



Web-Based Library Information System Using ReactJS: Case Study at the Faculty of Mathematics and Natural Sciences, Sam Ratulangi University

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Abstract

Digital transformation has reshaped the library landscape, transitioning from manual to digital systems. This research aims to develop a web-based library information system for the Faculty of Mathematics and Natural Sciences (FMIPA) at Sam Ratulangi University (UNSRAT) using ReactJS, NestJS, and PostgreSQL. The system is designed to address the inefficiencies of manual library management and enhance book information accessibility. The Rapid Application Development (RAD) method was applied, encompassing requirements planning, user design, construction, and cutover. Data were collected through interviews, observations, and surveys. The results demonstrate that the system facilitates online book searching and borrowing, accelerates administrative processes, and improves service efficiency. User satisfaction evaluation through surveys showed high levels of approval. This system is expected to support teaching and learning processes and enhance the quality of library services at FMIPA UNSRAT.

Keywords: Library information system; E-Library; ReactJS; NestJS; PostgreSQL; Prisma ORM; Rapid Application Development (RAD);

1. INTRODUCING

In the digital era, Information and Communication Technology (ICT) plays a crucial role in driving development across sectors, including education [2]. Libraries, as key academic support facilities, are also experiencing transformation through the adoption of digital systems. According to Undang-Undang No. 43 of 2007 on Libraries, libraries are institutions that professionally manage collections to support education, research, and information dissemination. Traditionally reliant on manual processes, libraries are now shifting to digital frameworks to enhance service efficiency [1].

At the Faculty of Mathematics and Natural Sciences, Sam Ratulangi University, the library still operates using a manual system, which causes various inefficiencies in managing book searches, borrowing processes, and the communication of book availability. Users face difficulties in locating books due to the lack of a digital catalog, while the borrowing process remains time-consuming and cumbersome. Additionally, there

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are no automated notifications for book returns, and the status of book availability is often outdated or unclear. To address these challenges, it is essential to develop a web-based library information system. This system would modernize library operations by streamlining administrative tasks, improving real-time access to information, and enhancing the overall user experience. Ultimately, it would better support the faculty's teaching and research activities through more efficient resource management [9].

Several previous studies have contributed to the development of digital library systems using various technologies; however, significant limitations remain, indicating opportunities for further advancement. Ripai and Sambas [16] examined the implementation and user acceptance of the INLIS Lite application at MTsN 7 Kuningan, where the library previously relied on manual management. Their mixed-methods study showed positive user perceptions 76.2% approval for interface design, 77.9% for ease of use, and an overall satisfaction rate of 77.2%. However, the study primarily focused on usability evaluation without addressing the system's technical development or the integration of modern digital frameworks. Yosephine [11] developed a Laravel-based digital library system, but it lacked essential features such as book borrowing, highlighting the need for a more comprehensive and functional solution. Kumar and Patel [17] introduced a web-based library management system that automated routine operations but did not incorporate contemporary frontend technologies like ReactJS, which limited the system's user interface capabilities. Similarly, Sari and Wijaya [18] designed a Laravel-based system for a vocational high school, focusing mainly on digitizing manual processes within a narrow institutional context and without adopting modern frontend tools. Rahman, Nasution, and Siregar [19] also developed a library system using Laravel with an MVC architecture, but the system emphasized backend functionality and lacked attention to user interface design and structured development methodologies.

These studies collectively reveal a gap in the development of modern, user-centered, and fully integrated library information systems that align with current technological trends. To address this gap, the present study proposes the design and development of a ReactJS-based library information system aimed at enhancing usability, expanding functionality, and supporting academic activities at the Faculty of Mathematics and Natural Sciences, Sam Ratulangi University.

