

Agile-Based Development of a Web-Based Competition Registration Information System

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Vinza Hedi Satria^{1*}, Angga Lisdiyanto², Muhammad Reza Pahlawan³, Olive Khoirul Lukluil Maknun Al Faishol⁴

¹Informatika, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

²Teknologi Informasi, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

³Sistem Informasi, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

⁴Sains Data, Universitas Pembangunan Nasional Veteran Jawa Timur, Surabaya, Indonesia

*e-mail Corresponding Author: vinzasatria.if@upnjatim.ac.id

Abstract

Competition registration in educational institutions is often managed using traditional methods. This results in inefficient management of data and administrative processes. This study developed a web-based Competition Registration Information System to offer a simple solution to problematic competition management. This system developed via the Agile software development approach, and the technologies used to develop this system were HTML, CSS, JavaScript, and SQLite. Agile development offered the opportunity to improve the system continuously during the development process and refine the requirements iteratively. Black Box Testing was the method used to conduct a functional evaluation of the system, and the System Usability Scale (SUS) was the method used in this study to evaluate the system's usability. A total of 20 participants were involved in the study. Results of the evaluations indicated that all functional requirements were implemented and worked as expected. Additionally, the system evaluated achieved a SUS score of 84.0, which indicates an Excellent level of system usability and a high level of system acceptance. The results of the evaluations indicate that the system is functionally reliable and easy to use, and system helps the competition registration and management process. The system developed offers educational institutions an affordable solution to improve the efficiency of competition management.

Keyword: Agile Software Development; Competition Registration Information System; Information System; SQLite; System Usability Scale (SUS)

Abstrak

Pendaftaran kompetisi di lembaga pendidikan sering kali dikelola menggunakan metode tradisional. Hal ini mengakibatkan pengelolaan data dan proses administratif yang tidak efisien. Penelitian ini mengembangkan Sistem Informasi Pendaftaran Kompetisi berbasis web untuk menawarkan solusi sederhana terhadap masalah pengelolaan kompetisi. Sistem ini dikembangkan melalui pendekatan pengembangan perangkat lunak Agile. Pengembangan Agile memberikan kesempatan untuk terus meningkatkan sistem selama proses pengembangan dan menyempurnakan persyaratan secara berulang. Pengujian Black Box merupakan metode yang digunakan untuk melakukan evaluasi fungsional sistem, sedangkan Skala Kegunaan Sistem (SUS) merupakan metode yang digunakan dalam penelitian ini untuk mengevaluasi kegunaan sistem. Sebanyak 20 peserta terlibat dalam penelitian ini. Hasil evaluasi menunjukkan sistem yang dievaluasi mencapai skor SUS sebesar 84,0, yang menunjukkan tingkat kegunaan sistem yang Sangat Baik dan tingkat penerimaan sistem yang tinggi. Hasil evaluasi menunjukkan bahwa

sistem ini andal secara fungsional dan mudah digunakan, serta membantu proses pendaftaran dan pengelolaan kompetisi.

Kata Kunci: *Pengembangan Perangkat Lunak Agile; Sistem Pendaftaran Kompetisi; Sistem Informasi; SQLite; Skala Kegunaan Sistem (SUS)*

1. Introduction

In recent years, information technology has advanced rapidly, and organizations have adapted accordingly [1], [2]. Managing processes like competition or event registration has greatly benefited from the advent of web-based information systems [3], [4]. For many organizations, the manual entry of participants into a system has been replaced with an automated digital solution [3], [4]. While many of the advantages of web-based information systems have been realized, many educational and community-based organizations continue to use a manual registration system [5]. Even generalized online forms (used in place of a manual registration form) lack automated validation, reporting, and centralized participant management [5]. While working on improvement initiatives for an organization that conducts a variety of educational competitions, a gaps analysis was performed. To protect the organization's identity, I will not disclose its name in this paper. Based on the gaps analysis, the organization demonstrated a strong desire to digitalize the competition registration process. However, the organization did not have the ability to develop or support a sophisticated information system. For this organization, the information system was needed to be easy to develop, maintain and low cost. To meet these criteria, the information system needed to be provided via a web browser and not require complex server infrastructures.

Several studies have developed web-based information systems using different software development methodologies to improve organizational administrative processes. Table 1 summarizes representative studies that are closely related to the present research.

