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DEVELOPMENT OF WEB-BASED LABORATORY EQUIPMENT BORROWING AND RETURNING APPLICATION

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ABSTRACT

Laboratories are essential supporting facilities in vocational and professional education, serving as platforms for practical learning and the development of students' clinical competencies. However, laboratory management that is still conducted manually often leads to inefficiency, recording errors, and limited transparency, thereby requiring more effective solutions. This study aims to develop a web-based application for the borrowing and returning of laboratory equipment and materials as a solution to improve efficiency, accuracy, and transparency in midwifery laboratory management. The research method used is Research and Development (R&D), with initial stages focusing on user needs analysis, system design, and prototype development involving laboratory staff, lecturers, and students. The subsequent stages include application implementation, limited trials, functionality evaluation, and system refinement based on testing results to ensure the application's readiness for sustainable use. The results show that the developed application facilitates inventory management, provides real-time information on equipment availability, and enhances efficiency and transparency in the borrowing and returning process. In conclusion, the developed web-based application is effective in improving the quality of laboratory management through a modern, transparent, and efficient system, thereby positively impacting laboratory administration and enhancing the quality of the learning process in health education environments.

Keywords: digital inventory management system; information system; laboratory; laboratory web application development

INTRODUCTION

The development of science and technology in the field of laboratory health has continued to experience significant progress in line with the increasing public demand for fast, accurate, and reliable diagnostic services. Laboratory examinations play an important role in supporting diagnosis, monitoring therapy, and evaluating patients' health conditions. Therefore, the quality of examination procedures and the accuracy of the methods used are key aspects that must be considered by medical laboratory personnel. Problems that often arise in laboratory services include variations in examination results caused by pre-analytical, analytical, and post-analytical factors. Errors at these stages can affect the validity of the test results, which in turn impacts the clinical decisions made by medical professionals. In addition, the lack of consistent standard operating procedures and optimal quality control also poses challenges in improving laboratory service quality.

Various previous studies have discussed the importance of procedure standardization and quality control in laboratory examinations. However, further studies are still needed to focus on optimizing methods and implementing more effective and efficient examination techniques. This research offers an approach that emphasizes improving the quality of examination processes through the evaluation of working methods and the implementation of more systematic procedures, thereby expected to provide novelty in laboratory health practices. With this research, it is expected to obtain a clearer understanding of the implementation of optimal examination methods and their contribution to improving the quality of laboratory results. The results of this study are also expected to serve as a reference for laboratory personnel and health education institutions in developing better and more sustainable examination standards.

METHOD

This study employed the Research and Development (R&D) method, which aims to design and develop a web-based application for borrowing and returning laboratory equipment (Si-Labora). The research stages included user needs and technological facility analysis, system analysis, application design and development, application implementation, as well as product testing and evaluation to determine system quality and user satisfaction levels. The study was conducted in the laboratories of the Midwifery, Nursing, Nutrition, and Sanitation departments. The research population consisted of all laboratory users, including laboratory staff, lecturers, and PJMK students. The sample was determined using a purposive sampling technique, with a total of 90 respondents. The types of data used were primary and secondary data. Primary data were collected through interviews, observations, and a two-stage questionnaire using a Likert scale of 1–5 to assess system requirements, interface design, application implementation, and user satisfaction. Secondary data were obtained from literature, scientific journals, and laboratory information system guidelines.

The research instrument was a questionnaire that had undergone content validity testing by experts and construct validity testing using Pearson Product Moment correlation, with all items declared valid. Reliability testing using Cronbach's Alpha showed a value of 0.986, indicating that the instrument was highly reliable. The system design techniques included program structure design, user interface design, and database design using an Entity Relationship Diagram. Data processing was carried out through the stages of editing, coding, tabulating, and data input. Data analysis employed descriptive quantitative analysis by calculating the mean and percentage to evaluate system effectiveness and user satisfaction levels. This study has obtained ethical approval with Ethical Clearance number: No. LB.02.03/1/0003/2026.

RESULT

This research was conducted at five laboratories within Poltekkes Kemenkes Kupang, namely the Laboratories of the Department of Midwifery, Department of Nursing, Department of Nutrition, Department of Sanitation, and Department of Pharmacy. These five laboratories are located on Jl. Piet A. Tallo, Jl. Kartini, and Jl. Farmasi in Kupang City, East Nusa Tenggara Province. These laboratories serve as practical learning units for students to acquire fundamental skills through practicum activities, clinical simulations, and basic skills training, including food processing. Each laboratory is equipped with various practical tools and instructional supporting materials.

