Vol. 4 No. 1 Edisi November – Januari 2027 E. ISSN. 3032-2472
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DESIGN OF A WEB-BASED LIBRARY INFORMATION SYSTEM FOR BIREUEN DISTRICT USING THE LARAVEL FRAMEWORK

PERANCANGAN SISTEM INFORMASI PERPUSTAKAAN KABUPATEN BIREUEN BERBASIS WEB MENGGUNAKAN FRAMEWORK LARAVEL

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DOI: https://doi.org/10.62567/micjo.v4i1.3447

Abstract

Library administration in regional libraries that still relies on manual records and simple office applications leads to duplicated data, recording errors, and delayed reporting. This study aims to design and build a web-based Library Information System for the Bireuen Regency Library using Laravel 12 that integrates the management of books, categories, members, staff, borrowing, returns, an online public access catalog (OPAC), reports, and user access rights in a single platform. The study applies a Research and Development approach with the Waterfall SDLC model. Requirements were collected through observation, interviews, and documentation study; the design used UML and ERD; and the system was implemented with PHP, MySQL, and Bootstrap on an MVC architecture. Testing combined Black Box Testing and User Acceptance Testing (UAT). All 12 Black Box scenarios passed, and the UAT with 5 respondents yielded a score of 244 out of 250 (97.6%), categorized as Very Good/Very Feasible. The system meets the operational needs of the library and can serve as a basis for the digital transformation of regional library services.

Keywords : Library Information System, Laravel, MVC, Black Box Testing, User Acceptance Testing, Bireuen Regency.

Abstrak

Pengelolaan administrasi perpustakaan daerah yang masih bertumpu pada pencatatan manual dan aplikasi perkantoran sederhana menimbulkan duplikasi data, kesalahan pencatatan, dan keterlambatan penyusunan laporan. Penelitian ini bertujuan merancang dan membangun Sistem Informasi

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Perpustakaan Kabupaten Bireuen berbasis web menggunakan Framework Laravel 12 yang mengintegrasikan pengelolaan buku, kategori, anggota, petugas, peminjaman, pengembalian, katalog dare (OPAC), laporan, dan hak akses pengguna dalam satu platform. Penelitian menggunakan pendekatan Research and Development dengan model SDLC Waterfall. Kebutuhan sistem dikumpulkan melalui observasi, wawancara, dan studi dokumentasi; perancangan menggunakan UML dan ERD; implementasinya menggunakan PHP, MySQL, dan Bootstrap dengan arsitektur Model-View-Controller (MVC). Pengujian dilakukan dengan Black Box Testing dan User Acceptance Testing (UAT). Hasilnya, seluruh 12 skenario Black Box Testing berstatus berhasil, dan UAT terhadap 5 responden memperoleh skor 244 dari 250 atau 97,6% (kategori Sangat Baik/Sangat Layak). Sistem yang dihasilkan memenuhi kebutuhan operasional perpustakaan dan dapat menjadi dasar transformasi layanan digital perpustakaan daerah.

Kata Kunci : Sistem Informasi Perpustakaan, Laravel, MVC, Pengujian Kotak Hitam, Pengujian Penerimaan Pengguna, Kabupaten Bireuen.

1. INTRODUCTION

Advances in information technology have transformed the way organizations manage data, provide services, and communicate with the public. For government agencies, digital transformation is no longer an option but a strategic necessity to improve the quality of public services, enabling business processes to be faster, more accurate, more transparent, and more well-documented. This situation has encouraged various institutions, including libraries, to innovate by implementing web-based information systems to improve the accessibility and quality of information services (Vitriana, 2024). Law Number 43 of 2007 defines a library as an institution that professionally manages collections of written works, printed works, and/or recorded works to meet the public's educational, research, preservation, information, and recreational needs (Indonesia, 2007). This strategic function requires integrated collection management, membership, circulation, and information presentation.

However, many regional libraries still conduct much of their administration manually. Membership registration, loan and return registration, collection searches, and report preparation often use ledgers or simple office applications. This work method results in data duplication, recording errors, reporting delays, and difficulties in historical data retrieval. Initial observations at the Bireuen Regency Library revealed a similar situation: managing collection data, transactions, membership, and reports still requires a lengthy process and is not yet integrated into a single system, making it difficult for management to obtain accurate information for decision-making. This is despite the fact that library affairs in Bireuen Regency are managed by the Library and Archives Service as part of the regional public service, and several village libraries have participated in the Social Inclusion-Based Library Transformation program initiated by the National Library of Indonesia.

