

Web-Based Competency Test Information System with Automated Scoring Using the Waterfall Method

¹Burhanuddin Damanik , ²Sadarmanis Halawa

^{1,2}Information Systems Study Program, Sari Mutiara Indonesia University, Medan

¹damanikburhanuddin@gmail.com, ²sadarmanishalwa@gmail.com

Abstract— The implementation of competency tests in vocational high schools (SMK) is still largely conducted manually, leading to several issues such as delays in score processing, data recording errors, and inefficiencies in managing examination records. This study aims to design and develop a web-based competency test information system using the Waterfall method to improve efficiency, accuracy, and transparency in the examination process. The system was developed using PHP, MySQL, HTML, CSS, and JavaScript, incorporating six main features: user login, participant registration, question management, online examination, automatic scoring, and result reporting. System evaluation was conducted using Black Box Testing to assess functional performance and the System Usability Scale (SUS) to measure user satisfaction. The results show that all system features operated successfully with a functional success rate of 100% across all test scenarios, indicating high system reliability. In addition, usability evaluation involving 30 respondents, consisting of 20 students and 10 teachers, resulted in an average SUS score of 92, which falls into the “excellent” category. The system also significantly improves efficiency by reducing result processing time from 2–3 days to real-time processing, while minimizing data entry errors. Therefore, the developed system not only improves the efficiency and accuracy of competency test implementation but also provides a reliable and user-friendly solution, contributing to the development of educational information systems based on user experience.

Keywords— Competency Test, Information System, Waterfall, Usability, SUS

I. Introduction

The rapid development of information technology has significantly influenced the education sector, particularly in improving the efficiency and effectiveness of learning evaluation processes. One important form of evaluation in vocational high schools (SMK) is the competency test, which aims to measure students' skill achievements based on predetermined competency standards [1]. However, in practice, the implementation of competency tests in several SMKs is still conducted manually, leading to various problems such as delays in score processing, data recording errors, and inefficiencies in managing examination records [2], [3]. Based on observations conducted at SMK Negeri 1 Lolomatua, the process of grading competency tests requires a relatively long time, averaging 2–3 days after the examination. In addition, there is a high potential for data entry errors due to manual processes, as well as difficulties in retrieving archived examination data stored in physical documents. These conditions indicate that the existing

system has not been able to optimally support the management of competency tests. Previous studies have shown that the implementation of web-based Computer Based Test (CBT) systems can improve the efficiency of examination processes and facilitate integrated data management [4]–[8]. Furthermore, the use of the Waterfall method in information system development has been proven to produce structured systems that align with user requirements [9], [10]. The implementation of web-based information systems has also been shown to enhance service quality in education and improve data management effectiveness [11][12]. However, most of these studies primarily focus on system development without incorporating quantitative usability evaluation, making it difficult to objectively measure user acceptance. Usability evaluation is a critical aspect of information system development, as it is directly related to ease of use and user satisfaction [13]. In addition, web-based information systems offer advantages in terms of accessibility and flexibility. Such systems allow users to access applications in real-time without limitations of space and time, thereby enabling a more efficient and controlled examination process. This is in line with the ongoing digital transformation in education, which demands adaptive, integrated, and user-friendly systems for diverse users. On the other hand, usability plays a crucial role in the successful implementation of information systems. A system with good functionality but poor usability may lead to low user acceptance. Therefore, quantitative usability measurement methods such as the System Usability Scale (SUS) are essential to ensure that the system not only performs well technically but also provides an optimal user experience. Thus, integrating system quality and user experience becomes a key factor in developing effective and sustainable educational information systems. Based on the above discussion, a research gap is identified, namely the lack of integration between functional system testing and user experience evaluation in web-based competency test systems. Therefore, this study proposes a novelty in the form of developing a web-based competency test information system that is evaluated not only through Black Box Testing but also through the System Usability Scale (SUS) to measure user satisfaction and usability [14]. The objective of this study is to design and develop a web-based competency test information system that improves efficiency, accuracy, and transparency in examination processes, while also evaluating system quality based on user experience. The results of this study are expected to contribute to the development of educational information systems, particularly in the



implementation of technology-based competency testing that is more effective and measurable.

