment.

This study employs the Research and Development (R&D) method, which is generally a research approach aimed not only at creating a new product but also at testing its effectiveness through a series of validation and revision stages [4]. According to Sugiyono, R&D is used to design scientific products such as models, methods, or systems, which are then tested and refined based on the results of those tests. In the literature, there are various R&D models, including Borg & Gall, ADDIE, 4D, and Dick & Carey, as well as a local model developed by Sugiyono, with each model featuring systematic and phased stages This research selected the R&D method because it is highly suitable for developing a web-based library information system with barcode integration, a process that requires iterations of design, testing, and revision to achieve a system that meets the criteria of validity, practicality, and effectiveness according to R&D standards Furthermore, the primary advantage of R&D is its ability to produce a product that has been field-tested and scientifically validated, thus possessing higher generalizability and durability compared to other methods [7]. Therefore, this method is highly appropriate for the research titled "Implementation of a Web-Based Library Management Information System Using Barcodes at Al-Islam Vocational High School Surakarta," as its framework allows for the development of a mature system, its feasibility is measured through direct trials, and its results are scientifically accountable.

Although a previous study by Lamada and Fatahillah (2022), "Analysis of Quality and Development of a Web-Based Library Information System Using Barcode Technology," demonstrated the feasibility of a barcoded web-based library system through a prototype model and testing of ISO 25010 aspects (functionality, performance efficiency, usability, compatibility, portability), the research was limited in two main respects. First, system validation was only conducted by two content experts and one system expert, without involving direct trials with end-users, such as librarians and students, who could provide concrete feedback on real-world usability. Second, despite being technically feasible, the previous study did not measure service effectiveness indicators like transaction data accuracy, book circulation speed, or end-user satisfaction [2]. This creates a significant gap, as the implementation at Al-Islam Vocational High School Surakarta requires stronger empirical evidence regarding the system's performance in a real-world setting. The current research aims to address this gap, particularly the lack of user testing, by conducting a field test involving librarians and students. By utilizing the R&D method to obtain validation from direct users, this study will present quantitative data on the enhanced efficiency and effectiveness of the web-based library service with barcodes compared to the previous manual and prototype systems.

2. Research Methodology

The research method employed in this study is Research and Development (R&D) with an approach centered on developing a web-based information system. The study commenced with a data collection phase through direct observation and interviews with the librarian and library service users at Al-Islam Vocational High School Surakarta. The collected data was then processed to formulate system requirements, which were translated into UML diagrams and a system interface design using a participatory approach. This design process aimed to create a system that aligns with the library's operational needs. Subsequently, the system was built using the PHP programming language and a MySQL database, supported by barcode technology to automate the book borrowing and returning processes. Following the construction phase, the system was tested to ensure its functionality and user acceptance. The research workflow adheres to an iterative principle, allowing for improvements and further development based on the results of the system trials. This approach is believed to be effective in producing a library information system that is practical and efficient in supporting the digital management of book circulation. [8].

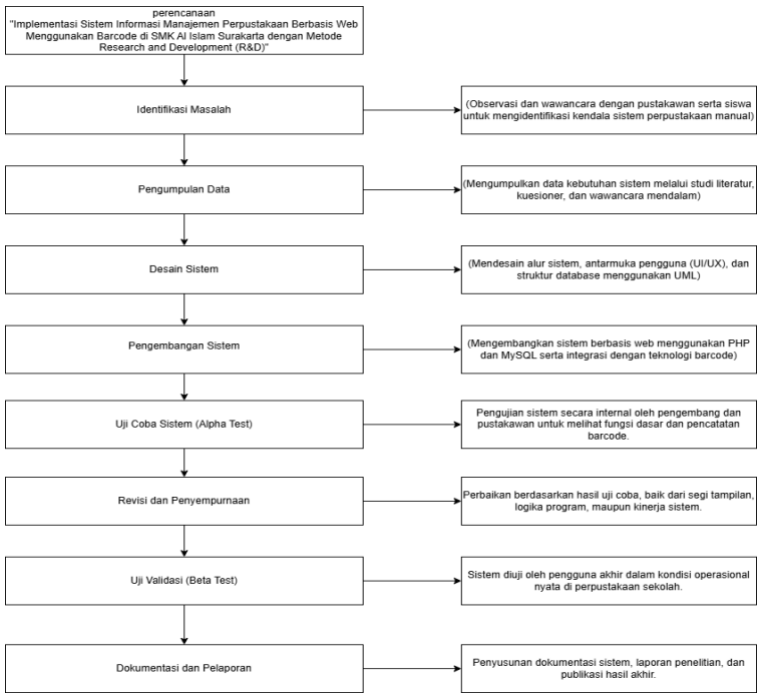

Fig.1: R&D Research Process

2.1. Data Collection

In the research "Implementation of a Web-Based Library Management Information System Using Barcodes at Al-Islam Vocational High School Surakarta," data collection techniques were employed to obtain accurate and relevant information as a basis for the needs analysis and system development process. The three primary techniques used were interviews, observation, and literature study [9].

a. Interview
   Interviews were conducted directly with the librarian and library staff at Al-Islam Vocational High School Surakarta. The objective was to gather information regarding the constraints of the current manual system, user requirements for a web-based information system, and their expectations for the integration of barcode features. These interviews were conducted in a structured manner using a predefined list of questions to obtain in-depth data on both the technical and non-technical aspects of the library services.
b. Observation
   Observation was carried out to directly examine the processes within the library environment, such as book borrowing and returning, member data recording, and the creation of loan reports. Through this technique, the researcher could document the actual existing workflow and identify obstacles or potential errors in the manual process. This observation was participatory passive, where the researcher did not directly engage in the activities but observed them as a source of primary data.
c. Literature Study
   A literature study was conducted to support the conceptual understanding of library management information systems, barcode technology, and the Research and Development (R&D) method. Data was sourced from various references such as scientific journals, reference books, seminar proceedings, and online repositories relevant to the research topic. This study assisted the researcher in formulating a theoretical framework, comparing findings from previous research, and compiling system requirement indicators that align with the standards of web-based information system development.

By utilizing these three techniques, the data obtained was more comprehensive and in-depth, thereby effectively supporting a targeted and contextually appropriate system design and implementation process.

