OPEN ACCESS
Jurnal Ilmiah Ilmu Terapan Universitas Jambi
Vol. 10 No. 1. Ferbruary 2026, pp. 01-16
DOI. [10.22437/jiituj.v10i1.47430](https://doi.org/10.22437/jiituj.v10i1.47430)
Research Article

DEVELOPMENT AND ISO 25010 EVALUATION OF A WEB-BASED LABORATORY AND WORKSHOP INVENTORY SYSTEM

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Article Info
Received: Jul 27, 2025
Revised: Nov 24, 2025
Accepted: Dec 12, 2025
OnlineVersion: Feb 02, 2026

Abstract
Effective management of laboratory tools and materials is essential to support experimentation and practical learning in higher education. However, many institutions still rely on manual inventory processes, which lead to data inaccuracies, inefficiencies, and limited monitoring capabilities. This study aims to develop and evaluate a web-based laboratory and workshop inventory management system tailored to the Department of Electronics and Informatics Education Engineering (DPTEI). The research adopts a Research and Development (R&D) design using the Waterfall Model, encompassing communication, planning, modeling, construction, and deployment phases. Data were collected from 22 participants (laboratory officers, workshop technicians, and lecturers) selected through purposive sampling. Requirement analysis was conducted via observations, structured interviews, and document review, while system evaluation employed questionnaires and automated testing tools. System quality was assessed using ISO 25010 criteria—functional suitability, reliability, performance efficiency, and usability—and a paired t-test was used to compare inventory management efficiency before and after implementation. The system achieved 100% functional suitability, very high reliability (up to 99.84% in stress testing), and strong performance efficiency with an average Largest Contentful Paint (LCP) of 1.180 seconds. The System Usability Scale (SUS) yielded a score of 84, classified as excellent, and the paired t-test ($p = 0.002$) indicated a significant improvement in inventory efficiency. These findings demonstrate that the developed system is robust, reliable, and well-accepted by users, contributing a domain-specific, empirically validated solution for digital resource management in academic laboratory settings.

Keywords: Inventory Information System, ISO 25010, Laboratory and Workshop, Waterfall Model, Web-based.

INTRODUCTION

University laboratories and workshops serve as essential infrastructure that support scientific experimentation, practical learning, and research-based innovation across higher education institutions. They play a critical role in developing student competencies, enhancing hands-on learning, and fostering technological advancement (Hernandez-de-Menendez et al., 2020; Pawlicka-Deger, 2020). As universities expand their academic programs and student populations, the demand for laboratory facilities and the volume of tools and materials to be managed have increased significantly (Chen & Yang, 2016; Wang, 2022). However, this growth has not been matched by improved management systems, resulting in increasingly complex, time-consuming, and error-prone inventory processes (Timoteo et al., 2020; Tziakou et al., 2023).

Manual and traditional inventory management methods—such as handwritten logbooks, spreadsheet records, or fragmented databases—are still widely used in many institutions (Nikolic et al., 2015; Accad et al., 2023). Such methods are vulnerable to data inaccuracies, update delays, misplaced records, and limited traceability of borrowing and return activities (Kranjc, 2021; Zhang & Li, 2021). Ineffective asset management also impacts accountability, laboratory readiness, and the ability to support practical courses efficiently (Putri, 2023). Studies have shown that poor laboratory management directly affects the quality of practical training, the safety of laboratory environments, and student learning outcomes (Munir et al., 2018; Kapici et al., 2020; Dewanto et al., 2021). This underscores the need for reliable, integrated, and technologically enhanced systems to support laboratory operations.

Digital transformation efforts have motivated universities to adopt information systems that support real-time data monitoring, automation, and efficient resource allocation (Yang, 2021; Senagi & Tonnang, 2022). Web-based inventory systems, in particular, offer advantages such as ubiquitous access, centralized data storage, automatic updates, and error reduction (Almassalkhi et al., 2022; Hadikin & Wiratama, 2024). Numerous studies have proposed digital solutions for inventory or asset management, yet many remain generic and do not fully address the specialized workflows, safety requirements, and operational constraints of academic laboratories (Hernandez-de-Menendez et al., 2020; Kranjc, 2021; Comeaga, 2022). Furthermore, prior work rarely incorporates systematic quality evaluations grounded in international software standards such as ISO 25010, leaving limited evidence regarding system reliability, usability, and performance efficiency in educational contexts (Souza-Pereira et al., 2021; Chrysohoou et al., 2025).

A review of existing literature highlights several important gaps. First, previous studies predominantly focus on general-purpose inventory platforms with minimal attention to the distinctive needs of university laboratories and workshops (Nikolic et al., 2015; Tziakou et al., 2023). Second, few studies integrate comprehensive software quality evaluation frameworks to validate system performance across functional, technical, and user experience dimensions (Souza-Pereira et al., 2021). Third, empirical evidence demonstrating the measurable improvement in laboratory efficiency after implementing a digital inventory system remains limited, with most studies relying solely on descriptive evaluations rather than comparative statistical analysis (Mejri et al., 2024; Shehun, 2025). These limitations reveal a persistent gap in research on academically oriented inventory systems that are rigorously evaluated and empirically tested for effectiveness.