II. Research Method

A. Method

This study is classified as software development research aimed at designing and developing a web-based competency test information system. The development process adopts the Waterfall model, which is systematic and sequential in nature [15]. The research was conducted at SMK Negeri 1 Lolomatua from April to July 2025. Data were collected using several techniques, including observation, interviews, and documentation. Observation was carried out to examine the current manual competency test process, while interviews were conducted with teachers and administrators to identify system requirements and existing problems. Documentation was used to collect data related to participants, examination procedures, and previous test results [16].

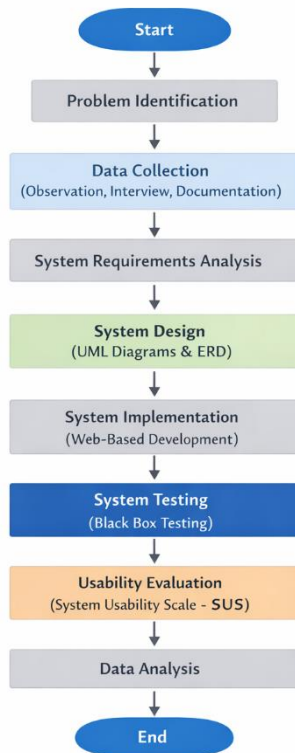


Figure 1. Research Flowchart

B. System Development Method

The system development process follows the stages of the Waterfall model. The first stage is requirements analysis, which involves identifying system requirements based on the results of observation and interviews. This includes identifying user requirements such as administrators, teachers, and students, as

well as functional and data requirements. The second stage is system design, which is carried out using Unified Modeling Language (UML), including use case diagrams, activity diagrams, sequence diagrams, and class diagrams. In addition, an Entity Relationship Diagram (ERD) is designed to represent the database structure. These models are used to describe system workflows, user interactions, and relationships between data [17].

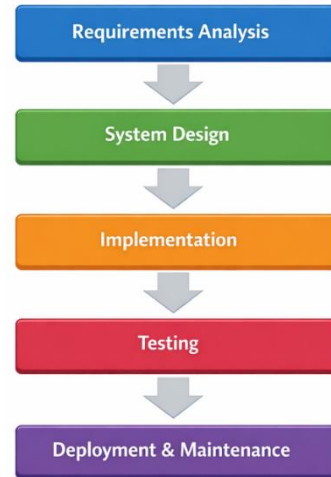


Figure 2. Waterfall methodology

The next stage is implementation, where the system is developed using web-based technologies such as PHP, HTML, CSS, JavaScript, and MySQL database, based on the previously designed system. After implementation, system testing is conducted using Black Box Testing to evaluate whether each function operates according to the specified requirements [18]. The testing covers key features such as login, participant registration, question management, online examination, automatic scoring, and result reporting. Following the testing phase, the maintenance stage is performed to correct errors and improve the system based on user needs.