2. RESEARCH METHODOLOGY

2.1. Research Design

This study adopts the Rapid Application Development (RAD) methodology, which emphasizes speed and flexibility through iterative development and active user participation [6]. RAD is particularly well-suited for information system projects that require accelerated delivery while maintaining close alignment with stakeholder expectations. The RAD approach was selected because it enables iterative development with active user involvement at every stage, making it especially appropriate for the transformation of library systems that demand timely user feedback.

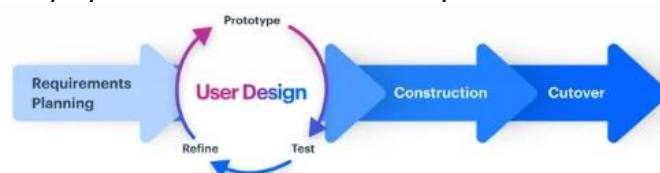


Figure 1. RAD Method

A notable characteristic of RAD is its non-linear structure. The User Design and Construction phases are highly iterative, allowing for continuous user engagement and ongoing refinement of the system throughout the development process. This iterative



feedback loop ensures that the final system closely aligns with the functional requirements and institutional goals [4].

2.2 Data Collection Techniques

Data collection techniques are systematic methods of gathering information from various sources, such as interviews, observations, questionnaires, and document analysis, to support research, analysis, and decision-making.

Table 1. Data Collection Techniques

Table with 3 columns: No, Techniques, Goal. Rows include Literature Review, Interviews, and Observation with their respective goals.

The interviews were conducted in two phases: pre-implementation and post-implementation. The pre-implementation interviews were conducted with library staff to gather detailed requirements, understand user needs, and identify current challenges in managing library operations.

2.3 Tools and Technologies

The development and evaluation of the web-based tracer study information system utilized a set of integrated tools and techniques to ensure robust functionality, usability, and data integrity.

Table 2. Tools and Technologies

Table with 3 columns: No, Stages, Tools and Technologies. Rows include Development, Modelling, and Testing with their respective tools.

TypeScript was employed as the primary programming language for handling functions and implementing server-side scripting to generate dynamic content [15]. ReactJS, an open-source JavaScript library, was used to optimize the development process by providing a wide range of UI packages that facilitate efficient front-end construction. Next.js was integrated with ReactJS to enable efficient file-based routing and improve performance through built-in support for server-side rendering. Tailwind CSS, a utility-first CSS framework, simplified the styling process with concise syntax directly applied via className attributes, eliminating the need for separate style definitions [12]. Prisma served as the Object-Relational Mapping (ORM) tool, streamlining database interaction and allowing developers to manage and visualize the database schema without manually writing SQL queries. PostgreSQL was utilized as the database management system for storing, retrieving, and managing application data [13].

Unified Modelling Language (UML) diagrams were utilized to visually represent and systematically document the system requirements and design. The application of Use Case Diagrams entails the delineation of user interactions and system functionalities. Activity

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diagrams are a tool that can be used to illustrate workflow processes for administrators and user. Class diagrams are a tool used to depict the structural relationships between system entities.

System testing was carried out using Postman [14] to verify the correctness and reliability of API endpoints. This testing process focused on ensuring that each request returned the expected response and that the integration between the frontend and backend components functioned properly. The testing confirmed that the system's core functionalities were operating as intended. Additionally, Survey and Questionnaire involved administration and users to evaluate the system's usability, functionality, and overall satisfaction. A structured questionnaire based on the Likert scale was used to collect quantitative feedback from users [5].

2.5 Likert Scale Equation for User Acceptance Testing (UAT)

The Likert scale is a quantitative tool that gauges user perceptions regarding system attributes, including ease of use, interface clarity, and data accuracy. The analysis utilizes the following equation:

$$Likert\ Score_{Qj} = \frac{\sum_{i=1}^n X_{ij}}{n} \tag{1}$$

Where:

X_{ij} = score given by respondent i (e.g., 1 = strongly disagree, 5 = strongly agree) from question j

n = total number of respondents

Therefore, to count overall Likert score aggregates all responses, providing a holistic measure of system acceptance:

$$Overall\ Likert\ Score = \frac{\sum_{i=1}^n \sum_{j=1}^m X_{ij}}{m} \tag{2}$$

Where:

X_{ij} = score given by respondent i (e.g., 1 = strongly disagree, 5 = strongly agree) from question j

m = total number of questions

Table 3. Likert Scale Interpretation

Score Range	User Acceptance Level	Interpretation
4.21 – 5.00	Very High	Excellent acceptance and satisfaction
3.41 – 4.20	High	Good acceptance, minor improvements possible
2.61 – 3.40	Moderate	Moderate acceptance, several improvements needed
1.81 – 2.60	Low	Low acceptance, major improvements needed
1.00 – 1.80	Very Low	System rejected by users

2.6 Methodological Rationale

The Rapid Application Development (RAD) approach was selected for its ability to deliver a user-centered, adaptable, and efficient information system within a limited timeframe. Through iterative prototyping and continuous stakeholder feedback, the system was designed to address real-world needs and adjust promptly in response to user input.

3. RESULT AND DISCUSSIONS

3.1 Pre-Implementation Interview

The pre-implementation interviews were conducted with library staff to gather detailed requirements, understand user needs, and identify current challenges in managing library operations. Table 4 presents the set of interview questions that were developed to systematically capture the needs, pain points, and expectations of the library staff.

Table 4. Interview with the FMIPA library staff

No.	Question	Answer
1	What concerns do you experience as a librarian?	Book lending and book administration are still done manually
2	What features are expected for the development of this website?	All students can see what books are available in the library
3	What efforts are made to ensure that books are returned on time?	Usually, I look for borrowers to remind them to return the books.

These interviews helped define the functional features required in the system, such as book search, availability tracking, and borrowing functionality. Direct observation of the existing manual processes, such as lending, recording, and return tracking which provided insight into inefficiencies, limited accessibility, and the reliance on physical records. This analysis revealed key pain points including delays in book borrowing and difficulty in monitoring availability. The findings formed the basis for system design aimed at digitizing and streamlining library services for both users and administrators.

3.2 System Architecture and Modelling

The system architecture and design phase built upon the comprehensive needs analysis outlined in section 3.1, translating stakeholder requirements into a structured blueprint for the library information system [8].

1. Use Case Diagram

Use case diagram delineated primary actors-administrators and users-and their interactions with key system functions. This diagram established functional boundaries and clarified user roles, ensuring alignment with stakeholder expectations.

1. Use Case Diagram

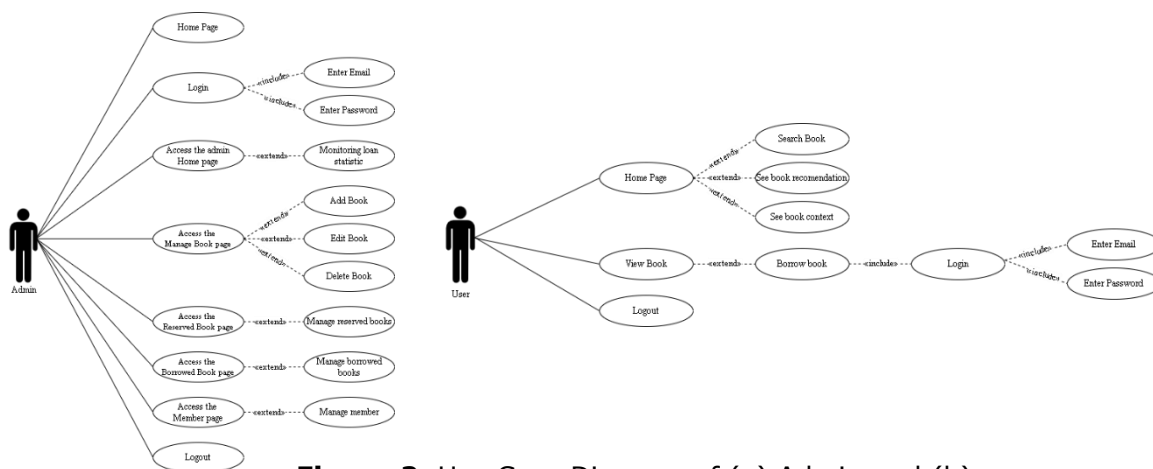


Figure 2. Use Case Diagram of (a) Admin and (b)