This study aims to address these gaps by developing a web-based laboratory and workshop inventory information system specifically designed for the Department of Electronics and Informatics Education Engineering (DPTEI), Faculty of Engineering. The system targets common issues in manual laboratory management such as inefficient recording, difficulty retrieving data, borrowing inaccuracies, and lack of real-time updates identified through observations and interviews with laboratory officers and faculty members, consistent with prior evidence that academic laboratories require inventory solutions adapted to their operational context rather than generic tools (Soegoto & Palalungan, 2020; Oyekan & Ikuomola, 2024). The research employs a Research and Development (R&D) methodology using the Waterfall Model to ensure structured, sequential system development aligned with user requirements, an approach commonly recommended when requirements are stable and documentation is critical for institutional systems (Saravanos & Askounis, 2023; Anggara et al., 2024). Additionally, the system undergoes comprehensive quality testing based on the ISO 25010 standard, covering functional suitability, reliability, performance efficiency, and usability, following established practice in multidimensional software quality assessment (Mulyawan et al., 2021; Ratnaduhita et al., 2023). A paired t-test is further employed to evaluate the system’s impact on inventory management efficiency before and after implementation, while usability is measured with the System Usability Scale to ensure reliable user-centered validation (Gronier & Baudet, 2021; Rahmawati et al., 2024).

The significance of this study lies in its contribution to the development of a domain-specific inventory management solution tailored to educational laboratories (Soegoto & Palalungan, 2020; Oyekan & Ikuomola, 2024). The study also contributes theoretically by demonstrating how ISO 25010 can be systematically applied to evaluate academic information systems, offering a replicable framework for future research (Kadi et al., 2016; Mulyawan et al., 2021; Ratnaduhita et al., 2023). Practically, the system enhances transparency, operational efficiency, and accountability in managing laboratory tools and materials, aligning with broader digital transformation trajectories in higher education (Soegoto & Palalungan, 2020; Mishra et al., 2023; Oyekan & Ikuomola, 2024). The findings offer actionable insights for institutions seeking to modernize resource management processes and support digital transformation agendas (Dąbrowska et al., 2022; Mohamed Hashim, Tlemsani, & Duncan Matthews, 2022; Martínez-Peláez et al., 2023).

RESEARCH METHOD

This study employed a Research and Development (R&D) design to develop and evaluate a web-based laboratory and workshop inventory information system tailored to the operational needs of the Department of Electronics and Informatics Education Engineering (DPTEI). The R&D approach was selected because it enables the systematic creation of a functional product grounded in user needs while allowing iterative refinement during development (Bock, 2020). The system was developed using the Waterfall Model, a structured software development life cycle (SDLC) consisting of sequential phases: communication, planning, modeling, construction, and deployment (Gurung et al., 2020; Pressman, as cited in Meneses & Varajão, 2022) as Figure 1. This model was chosen due to the clearly defined system requirements, the need for comprehensive documentation, and the minimal risk of scope changes throughout development.

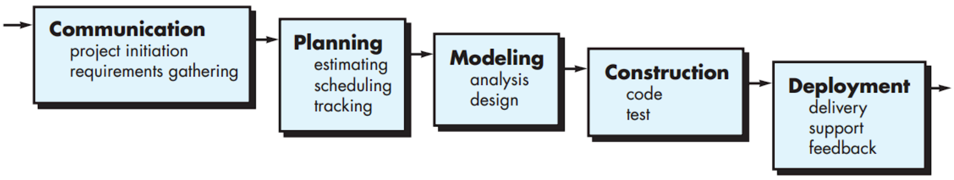


Figure 1. Waterfall Model Pressman

The evaluation of the system followed a mixed-methods approach, combining qualitative data from observations and interviews with quantitative assessment based on ISO 25010 quality attributes—functional suitability, reliability, performance efficiency, and usability. Additionally, a paired t-test was conducted to statistically evaluate improvements in inventory efficiency before and after system implementation. A total of 22 participants were selected using purposive sampling, consisting of 8 laboratory officers, 4 workshop technicians, and 10 faculty members involved in practicum supervision. These participants were chosen because of their direct responsibility for inventory operations and their capacity to provide informed system evaluation. Ethical considerations were maintained by informing all participants about study procedures, ensuring voluntary participation, and excluding personal identifying information.

Requirement analysis was conducted through direct observations of manual inventory processes, structured interviews with laboratory personnel, reviews of inventory logbooks, and open-ended questionnaires to identify current challenges and desired system features. The collected data informed the system specifications. System development followed the Waterfall Model. During communication and planning, requirement documents and development timelines were prepared using Microsoft Project and Excel. In the modeling phase, system architecture and workflows were translated into UML diagrams (Use Case, Activity, Sequence) using StarUML and Visio, while interface prototypes were developed with Figma and database schemas designed using MySQL Workbench. The construction phase involved implementing the front end using HTML, CSS, and JavaScript, and the back end using PHP and MySQL. Development was conducted in Visual Studio Code, with Apache as the local server and GitHub for version control. After unit testing of each module, the system was deployed via cPanel and made accessible at https://silabdptei.com, followed by user training and initial feedback collection.

Data for system evaluation were collected through functional suitability checklists, usability questionnaires, expert assessments, automated performance tests, and pre–post efficiency measurements. Instruments were developed based on ISO 25010 and validated through expert review. Reliability testing of the instruments yielded Cronbach's Alpha values of 0.92 (SUS) and 0.89 (functional suitability), surpassing the recommended threshold of 0.70. Functional suitability was measured through a Guttman-scale test case checklist (Itakussu et al., 2021) completed by three experts. The results of the functional suitability testing are processed using the following Eq. (1).

$$Result = \frac{Current\ score}{Maximum\ score} \times 100\% \qquad (1)$$

The test results are then converted into five-scale qualitative values using a Likert scale, as shown in Table 1 (Chyung et al., 2017).