2.2. System Development Model

The system development model used in this research is Research and Development (R&D), a method that focuses not only on product creation but also on scientific validation and repeated improvement iterations. According to Sugiyono (2011) and Borg & Gall (1983) in educational studies, R&D is designed as a cycle that starts with data collection and literature study, followed by design, prototype development, limited trials, revision, and concludes with full-scale trials and final product dissemination [7]. Following the initial design consultation and expert testing, the library system prototype was developed, tested by its initial user (the library administrator), and then improved based on feedback, adhering to the continuous R&D cycle. The R&D method is highly relevant for a web-based library system with barcode integration because it allows for the active involvement of users from the initial stages to the final evaluation, and provides flexibility in system development and refinement. As demonstrated in educational research that uses the 4D (Define, Design, Develop, Disseminate) model, R&D ensures that the resulting product is not only theoretically valid but also practical and effective for use in a real-world environment. With this approach, the research can produce a library information system that meets the operational needs of Al-Islam Vocational High School Surakarta and can be optimally implemented with minimal additional iterations.

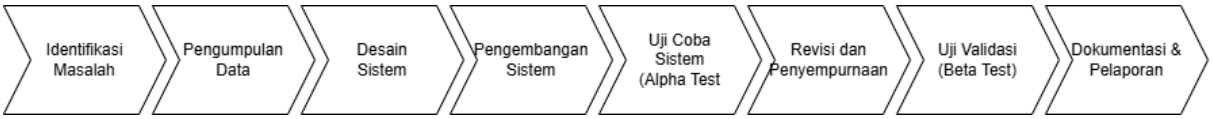

Fig. 2: Research & Development (R&D) Model

The Research & Development (R&D) model involves the following stages of system development:

a. Problem Identification
   The initial stage in the R&D model is to identify existing problems in the field. At this stage, the researcher observes phenomena and looks for gaps or shortcomings in the current (existing) system. The main objective is to gain an in-depth understanding of the problems that require a technological solution. In the context of a library system, problems could include manual record-keeping, service delays, or data errors.
b. Data Collection
   After the problem has been identified, the next step is to collect relevant data. The techniques used can include observation, interviews, literature studies, or documentation analysis. This data is needed to understand user requirements and serves as a basis for designing the system to be developed. A literature review is also crucial for examining existing theories or previous research to establish a scientific foundation.
c. System Design
   Based on the data analysis results, the researcher begins to create a system design. The system design includes creating a system flowchart, interface design (UI/UX), and database design. An initial prototype can also be developed as an early visualization of the system. This stage is crucial to ensure that the development process does not deviate from the predetermined requirements.
d. System Development
   This stage is the implementation of the design into a tangible product, such as software or an information system. Development is carried out by coding according to the previously created design, for instance, using PHP, MySQL, and supporting technologies like a barcode scanner.
e. System Testing (Alpha Test)
   The developed system is tested on a small scale to check its initial functionality (basic features). This testing is usually conducted by the internal development team and user representatives to identify bugs or discrepancies between the system and the initial design. The evaluation at this stage is technical and structural in nature.
f. Revision and Refinement

The results from the alpha test are used to make improvements to the system. These improvements can include refining the workflow, interface, system speed, or adding features. The goal is to prepare a more stable system before it is tested by a wider user base.

g. Validation Testing (Beta Test)
This stage is conducted to test the system directly with end-users (real users). The system validation is performed in an actual operational environment (real-setting). The results are used to assess the extent to which the system is accepted and used by the target users, as well as its effectiveness in solving the problems identified at the beginning.

h. Documentation and Reporting
Tahap akhir dari model R&D adalah mendokumentasikan seluruh proses dan hasil penelitian dalam bentuk laporan. Dokumentasi ini
The final stage of the R&D model is to document the entire research process and its results in a report. This documentation includes the problem identification, methodology, design, test results, and conclusion. Besides academic purposes, this report also serves as a basis for implementing the system on a broader scale.

3. Result and Discussion

This chapter provides a detailed outline of the results from the research and development of the library management information system implemented at Al-Islam Vocational High School Surakarta. This research process adopts the Research and Development (R&D) model, which consists of several systematic stages, ranging from potential and problem identification, data collection, product (system) design, product development, internal testing (Alpha Test), product revision, usage trials (Beta Test), to the documentation and reporting stage. Each stage will be discussed in-depth to present comprehensive research findings and discussion analysis.

3.1. Problem Identification

The first stage in this research is problem identification, which forms the primary basis for the urgency of system development [10]. Based on preliminary observations and initial interviews with the Head of the Library and staff at Al-Islam Vocational High School Surakarta, several key problems were identified within the existing conventional (manual) library management system. These problems include:

Table 1: Problem Identification

Main Problem	Impact/Effect on the Library Information System
Manual recording of book and member data	Book and member data are recorded manually in ledgers. This leads to disorganized records and makes it difficult to update or correct data quickly and efficiently.
Slow borrowing and returning process	The manual recording of borrowing and returning transactions results in longer service times for members. This slow process also negatively impacts the satisfaction level of library users.
Recording errors (human error)	Manual recording is prone to human error, which can lead to inaccurate data or the loss of important information regarding a book's status (i.e., whether it is borrowed or available).
Difficulty in tracking book status	The absence of an automated system to monitor book status makes it difficult to determine if a book is currently on loan or available for borrowing. This slows down service and increases the likelihood that lost or overdue books are not detected promptly.
Manual compilation of recapitulation reports	Compiling monthly or annual recapitulation reports manually is time-consuming. This makes it difficult to obtain accurate and timely data, thereby hindering data-driven decision-making.

The discussion at this stage emphasizes that the inefficiency of the manual system not only impacts the performance of the library staff but also affects the satisfaction level of students as the primary users. The continued reliance on manual management, coupled with a lack of significant development, has the potential to reduce students' interest in reading. Furthermore, the absence of a computerized catalog search system makes it difficult for students to find the books they need. This situation underscores the need for an innovation in the form of a computerized information system that can automate these processes, improve efficiency and data accuracy, and provide easy access to information for all stakeholders. The implementation of barcode technology is identified as a potential solution to drastically accelerate the transaction process [11].

3.2. Data Collection

Once the problems were identified, the subsequent stage was in-depth data collection to understand the existing system's workflow (as-is) and to formulate the requirements for the system to be developed (to-be). At this stage, the researcher utilized three primary data collection methods: observation, interviews, and documentation study [11].

Table 2: Observation Findings

Observation	Findings
Data Processing Process	• Book data, member data, and loan and return transactions are recorded manually in a logbook and on member cards. • Each transaction is recorded by the library admin by writing down the member ID and transaction details manually. • The recording is linear and text-based, which leads to potential errors such as entering incorrect member IDs, causing tracking difficulties.
Book Search Process	• Book searches can only be conducted by manually checking the book list in the catalog. • There is no computerized catalog system that enables fast searches based on title, author, or category.

Difficulties in Report Generation	• Monthly recapitulation reports or other reports are created manually, which requires significant time and effort. • Calculation and recording errors often occur due to reliance on manual processes.