Respondent Identity Status

This study involved 90 respondents consisting of lecturers, laboratory staff, and students of Poltekkes Kemenkes Kupang.

Tabel 1.
Respondent Identity Status

Respondent status	f	%
Students	82	91
Lectures	7	8
Laboratory staff	1	1

Table 1 illustrates that the majority of respondents were students, totaling 82 individuals (91%), followed by 7 lecturers (8%) and 1 laboratory staff member (1%). These results indicate that the primary users of the laboratories at Poltekkes Kemenkes Kupang are students actively engaged in practicum activities, while lecturers and laboratory personnel serve as supervisors and managers of laboratory operations.

System Needs Analysis Results

The respondents' assessment results regarding the level of urgency and feature requirements in the development of the Si-Labora information system are presented in table 2.

Table 2.

System Needs Analysis for the Si-Labora (System Information Laboratory Borrowing Application)

Question Aspects	Average score	criteria
The application should have a tool loan and return feature.	4,38	Strongly Agree
The application should have a tool search feature by name or code	4,28	Strongly Agree
The application should provide tool return reminder notifications.	4,30	Strongly Agree
The application should have a laboratory tool and material stock management feature.	4,29	Strongly Agree
The application should be able to differentiate access rights between students, lecturers, and staff.	4,13	Agree
The application should have a loan history report.	4,33	Strongly Agree
The application should have a loan approval system by the manager before items can be borrowed.	4,33	Strongly Agree

Based on the data from table 2, the majority of respondents strongly agreed with the development of web-based laboratory application features. The equipment borrowing and return feature received the highest mean score (4.38), followed by return reminder notifications (4.30), borrowing history reports and manager approval systems (4.33), equipment and material stock management (4.29), equipment search functionality by name or code (4.28), and user access right differentiation (4.13). These findings emphasize that transparency, control, and operational ease are critical aspects of the laboratory equipment borrowing process.

Interface Design and System Structure Requirements

The assessment of the application's interface design and structural organization is essential to ensure user accessibility. These results are presented in table 3.

Table 3.

Interface Design and System Structure Requirements for the Laboratory Equipment Borrowing and Return Application (Si-Labora)

Question Aspects	Avarage Score	Criteria
The application interface is clear and uncluttered.	4,24	Strongly agree
The application menus and features are easy to find.	4,30	Strongly agree
The application menu structure is logical.	4,32	Strongly agree
Navigating between application pages is easy to use.	4,41	Strongly agree
The application design is comfortable for long-term use.	4,29	Strongly agree

Table 3 presents that the application's usability aspects fall within the good to excellent categories. The interface design aspect obtained a mean score of 4.38, demonstrating that users perceive the application's appearance as clear, organized, and easy to understand. The ease of locating menus and features was also rated highly with a score of 4.30, indicating that users encountered no significant difficulties when accessing available functions. Furthermore, the aspect of logical menu structure received a score of 4.32, explaining that the menu arrangement aligns with user needs and expectations. The navigation between pages achieved the highest score of 4.41, showing that transitions between pages within the application are highly intuitive and straightforward. Meanwhile, the comfort of using the application for extended periods obtained a score of 4.29, which remains in the good category, despite being the indicator with the relatively lowest value compared to others.

Implementation Results of the Si-Labora Application System

The implementation of the Si-Labora (System Information Laboratory Borrowing Application) aims to support the digitalization of laboratory equipment and material loan management to ensure it is more effective, efficient, and well-*documented*. This system was developed and implemented as a solution to manual laboratory management issues, such as recording in logbooks or paper forms, which are prone to recording errors, data loss, and information delays.

Tabel 4.

Implementation of the Laboratory Equipment Borrowing and Return Application System (System Information Laboratory Borrowing Application)

Aspek Pertanyaan	Avarage Score	Criteria
The application is capable of displaying accurate laboratory equipment stock data.	4,38	Strongly agree
The equipment loan process through the application runs smoothly.	4,33	Strongly agree
The equipment return process through the application runs smoothly.	4,32	Strongly agree
Equipment loan and return data are recorded automatically.	4,41	Strongly agree
The application is ready to support laboratory equipment management.	4,29	Strongly agree

The implementation results presented in Table 4 demonstrate that the Si-Labora application effectively facilitates an integrated laboratory borrowing and return process. The system features comprehensive user and equipment data management, transaction recording, and automated inventory reporting. Furthermore, all data is stored in a centralized database, enabling laboratory staff to monitor equipment availability in real-time.

