

Implementation of Digital Library Web Application Development Using Agile Methods

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Abstract

The advancement of information technology has brought significant changes to the management of library systems. Traditional methods that rely on manual record-keeping are gradually transitioning to web-based digital systems to improve efficiency and accessibility of information. This study examines the implementation of the Scrum methodology in the development of a digital library web application. Scrum was selected due to its flexibility, adaptability to evolving requirements, and its ability to enhance collaboration within the development team. The results of this study show that the application of the Scrum framework accelerates the development process, reduces errors, and produces an application that meets user needs.

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Keywords

Agile; Digital Library; Project Management; Scrum; Web Development.

Introduction

Libraries are information centers that play a vital role in education. However, with the advancement of technology, traditional library management systems have begun to experience various challenges, such as limited space, difficulty in searching for book data, and slow administrative processes (Onunka et al, 2023). The solution to these challenges is the development of a digital library web application that can be accessed online by users.

In software development, selecting the right methodology is crucial to ensuring project success (Adanna et al, 2020). One popular method is Scrum, a framework within the Agile Software Development approach. Scrum enables development teams to work iteratively and incrementally, with a focus on collaboration, adaptability, and measurable results (Natarajan et al, 2024). This research aims to:

- Analyze the application of the Scrum method in developing digital library web applications.
- Identify the Scrum stages that have the most influence on development effectiveness.
- Evaluate the results of Scrum implementation on the quality of the resulting application.

The rapid advancement of information technology has significantly transformed the way libraries manage and provide access to information resources (Febriyanti et al, 2023). Digital libraries have emerged as an effective solution to support efficient data management, improve accessibility, and enhance user experience by enabling users to access collections anytime and anywhere (Panda et al, 2023). However, the development of digital library web applications requires a systematic and flexible approach to accommodate evolving user needs and ensure the reliability of the system. Therefore, selecting an appropriate development methodology plays a crucial role in achieving a high-quality digital library application.

Agile methods offer an adaptive and iterative development approach that emphasizes continuous feedback, incremental delivery, and close collaboration between developers and stakeholders (Aleryani et al, 2025). By applying Agile methods in the development of a digital library web application, system requirements can be refined progressively, allowing faster response to changes and improved system quality. This study aims to implement Agile methods in the development of a digital library web application and to analyze how this approach supports effective system design, development efficiency, and maintainability (Noer et al, 2025).

Agile is an approach to software development that focuses on rapid adaptation to changing requirements, team collaboration, and effective communication (Mehta et al, 2023). Agile emphasizes short iterations and continuous feedback.



Figure 1. Agile Method

Scrum is an Agile framework that divides projects into short work cycles called sprints (Akhtar et al, 2022), Scrum consists of several key elements:

- a) Roles: Product Owner, Scrum Master, dan Development Team.
- b) Artifacts: Product Backlog, Sprint Backlog, dan Increment.
- c) Events: Sprint Planning, Daily Scrum, Sprint Review, dan Sprint Retrospective.

Furthermore, this research focuses on the implementation process of the digital library web application, including system design, database modeling, and user interface development. The study also evaluates how Agile practices contribute to better project management, risk reduction, and alignment between functional requirements and system outcomes (Omar et al, 2024). The results of this research are expected to provide practical insights and references for developers and academic institutions in developing similar digital library systems using Agile methods.

Methodology

This study applied the Agile software development method to develop a digital library web application. Agile was chosen for its iterative and flexible approach, allowing continuous adaptation to user requirements. The development process was divided into several iterations, each including requirement analysis, system design, implementation, and testing. User requirements were collected

through observations and interviews with librarians and students, then documented as user stories and organized into a prioritized product backlog.

Each iteration focused on incremental feature development followed by continuous testing to ensure system functionality and usability. Stakeholder feedback was gathered through regular review sessions and used to refine the application in subsequent iterations. The final system was evaluated using functional testing and user acceptance testing to confirm that the application met digital library service requirements and user expectations.