Table 1. Percentage of Functional Suitability

No.	Result	Description
1	0% to 20%	Very Poor
2	21% to 40%	Poor
3	41% to 60%	Acceptable
4	61% to 80%	Good
5	81% to 100%	Very Good

System reliability was evaluated using WAPT 10 to assess session stability, page loads, and server hits. The calculation formula of system reliability is Eq. (2).

$$Result = \frac{\text{successful hits} + \text{successful sessions} + \text{successful pages}}{\text{total hits} + \text{total sessions} + \text{total pages}} \times 100\% \qquad (2)$$

The test results are then converted into five-scale qualitative values, as shown in Table 2. According to the Telcordia GR-282 standard, an information system is considered good if it achieves a value of 95% (Asthana & Olivieri, 2009).

Table 2. Percentage of Reliability

No.	Result	Description
1	0% to 20%	Very Low
2	21% to 40%	Below Average
3	41% to 60%	Average
4	61% to 80%	Above Average
5	81% to 100%	Very High

Performance efficiency was analyzed using GTMetrix, focusing on performance score, structure score, and Largest Contentful Paint (LCP). The data obtained from GTMetrix tests include parameters such as page load time, page size, and total requests. Performance efficiency testing is successful if the system response time is 2.5 seconds or less (Namoun et al., 2021). Usability was measured using the System Usability Scale (SUS). According to its parameters (Chrysohoou et al., 2025), SUS consists of ten statements with five possible responses: Strongly Disagree (SD), Disagree (D), Undecided (U), Agree (A), and Strongly Agree (SA). The formula for calculating the SUS score is outlined as Eq. (3).

$$SUS\ Score = \begin{Bmatrix} (B1-1)+(5-B2)+(B3-1)+(5-B4)+(B5-1)+ \\ (5-B6)+(B7-1)+(5-B8)+(B9-1)+(5-B10) \end{Bmatrix} \times 2.5 \qquad (3)$$

Description:
B = Value of the respondent's contribution to the item.

Figure 2 shows that the final System Usability Scale (SUS) score is derived by computing the average SUS score across all research subjects.

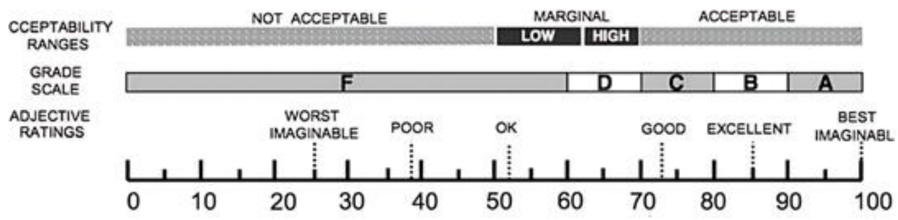


Figure 2. SUS Score

Additionally, operational efficiency was assessed by comparing the time required for inventory recording before and after system implementation, with statistical significance tested using a paired t-test in SPSS version 26. Qualitative data from interviews, observations, and open-ended responses underwent thematic analysis to identify user feedback, usability issues, and recommendations.

RESULTS AND DISCUSSION

The Waterfall Model Approach

The web-based laboratory and workshop inventory information system is the final result of this research. The development process follows the waterfall model approach: communication, planning, modeling, construction, and deployment.

Communication

The communication stage was conducted through direct observations at DPTEI, Faculty of Engineering. Lecturers and laboratory or workshop officers were involved to identify and document current inventory management problems in the laboratories and workshops. The findings from this observation stage are summarised in Table 3.

Table 3. Observation Result

No	Main Functions	Current Process	Proposed Process
1	Recording inventory data for borrowing and returning items	Manually, written in a book	Automatically, updated in the system
2	Searching for inventory data	Slow, ineffective, and inefficient	Fast, effective, and efficient
3	Managing inventory data	Officers find it difficult	Officers find it easy
4	Generating inventory data entry and exit reports	Diachronous data recapitulation	Simultaneous data recapitulation
5	Implementing the web-based laboratory and workshop inventory information system of DPTEI	Not yet implemented	Needs to be implemented

Planning

After completing the communication stage, the planning stage of developing a web-based DPTEI laboratory and workshop inventory information system is described in Table 4 below.

Table 4. Observation Result

No	Stages	Duration (in days)
1	Communication	7 days
2	Needs Analysis	7 days
3	UML Design	10 days
4	Construction	30 days
5	Evaluation	2 days
6	Improvement	14 days
7	Deployment/Implementation	5 days

Based on the design of the development schedule and time allocation of the information system above, the inventory information system for lab and workshop items in DPTEI is implemented for 75 days, or about 2.5 months.

Modeling

During the modeling stage, the system architecture, user interface, and database were designed using UML. Three diagrams were produced: a Use Case Diagram to show users and system functions (Figure 3), an Activity Diagram to map the workflow (Figure 4), and a Sequence Diagram to illustrate interactions among system components (Figure 5). Together, these diagrams define the system's structure and behaviour.