Figure 1. Main Menu Display

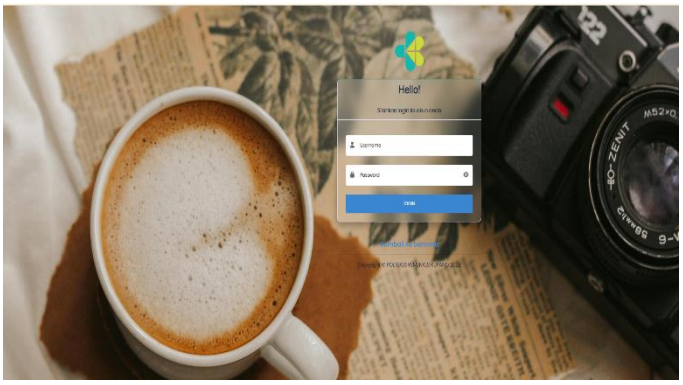

Figure 2. Si-Labora Login Display

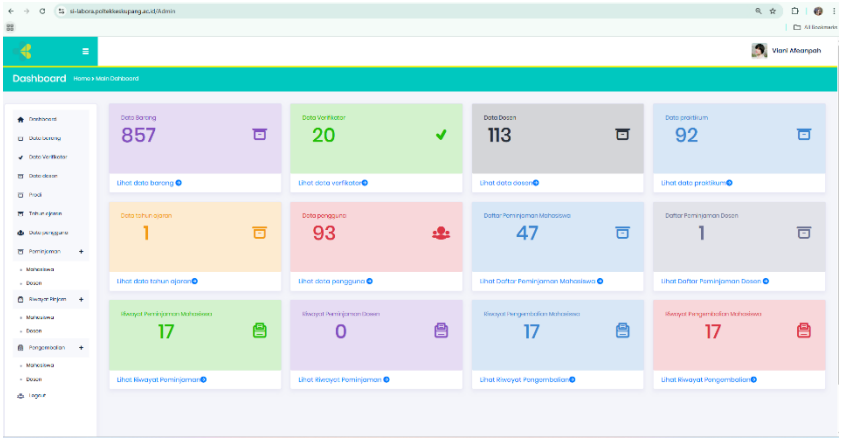

Figure 3. Laboratory Home View

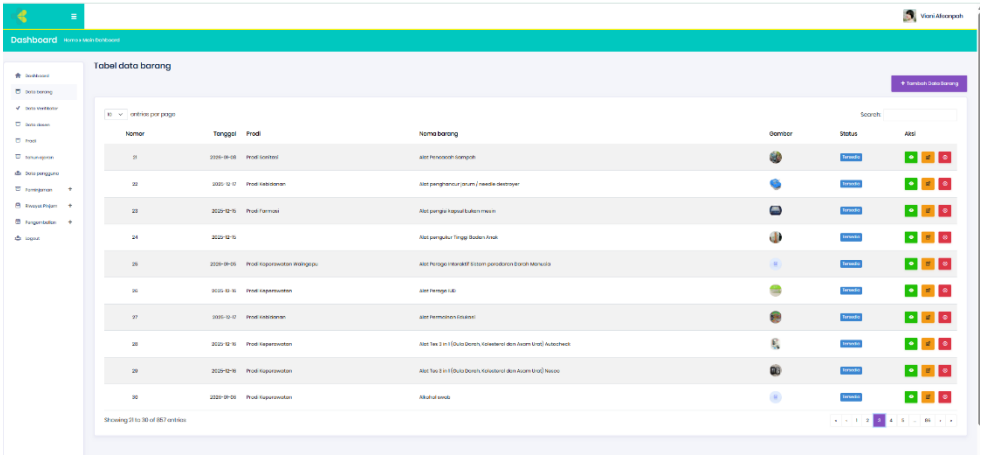

Figure 4. Item List View

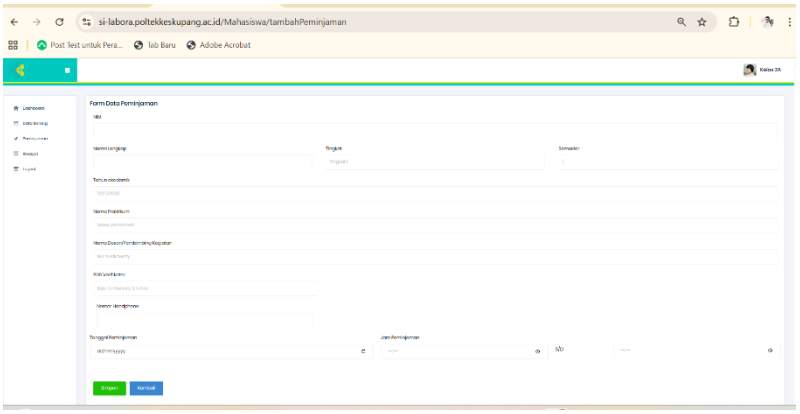

Figure 5. Equipment Loan Form Display

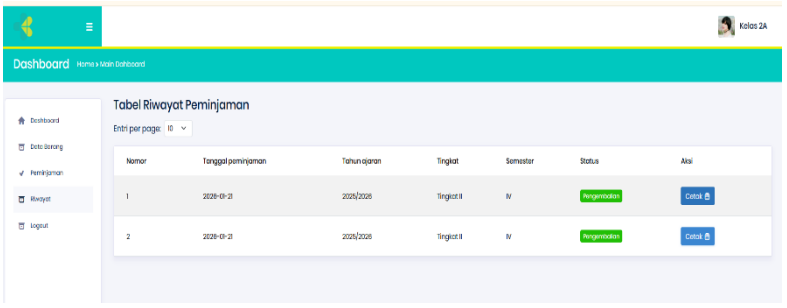

Figure 6. Loan History

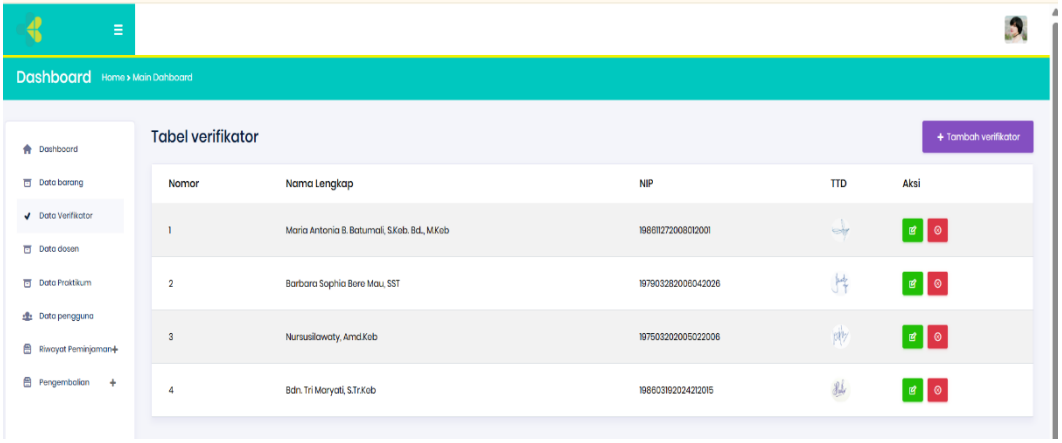