The first use case diagram (a) illustrates admin interactions within the system. The login process requires entering an email and password (an «include» relationship). After authentication, the admin can access various system features such as managing books, reservations, borrowed books, and members—each represented as optional tasks through «extend» relationships. Monitoring loan statistics from the Admin Home Page is also optional. The Logout function is a standalone use case to end the session.

The second diagram (b) shows user interactions. Upon accessing the website, users land on the Home Page, where they can search for books, view recommendations, and read book content—optional actions shown as «extend» relationships. To borrow books, users must log in by entering their email and password («include» relationship). Borrowing is only available after authentication.

2. Entity Relationship Diagram

2. Entity Relationship Diagram

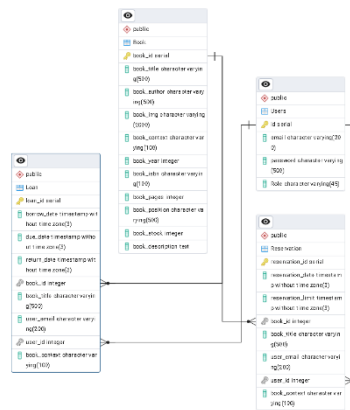


Figure 3. Entity Relationship Diagram of FMIPA UNSRAT e-Library

This diagram contains four interconnected tables. This database design ensures efficient book management, borrowing, and reservations within the e-library system.

3. Activity Diagram

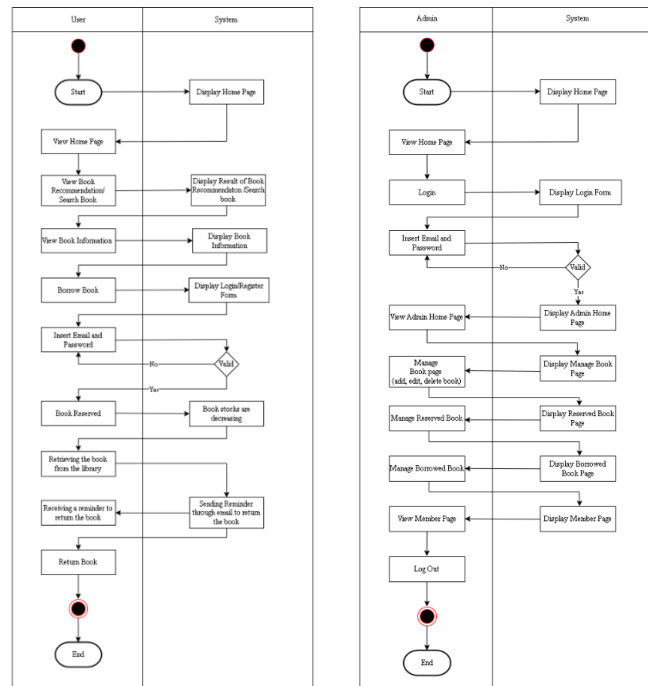


Figure 4. Activity Diagram of (a) User and (b) Admin

The first activity diagram (a) illustrates the user’s book borrowing process in the FMIPA UNSRAT e-Library system. It starts with the user accessing the homepage, searching for a book, and viewing its details. To borrow the book, the user must log in or register. Once authenticated, the system reserves the book, updates stock, and prompts the user to collect it from the library. A return reminder is later sent via email, and the process concludes with the book being returned.