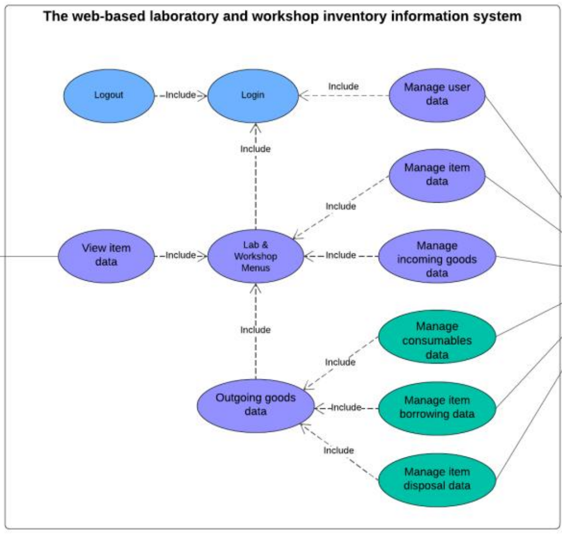


Figure 3. Use Case Diagram

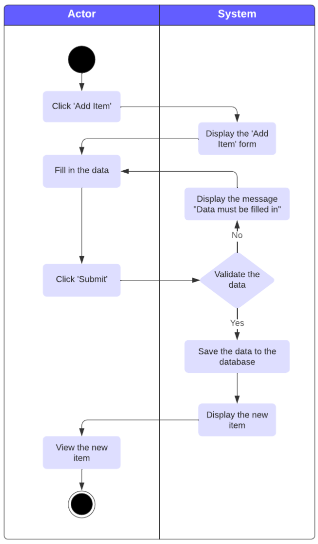


Figure 4. Activity Diagram

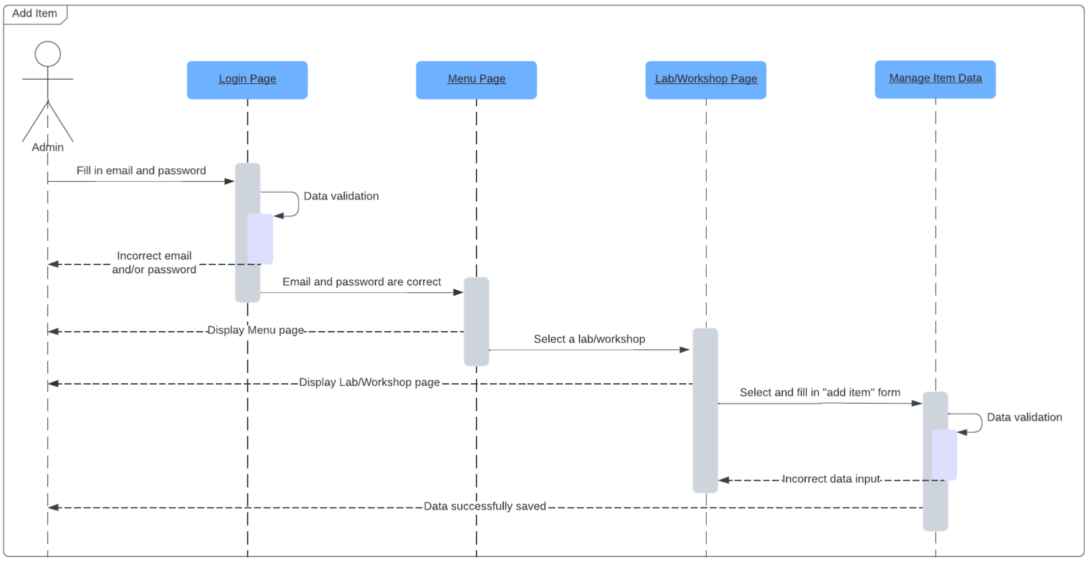


Figure 5. Sequence Diagram

After the architectural design modeling stage, the next step is designing the user interface. The user interface design visually represents the website, depicting its actual appearance. Figure 6 is an example of the resulting interface design.

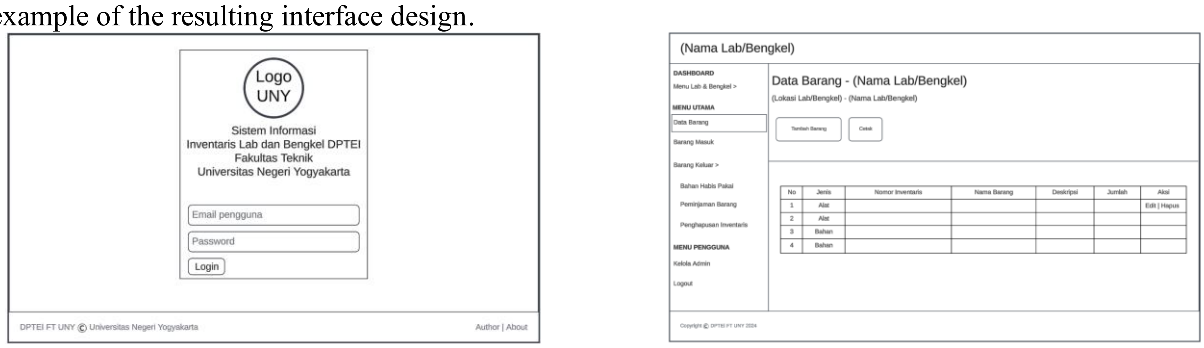


Figure 6. Sample of User Interface Design

The next step is designing the database. The database design illustrates the table structures and relationships within the developed system. Each table is titled with its name at the top, followed by a list of attributes and their corresponding data types. The information within each table details the data types and attribute names used. Figure 7 displays the result of the database design and the established relationships.