Web-based information systems have advantages over manual management or desktop applications. Applications can be accessed from various devices without special installation, data is stored in a centralized database, allowing for faster searches and reduced redundancy, and security is enhanced through authentication and user access rights management. The development in this study utilized Laravel, a modern PHP framework that implements a Model-View-Controller (MVC) architecture and provides features such as Eloquent ORM, Blade Templates, Migration, Middleware, and Authentication (Stauffer, 2023; Otwell, 2024).

Several studies have developed web-based library information systems using Laravel (Agustina & Hidayat, 2022; Arifin & Hidayat, 2023; Ariyanto & Saputra, 2023) and implemented MVC in library systems (Rahman & Sari, 2024). Based on the author's review, most previous research has focused on school or college libraries with basic features such as book management, membership, and circulation. Therefore, there is still room for research in local government library systems that integrate collection management, membership, circulation, online catalogs (OPAC), management reports, and access rights management. The novelty of this research lies in the design of a Laravel 12-based system

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that integrates all service processes into a single platform according to the operational needs of the Bireuen Regency Library. It is equipped with statistics and database backup and restore facilities. It is then tested through Black Box Testing and User Acceptance Testing (UAT).

The objectives of this research are (1) to design a web-based Bireuen Regency Library Information System using the Laravel Framework to meet the needs of library service management; (2) implementing Laravel in developing a system that includes managing book data, members, librarians, borrowing and returning transactions, and reports; and (3) testing the functionality and level of system acceptance. The scope is limited to the requirements analysis, design, implementation, and testing stages; integration with RFID, barcode scanners, mobile applications, payment gateways, and e-book services is not discussed.

2. RESEARCH METHOD

a. Development Approach and Model

This research uses a Research and Development (R&D) approach, which aims to produce a usable product through planned stages (Sugiyono, 2022). Software development follows the Waterfall System Development Life Cycle (SDLC) model, which requires each stage to be completed before the next (Pressman & Maxim, 2020). This model was chosen because library user needs are relatively clear from the outset and each stage is well-documented. The stages, as shown in Figure 1, include needs analysis, system design, implementation, testing, and maintenance; maintenance is not discussed operationally in this study.

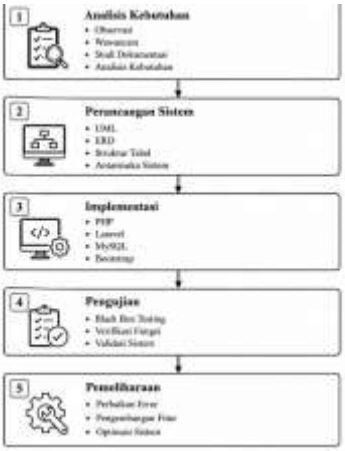


Figure 1. Waterfall SDLC model used in the research

b. Data Collection and Needs Analysis

Data was collected at the Bireuen Regency Library through three techniques: observation of collection management, membership, and circulation processes; interviews with relevant parties; and documentation studies. The results were analyzed to map the current system, problems, user needs, and the proposed system, which were then formulated into functional and non-functional requirements (Sommerville, 2019).

c. Design and Implementation

The design utilizes Unified Modeling Language (UML) in the form of Use Case Diagrams, Activity Diagrams, Sequence Diagrams, and Class Diagrams (Booch et al., 2005), as well as Entity Relationship Diagrams (ERD) as the basis for database design (Elmasri & Navathe, 2017; Connolly & Begg, 2015). The design was implemented using PHP, Laravel 12, MySQL, and Bootstrap, with XAMPP as the local server and Visual Studio Code as the code editor. The table structure was built using the Migration feature and managed through the Eloquent ORM.

d. Testing

Black Box Testing checks the suitability of the inputs and outputs of each function without reviewing the program code (Pressman & Maxim, 2020); the actual output is compared with the

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expected results in each scenario. User Acceptance Testing (UAT) was conducted on 5 respondents, namely 1 Head of Library, 1 System Administrator, and 3 Library Officers, with 10 statements on a five-level Likert scale: Strongly Agree (SS) = 5, Agree (S) = 4, Neutral (N) = 3, Disagree (TS) = 2, and Strongly Disagree (STS) = 1. The percentage of acceptance was calculated using the formula P = (score obtained / maximum score) × 100%, with a maximum score of 5 × 10 × 5 = 250. The percentage of 81%–100% is categorized as Very Good/Very Appropriate.