Table 1. Related Works

Study	Application Domain	Development Method	Main Contribution	Limitation
[6]	Attendance Information System	Agile	Developed a web-based attendance management system using an iterative development approach.	Focused solely on attendance management and did not address competition registration or usability evaluation.
[7]	Enterprise Information System	Rapid Application Development (RAD)	Implemented a web-based enterprise management system with rapid prototyping techniques.	Designed for industrial enterprise applications rather than educational event management.
[8]	Competition Management Information System	Prototype	Developed a website-based competition management system using the Prototype methodology.	Primarily emphasized functional implementation without comprehensive usability evaluation or a lightweight technology stack.
[9]	Collaboration Information System	Waterfall	Designed a web-based collaboration platform using the Waterfall development model.	Relied on a sequential development process that is less adaptable to changing user requirements.

Past research has indicated web-based info systems can be deployed to develop software systems that streamline administrative processes[10], [11]. Most prior studies, however, are centered on systems for managing attendance, systems for team collaboration, enterprise systems, and systems for managing general competition. Also, the preceding systems mostly

adopt methodologies such as Prototype, Waterfall, and Rapid Application Development (RAD). Few, if any, have researched the use of Agile Software Development, combined with a slim technology stack (HTML, JavaScript, and SQLite). Usability assessment, through System Usability Scale (SUS) and functional evaluation testing, have also been largely absent from prior studies. This explains the reason for developing an Agile-based web application in this study, and combining lightweight web technologies, functional and usability evaluation. This serves as a real-world competition registration solution for resource-constrained organizations.

Systems used for collecting and processing data are vital to the operation of successful businesses. They allow managers to make informed decisions quickly. Information technology allows the integration of data and workflow to improve the efficiency of service provisions and the accuracy of data. The benefits of information technology affect a number of service industries including education. Within education, systems used for data processing and collection have been used to handle the enrollment of students, the provision of academic services, the management of libraries and the administration of events. These systems have been successful in decreasing the amount of work done manually and improving the ease of access to systems for users and administrators. [1], [2]. Web-based information systems have even further improved ease of access such that users are no longer required to download application systems in order to access services. When systems are based on the internet, data is easier to manage and maintain. These systems also promote quicker communication by providing the means to upload information in real time. Users are also able to exchange information with the administrators of the systems, and less data entry is required. [3], [4]. It has been proven from recent research that online information systems improve efficient administration throughout educational systems. They help streamline daily functions and improve the efficiency of data and reports by using centralized databases. There are still many companies that rely on manual registration or use online forms that only provide a basic level of function. These forms do limited participant verification, do not provide an easy way to track registration, and do not help with administrative reporting [3], [4].

This research has taken the aforementioned organizational needs and challenges and has proposed the creation of a web-based Competition Registration Information System. This system will utilize HTML, JavaScript, and SQLite. The proposed system will use the HTML markup language, which structures a web page and allows for lightweight web browser digital interfaces. JavaScript will be used to provide the web-based information system with the client-side application logic. The proposed system will use a lightweight portable SQLite database to capture competition registrations. SQLite will provide a serverless database solution that meets the system's needs [12]. The suggested system will substantiate a lightweight portable registration system that requires minimal infrastructure to support participant registration and competition management. The system will provide the necessary administrative reporting. Due to evolving user requirements during the development process, the Agile methodology was utilized [13], [14]. This methodology is especially beneficial for projects comprising restricted resources, as it encourages the development of an application in increments through constant feedback from stakeholders to refine and enhance the functionality of the system [15], [16]. Using this iterative approach, the system can be refined and the quality and usability of the application improved, based on feedback received throughout the lifecycle of the system [17]. The system designed offers functions for the registration of participants, management of competitions, verification of registrations, and management of participant data. To measure the effectiveness of the designed system, functional testing was performed in line with the principles of Black Box Testing. The usability of the system was measured using the System Usability Scale (SUS) and involved twenty participants. The aim of these assessments was to ensure the system was both functional and provided a positive user experience.

The objective of this research is to design, build, and assess the web-based Competition Registration Information System built with HTML, JavaScript, and SQLite using the Agile software development methodology. It is anticipated the system will offer a pragmatic, cost-effective solution for resource-poor institutions and improve the speed and ease of use of the competition registration process.

3. Research Methodology

In developing a web-based Competition Registration Information System, the Agile Software Development methodology was applied to design and evaluate the system, as this methodology accommodates iterative processes to refine system functionalities with the help of

stakeholders throughout the software development process. The overall process of the research was divided into four main stages: requirements engineering, development of the system based on Agile methods, implementation of the system, and evaluation of the system can be seen on figure one below.