Figure 7. List of Verifiers

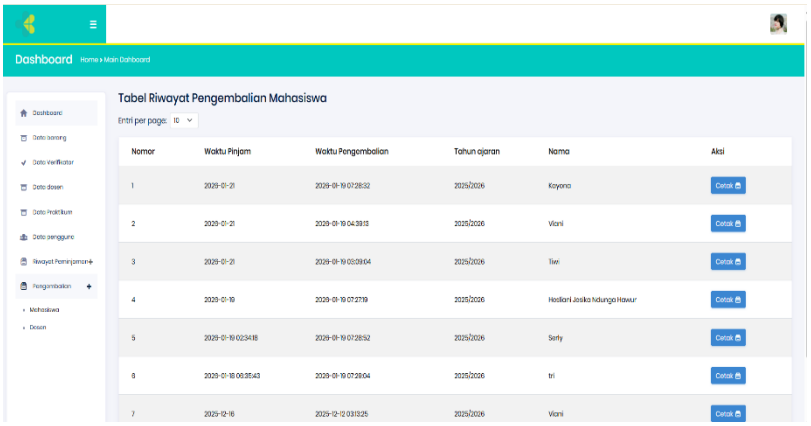

Figure 8. Return History

User Satisfaction and Efficiency

To evaluate the relationship between system performance and user acceptance, a statistical analysis was conducted on several key indicators. The following table details the correlation between ease of use, effectiveness, security, comfort, and satisfaction regarding the utilization of the Si-Labora application