3. RESULTS AND DISCUSSION

a. Analysis of the Current System and System Requirements

Analysis of the current system shows that data management for books, members, loan and return transactions, and reports is still performed manually or using simple office applications. Three main problems were identified. First, manual transaction recording increases the risk of input errors, data duplication, and archive loss. Second, searching for collection data and loan history takes a long time because the data is not yet stored in an integrated database. Third, manual report preparation becomes less efficient as transactions increase. This identification is important because it illustrates the gap between the current and desired conditions (Rosa & Shalahuddin, 2018).

The proposed system serves three user groups: administrators, librarians (staff), and members. Functional requirements are summarized in Table 1, while non-functional requirements, which serve as benchmarks for system quality, are summarized in Table 2 (Sommerville, 2019).

Tabel 1. Kebutuhan fungsional sistem

No.	Need	Description
1	System login	Authentication for administrators, librarians, and members.
2	User management	Administrators add, change, delete, and view user data.
3	Book and category management	Book data management and collection classification, including searching.
4	Member management	Librarians manage library member data.
5	Loan transactions	Automatic recording of book loan transactions.
6	Return transaction	Return processing and collection status updates.
7	Book search (OPAC)	Search by title, author, or category.
8	Report	Reports on book data, members, borrowings and returns.
9	Logout	Securely terminate user sessions.

Tabel 2. Kebutuhan nonfungsional sistem

No.	Need	Description
1	Performance	Searching, storing, and retrieving data takes place with fast response times.
2	Security	User authentication, password encryption, data validation, and role-based access rights.
3	Reliability dan availability	The system operates stably with minimal errors and can be accessed as long as the server and network are available.
4	Usability	The interface is simple and easy to use by administrators, librarians and members.
5	Compatibility	Accessible through modern browsers such as Chrome, Firefox, and Edge.
6	Maintainability	Easy to maintain and develop because it uses Laravel with MVC architecture..

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No.	Need	Description
7	Scalability	It can be expanded to add data, users, and features without changing the main structure.
8	Data integrity	Data consistency and accuracy are maintained through integrated input and database validation.
9	Backup dan recovery	Supports data backup and recovery to reduce the risk of information loss.

b. System Design

The system architecture is shown in Figure 2. The system is accessed by administrators, librarians, and members according to their respective access rights. All data is processed through a Laravel web application and stored in a MySQL database, while the output is information and reports to support library management.

User interaction with the system is modeled using the Use Case Diagram in Figure 3, with three actors. The administrator has full access to manage users, staff, members, books, categories, transactions, and reports. Staff manage operational data according to their authority. Members have limited access rights, including logging in, searching collections, viewing borrowing history, and logging out.

The process flow is detailed through Activity Diagrams and Sequence Diagrams. During the login process (Figure 4, left), the user enters a username and password, the system validates the data, and then either logs in to the dashboard or receives a failure message. During the borrowing process (Figure 4, right), the staff selects members and books, the system checks stock availability, saves the transaction, and reduces the book stock. If stock is unavailable, the system displays a message stating that the book is unavailable.