The results from this data collection provide a comprehensive overview. It was found that the existing workflow is highly linear and prone to errors. This data subsequently formed the basis for the functional and non-functional requirements for the system design [12].

Table 3: Interview Results

Interview Results	Managerial Requirements (Requirements from the Head of the Library)
Book and member data entry	The Head of the Library wants book and member data to be entered digitally to facilitate easier data updates and management.
Fast borrowing and returning transactions	The Head of the Library wants a system that can accelerate book borrowing and returning transactions, suggesting the use of barcode technology as one method.
Easy book search	The Head of the Library stated that students and staff need an easy search system based on title, author, or category to accelerate book discovery.
Automatic report generation	The Head of the Library wants book borrowing and returning reports, as well as monthly or annual reports, to be generated automatically by the system.

In the Documentation Study, the following problems were also found:

Table 4: Documentation Study Results

Studi Dokumentasi	Format dan Proses yang Digunakan
Master Register and Member Cards	The master register and member cards are used to record all data related to books and members. However, this format is inefficient and prone to recording errors.
Loan Record Book	The loan record book is used to log book borrowing transactions. This data is recorded manually and is not integrated with any other system, which makes real-time tracking difficult.

This data will serve as an essential basis for designing an information system that is more efficient and tailored to the needs of the library at Al-Islam Vocational High School Surakarta.

3.3. System Design

Based on the user requirements data that has been collected, the subsequent stage is the system design. This design serves as a blueprint before the coding process begins, with a primary focus on the functionality for a single user type: the Librarian (Admin). The design is created using the Unified Modeling Language (UML) to visually model the system. The primary design output includes a Use Case Diagram to illustrate the interactions between the Librarian and all system features, such as managing book data, managing member data, and processing transactions.

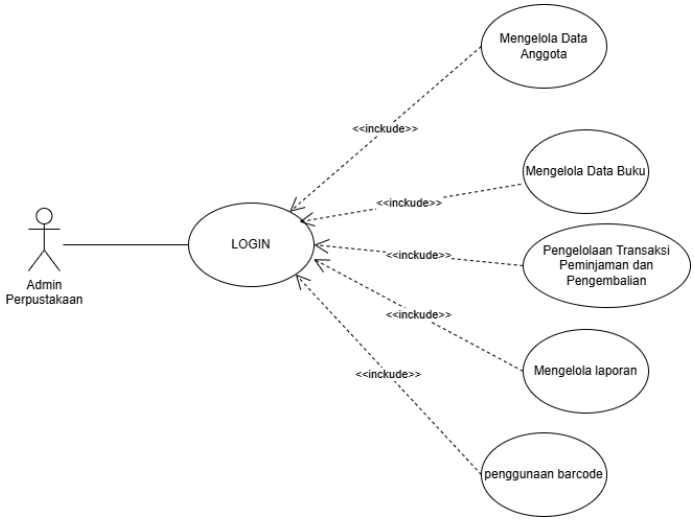

Fig. 3: Use Case Diagram

Furthermore, an Activity Diagram is used to explain the detailed workflow of each use case, beginning with the login diagram in Fig. 4:

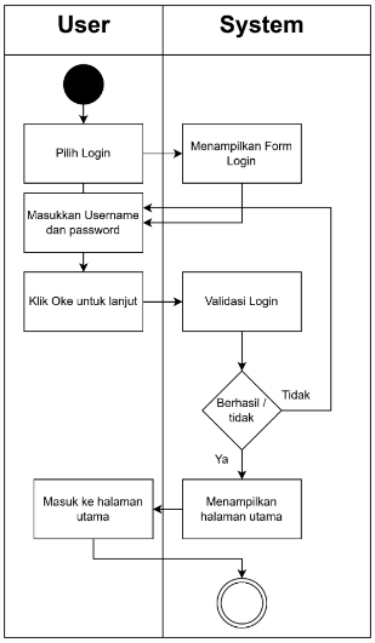

Fig. 4: Diagram Login

After successfully logging in, the admin can proceed by adding new member data. This process is done by accessing the member registration menu and then filling out a digital form containing information such as name, identification number, address, date of birth, and phone number. The system automatically validates each input, including checking that fields intended for numbers are not filled with non-numeric characters. If the data is valid, the system saves it and confirms the successful completion of the process to the user. This is illustrated in Fig. 5:

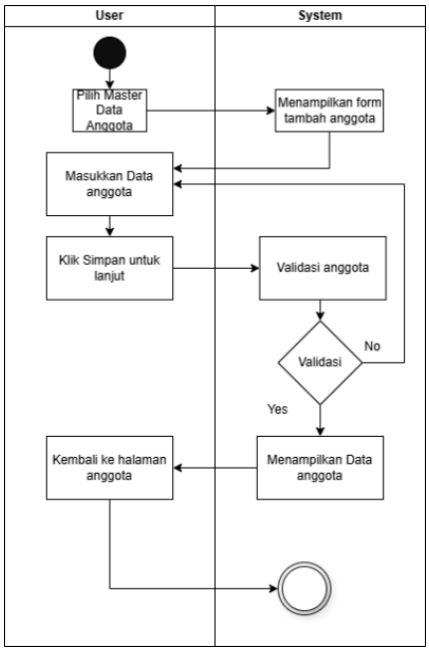

Fig. 5: Member Data Diagram

Similarly, the same process applies to adding new book data. The admin opens the new book entry form and enters information such as the title, author, publisher, publication year, ISBN, and a unique book code. The system then processes this data and generates a unique barcode based on the book code, which can be printed and affixed to the physical book. The purpose of this process is to streamline subsequent transactions through scanning.

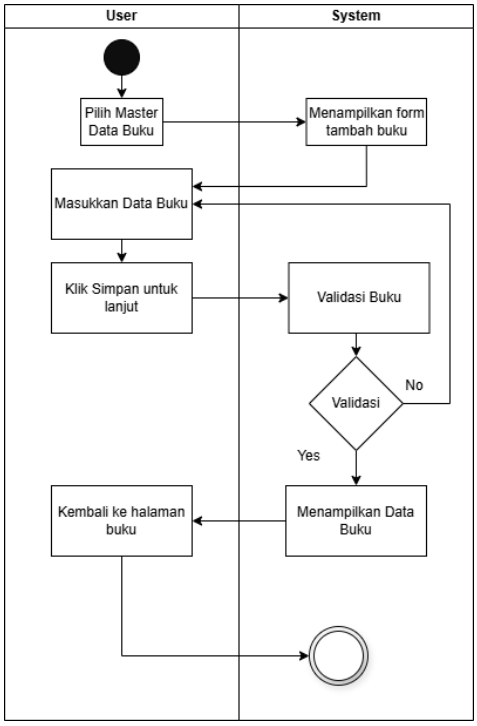

Fig. 6: Book Diagram Data

During the borrowing process, the admin searches for a member's data by ID or name, after which the system displays the corresponding member information. Next, the barcode on the book to be borrowed is scanned using a barcode scanner. The system recognizes the code and displays the relevant book details. Once all the borrowed books are added to the transaction list, the admin clicks the "save" button, and the system records the borrowing date while automatically calculating the return due date. This transaction is then saved to the database as an active loan record.