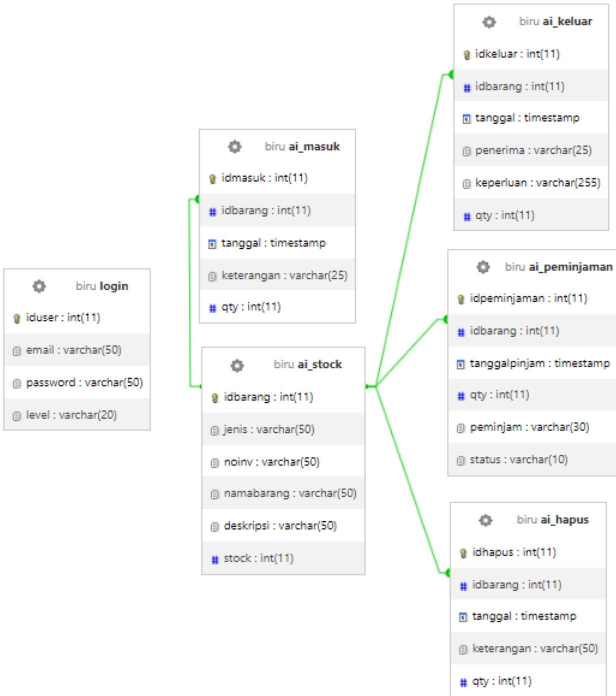


Figure 7. Database Design

Construction

The next stage is the construction stage, which involves developing a database, writing program code, and implementing the interface design for DPTEI's web-based laboratory and workshop inventory information system. The following are the results of the construction stage of information system development. The database for the web-based laboratory and workshop inventory information system of DPTEI uses MySQL. This database consists of 76 tables: 1 table for storing information system user data (both admin and user) and 75 tables for storing data on each DPTEI lab and workshop. There are 15 lab rooms and workshops, each requiring five tables to store data. Figure 8 is a sample of the construction of this information system database.

←T→				iduser	email	password	level
☐	Edit	Copy	Delete	1	lab@gmail.com		admin
☐	Edit	Copy	Delete	4	doni_se@uny.ac.id		admin
☐	Edit	Copy	Delete	5	se@uny.ac.id		admin
☐	Edit	Copy	Delete	7	admin@admin		admin
☐	Edit	Copy	Delete	8	user@user		user
☐	Edit	Copy	Delete	9	dosen@dosen		user

Figure 8. Database Table of Login

The next step is developing program code using the PHP programming language to integrate functionality into DPTEI's web-based laboratory and workshop inventory information system. Figure 9 is a sample of the program code for this information system.

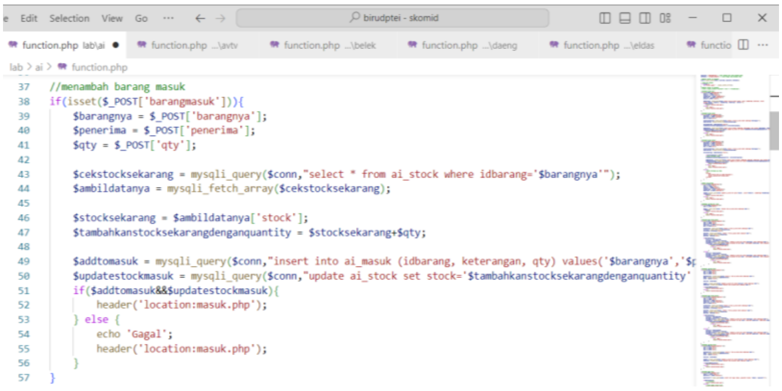


Figure 9. Code Program of Add Item

This development includes several main functions, such as adding user accounts, new item data, incoming items, outgoing items (including sub-functions for consumable materials), borrowing items, and deleting inventory. The user interface display is the result of the construction stage, showcasing the design of the information system website in the browser. Figure 10 presents a sample of the interface development for DPTEI's web-based laboratory and workshop inventory information system.

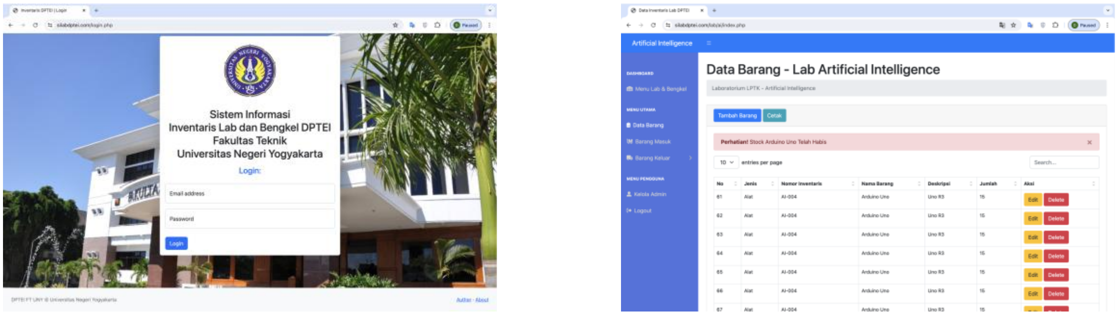


Figure 10. User Interface of Login & Lab Item Data

Deployment

The deployment stage of DPTEI's web-based laboratory and workshop inventory information system involves deploying the website to a hosting platform. The system is accessible at https://silabdptei.com/. After deployment, users can access the information system publicly through a browser on their devices.

Product Quality Testing

This stage tests the quality of the information system created based on the ISO 25010 standard. The following describes the test results for functional suitability, reliability, performance efficiency, and usability.