The first stage of the research was requirements engineering, and in this stage the competition registration process of the organization was observed and organized in discussions to collect relevant information. The aim of this stage was to uncover the problems of the system in operation, the expectations of the competition registration process users, as well as to define the functional and non-functional requirements of the system.

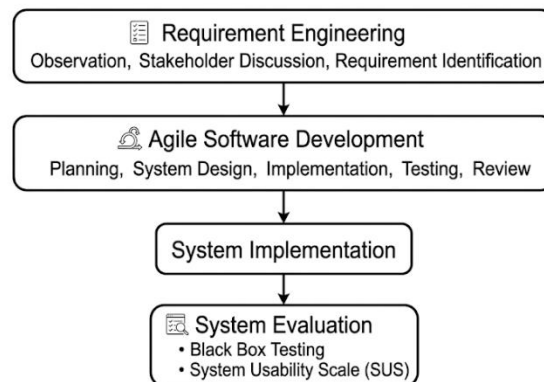


Figure 1. Research Method

The next stage was the development of the proposed system, which was done using iterative Agile development cycles. Each cycle was preceded by planning, and was comprised of system design, implementation, testing, and reviewing activities. Constructive critique given after each cycle was used to further improve and develop the system in subsequent Agile cycles.

The system was implemented after the development process was completed, and the system was then evaluated. Black Box Testing was done to verify that the system implemented all required and designed features, and then the usability of the system was assessed by the System Usability Scale (SUS). Twenty evaluators completed the SUS after they interacted with the developed system. Technical evaluation of the system and functional and usability evaluation of the system were done to verify that the system was built and designed correctly, and to assess the acceptance of the system by its users.

3.1 Requirement Engineering

Requirement Engineering was the first step of the system development process and focused on assessing the functional and operational requirements of the anticipated Competition Registration Information System. This step was crucial in ensuring that the system development matched the organization's business practices while ensuring that the system was flexible enough to provide a practical solution using a thin client web-based solution.

Requirement Engineering consisted of four important linked steps: requirement elicitation, requirement analysis, requirement specification, requirement validation. Each of these steps was important in the development of the system requirements prior to the actual system development.

3.1.1 Requirement Elicitation

This step was accomplished by directly observing the organization's current practice in registering for competitions, performing a few interviews, and by conducting a few structured discussions. The purpose of this step was to ascertain the existing system and practices, the system and operational challenges, as well as the expectations of the stakeholders from the proposed system. The greatest focus was on the registration process, management of participants' data, management of the competitions, and reporting.

3.1.2 Requirement Analysis

In this step, requisite system functionalities were separated from the system enhancements. During this step, resolved duplications, clarifications to ambiguous statements, and the project's constraints were evaluated for the system's requirements. The outcome of this step was the functional requirements that were prioritized for system development.

3.1.3 Requirement Specification

The prioritized requirements were documented in a formal system specification and were divided into functional and non-functional requirements. Functional requirements describe the services that the system must provide. Non-functional requirements describe the quality attributes of the system such as usability, maintainability, portability, and performance. Table 2 presents the primary functional requirements identified during the requirement engineering process.

Table 2. Primary function

Requirement ID	Functional Requirement
FR-01	User registration
FR-02	User authentication
FR-03	Competition management
FR-04	Competition registration
FR-05	Registration verification
FR-06	Participant management
FR-07	Report generation

Table 3 summarizes the non-functional requirements considered during system development.

Table 3. Non functional Requirement

Requirement ID	Non-Functional Requirement
NFR-01	Ease of use
NFR-02	Low infrastructure requirement
NFR-03	Fast response time
NFR-04	Data integrity
NFR-05	Maintainability
NFR-06	Browser compatibility

3.1.4 Requirement Validation

The final activity involved validating the identified requirements through stakeholder review sessions. During these sessions, the proposed functional and non-functional requirements were discussed with organizational representatives to confirm that they accurately represented organizational needs. Feedback obtained during validation was incorporated before entering the Agile development phase, thereby minimizing misunderstandings during implementation.

3.2 Agile Development Process

After the requirement engineering step, the proposed Competition Registration Information System was built using the iterative Agile Software Development technique. Instead of assembling every feature of the system at once, the development work was carried out in multiple iterations. Consequently, the stakeholders were able to refine the system features in a more granular manner.