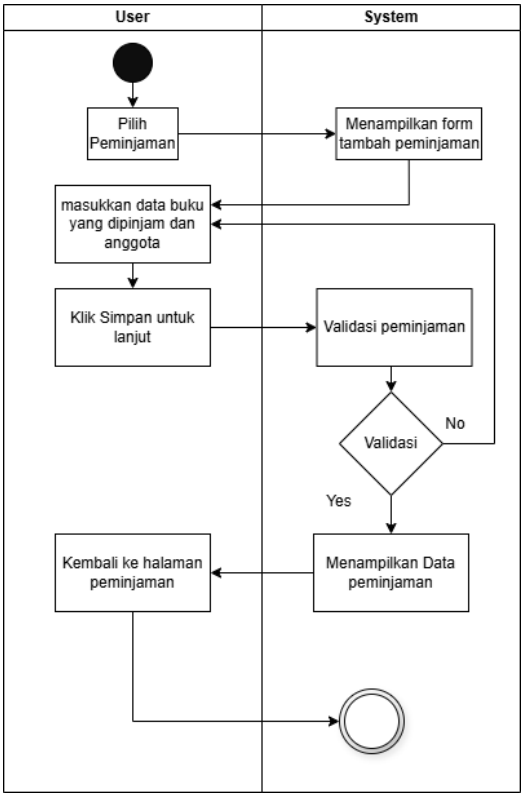

Fig. 7: Loan Diagram

The return process is similar, beginning with the scanning of the barcode on the returned book. The system automatically retrieves the previous transaction data and compares the actual return date with the due date. If the book is overdue, the system calculates the number of late days and the corresponding fine amount according to the applicable policy. The admin can then confirm the return to complete the transaction, and the system will update the book's status to “Available,” making it ready to be borrowed again.

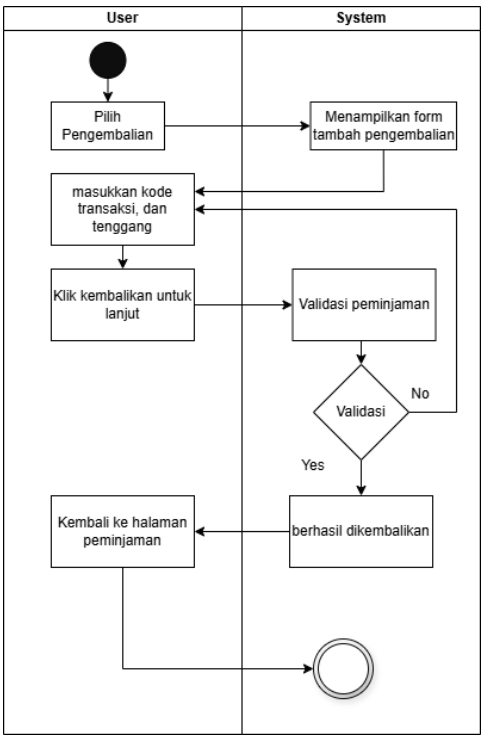

Fig. 8: Return Diagram

The Class Diagram is designed to establish the database structure, including the necessary tables such as tbl_buku, tbl_anggota, and tbl_transaksi, and the logical relationships between them. [13].

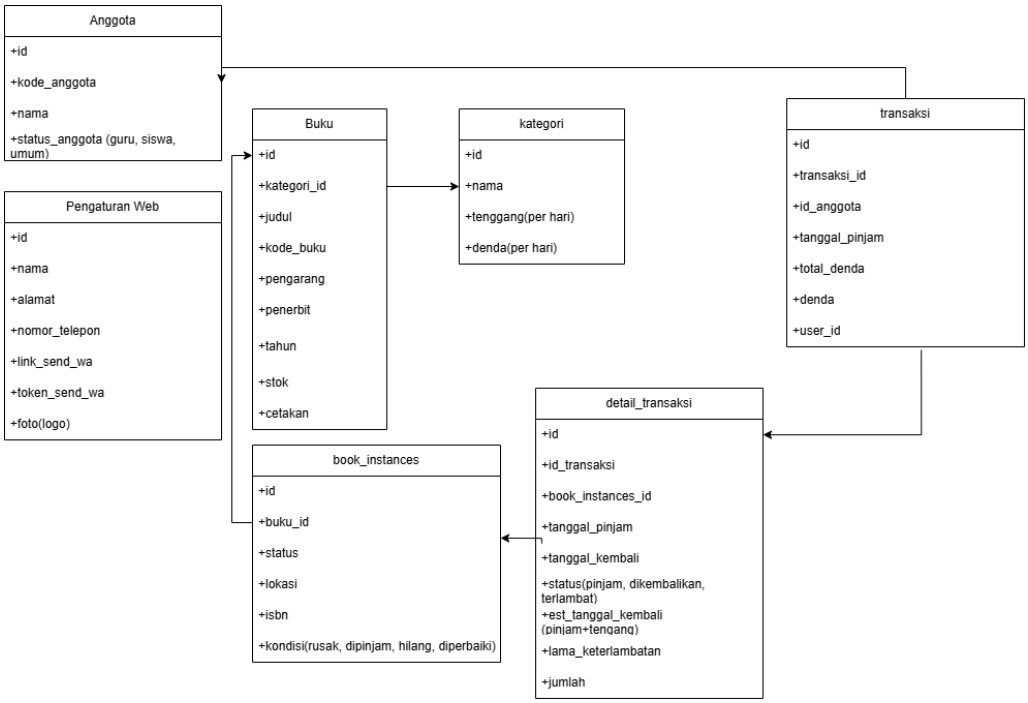

Fig. 9: Class Diagram

The system architecture is designed as a web-based application with a client-server model to facilitate ease of maintenance and accessibility for the staff. The server-side is developed using the PHP programming language with the Laravel framework to accelerate development and ensure the code is well-structured. For database management, MySQL is utilized due to its open-source nature and reliability in handling medium-scale data. On the client-side, the interface for the Librarian will be accessed through a standard web browser, with the front-end built using HTML, CSS, and JavaScript to ensure responsiveness and interactivity. This design ensures the system can be easily accessed by the Librarian from any computer within the school environment that is connected to the local network, without requiring any special installation. [14].