Table 5.
Correlation Between Ease of Use, Effectiveness and Efficiency, System Security, User Comfort, and User Satisfaction with the Use of the Laboratory Equipment Borrowing and Return Application (Si-Labora)

Variable	r value	p-value	Interpretation
Convenience	0,930	0,000	There is a relationship
Effectiveness and Efficiency	0,948	0,000	There is a relationship
System Security	0,931	0,000	There is a relationship
User Convenience	0,912	0,000	There is a relationship
Application User Satisfaction	0,956	0,000	There is a relationship

The statistical analysis results presented in Table 5 indicate that all tested indicators have a significant relationship with the use of the web-based laboratory application. These indicators encompass ease of use, effectiveness and efficiency, system security, user comfort, and user satisfaction. Correlation tests reveal that all variables possess a very high coefficient ($r > 0.90$) with a p-value of 0.000 ($p < 0.05$), signifying a very strong and significant positive relationship between each indicator and the utilization of the application.

DISCUSSION

Respondent Characteristics

The application features reflect user needs from the user perspective. Based on this perspective, the need for a laboratory equipment borrowing and returning system is categorized as “high,” with an average score of 4.38. This value indicates that the application significantly meets user needs during the borrowing and returning process, with ease of access, system speed, and data security being the most appreciated features. This finding is consistent with the study by Muhasshanah and Qamariyah (2021), which reported that the implementation of a Laboratory Management Information System in the Midwifery Laboratory of the Faculty of Health Sciences at Ibrahim University was able to meet user needs in managing laboratory activities, particularly in terms of data accuracy and ease of use. Similarly, Karomah et al. (2024) demonstrated that the development of a web-based laboratory management system can improve the effectiveness of laboratory management, especially in inventory data management and administrative processes. These findings are also in line with Zuhdi et al. (2017), who showed that a web-based laboratory information management system plays an important

role in supporting the digitalization of laboratory environments by providing fast, accurate, and integrated data access.

From an information systems perspective, the implementation of digital technology in laboratory management can improve organizational operational efficiency and support data-driven decision-making (Laudon & Laudon, 2022). In addition, the management of educational laboratories requires well-organized administrative systems to optimally support learning activities (Semarang, 2021; Susandi & Sukisno, 2018). The researcher concludes that users support the development of the laboratory system application. The high level of need expressed by users indicates that they have provided positive evaluations of the application in terms of functionality and security, as well as its ability to reduce operational errors in laboratory management systems.

Application Feature Requirements

The results of the study indicate that the requirements for the web-based laboratory equipment borrowing and returning system fall into the "high" category, with an average score of 4.38. This suggests that users perceive the application as meeting their needs in carrying out borrowing and returning processes, with ease of access, system speed, and data security being the most appreciated aspects. These findings are consistent with Adekunle et al. (2024), who stated that a web-based laboratory management system can improve the efficiency of laboratory resource management and facilitate digital tracking of equipment inventory. Similarly, Karomah et al. (2024) reported that a web-based laboratory management system can enhance the effectiveness of laboratory data management and improve administrative processes in a more systematic manner. Zuhdi et al. (2017) also emphasized that web-based laboratory information management systems play an important role in supporting the digitalization of laboratory environments by providing fast, accurate, and integrated data access. The management of educational laboratories requires well-organized and well-documented administrative systems to optimally support learning activities. The researcher concludes that the development of the Si-Labora application is considered capable of meeting user needs in terms of functionality and data security, as well as helping to minimize operational errors in laboratory management.

Interface Design and System Structure Requirements

The results show that the interface design and system structure obtained a score of 4.31, which falls into the "high" category. This indicates that the application's design, navigation, and menu structure are user-friendly and easy to use. This study is in line with the findings of Karomah et al. (2024), which showed that the development of a web-based laboratory management system with a clear interface and simple navigation can enhance user convenience in accessing and managing laboratory data. In addition, Nafi'ah et al. (2020) explained that a web-based laboratory management information system designed with a systematic menu structure can improve data management effectiveness and facilitate users in operating system functions. According to Alhaj et al. (2025), an intuitive interface design in web-based laboratory management systems is essential for supporting user interaction with digital laboratory systems. Likewise, Laudon and Laudon (2020) stated that a logical and intuitive system structure can improve user productivity. The researcher concludes that the high level of interface design and system structure indicates that the Si-Labora application is easy to use for students and laboratory assistants, which directly supports the effectiveness of laboratory processes.