Functional Suitability

Testing the functional suitability aspect involves respondents from expert lecturers and programmers/web developers. Functionality testing is conducted using the test case method with a checklist instrument. Table 5 shows the results of functional suitability testing.

Table 5. Result of Functional Suitability Testing

Profession	Total Functions	Success	Failed
Expert Lecturer	53	53	0
Programmer, Freelancer Web Developer	53	53	0
Programmer/Web Developer	53	53	0
Total	159	159	0

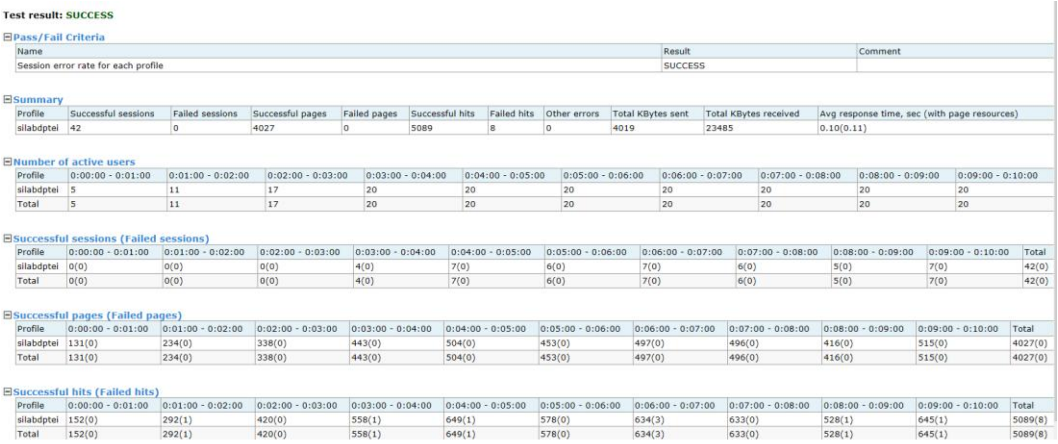
Based on Table 5, the percentage of the system's feasibility in terms of its functional suitability can be calculated using Eq. (1).

$$Result = \frac{159}{159} \times 100\% = 100\%$$

The results of the data analysis for the functional suitability aspect show a 100% success rate, indicating that feasibility has been achieved.

Reliability

The following quality test results for the reliability aspect were obtained using WAPT 10 software. This tool measures session, page, and hit parameters. The reliability test results are shown in Figure 11 and Table 6.



Test result: SUCCESS

Pass/Fail Criteria

Name	Result	Comment
Session error rate for each profile	SUCCESS	

Summary

Profile	Successful sessions	Failed sessions	Successful pages	Failed pages	Successful hits	Failed hits	Other errors	Total KBytes sent	Total KBytes received	Avg response time, sec (with page resources)
silabdptei	42	0	4027	0	5089	8	0	4019	23485	0.10(0.11)

Number of active users

Profile	0:00:00 - 0:01:00	0:01:00 - 0:02:00	0:02:00 - 0:03:00	0:03:00 - 0:04:00	0:04:00 - 0:05:00	0:05:00 - 0:06:00	0:06:00 - 0:07:00	0:07:00 - 0:08:00	0:08:00 - 0:09:00	0:09:00 - 0:10:00
silabdptei	5	11	17	20	20	20	20	20	20	20
Total	5	11	17	20	20	20	20	20	20	20

Successful sessions (Failed sessions)

Profile	0:00:00 - 0:01:00	0:01:00 - 0:02:00	0:02:00 - 0:03:00	0:03:00 - 0:04:00	0:04:00 - 0:05:00	0:05:00 - 0:06:00	0:06:00 - 0:07:00	0:07:00 - 0:08:00	0:08:00 - 0:09:00	0:09:00 - 0:10:00	Total
silabdptei	0(0)	0(0)	0(0)	4(0)	7(0)	6(0)	7(0)	6(0)	5(0)	7(0)	42(0)
Total	0(0)	0(0)	0(0)	4(0)	7(0)	6(0)	7(0)	6(0)	5(0)	7(0)	42(0)

Successful pages (Failed pages)

Profile	0:00:00 - 0:01:00	0:01:00 - 0:02:00	0:02:00 - 0:03:00	0:03:00 - 0:04:00	0:04:00 - 0:05:00	0:05:00 - 0:06:00	0:06:00 - 0:07:00	0:07:00 - 0:08:00	0:08:00 - 0:09:00	0:09:00 - 0:10:00	Total
silabdptei	131(0)	234(0)	338(0)	443(0)	504(0)	453(0)	497(0)	496(0)	416(0)	515(0)	4027(0)
Total	131(0)	234(0)	338(0)	443(0)	504(0)	453(0)	497(0)	496(0)	416(0)	515(0)	4027(0)

Successful hits (Failed hits)

Profile	0:00:00 - 0:01:00	0:01:00 - 0:02:00	0:02:00 - 0:03:00	0:03:00 - 0:04:00	0:04:00 - 0:05:00	0:05:00 - 0:06:00	0:06:00 - 0:07:00	0:07:00 - 0:08:00	0:08:00 - 0:09:00	0:09:00 - 0:10:00	Total
silabdptei	152(0)	292(1)	420(0)	558(1)	649(1)	578(0)	634(3)	633(0)	528(1)	645(1)	5089(8)
Total	152(0)	292(1)	420(0)	558(1)	649(1)	578(0)	634(3)	633(0)	528(1)	645(1)	5089(8)

Figure 11. Result of Reliability Testing WAPT 10

Table 6. Percentage of Reliability Testing

Matrix	Success	Failed	Percentage	Result
Sessions	42	0	100%	Very High
Pages	4027	0	100%	Very High
Hits	5089	8	99.84%	Very High

From the reliability test, which is then converted into a qualitative value, the percentage results fall into the 'Very High' category when converted using a Likert scale. This test confirms that the information system fulfills the reliability aspect, as the overall score exceeds the minimum reliability test standard of 95%.