Figure 2. System architecture

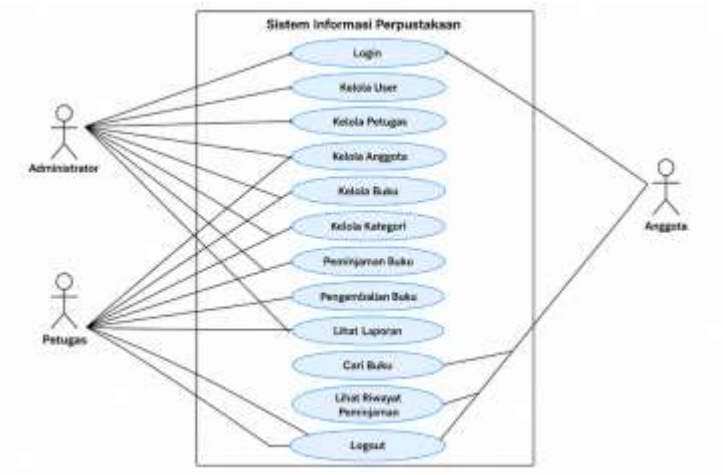


Figure 3. Use Case Diagram of the system

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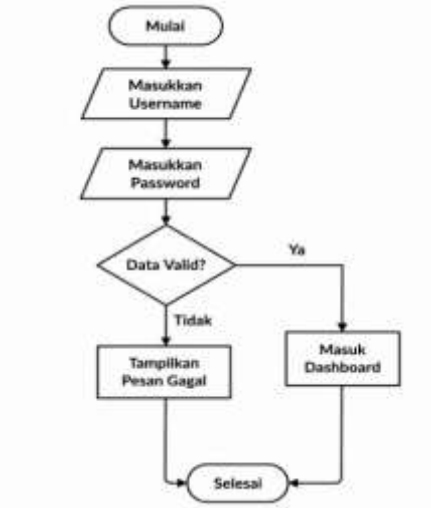


Figure 4a. Activity Diagram login

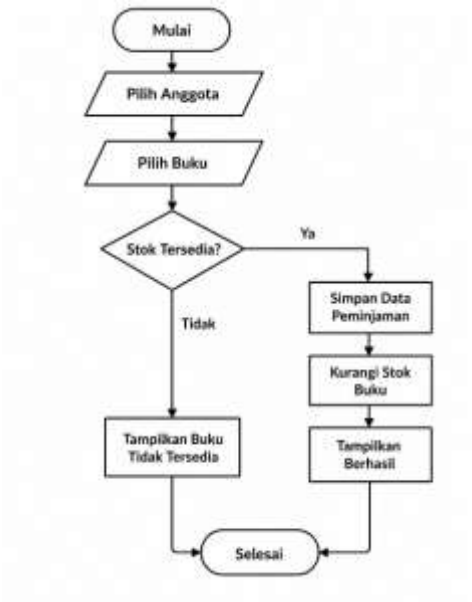


Figure 4b. Activity Diagram for borrowing books

The object structure in the application is modeled using a Class Diagram consisting of seven classes: User, Member, Officer, Category, Book, Borrowing, and Returning, which forms the basis for building the Eloquent model in Laravel. Unlike an ERD, which focuses on database structure, a Class Diagram depicts classes, attributes, and relationships between objects, supporting the application of object-oriented programming concepts.

The data structure is designed using the ERD in Figure 5, which contains seven entities: users, officers, members, categories, books, borrowing, and returning. The users table stores accounts and roles for authentication and authorization. Relationships between tables are implemented using primary and foreign keys to maintain referential integrity (Table 3), while the column structure of the collections and transactions tables is detailed in Table 4. The relationship between borrowing and returning is one-to-zero because transactions with the Borrowed status do not yet have return data.

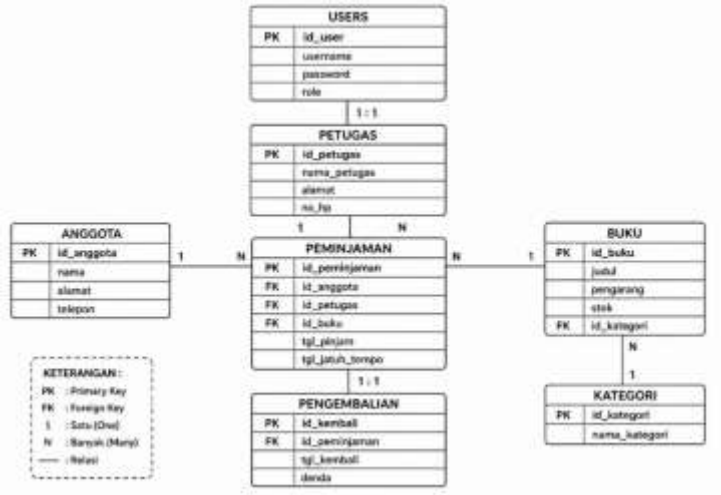


Figure 5. Entity Relationship Diagram (ERD) system

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Table 3. Relationships between tables

Master table	Cardinality	Goal table	Information
users	1 : 1	officer	Accounts with the officer role are associated with one officer data.
users	1 : 1	member	An account with a member role is associated with one member record.
kategori	1 : N	book	One category has many books.
anggota	1 : N	borrowing	One member can make multiple loans.
petugas	1 : N	borrowing	One officer can serve many transactions.
buku	1 : N	borrowing	One book can be borrowed in multiple transactions.
peminjaman	1 : 0..1	return	One loan produces at most one return data.