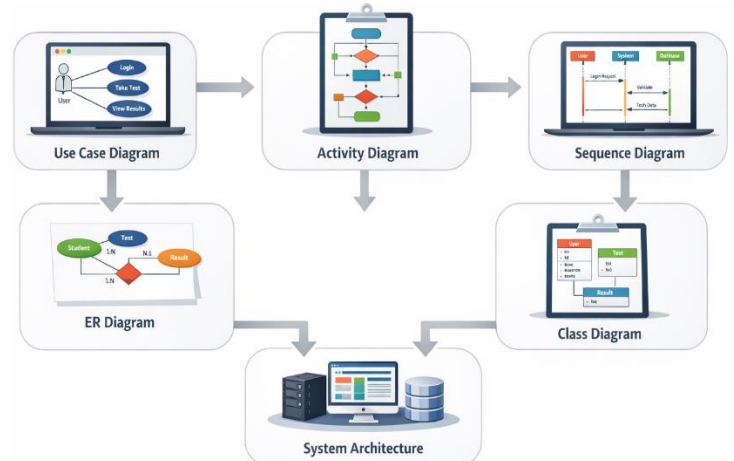


Figure 3. System Design

In addition to functional testing, system evaluation is also conducted using the System Usability Scale (SUS) to measure user satisfaction and system usability. The evaluation involves 30 respondents consisting of students and teachers. The instrument uses a Likert scale ranging from 1 to 5, and the results are converted into a score between 0 and 100 to determine the usability level of the system [19].

Use Case Diagram of the System

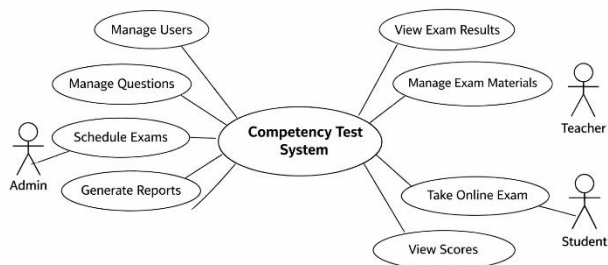


Figure 4. Use Case Diagram System

The collected data are analyzed using a descriptive quantitative approach. The results of Black Box Testing are analyzed based on the functional success rate of the system, while the SUS results are analyzed to determine the level of user satisfaction and ease of use [20]. The overall research process is illustrated in a research flowchart, which includes stages such as problem identification, data collection, system analysis, system design, implementation, testing, evaluation, and conclusion.

III. Results and Discussion

The developed system is a web-based competency test information system designed to support the entire examination process, including participant management, question bank management, examination execution, automatic scoring, and report generation. The system was implemented using PHP, HTML, CSS, JavaScript, and MySQL, enabling centralized data processing and real-time access for users. The system accommodates three main user roles, namely administrators, teachers, and students, where each role has specific access rights to ensure system security and data integrity [21]. Functional testing was conducted using the Black Box Testing method to evaluate system performance across major modules, including login authentication, participant registration, question management, examination execution, automatic scoring, reporting, system settings, and logout functionality. The results show that all tested features operated successfully with a functional success rate of 100% across all test scenarios. This indicates that the system meets all specified functional requirements and demonstrates a high level of reliability. The testing results further confirm that each module consistently produces the expected output without errors, which aligns with established software testing principles [19], [22].

Table 1. Black Box Testing Results

No	Test Scenario	Expected Result	Actual Result	Status	Success (%)
1	Login System	User can log in with valid credentials	System successfully authenticates user	Pass	100%
2	Failed Login	System rejects invalid username /password	System displays error message	Pass	100%
3	Dashboard Display	Dashboard displayed after login	Dashboard loads correctly	Pass	100%
4	User Management	Admin can manage user data	Data successfully added, edited, deleted	Pass	100%
5	Question Management	Teacher can manage question bank	Questions successfully stored and updated	Pass	100%
6	Exam Process	Students can take exam online	Exam runs smoothly without errors	Pass	100%
7	Automatic Scoring	System calculates scores automatically	Scores generated accurately	Pass	100%
8	Result Reporting	System generates exam reports	Reports displayed correctly	Pass	100%
9	System Settings	Admin can update system settings	Settings updated successfully	Pass	100%
10	Logout	User can exit system	System logs out user correctly	Pass	100%



In addition to functional testing, usability evaluation was conducted using the System Usability Scale (SUS) involving 30 respondents consisting of 20 students and 10 teachers. The evaluation results show that the system obtained an average SUS score of 92, with students scoring 91 and teachers scoring 93. Based on SUS interpretation standards, this score falls into the “Excellent” category, indicating that the system is highly usable, easy to learn, and well accepted by users [14], [23]. This demonstrates that the system not only performs well technically but also provides a positive user experience.