3.4. System Development

The development stage is the implementation of all previously created designs. This process involves writing program code (coding) to build all of the system's functional modules. Development was conducted modularly, beginning with the creation of the MySQL database according to the designed Class Diagram. Subsequently, the development team built the main modules in stages, including the Authentication Management Module (Login/Logout), Master Data Management Module (CRUD for book, category, and member data), Transaction Management Module (borrowing and returning with barcode reader integration), and the Reporting Module. The PHP programming language with the Laravel framework was used for the backend, while HTML, CSS (with the Bootstrap framework), and JavaScript were used for the frontend.

The system's key feature, barcode integration, was developed during this stage. The system was equipped with a function to automatically generate unique barcodes for each newly registered book and for every member card. These barcodes use the Code-128 format, which is common and easily read by scanning devices. During transactions, the librarian simply scans the barcode on the member's card and then scans the barcode on the book. The system automatically populates the transaction form with the relevant data, allowing a process that previously took several minutes to be completed in a matter of seconds. The entire development process was conducted in a local environment (localhost) using Laragon before being deployed to the school's server.

a. Login Page

This image shows the system's login page, where the user (admin) enters a username and password to access the system. Validation is performed to ensure that only registered users can log in.

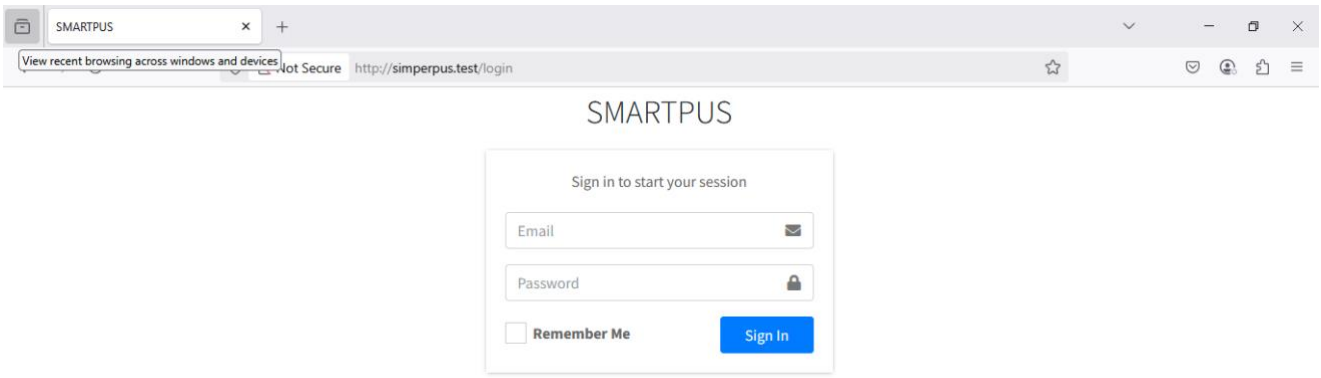

Fig. 10: Login Interface

b. Dashboard Page

The dashboard is the main page displayed after logging in. This view presents a summary of important information, such as the total number of books, members, and active transactions, as well as quick access to the system's main menu.

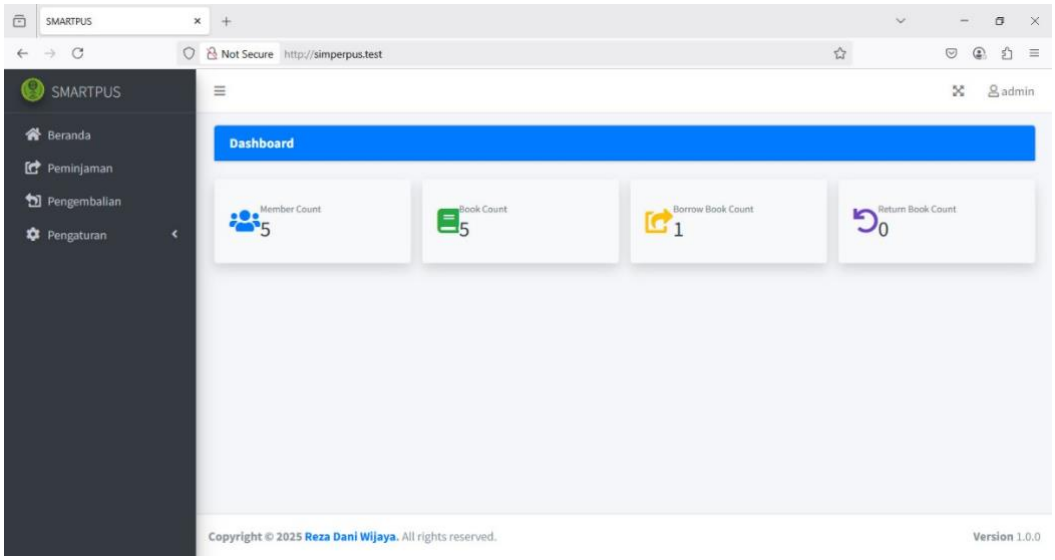

Fig. 11: Dashboard Page

c. Member Page

This page displays a list of library members, complete with features to edit and delete data. It also includes an "Add Member" form to input new information such as Name, ID Code, and Member Status.