Table 4. Structure of the book, borrowing, and return tables

Tabel	Field	Data type (length)	Key	Information
buku	id_book	BIGINT (20)	PK	book ID
	id_category	BIGINT (20)	FK	Relationship to category
	title	VARCHAR (200)	-	book title
	author, publisher	VARCHAR (100)	-	Author, publisher
	publication year, ISBN	YEAR; VARCHAR (30)	-	Publication, ISBN
	stock	INT (11)	-	Number of books
peminjaman	loan id	BIGINT (20)	PK	Transaction ID
	member_id, officer_id, book_id	BIGINT (20)	FK	Relationship to parent table
	loan_date, due_date	DATE	-	Borrow date, return deadline
	status	ENUM	-	Borrowed/Returned
return	return_id	BIGINT (20)	PK	Return ID
	loan id	BIGINT (20)	FK	Relationship to lending
	return date	DATE	-	Return date
	lateness, fines	INT (11); DECIMAL (10,2)	-	Long overdue, total fine

c. System Implementation

The implementation translates the design into an MVC-architected web application. The development environment uses Windows 11 64-bit, an Intel Core i5 processor or equivalent, a minimum of 8 GB of RAM, and a minimum of 256 GB of SSD/HDD storage. The software used is PHP 8.x, Laravel 12, MySQL, XAMPP (Apache), Visual Studio Code, and Google Chrome and Microsoft Edge browsers for testing. The system consists of ten integrated modules: Login, Dashboard, Staff Data, Member Data, Category Data, Book Data, Borrowing, Returns, Reports, and Logout. Table and relationship creation is performed through Migrations, while data access uses the

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Eloquent ORM, allowing add, read, modify, and delete operations to be performed through the model without writing SQL at each stage.

Access restrictions implement role-based access control using Laravel Authentication and Middleware (Table 5). The Access Rights Settings page displays three roles with varying access rights: Administrator with 35 access rights, Librarian with 25 access rights, and Member with 3 access rights.

Table 5. User access rights

Role	Number of access rights	Scope of authority
Administrator	35	Manage all system data: users, officers, categories, books, members, transactions, reports, and system settings.
Librarian/Officer	25	Manage member data, loan and return transactions, and view reports.
Member	3	Login, browse the catalog (OPAC), view book availability, and monitor borrowing history.

d. System Display

The Login page (Figure 6) serves as the system's entry point. Users enter their username or email address and password, with options like Remember me, Forgot password?, and a Login button. The left-hand panel introduces digital cataloging, automated circulation, and reporting services within a single, integrated platform. After successful authentication, users are directed to their access rights.

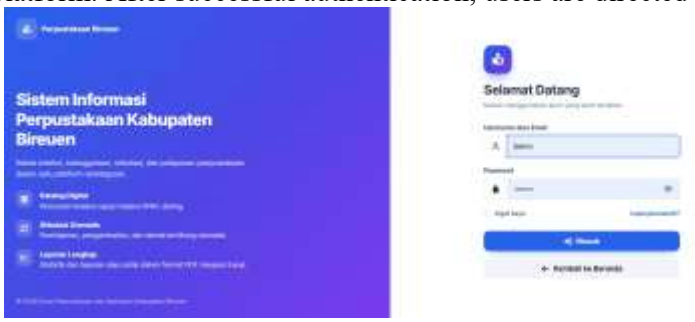


Figure 6. Login page

The administrator dashboard (Figure 7) summarizes the library's status on a single page: 183 titles with 708 copies, 40 members (36 of whom are active), 10 categories, and 4 staff, complete with new transaction shortcuts, as well as a monthly circulation graph and a collection donut chart per category. Data that previously had to be checked through multiple menus can now be monitored centrally.



Figure 7. Administrator dashboard

The Book Data page (Figure 8) provides search by title, code, ISBN, or author, filtering by category, shelf, and status, as well as add, edit, delete, import, and export functions. The collection is presented as cards containing cover, author, category, and stock information. The category, member, and staff modules follow the same pattern as the data table, search, filter, and action buttons; the

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member module also displays the membership expiration date and the number of books currently on loan.