Implementation of the Si-Labora Application System

The Si-Labora application system (System Information Laboratory Borrowing Application) has been developed and tested in five departments/study programs within the laboratories of Poltekkes Kemenkes Kupang. The testing was conducted using the User Acceptance Testing (UAT) method by collecting feedback on system functionality, system quality, and user experience, including aspects of ease of use, effectiveness, security, convenience, and user satisfaction (Janto et al., 2025). This testing was carried out to ensure that the system meets real user needs, thereby making it ready for full

implementation. Based on the implementation performance, the average score obtained was 3.94, which is considered high. This indicates that the application is capable of accurately displaying equipment stock availability, processing borrowing and returning transactions, and automatically recording data.

These results are consistent with Adekunle et al. (2024), who found that web-based laboratory management systems can improve the accuracy of inventory management and facilitate the monitoring of laboratory equipment usage. Chen et al. (2022) explained that web-based laboratory information management systems can enhance laboratory operational efficiency through data integration and digital information management. According to Laudon and Laudon (2020), the implementation of integrated information systems can improve organizational operational efficiency and reduce errors commonly found in manual administrative processes. Sulistyani Puteri Ramadhani (2020) also emphasized that modern laboratory management requires accurate and reliable systems for recording inventory and managing equipment borrowing. The researcher concludes that effective application implementation supports the efficiency and effectiveness of laboratory processes, allowing users to focus on practical activities without being hindered by manual administrative tasks.

User Satisfaction with the Si-Labora Application

Statistical analysis showed that all indicators were significantly related to the use of the Si-Labora application. These indicators include ease of use, effectiveness and efficiency, system security, user comfort, and overall user satisfaction. All variables had correlation coefficients above 0.90 with a p-value of 0.000 ($p < 0.05$), indicating a very strong positive correlation between system quality and application utilization.

Ease of Use

The ease of use indicator had a correlation coefficient of $r = 0.930$ ($p = 0.000$). This means that the easier the system is to use, the higher its utilization. This finding aligns with Bayu Saputra et al. (2020), who explained that web-based laboratory management systems with simple and easy-to-understand interfaces can enhance user interaction and facilitate laboratory data management. Karomah et al. (2026) also emphasized that web-based laboratory systems designed with clear navigation increase user acceptance of digital systems.

Effectiveness and Efficiency

The effectiveness and efficiency indicator had a correlation coefficient of $r = 0.948$ ($p = 0.000$), indicating a very strong relationship with application usage. Systems that can speed up services, reduce recording errors, and improve administrative organization encourage greater utilization. This is consistent with Laudon & Laudon (2020), who stated that information systems improve organizational operational efficiency. Additionally, Adekunle et al. (2024) found that web-based laboratory management systems can enhance inventory management efficiency and improve laboratory equipment monitoring processes.

System Security

The system security indicator had a correlation coefficient of $r = 0.931$ ($p = 0.000$). This shows that data security, access control, and reliable data storage affect application usage. These findings are consistent with Laudon and Laudon (2020), who explained that information systems with robust security mechanisms increase user trust in the system. Security is also an essential component of well-organized and accountable laboratory management (Deitje Adolfien Katuuk, 2025; Susandi & Sukisno, 2018). Overall, the very strong relationships between all indicators and application usage indicate that system quality is a key determinant of the successful implementation of Si-Labora. These findings reinforce the importance of developing web-based laboratory information systems that are user-centered, operationally efficient, and secure.

CONCLUSION

Based on the research results and discussion, the implementation of the Si-Labora (System Information Laboratory Borrowing Application) has been successfully established as a digital solution for laboratory equipment and material management. This system enhances the effectiveness and efficiency of the borrowing process through integrated, structured, and well-documented data recording. Evaluation results indicate a very high level of system reliability, with a Cronbach's Alpha value of 0.984, signifying excellent consistency of the assessment instrument. This proves that the Si-Labora application is feasible for use as a laboratory management tool capable of providing accurate and reliable information. Furthermore, the application provides ease of access for users to check equipment availability, submit borrowing requests, and monitor the status of loans and returns. Consequently, this system supports improved accountability, transparency, and security in laboratory management and offers prospects for further development through system integration, enhanced security features, and the development of a mobile version in future research.

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