This study employs an Agile-based development methodology to design and implement a digital library web application (Hanief et al, 2025). The methodology consists of iterative phases including requirement analysis, system design, development, testing, and evaluation, which are conducted in short development cycles to allow continuous feedback and improvement. System modeling is performed using conceptual and physical data models to ensure a structured database design, while functional features are developed and tested incrementally to meet user requirements. The Agile approach enables flexibility in handling requirement changes, improves collaboration between developers and stakeholders, and ensures the delivery of a reliable and maintainable digital library web application.

Tools and Technology

- Programming Language: PHP, HTML, CSS, JavaScript
- Databases: MySQL
- Collaboration Tools: Trello dan GitHub
- Test Method: Black Box Testing and UAT (User Acceptance Test)

System Design

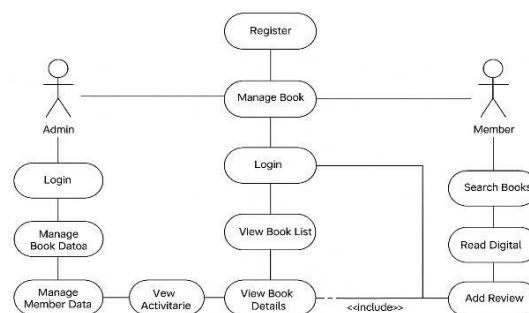


Figure 1. Research Use Case

Table 1. Admin

No	Use Case Name	Short Description
1	Login	Admin logs into the system using username & password.
2	Manage Book Data	Admin can add, edit, or delete book data.
3	Manage Member Data	Admin manages member data (add, change, delete).
4	Manage Book Category Data	Admin organizes book categories such as fiction, science, history, etc.
5	View Activity Report	Admins view reports of frequently read books, number of members, and other statistics.

The CDM and PDM design in this system can be seen in Figure 2 below.

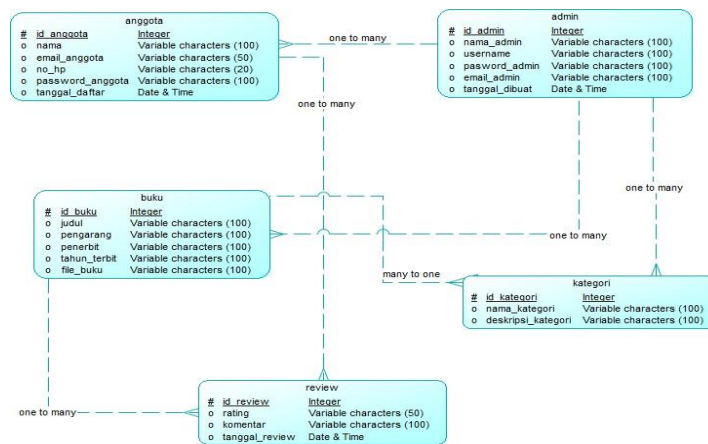


Figure 2.1 CDM

In this study, the Conceptual Data Model (CDM) and Physical Data Model (PDM) are used to ensure a structured and systematic database design for the digital library web application developed using Agile methods. The CDM represents a high-level abstraction of the system by defining the main entities, attributes, and relationships required to support core library functionalities, such as user management, digital collections, and borrowing activities, without considering technical implementation details.

Meanwhile, the PDM translates the conceptual design into a detailed database schema by specifying tables, primary and foreign keys, data types, and constraints in accordance with the selected database management system. Through iterative Agile development, both models are continuously refined to accommodate changing requirements, ensuring data consistency, scalability, and efficient integration with the web application.