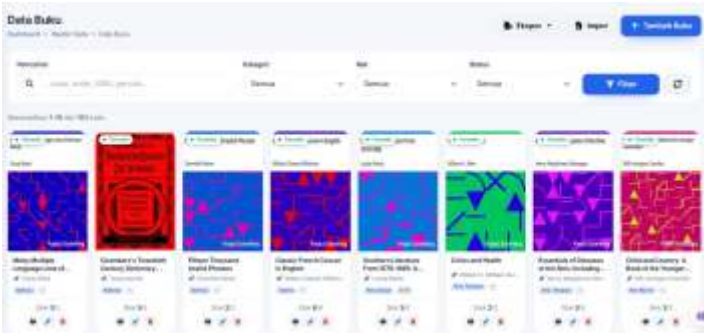


Figure 8. Book data page

The circulation module (Figure 9) displays a transaction summary, searches by loan or membership number, status and date range filters, and Borrowed and Overdue transaction statuses along with the number of days overdue. The returns module records the return date, loan duration, overdue, book condition (good or damaged), and fines, with a total fine recorded of Rp191,000. For members, the OPAC (Figure 10) allows browsing the collection by title, author, or ISBN with filter panels for category, author, publisher, year, language, and availability.

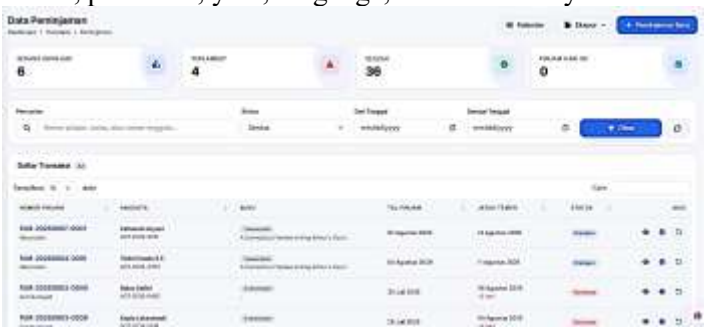


Figure 9. Loan page



Figure 10. Book catalog page (OPAC)

The Reports page (Figure 11) provides twelve types of reports, including data on books, members, staff, borrowings, returns, overdue books, fines, bestsellers, most active members, and monthly and annual summaries, each of which can be generated in PDF and Excel formats. The Library Statistics page presents circulation graphs and monthly summaries, while the Database Backup and Restore page allows administrators to create database copies and restore them from .sql files up to 50 MB in size.

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Figure 11. Report page

e. Black Box Testing Results

Testing covered the Login, Officer Data, Member Data, Category Data, Book Data, Borrowing, Returns, Reports, and Logout modules. All 12 scenarios produced actual output consistent with the expected results (Table 6), so no functional errors were found that disrupted system operation.

Table 6. Black Box Testing Results

No	Module	Test scenario	Expected result = actual result	Status
1	Login	Username and password are correct	Login to dashboard	Succeed
2	Login	Incorrect username or password	An error message is displayed	Succeed
3	Officer Data	Adding officer data	Data is saved to the database	Succeed
4	Member Data	Adding member data	Member data saved	Succeed
5	Category Data	Adding book categories	Category successfully added	Succeed
6	Book Data	Adding book data	Book data saved	Succeed
7	Book Data	Changing book data	Data updated	Succeed
8	Book Data	Deleting book data	Data deleted	Succeed
9	Borrowing	Add loan transactions	Saved transactions	Succeed
10	Return	Returning the book	The book status becomes available	Succeed
11	Report	Displaying loan reports	Report displayed	Succeed
12	Logout	Exit the system	Return to login page	Succeed

f. User Acceptance Testing (UAT) Results

The UAT involved five respondents with 10 statements. A summary of the responses is presented in Table 7. All responses fell into the SS (44 responses) and S (6 responses); there were no

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Neutral, Disagree, or Strongly Disagree responses. The total score obtained was 244 out of a maximum of 250.

Tabel 7. Hasil User Acceptance Testing

No	Statement	SS	S	N	TS	STS	Skor
1	The application display is easy to understand	4	1	0	0	0	24
2	The login process is running smoothly	5	0	0	0	0	25
3	The system menus are easy to use	4	1	0	0	0	24
4	Book data management is running well	4	1	0	0	0	24
5	Member data management makes work easier	4	1	0	0	0	24
6	The book borrowing process becomes faster	5	0	0	0	0	25
7	The book return process went well	5	0	0	0	0	25
8	OPAC makes it easier to search book collections	4	1	0	0	0	24
9	Reports generated as needed	4	1	0	0	0	24
10	The system helps improve the efficiency of library services.	5	0	0	0	0	25
	Total	**44**	**6**	**0**	**0**	**0**	**244**

The user acceptance percentage is calculated as follows:
P = (Score obtained / Maximum score) × 100%
P = (244 / 250) × 100% = 97.6%

A score of 97.6% falls within the 81%–100% range, making it a Very Good/Very Adequate category. The login, borrowing, returning, and service efficiency aspects received a maximum score of 25, while other aspects received a score of 24. For the Head of the Library, the system helps obtain operational information through reports; for administrators, the system facilitates data management and access rights; and for staff, the system accelerates book management, membership, transactions, collection searches, and report preparation.