The second activity diagram (b) depicts the admin's workflow. After accessing the system and logging in, the admin is directed to the admin home page. From there, the admin can manage books (add, edit, delete), monitor reserved and borrowed items, and view member information. The process ends when the admin logs out.

3.3 Implementation

The interface of the FMIPA UNSRAT e-Library system was developed as a web-based platform designed to accommodate both users and administrators [10]. The Home Page provides access to core features such as book search, personalized recommendations, and automated announcements regarding library operating hours, integrated using the NagerDate API. Users are required to log in to borrow books and access the Borrow History feature.

Users can explore available books through context-based filtering, search functionality, and detailed Book Pages containing comprehensive bibliographic information along with a borrowing option. The Login and Registration pages include validation mechanisms that require users to register using a valid UNSRAT faculty email address. Once logged in, users can view their borrowing history via the “Riwayat” menu.

Administrators have access to a dedicated Admin Dashboard, which presents loan statistics and includes a feature for downloading monthly reports. Additional administrative

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functionalities include managing book records via the Manage Book Page, processing Reserved and Borrowed Books, and overseeing registered users through the Member Page.

Furthermore, to improve service efficiency, users automatically receive an email reminder one day before the book's return due date.



Figure 5. Register Menu (a), Home Page (b), and Admin Page (c)

3.4 System Validation and User Acceptance

The validation of the system and the execution of user acceptance testing were foundational elements in ensuring that the developed library information system satisfied its functional requirements and aligned with the expectations of the relevant stakeholders [7]. The validation process was executed in two primary stages. Initially, Postman for API Testing testing was employed to verify functionality. Subsequently, user acceptance testing (UAT) was conducted using a Likert scale questionnaire to evaluate user satisfaction and usability.

1. Postman API Testing

Table 5. List of all API Endpoints created

No	Verb	Path	Status
1.	GET	/book	Succeed
2.	GET	/book/{id}	Succeed
3.	POST	/auth/register	Succeed
4.	POST	/auth/login	Succeed
5.	GET	/loan	Succeed
6.	GET	loan/user-history	Succeed
7.	GET	/loan/{id}	Succeed
8.	PATCH	/book/{id}	Succeed
9.	PUT	/book/{id}	Succeed
10.	POST	/book/{id}	Succeed
11.	GET	/reservation	Succeed
12.	GET	/user	Succeed
13.	POST	/loan	Succeed

The system testing using Postman showed that all API endpoints responded as expected, indicating that the integration between the frontend and backend worked well and the system functioned reliably [3].

2. User Acceptance Testing with Likert Scale Score

a. Admin

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User Acceptance Testing was conducted as a post-implementation interview with library staff who will serve as system administrators. This evaluation was carried out to fulfill the Construction phase of the Rapid Application Development (RAD) methodology and assessed using the Likert scale method.

Table 6. Post Implementation Interview with the FMIPA library staff

No	Question	Respon
1.	The admin dashboard interface design is intuitive and easy to understand.	Strongly agree
2.	The process of using the system runs smoothly without any technical problems.	Strongly agree
3.	I find it helpful to have contextual book lending statistics on the Home page.	Strongly agree
4.	I find it helpful to have the total number of books available and the total number of books borrowed on the Home page.	Strongly agree
5.	I find the monthly recap download feature helpful.	Strongly agree
6.	I find it easy to manage book data through the Manage Book page, such as adding books, editing books, and deleting books.	Strongly agree
7.	I find it easy to manage reserved and borrowed books.	Strongly agree
8.	I find it easy to view the list of users.	Strongly agree
9.	Overall, I am satisfied with the performance and functionality of the e-library website from an administrative perspective.	Strongly agree
10.	I find this website supports my administrative work effectively.	Strongly agree

The outstanding feedback from the admin indicates that the system implementation aligns well with expectations, demonstrating that the developed solution effectively meets the needs and operational goals of the library.

b. User (Student)

User acceptance testing was conducted with 20 anonymous respondents (R1–R20) comprising academic staff and alumni. The evaluation instrument consisted of 10 Likert-scale questions (Q1–Q10). Respondents rated each item on a scale from 1 (strongly disagree) to 5 (strongly agree).