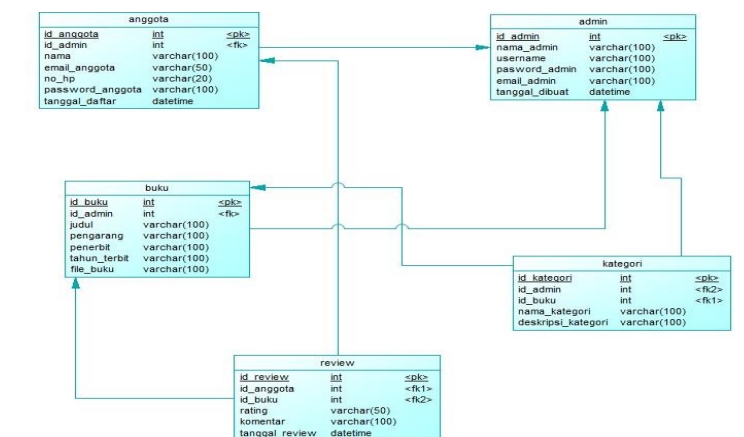


Figure 2.2 PDM

In addition, the use of CDM and PDM supports better communication between developers and stakeholders during the Agile development process. The CDM helps stakeholders understand the overall data structure in a technology-independent manner, while the PDM provides clear technical guidance for implementation and optimization at the database level. This alignment enables faster iterations, reduces design inconsistencies, and improves the overall quality and maintainability of the digital library web application.

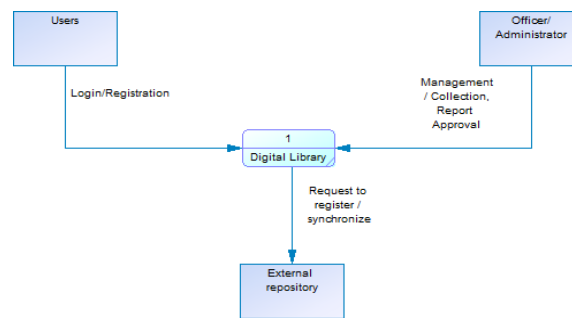


Figure 3.1 DFD level 0 of the Digital Library

Results and Discussion

Results

The following are some of the results of implementing a web-based digital library application using the Agile method.

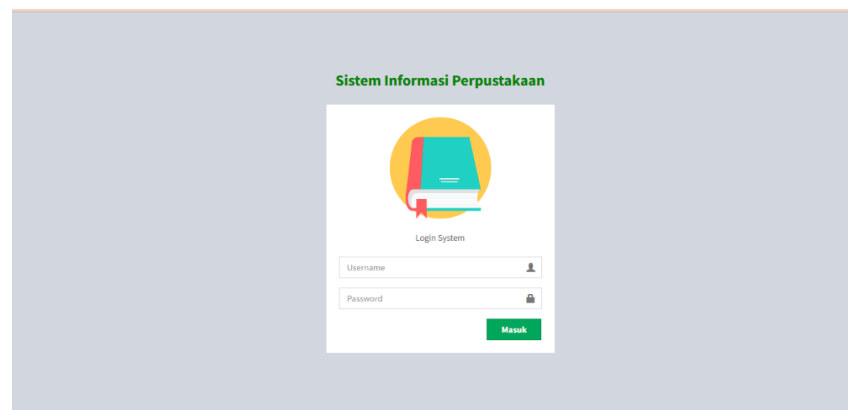


Figure 4.1 Login Page

Figure 4.1 The login page functions as the primary access control interface of the digital library web application, allowing users to authenticate themselves using valid credentials. This page ensures system security by restricting access to authorized users only and serves as the initial step before accessing application features.

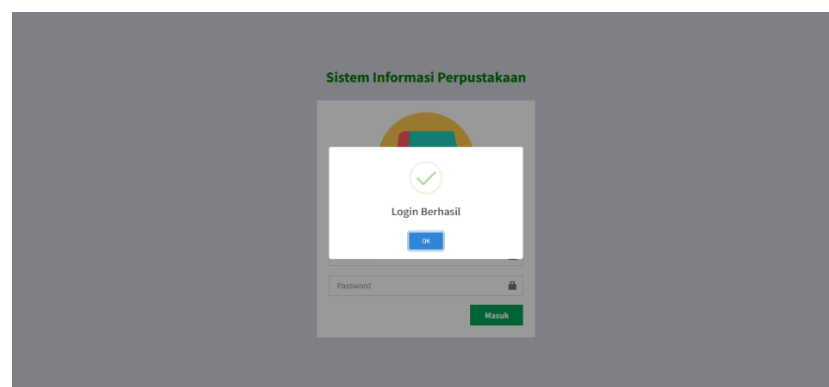


Figure 4.2 Successful Login Display

The successful login display appears after the authentication process is completed correctly, providing confirmation that the user has been granted access to the system. This display enhances user experience by clearly indicating a successful login before redirecting the user to the main dashboard.