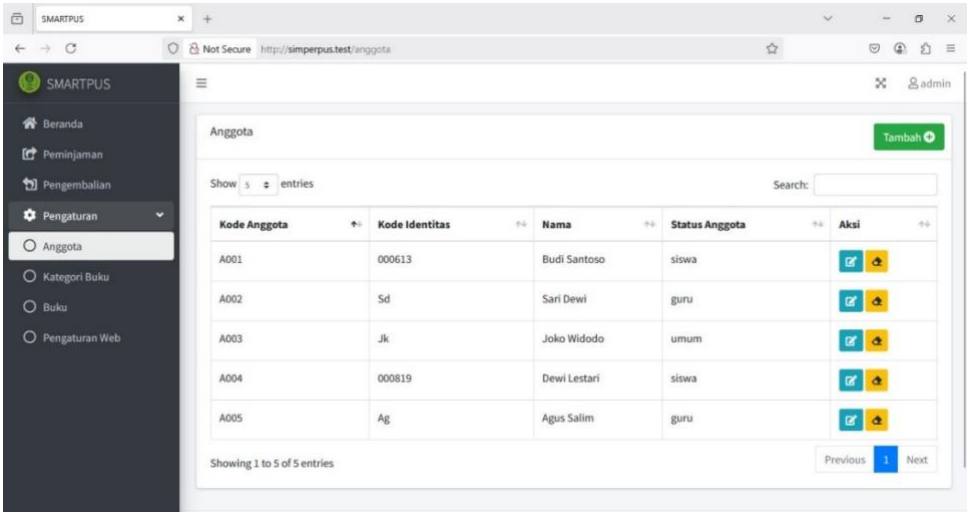

Fig. 12: Member Data Interface

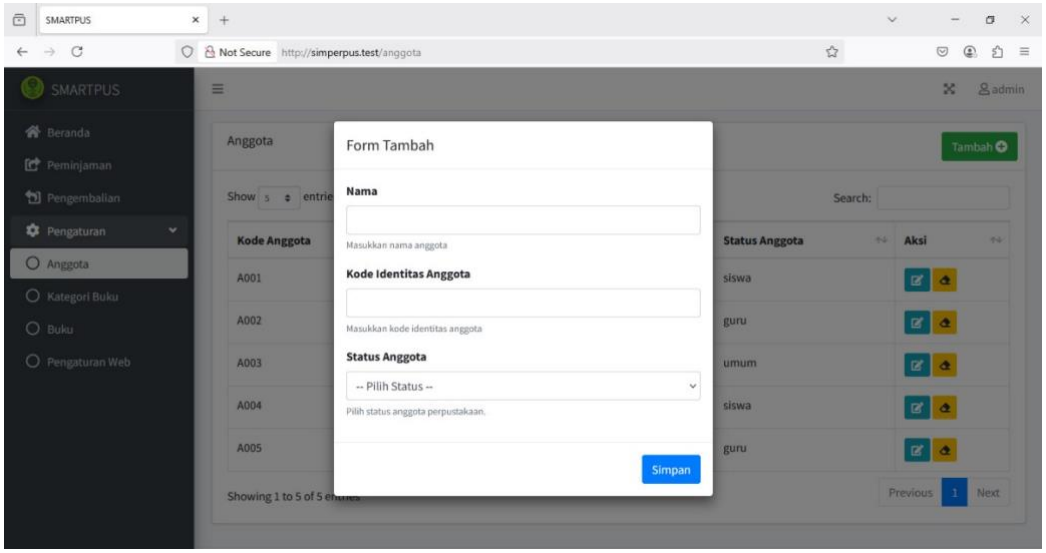

Fig. 13: Add Data Member Interface

d. Book Page

This image shows the book collection list, complete with search and data management features. In the 'Add Book' form, the admin can input the title, author, publisher, publication year, ISBN, and book code, which is automatically linked to the barcode system.

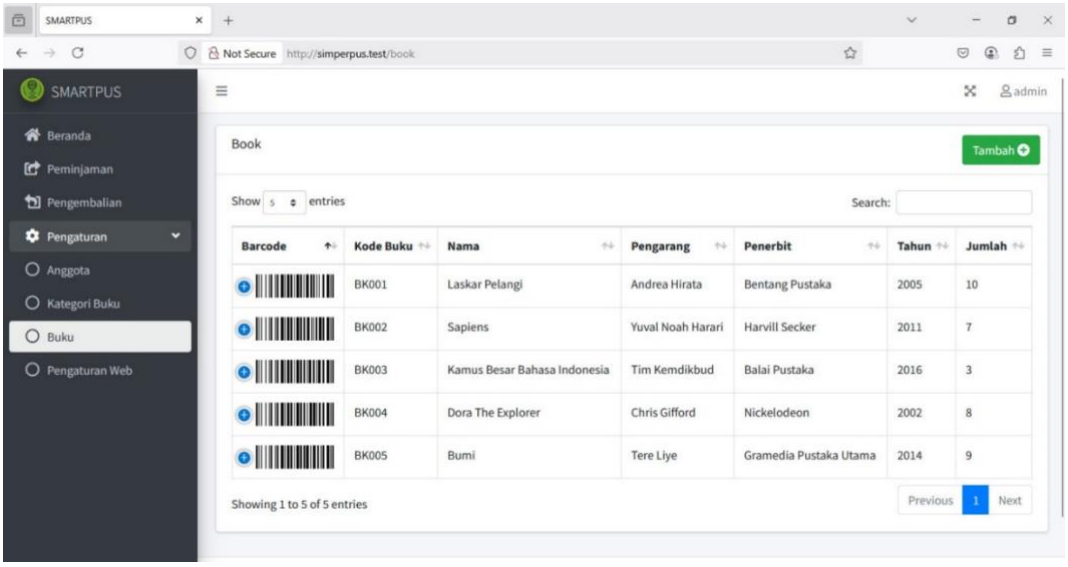

Fig. 14: Book Data Interface

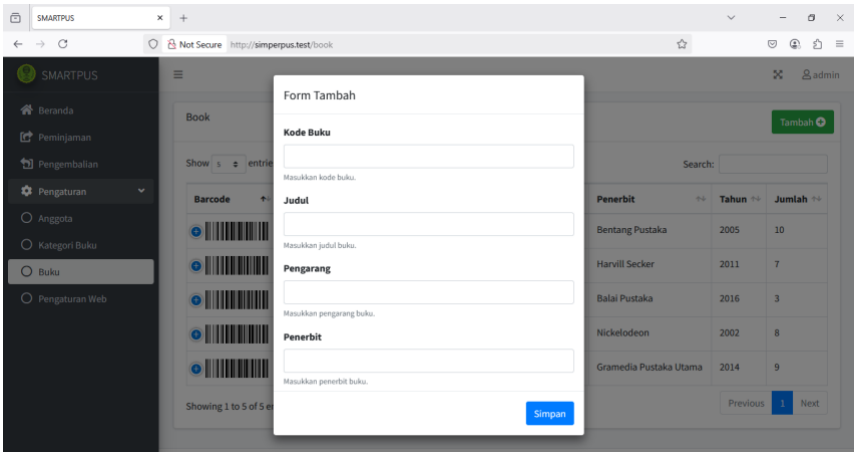

Fig. 15: Add Book Data Interface

e. Book Category Page

This page is used to manage book categories, such as "Textbooks," "Reference," "General," and others. Each category has different borrowing rules and fine policies. For example, the "Textbooks" category has a longer loan period and a smaller fine per day of delay, whereas the "Reference" category has a shorter loan period and a larger fine. This category data serves as the basis for the system to automatically calculate the overdue fine amount during the return process. Thus, a book's category functions not only as a classification but also as a logical parameter for transaction rules.