Performance Efficiency

The system quality test for the performance efficiency aspect was conducted using the GTMetrix platform. GTMetrix provides a standard percentage value ranging from 1 to 100%. Figure 12 is the sample result from the web-based laboratory and workshop inventory information system pages.

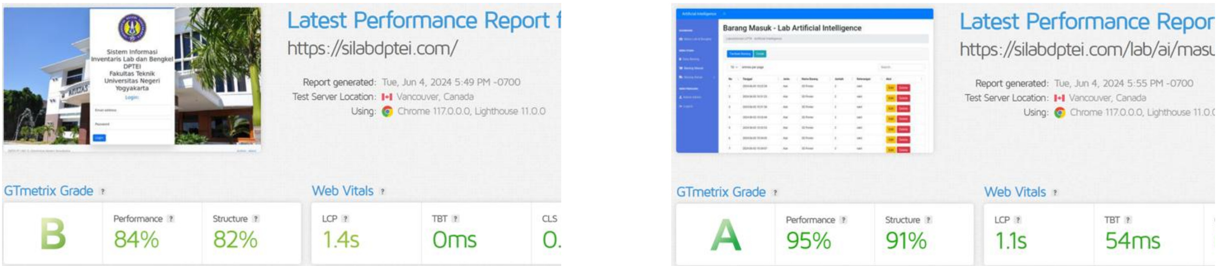


Figure 12. Sample Result of Performance Efficiency Testing GTMetrix

Table 7. Result of Performance Efficiency

Testing Page	Grade	Performance	Structure	LCP*
Login Page	B	84%	82%	1.4s
Lab & Workshop Menu Page	B	89%	87%	1.8s
Item Data Page	B	84%	88%	1.1s
Incoming Goods Data Page	A	95%	91%	1.1s
Consumable Data Page	A	96%	90%	1.1s
Item Borrowing Data Page	A	96%	90%	1.1s
Item Disposal Data Page	A	96%	91%	1.1s
Print/Export Data Page	A	86%	95%	0.822s
User Data Page	A	90%	93%	1.1s
Average		90.67%	89.67%	1.180s

*Largest Contentful Paint

The results show that the performance aspect achieved an average percentage score of 90.67%, the structure reached 89.67%, and the average LCP was 1.180 seconds. Therefore, the performance efficiency can be categorized as 'Good'.

Usability

The final usability test was conducted using the System Usability Scale (SUS) questionnaire. Ten respondents were tested, including six educators working as lab or workshop officers and four department lecturers. Table 8 shows the results of the usability aspect test.

Table 8. Result of Usability Testing SUS

Respondent	Item Scores										Total	SUS Score
	1	2	3	4	5	6	7	8	9	10		
Respondent 1	4	4	4	2	4	3	4	4	4	3	36	90
Respondent 2	4	3	3	1	4	1	4	4	3	3	30	75
Respondent 3	4	3	3	3	3	3	4	4	4	4	35	87.5
Respondent 4	4	4	4	4	4	4	4	4	4	4	40	100
Respondent 5	3	4	4	3	4	3	3	4	4	4	36	90
Respondent 6	4	3	3	1	4	2	4	3	3	1	28	70
Respondent 7	3	3	3	1	3	3	3	3	3	2	27	67.5
Respondent 8	4	3	4	4	4	4	4	4	4	4	39	97.5
Respondent 9	4	3	3	1	4	4	3	4	4	1	31	77.5
Respondent 10	3	3	4	3	4	3	4	3	3	4	34	85
Total											336	840

The processed data shows that the total SUS score of all respondents in this research is 840, with a total of 10 respondents. Using the Eq. (4), the final SUS score is calculated as follows:

$$SUS\ Final\ Value = \frac{840}{10} = 84$$

Based on the above calculations, the final SUS score is 84. This score is converted into a qualitative value based on the SUS value scale. The conversion results indicate that the final SUS score is categorized as 'Acceptable' in the Acceptability Ranges, 'B' on the Grade Scale, and 'Excellent' in the Adjective Ratings.

Statistical Analysis and Comparative Benchmarks

Incorporation of Statistical Validation

To validate whether the developed web-based inventory system significantly improves management efficiency, a paired t-test was conducted comparing the duration of inventory recording before and after system implementation. The hypothesis was formulated as follows:

- H_0: There is no significant difference in inventory management efficiency before and after implementing the system.

- H_1: There is a significant difference in inventory management efficiency after implementing the system.

A total of 20 laboratory and workshop officers participated in the efficiency measurement. Results show a p-value of 0.002 ($p < 0.05$), indicating a statistically significant improvement in operational efficiency. This confirms that the web-based system effectively reduces time, errors, and delays that were commonly found in manual management processes.

Comparison with Existing Systems

Table 9 shows the system's performance compared with two existing laboratory inventory management systems implemented in other institutions.