Table 2. System Usability Scale (SUS) Results

No	Respondent Type	Number of Respondents	Average Score	Category
1	Students	20	91	Excellent
2	Teachers	10	93	Excellent
	Total	30	92	Excellent

From an efficiency perspective, the implementation of the system significantly reduces the time required for processing examination results. Previously, the manual system required approximately 2–3 days for score processing, whereas the developed system enables automatic scoring and real-time result generation. In terms of data accuracy, the system minimizes human errors associated with manual data entry, as all processes are automated within the system, resulting in improved data consistency and reliability. This finding is consistent with previous studies that highlight the advantages of web-based systems in improving efficiency and reducing errors in educational environments.

Table 3. System Impact Analysis

Aspect	Before System (Manual)	After System (Web-Based)	Improvement
Processing Time	2–3 days	Real-time	Faster
Data Accuracy	Prone to errors	Automated processing	Higher
Accessibility	Limited	Anytime, anywhere	Flexible
Data Storage	Manual archive	Digital database	Organized
User Experience	Low	High (SUS = 92)	Improved

Compared to previous studies, this research provides a more comprehensive evaluation by integrating both functional testing and usability assessment. While earlier studies primarily focused on system development without evaluating user experience quantitatively, this study incorporates the System Usability Scale (SUS) to measure user acceptance objectively [25]. This integration provides a more holistic assessment of system quality, combining technical performance and user

experience evaluation, which is essential in modern information system research [24]. Overall, the developed system offers significant advantages in terms of efficiency, accuracy, usability, and transparency. The combination of a 100% functional success rate and a high usability score (SUS = 92) indicates that the system is not only reliable but also user-friendly, making it suitable for implementation in vocational education institutions.

IV. Conclusion

Based on the results and discussion, the conclusions of this study are as follows:

1. The web-based competency test information system was successfully designed and developed using the Waterfall method, providing a structured solution to replace the manual examination process.
2. The system demonstrates a high level of functional reliability, as indicated by a 100% success rate in Black Box Testing across all tested features, confirming that all system functions operate according to the specified requirements.
3. The usability evaluation using the System Usability Scale (SUS) resulted in an average score of 92, which falls into the “excellent” category, indicating that the system is easy to use and well accepted by users, including both students and teachers.
4. The implementation of the system significantly improves efficiency by reducing the examination result processing time from 2–3 days in the manual system to real-time processing, while also enhancing data accuracy by minimizing human errors.
5. This study contributes to the field of educational information systems by integrating functional testing and usability evaluation, providing a more comprehensive assessment of system quality compared to previous studies that primarily focused on system development.
6. The developed system can serve as a practical and scalable solution for improving competency test management in vocational education, while also emphasizing the importance of user-centered evaluation in future system development.

V. References

- [1] A. Juntarisna, R. I. Sudomo, and H. S. Mangiri, “Perancangan Sistem Computer Based Test (CBT) Berbasis Web,” *Journal of Systems, Information Technology, and Electronics Engineering*, vol. 5, no. 2, pp. 1–10, 2025.
- [2] F. N. Iman and I. Farida, “Pengembangan Aplikasi CBT Menggunakan Framework Laravel dan Electron.js,” *Jurnal Informatika*, vol. 9, no. 4, pp. 446–454, 2025.