Design and alignment with needs. The research process, from observation, interviews, and documentation studies to UML and ERD, resulted in a design that can be implemented into an application with three user groups. The division of authority separates administrative functions (administrators), operational functions (librarians), and information services (members), so that data management is not reliant on one type of user. This pattern aligns with the library administration and management functions proposed by Lasa Hs (2020) and addresses existing system issues, namely manual recording, slow data retrieval, and inefficient report preparation.

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P = (Score obtained / Maximum score) × 100%

P = (244 / 250) × 100% = 97.6%

A score of 97.6% falls within the 81%–100% range, making it a Very Good/Very Adequate category. The login, borrowing, returning, and service efficiency aspects received a maximum score of 25, while other aspects received a score of 24. For the Head of the Library, the system helps obtain operational information through reports; for administrators, the system facilitates data management and access rights; and for staff, the system accelerates book management, membership, transactions, collection searches, and report preparation.

Design and alignment with needs. The research process, from observation, interviews, and documentation studies to UML and ERD, resulted in a design that can be implemented into an

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application with three user groups. The division of authority separates administrative functions (administrators), operational functions (librarians), and information services (members), so that data management is not reliant on one type of user. This pattern aligns with the library administration and management functions proposed by Lasa Hs (2020) and addresses existing system issues, namely manual recording, slow data retrieval, and inefficient report preparation.

Implementation of Laravel 12. The MVC architecture separates data, views, and application logic so that administration, transaction, catalog, and report modules can be developed in a focused manner. Eloquent ORM manages the relationship between the application and MySQL, Authentication handles logins, Middleware restricts access based on roles, and Migration maintains the documented database structure. These findings align with research that places Laravel and MVC as the foundation of structured web-based library systems (Agustina & Hidayat, 2022; Rahman & Sari, 2024). The difference is that this study adapts functions to the needs of regional libraries and adds OPAC, access rights settings, statistics, and database backup and restore within a single platform.

Database integration. Relationships between tables connect transaction data: borrowings are linked to members, staff, and books, while returns forward borrowing transactions and update collection statuses. This interconnectedness reduces separate record keeping and maintains information consistency, in accordance with the DBMS principles proposed by Elmasri and Navathe (2021).

Testing. Black Box Testing proved that the main functions ran according to the scenario, including the interconnected flow between member data, collections, transactions, and reports. UAT complemented this in terms of user experience: a score of 244 out of 250 (97.6%) indicated that the system was not only technically functional but also very well-received. This two-tiered approach is consistent with practices in similar studies using Black Box Testing (Kurniawan & Sari, 2024) and Likert-scale UAT (Maulana & Fadli, 2023; Wahyuni & Hidayat, 2024).

Limitations. The research results need to be interpreted with several limitations in mind. The UAT only involved five respondents from the library management environment, so the perceptions of members as service users are not widely represented. Testing was limited to functional aspects and user acceptance; performance under load, security, and operational maintenance were not tested. Furthermore, the system did not include integration of RFID, barcodes, mobile applications, payment gateways, and e-book services.

4. CONCLUSION

This research successfully designed and built a web-based Bireuen Regency Library Information System using the Laravel 12 Framework, integrating book management, categories, members, staff, borrowing, returns, OPAC, reports, statistics, user access rights, and database backup and restore. Laravel was implemented through an MVC architecture, MySQL, Eloquent ORM, Blade Template, Authentication, and Middleware, with access rights divided among administrators, staff, and members.

All 12 Black Box Testing scenarios were successful, and the UAT (User Assessment Test) conducted on five respondents yielded a score of 244 out of 250, or 97.6%, categorized as Very Good/Very Feasible. Thus, the system met the tested functional requirements and was well-received by the users involved, supporting more structured library administration and service processes.

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