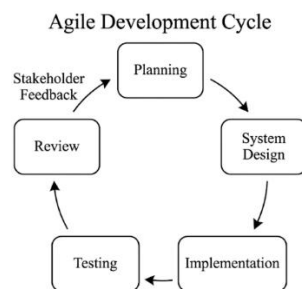


Figure 2. Agile Method

Each iteration consisted of five key actions: plan, design the system, build, test, and review. The complete process of Agile Development can be seen in figure 2

3.2.1 Planning

Each iteration began with a planning step for the developers to look at the requirements and refine them according to the stakeholder needs and the goals of the project. The main requirements were divided into smaller, easier tasks to be completed during the iteration. The flexibility in this step allowed for any changes in the requirements and the stakeholder goals later in the project.

3.2.2 System Design

In this step, the requirements that were prioritized were drawn out in design artifacts. A design step was done for the overall architecture of the system, its database, the layout of the user interface, and the design of the system's interaction to help guide the step of building.

3.2.3. Build

In this step, a web-based app was created with the UI built in HTML, with JavaScript in the client for functionality, and with SQLite as the database. The features of the system were continuously built to help make the application functional at every step of the process.

3.2.4 Implementation

This stage was concerned with the construction of the application. Construction of the application's UI was done with HTML. Construction of client-side application logic was done with JS. An SQLite database was used for storage. Features were constructed in accordance with the priority of the feature as determined during the planning stage. Newly constructed features were added with the aim of keeping the application as functional as possible during the construction stage.

3.2.5 Testing

For each construction stage, complete functional application logic was verified with functional tests. Each feature of the system was tested in isolation to ensure that the feature met the requirements before it was shown to the stakeholders. Errors found with testing were fixed before proceeding to the next stage.

3.2.6 Review

The completed stage was shown to the internal stakeholders to gather their assessment. Their comments about the functionality, usability and workflow of the system were collected and analyzed. The requests for improvements were incorporated into the planning stage of the next construction stage. This process continued until all the stakeholders were satisfied with the system.

3.3 Evaluation

We evaluate the developed Competition Registration Information System to see how it works and how easy it is to use. There are two components to this evaluation: functional testing is conducted with the Black Box Testing approach, and usability is evaluated with the System Usability Scale (SUS).

Black Box Testing was used to confirm that the functions of the system were carried out as required. Then, usability was evaluated with the participation of twenty subjects, each of whom interacted with the system and completed the standard, ten-item, SUS survey, each rated with a five-item Likert scale. Results from both evaluations are included and discussed in the subsequent chapter.

4. Result and Discussion

4.1 Overall System Architecture

The proposed Competition Registration Information System, shown in Figure 3, uses a three-layer, lightweight, and simple system architecture: user layer, application layer, and data layer. This architecture was selected to provide a simple yet effective solution that satisfies the system's operational requirements of organizations with limited technical resources.

There are two main actors in the user layer: participants and administrators. In the system, participants are able to register for competitions, view competition details, and check the status of their registration. Administrators have the ability to manage data for competitions, verify registrations, and create system reports. There is no additional software that needs to be installed for either actor, as they both access the system with a standard web browser.

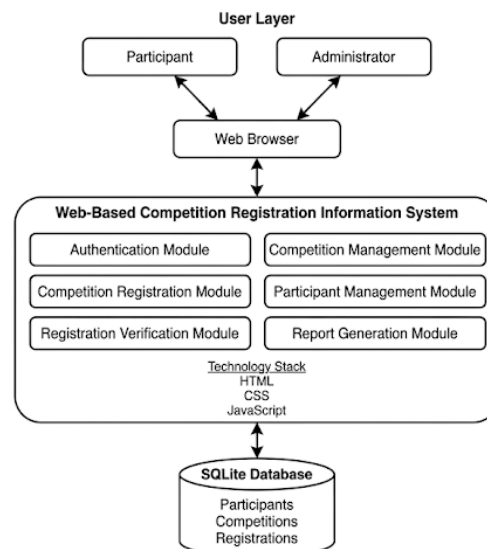


Figure 3. System Architecture

The application layer includes functional modules of the system that manage authentication, competitions, registration of participants, verification of registrations, management of participants, and report generation, all of which are implemented with HTML, CSS, and JavaScript.

4.2 System Implementation

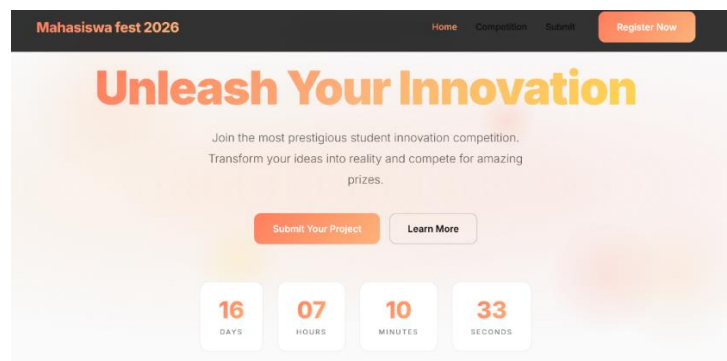


Figure 4. Homepage

The homepage of the Competition Registration Information System is featured in Figure 4. It contains information about the various competitions as well as the features of the system. Users can view competition information and access the menu for authentication to register or login.