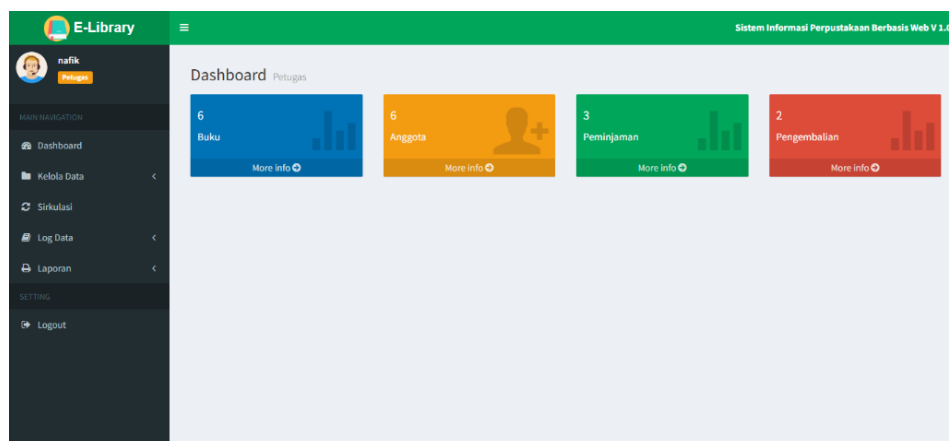


Figure 4.3 Dashboard View

The dashboard view presents a summary of key system information in a centralized interface, such as total books, members, and circulation activities. It enables users to quickly monitor system status and efficiently navigate to other functional modules of the digital library.

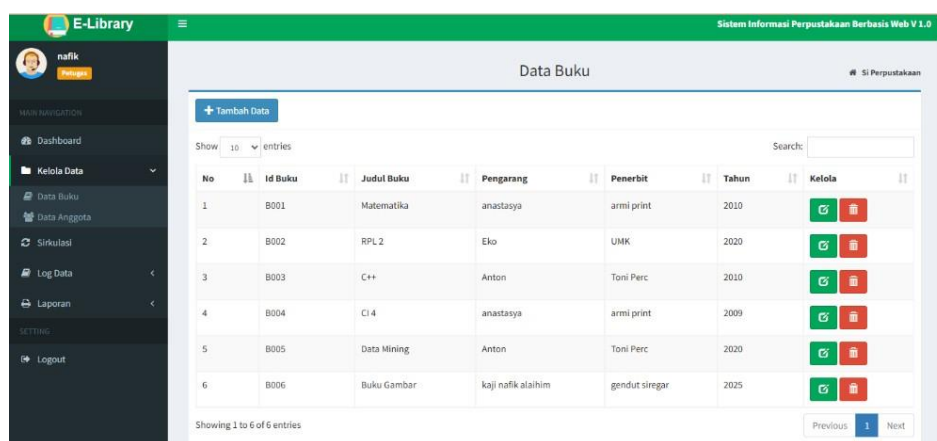


Figure 4.4 Book Data Display

The book data display provides detailed information about the digital library's collection, including book titles, authors, categories, and availability status. This feature supports efficient book management and facilitates quick searching and filtering of library resources.