- [3] Y. Hidayat, "Perancangan Sistem Computer Based Test Berbasis Web," *Jurnal SIMANTIK*, vol. 4, no. 1, pp. 1–8, 2024.
- [4] G. S. Haladi, "Aplikasi Computer Based Test Berbasis Website," *Jurnal INTEC*, 2024.
- [5] J. A. Prasetyo, "Pengembangan Aplikasi CBT Berbasis Web dengan Jaringan Nirkabel," *Jurnal Informatika*, vol. 3, no. 2, pp. 45–52, 2023.
- [6] M. S. Hidayatullah, "Pengembangan Sistem CBT Berbasis Web pada SMK," *Jurnal Sistem Informasi*, vol. 5, no. 1, pp. 45–53, 2023.
- [7] V. Wahyudi, "Implementasi Sistem Ujian Online Berbasis Web," *Jurnal Informatika*, vol. 10, no. 2, pp. 120–128, 2022.
- [8] L. Setiawan, "Analisis Sistem Informasi Berbasis Web dalam Pendidikan," *Jurnal Ilmu Komputer*, vol. 8, no. 2, pp. 67–75, 2022.
- [9] N. Saputra and R. Nugroho, "Evaluasi Usability Sistem Informasi Menggunakan SUS," *Jurnal Teknologi dan Sistem Komputer*, vol. 9, no. 1, pp. 12–18, 2021.
- [10] D. Maharani, F. Helmiah, and N. Rahmadani, "Pemanfaatan Website dalam Sistem Informasi Pendidikan," *Abdiformatika*, vol. 1, no. 1, pp. 1–7, 2021.
- [11] O. Indriani et al., "Sistem Informasi Berbasis Web Menggunakan PHP dan MySQL," *Jurnal Sistem Informasi*, vol. 4, no. 2, pp. 1–9, 2021.
- [12] H. Kurniawan et al., "Penerapan Metode Waterfall dalam Sistem Informasi," *Jurnal Interkom*, vol. 14, no. 4, pp. 13–23, 2021.
- [13] A. Azhar et al., "Sistem Informasi Uji Kompetensi Berbasis Web," *Jurnal Embedded System*, vol. 2, no. 2, pp. 101–110, 2021.
- [14] R. I. Borman and A. Ahmad, "Analisis dan Perancangan Sistem Informasi," *Jurnal Teknologi Informasi*, 2021.
- [15] A. T. Wibawa, "Pengembangan Sistem Informasi CBT," 2022.
- [16] M. Darwi et al., "Analisis Kepuasan Pengguna Sistem Informasi Menggunakan PIECES," *Jurnal ATASI*, vol. 2, no. 1, pp. 59–70, 2023. ([Nusamandiri Repository][6])
- [17] V. L. Bianto and J. I. Sihotang, "Analisis Kepuasan Pengguna Sistem Menggunakan PIECES," *CogITo Smart Journal*, vol. 8, no. 2, pp. 514–523, 2022.
- [18] S. Ardiansyah et al., "Perancangan Sistem Informasi Berbasis Web," *Jurnal Teknologi Informasi*, vol. 3, no. 2, pp. 142–152, 2024.
- [19] Y. Trimarsiah et al., "Pelaksanaan Uji Kompetensi pada SMK," *Jurnal Pengabdian Masyarakat*, vol. 2, no. 3, pp. 51–58, 2022.
- [20] A. Pratama, "Pengembangan Aplikasi Web Menggunakan PHP dan MySQL," *Jurnal TI*, vol. 7, no. 1, pp. 30–38, 2021.
- [21] S. Rahmawati, "Penerapan CBT dalam Evaluasi Pembelajaran," *Jurnal Pendidikan Teknologi*, vol. 6, no. 2, pp. 90–98, 2023.
- [22] A. Kurniawan and N. Santoso, "Pengembangan Sistem Ujian Online Berbasis Web," *Jurnal PTIIK*, vol. 7, no. 5, pp. 2581–2588, 2023.
- [23] A. Homaidi et al., "Perancangan Aplikasi Ujian Kompetensi," *Jurnal Teknologi Informasi*, vol. 4, no. 1, pp. 49–57, 2023.
- [24] R. S. Pressman, *Software Engineering: A Practitioner's Approach*, 8th ed., McGraw-Hill, 2019.
- [25] ISO 9241-11, "Ergonomics of Human-System Interaction — Usability," 2018.