Table 7. UAT Questions

Code	Question
Q1	The interface design of the FMIPA UNSRAT E-Library is designed to be intuitive and easy to understand
Q2	The process of using the system runs smoothly without any technical problems.
Q3	I find that the FMIPA UNSRAT E-Library website helps the time and effort efficiency, as it allows me to check the availability of books in the MIPA library.
Q4	I find helped by the existence of the FMIPA UNSRAT E-Library website, because I can see the details of the books in the MIPA library.
Q5	I find it helpful to have a Search feature on the FMIPA UNSRAT E-Library Website, because it makes it easier to search for books.
Q6	I find it helpful to have the Book Recommendation feature on the FMIPA UNSRAT e-Library Website
Q7	I find it very helpful to have the context feature as a tool to group book contexts in a more structured way.
Q8	I find it helped by the "Pinjam" feature on the FMIPA UNSRAT E-Library Website, because it helps me to reserve the books I want to borrow.
Q9	I find it helpful to have a reminder feature that the system will send as a reminder of the deadline for returning the books. (will be sent 6 days after borrowing the book)
Q10	Overall, I am satisfied with the performance and functionality of the FMIPA UNSRAT e-Library Website.

Table 8. UAT Respondant Score

Q R	1	2	3	4	5	6	7	8	9	10
1	5	5	5	5	5	5	5	5	5	5
2	5	5	5	5	5	5	5	5	5	5
3	5	5	5	5	5	5	5	5	5	5
4	5	5	5	5	5	5	5	5	5	5
5	4	5	5	5	4	4	4	4	4	4
6	3	5	5	4	5	4	5	4	4	4
7	5	4	5	5	4	5	5	4	5	5
8	5	5	5	5	5	5	5	5	5	5
9	5	5	5	5	5	5	5	5	5	5
10	5	5	5	5	5	5	5	5	5	5
11	5	5	5	5	4	5	5	5	5	5
12	4	4	5	5	5	4	4	5	5	5
13	4	4	4	4	4	5	4	4	5	5
14	4	3	4	4	4	4	4	4	4	4
15	4	5	3	4	5	5	5	3	5	4
16	5	5	5	5	5	5	5	5	5	5
17	4	4	5	5	5	4	4	5	4	4
18	4	5	5	5	5	5	5	5	4	5
19	3	5	5	5	5	4	5	5	3	3
20	3	3	4	4	4	3	4	4	3	4
QAvg	4.35	4.6	4.75	4.75	4.7	4.6	4.7	4.6	4.55	4.6

Using the formula (1) we can find each Questions score, after that, using the formula (2) we can conclude the score of the system

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$$LSQ1 = \frac{5 + 5 + 5 + 5 + 4 + 3 + 5 + 5 + 5 + 5 + 5 + 4 + 4 + 4 + 4 + 5 + 4 + 4 + 3 + 3}{20} = 4.35$$

$$OLS = \frac{4.35 + 4.6 + 4.75 + 4.75 + 4.7 + 4.6 + 4.7 + 4.6 + 4.55 + 4.6}{10} = 4.62$$

The overall Likert score of 4.62 places the system in the "Very High" acceptance range, indicating that users are highly satisfied with the system's usability, features, and reporting. High scores in Q10 (overall satisfaction) confirm the system meets its primary objectives for accreditation and user experience.

4. CONCLUSION

This research successfully developed a library information system that addresses operational inefficiencies in the FMIPA UNSRAT library. By providing features such as online book search, digital borrowing, and automated return notifications, the system enhances user access and streamlines administrative processes. Achieving a high user acceptance score (UAT 4.62), the system demonstrates both effectiveness and user-friendliness. Additionally, it contributes to the advancement of modern web technology implementation in academic library systems.

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