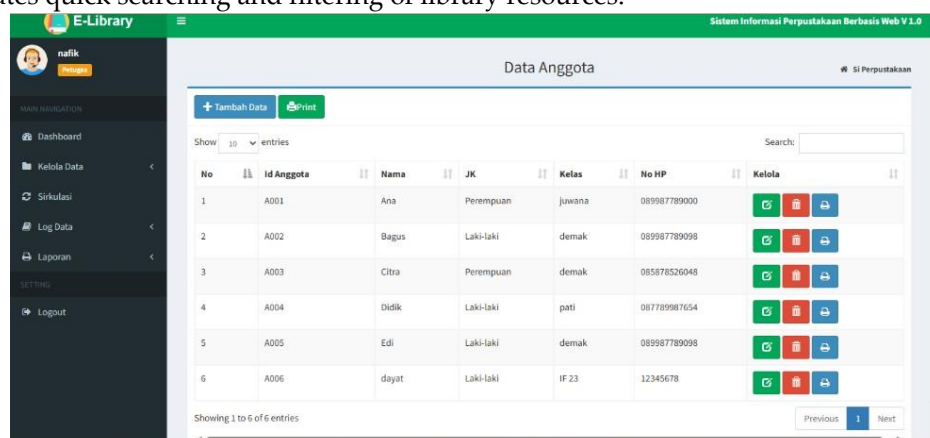
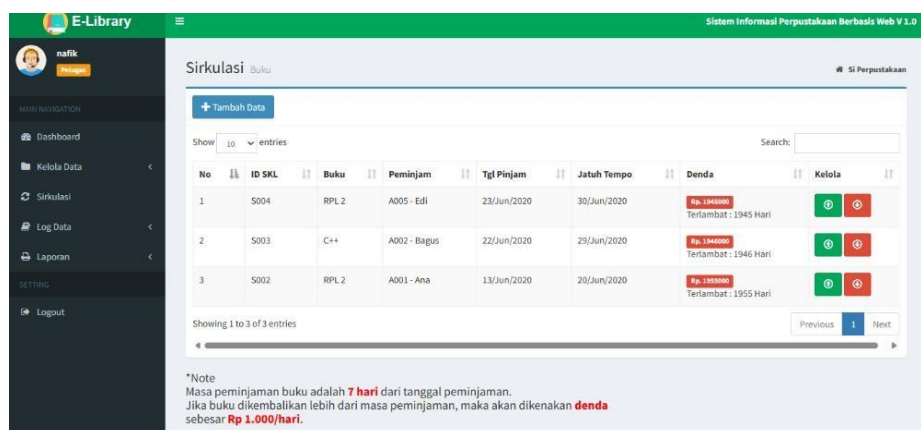


Figure 4.5 Member Data Display

The member data display shows comprehensive information about registered library members, such as personal details and membership status. This display assists administrators in managing member records and monitoring user participation within the system.



Sirkulasi Buku

+ Tambah Data

Show 10 entries Search:

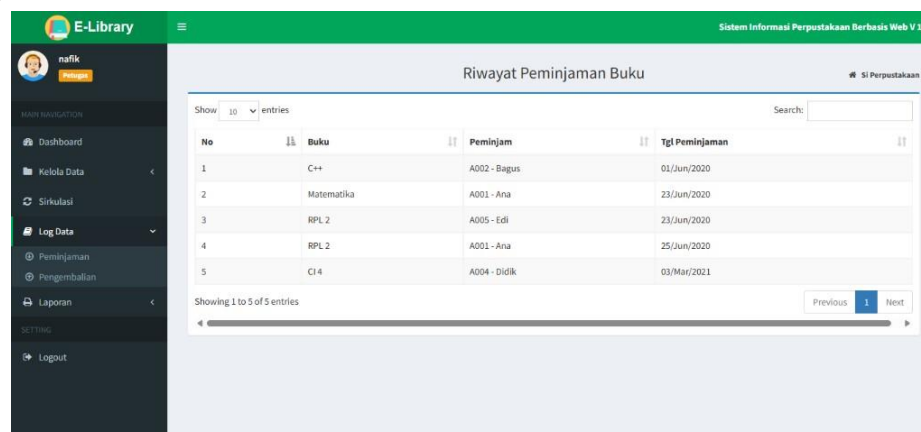
No	ID SKL	Buku	Peminjam	Tgl Pinjam	Jatuh Tempo	Denda	Kelola
1	S004	RPL 2	A005 - Edi	23/Jun/2020	30/Jun/2020	Rp. 1340000 Terlambat : 1945 Hari	⊕ ⊖
2	S003	C++	A002 - Bagus	22/Jun/2020	29/Jun/2020	Rp. 1340000 Terlambat : 1946 Hari	⊕ ⊖
3	S002	RPL 2	A001 - Ana	13/Jun/2020	20/Jun/2020	Rp. 1000000 Terlambat : 1955 Hari	⊕ ⊖

Showing 1 to 3 of 3 entries Previous 1 Next

*Note
Masa peminjaman buku adalah 7 hari dari tanggal peminjaman.
Jika buku dikembalikan lebih dari masa peminjaman, maka akan dikenakan denda sebesar Rp 1.000/hari.