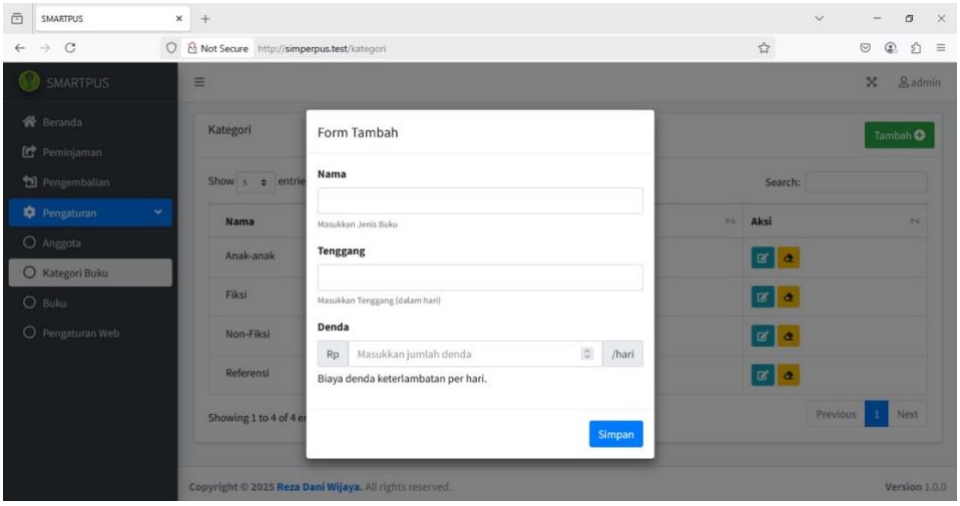

Fig. 16: Add Book Category Interface

f. Book Borrowing Page

This interface is used by the admin to record borrowing transactions. Books are selected or scanned using a barcode scanner, and the borrower's data is matched based on the member ID. The system automatically determines the due date.

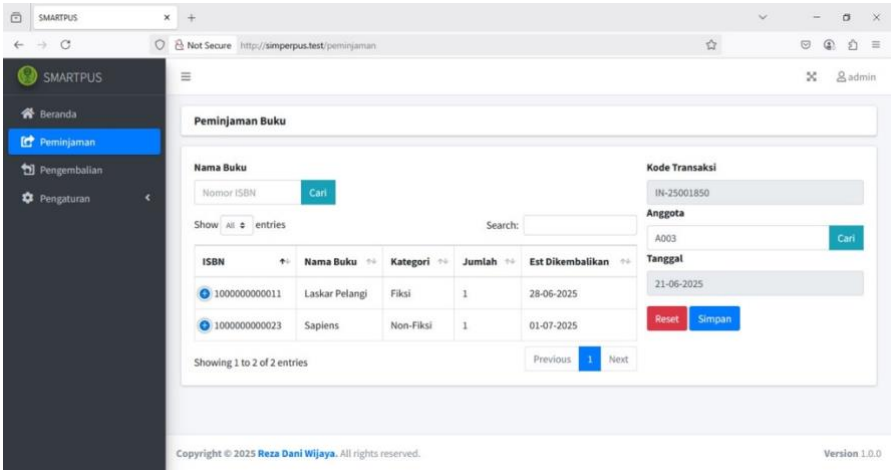

Fig. 17: Book Borrowing Interface

g. Book Return Page

This page facilitates the book return process. After the book's barcode is scanned, the system displays the transaction data and automatically calculates a fine if the return is overdue. The admin can complete the transaction directly via the save button.

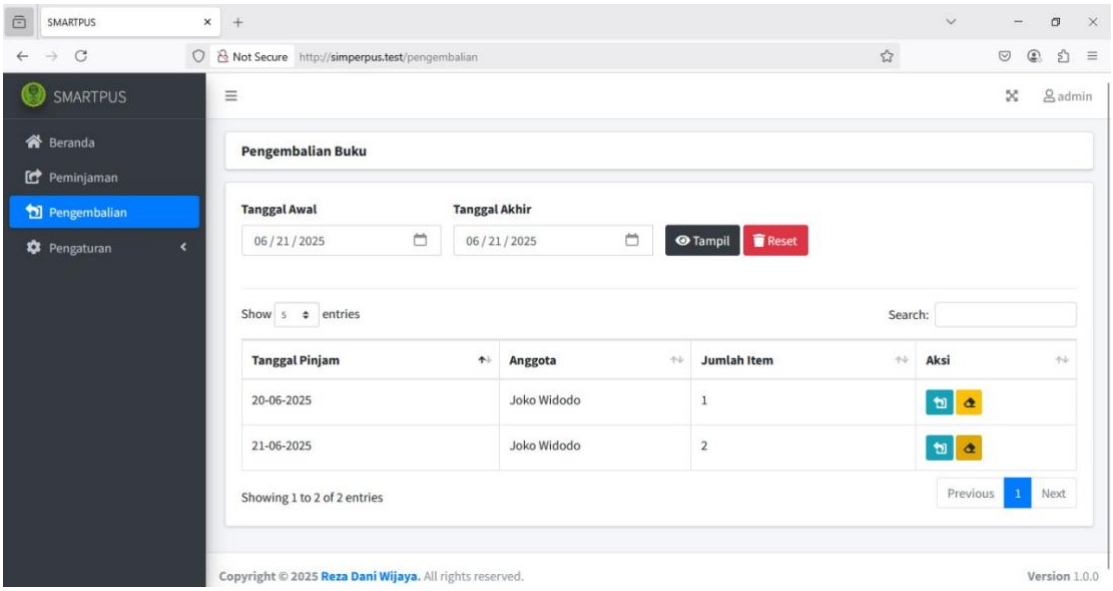

Fig. 18: Return Page Interface

3.5. System Testing (Alpha Test)

The system testing (Alpha Test) was conducted after the initial development phase was completed. The testing was performed internally by the development team using the Black Box Testing method, which focuses on testing the system's functionality based on its inputs and outputs without knowledge of the internal code structure. The test scenarios covered all the system's main features, including the login process, book data management, and borrowing and returning transactions using the barcode scanner technology. The test results revealed a number of findings that needed to be addressed before the system could proceed to the end-user testing phase (Beta Test).