Table 9. Comparison Table

Criteria	Developed System	System A	System B
Functional Suitability	100%	95%	92%
Reliability (WAPT)	99.84%	98.5%	97%
Performance Efficiency (LCP)	1.180 seconds	1.420 seconds	1.600 seconds
Usability (SUS Score)	84 (B - Excellent)	80 (C - Good)	78 (C - Good)

The comparison indicates that the developed system outperforms existing systems regarding functional suitability, performance efficiency, and reliability. Its usability score is also higher, reflecting better user acceptance. The developed system demonstrates superior performance, reliability, and usability compared to other systems used in similar institutions.

The novelty of this study lies in the development of a domain-specific inventory management system tailored to the unique workflows of academic laboratories and workshops. Unlike generic inventory platforms, the system incorporates specialised functions such as consumables tracking, borrowing management, and multi-laboratory structuring, which aligns with recent findings on the need for contextualised digital solutions in laboratory environments (Kammerlohr et al., 2023). The study also demonstrates a comprehensive and replicable use of ISO 25010 for software evaluation, combining expert checklist validation, automated stress testing, performance auditing, and user-based usability scoring to produce a multidimensional assessment of system quality, consistent with contemporary software quality assessment research (Pratama & Mutiara, 2021). The inclusion of a paired t-test further strengthens the contribution by providing empirical evidence of efficiency improvements after system implementation, reflecting trends in digital transformation studies that emphasise quantitative performance validation (Adekunle et al., 2024).

In practical terms, the system enhances transparency, accelerates stock monitoring, reduces human error, and improves reporting readiness for governance and auditing processes, which is aligned with previous research highlighting the organisational benefits of digital asset management tools in higher education (Benavides et al., 2020). Laboratory managers benefit from reduced administrative workload and increased accuracy in tracking stock status and borrowing histories. At the institutional level, the system supports broader digital transformation goals by strengthening resource accountability and enabling more effective coordination of laboratory assets across units, as supported by studies on digital governance and institutional resource optimisation (Mohamed Hashim, Tlemsani, & Matthews, 2022).

Despite its strengths, several limitations must be acknowledged. The evaluation was conducted within a single department, which may limit the generalisability of the findings to other organisational contexts. The usability testing sample was modest, and long-term patterns of system adoption were not assessed, similar to limitations noted in recent usability and system adoption evaluations (Kortum et al., 2021). Additionally, only four ISO 25010 quality attributes were evaluated, while security, maintainability, compatibility, and portability remain areas for future examination.

Future research should therefore explore system scalability across multiple faculties, assess long-term operational impacts such as cost savings and error reduction, and extend the ISO 25010 evaluation to additional quality dimensions. Further enhancement could involve integrating advanced technologies—such as QR codes, RFID, or IoT-based sensors—to enable real-time asset tracking, consistent with emerging developments in intelligent laboratory logistics (Kumar et al., 2024). Overall, the results demonstrate that the developed system achieves high software quality, significantly improves inventory efficiency, and provides a validated, context-specific solution for laboratory and workshop management in higher education.

CONCLUSION

This study developed and evaluated a web based laboratory and workshop inventory management system for DPTEI using an R&D approach and the Waterfall Model, implemented through communication, planning, modeling, construction, and deployment to ensure accurate requirement capture. ISO 25010 based testing confirms excellent software quality, with 100 percent functional suitability, very high reliability up to 99.84 percent in stress tests, strong performance efficiency with an average LCP of 1.180 seconds, and excellent usability reflected by an SUS score of 84. A paired t test further shows a statistically significant improvement in inventory efficiency after implementation, with $p = 0.002$, validating real operational benefits. The research contributes theoretically by demonstrating a structured, replicable application of ISO 25010 to academic information systems and by providing empirical evidence of efficiency gains that prior studies have rarely quantified. Practically, the system offers a scalable solution that improves transparency, reduces administrative burden, enhances traceability of tools and materials, and supports governance and resource accountability, with policy implications for strengthening institutional digital transformation and asset management standards. Limitations include evaluation in a single department and a short assessment period. Future work should examine long term adoption, extend deployment to multiple faculties or institutions, evaluate additional ISO 25010 dimensions such as security and maintainability, and integrate technologies like QR codes, RFID, or IoT sensors for real time monitoring. Overall, the study provides meaningful insight and demonstrates the strong potential of web based inventory systems to improve efficiency and resource management in higher education laboratories.

ACKNOWLEDGMENTS

The authors thanks to Universitas Negeri Yogyakarta, Indonesia, for supporting this article. And also thank you to all colleagues who have helped so that this research can be carried out and completed.

AUTHOR CONTRIBUTIONS

Bekti Wulandari coordinated the project activities and managed the task distribution among all team members. Dzul Fadli Rahman contributed to the design of the database structure and participated in program coding. Doni Fitriyanto assisted in system development, program coding, performance testing, system administration, and end-user training. Satriyo Agung Dewanto performed functionality testing and integration testing of the system. Muhammad Munir conceived the study and led the selection and specification of algorithms, as well as the preparation of publications. All authors contributed to the revision, reading, and approval of the final version of the manuscript.

CONFLICTS OF INTEREST

The author(s) declare no conflict of interest.

USE OF ARTIFICIAL INTELLIGENCE (AI)-ASSISTED TECHNOLOGY

The authors declare that no artificial intelligence (AI) tools were used in the generation, analysis, or writing of this manuscript. All aspects of the research, including data collection, interpretation, and manuscript preparation, were carried out entirely by the authors without the assistance of AI-based technologies.

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