Figure 4.6 Circulation Display

The circulation display presents an overview of borrowing and returning activities within the digital library. It helps administrators track transaction histories and monitor the flow of library materials effectively.



Riwayat Peminjaman Buku

Show 10 entries Search:

No	Buku	Peminjam	Tgl Peminjaman
1	C++	A002 - Bagus	01/Jun/2020
2	Matematika	A001 - Ana	23/Jun/2020
3	RPL 2	A005 - Edi	23/Jun/2020
4	RPL 2	A001 - Ana	25/Jun/2020
5	CI 4	A004 - Didik	03/Mar/2021

Showing 1 to 5 of 5 entries Previous 1 Next

Figure 4.7 Book Borrowing Display

The book borrowing display is used to manage and record borrowing transactions conducted by members. This interface ensures that borrowing processes are properly documented, including loan dates and due dates, to maintain accurate circulation records.



Riwayat Pengembalian Buku

No Buku Peminjam Tgl Pengembalian

1	A001	Ana	Matematika	30/Jun/2020	-
2	A004	Didik	CI 4	10/Mar/2021	27/Oct/2025

Figure 4.8 Book Return Display

The book return display facilitates the processing of returned books by updating their availability status in the system. This feature also supports monitoring of overdue returns and ensures data consistency in circulation management.

No	ID SKL	Buku	Peminjam	Tgl Pinjam	Jatuh Tempo	Tgl Pengembalian	Denda
1	S001	Matematika	Ana	23/Jun/2020	30/Jun/2020		
2	S005	CI4	Didik	03/Mar/2021	10/Mar/2021		

Total Denda Rp. 3.637.000

Showing 1 to 3 of 3 entries

Previous 1 Next

Figure 4.9 Circulation Report Display

The circulation report display provides summarized and structured reports of borrowing and returning activities over a specific period. These reports support data analysis and decision-making by offering insights into library usage and circulation trends.

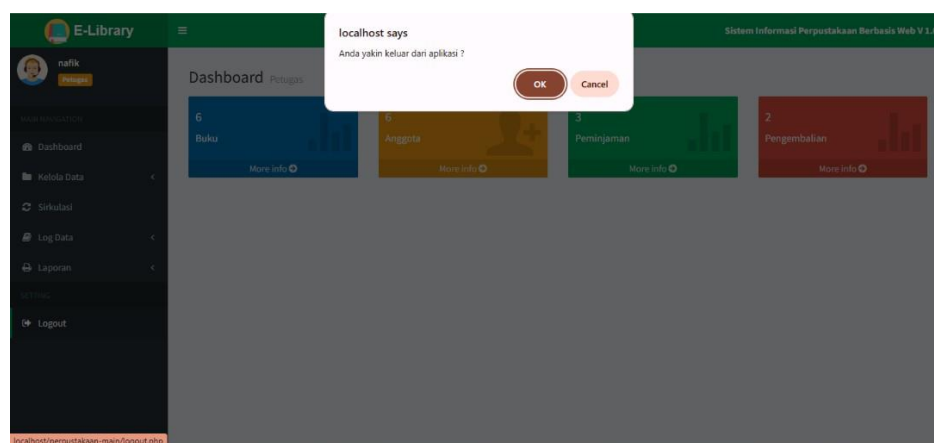


Figure 4.10 Logout View

The logout view functions as a security feature that allows users to safely terminate their session after completing their activities in the digital library web application. This view ensures that user access is properly ended, prevents unauthorized use of the system, and redirects users back to the login page, thereby maintaining data security and proper session management.

Conclusion

The application of the Scrum methodology to the development of a digital library web application has been proven to have a positive impact on the system development process and results. Scrum enables the team to work in a structured, iterative manner, allowing each requirement to be periodically evaluated and adjusted. Through the use of sprints, backlogs, and intensive collaboration, application development is faster, more measurable, and able to minimize errors.

The implementation results indicate that the resulting digital library application is able to meet user needs, such as managing book data, membership, borrowing, and returns, and providing circulation reports. This application also improves library administrative efficiency and facilitates online information access. Overall, the use of Scrum in this project was effective in increasing team productivity, software quality, and end-user satisfaction.

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