Table 5: Findings and Bugs Discovered

Functionality Tested	Bug Description	Severity Level
Login Session Security	The login session does not automatically terminate (timeout) after a period of inactivity, creating a security vulnerability on public computers.	Major
Fine Calculation	The fine calculation logic is incorrect; it consistently subtracts one day from the total overdue period.	Minor
Data Management	The system allows the deletion of a book's data while its status is "on loan," which invalidates the transaction history (creates an orphan record).	Major
Book Data Management	The ISBN and Book Code data fields are swapped, causing errors during book data input.	Major
Input Validation	The system accepts alphabetic characters in numeric-only fields, such as the 'Phone Number' on the member form and 'Publication Year' on the book form.	Minor
User Interface	There are typos on several buttons and labels (e.g., "Hapus Data Angota" is missing a "g").	Minor
Search	The book search function is case-sensitive, causing searches for "web programming" and "Web Programming" to yield different results.	Minor
User Interface	After successfully adding new data (e.g., a member or book), the form fields are not automatically cleared, making subsequent data entry cumbersome.	Minor
Input Validation	The member registration form allows selecting a date of birth in the future.	Minor
User Interface	Error notification messages are too generic (e.g., "An Error Occurred") and do not provide specific details to the user.	Minor
User Interface	The sorting function on the book list table does not work for the 'Publication Year' column.	Minor
User Interface	Pagination on the member list displays incorrect information when the data set is small (e.g., "Showing 1-10 of 7 items").	Minor

During the Alpha Test, several findings were identified. A total of 12 bugs were discovered with severity levels ranging from minor to Major. One of the minor findings was the incorrect spelling on several button labels and lax input validation on the member registration form (for example, it was still possible to input letters in the phone number field). Major findings included flawed logic in the overdue fine calculation, which was sometimes off by one day, and login sessions that did not automatically terminate after a certain period of time. All of these findings were recorded in detail in a test log, prioritized based on their level of urgency, and submitted back to the developer to be fixed in the subsequent phase.

3.6. Revision and Refinement

Following the Alpha Test phase, a number of findings related to system shortcomings were identified, covering aspects of core functionality, input validation, security, and the user interface. Based on these findings, a comprehensive product revision and refinement phase was carried out by the development team. The objective of this stage was to eliminate bugs, refine features, and improve the system's stability and usability.

Table 6: Bug, Findings, and Corrective Actions

Functionality Tested	Bug Description	Severity Level	Corrective Action	Status
Login Session Security	The login session (admin/member) does not automatically time out after a period of inactivity, creating a security vulnerability on public computers.	Major	An auto-logout feature was added to terminate the session after 30 minutes of inactivity, enhancing security on public computers.	Completed
Fine Calculation	The fine calculation logic is incorrect; it consistently subtracts one day from the total overdue period.	Minor	The fine calculation logic was corrected, and the server's time zone was adjusted.	Completed
Data Management	The system allows the deletion of a book's data while its status is "on loan," which invalidates the transaction history (creates an orphan record).	Major	A restriction notification was implemented to prevent deletion if the book's status is "on loan."	Completed
Book Data Management	The ISBN and Book Code data fields are swapped, causing errors during book data input.	Major	Corrected the input form binding and field mapping in the database.	Completed
Input Validation	The member registration form accepts alphabetic characters in the 'Phone Number' field and the 'Publication Year' field.	Minor	Regex validation was added to restrict input to numeric characters.	Completed
User Interface	There are typos on several buttons and labels (e.g., "Simpan" instead of "Simpan," "Hapus Data Angota" missing a "g").	Minor	All labels were corrected, checked, and adjusted to proper Indonesian spelling.	Completed
Search	The book search function is case-sensitive, causing searches for "web programming" and "Web Programming" to yield different results.	Minor	The search function was changed to be case-insensitive for more accurate results.	Completed
User Interface	After successfully adding new data (e.g., a member or book), the form fields are not automatically cleared, making subsequent data entry cumbersome.	Minor	A script was added to automatically reset the form after data is successfully saved.	Completed
Input Validation	The member registration form allows selecting a date of birth in the future.	Minor	The maximum date selectable was adjusted to the current date (server date).	Completed
User Interface	Error notification messages are too generic (e.g., "An Error Occurred") and do not provide specific details to the user.	Minor	Messages were updated to provide specific context for errors, such as input validation or connection issues.	Completed
User Interface	The sorting function on the book list table does not work for the 'Publication Year' column.	Minor	The sorting function for the affected column was fixed by correcting the DataTables parameter.	Completed
User Interface	Pagination on the member list displays incorrect information when the data set is small (e.g., "Showing 1-10 of 7 items").	Minor	The logic for calculating the total count was corrected to reflect the actual amount of data.	Completed

3.7. Validation Test (Beta Test)

Validation testing, often called a Beta Test, is the stage of system testing by end-users in the actual operational environment. The revised library management information system was installed on a local server at Al-Islam Vocational High School Surakarta. The user involved in this Beta Test was the Library Administrator. This trial lasted for two weeks, during which all library activities were managed entirely using the new system. Its objectives were to measure the system's validity in solving problems and to gather feedback on its ease of use (usability), performance, and user satisfaction.

To measure the effectiveness demonstrated by the positive Beta Test results, a comparison of transaction times was conducted:

Table 7: Transaction Time Comparison

Method	Average Time per Transaction	Time Reduction
Sistem Manual	2-3 Menit	-
Sistem Barcode	±35 detik	75–80% lebih cepat

During the Beta Test, users also provided some feedback for future system improvements, namely:

Table 8: User Feedback

User Feedback	Follow-up Action
Addition of a "Publisher" column on the Export search page	Scheduled for revision
The "Export to PDF" feature is not yet available in all modules	Will be followed up

3.8. Documentation and Reporting

The final stage of this R&D cycle is documentation and reporting. The resulting documentation is not limited to the final research report but also includes technical documentation and user documentation. The technical documentation was created for the purpose of future system maintenance and development, containing information on the system architecture, database schema, and an installation guide. Meanwhile, the user documentation (user manual) was prepared as a simple guidebook intended for librarians and students. The guidebook for librarians contains step-by-step instructions on how to operate all administrative features.

The final report of this research activity is presented in the form of this scientific journal article. This report is structured systematically according to scientific writing conventions, detailing the entire R&D process from the problem background through to the conclusions and suggestions. Its purpose is to disseminate the research findings to the academic community and other practitioners, so that it may serve as a reference or guide for other educational institutions facing similar challenges. This report serves as a testament to the scientific accountability of the entire research and development process undertaken to produce a functional and valid information system.

4. Conclusion

The implementation of a web-based library management information system with barcode technology at Al-Islam Vocational High School Surakarta has resulted in a significant breakthrough in the efficiency of book collection management and lending services. The system, developed using the Research and Development (R&D) method, offers an innovative solution to the problems of manual record-keeping, data irregularities, and delayed information access that have long been obstacles in the school library's operations. Test results indicate that the system significantly increases the speed of borrowing and returning transactions, reduces the potential for recording errors, and enhances data security and integrity through a systematic login and logout mechanism. The use of barcodes has proven to accelerate the book identification and tracking process, while the web-based interface enables centralized, real-time data access for the library administrator.

The primary novelty of this research lies in the integration of book collection management with barcode technology within the context of a vocational high school library, an application that had not previously been widely implemented in a systematic manner. The system not only successfully simplifies the library's workflow but also provides an automated reporting feature that supports transparency and accountability in the management of school assets. Therefore, the results of this research contribute tangibly to enhancing the quality of technology-based library services in secondary education and can serve as a model for similar implementations in other schools facing comparable challenges in book collection management.

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