Figure 5. Login Page

The user login interface is shown in Figure 5. Registered users and administrators enter their user login information to authenticate access to the system based on their roles. This feature allows system functions to be accessed only by valid users.

Figure 6. Submission page

The competition registration page is shown in Figure 6. Users can complete and submit the registration form electronically. The registration information is captured and stored in the system for verification by an administrator.

Figure 7. Admin Back-End Dashboard

Figure 7 displays the administrator management dashboard. Administrative management of competition information and participant registration and management is performed through this dashboard.

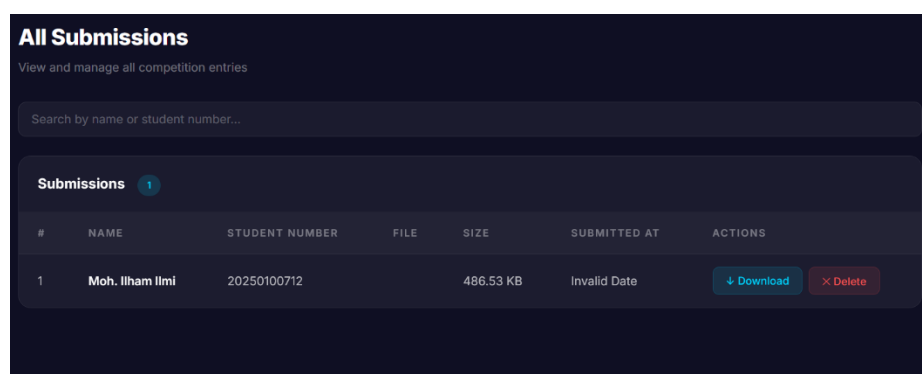


Figure 8. Submission Detail

Registration verification and reporting is shown in Figure 8. This page allows administrators to view and verify registered users and generate reports on the registered users. This feature provides an efficient management of competition activities.

4.3 Testing and Evaluation

4.3.1 Black Box Testing

Black Box Testing was conducted to verify that each functional module of the proposed Competition Registration Information System operated according to its specified requirements.

Table 4. Blackbox Testing Result

No.	Test Scenario	Expected Result	Result	Status
1	User login	User successfully logs into the system using valid credentials	Function executed as expected	Passed
2	User registration	New participant account is successfully created	Function executed as expected	Passed
3	Competition management	Administrator can add, edit, and delete competition information	Function executed as expected	Passed
4	Competition registration	Participant registration data are successfully submitted and stored	Function executed as expected	Passed
5	Registration verification	Administrator can verify participant registrations	Function executed as expected	Passed
6	Participant management	Administrator can view and manage participant data	Function executed as expected	Passed
7	Report generation	Registration report is successfully generated	Function executed as expected	Passed

The testing results indicate that all major system functions performed successfully. No functional errors were identified during the testing process, indicating that the proposed system satisfies the functional requirements defined during the development phase.

4.3.2 System Usability Scale

The System Usability Scale (SUS) was used to assess the usability of the proposed Competition Registration Information System. Sample 20 users were asked to perform standard system tasks (logging in, browsing competition info, registering for a competition, and exploring system features) and then complete the standard SUS survey which consists of 10 items, each using a 5-point Likert scale, to assess system usability. The list of question can be seen in Table 5 below:

Table 5. System Usability Scale Question

No.	Statement
1	I think that I would like to use this system frequently.
2	I found the system unnecessarily complex.
3	I thought the system was easy to use.
4	I think that I would need technical support to use this system.
5	I found the various functions in this system were well integrated.

No.	Statement
6	I thought there was too much inconsistency in this system.
7	I would imagine that most people would learn to use this system very quickly.
8	I found the system very cumbersome to use.
9	I felt very confident using the system.
10	I needed to learn a lot of things before I could use this system.

The SUS evaluation results are presented based on the average Likert scores obtained from the 20 participants. For the positive statements, namely Q1, Q3, Q5, Q7, and Q9, the mean scores were 4.30, 4.55, 4.25, 4.45, and 4.35, respectively. After applying the SUS scoring formula, these items contributed scores of 3.30, 3.55, 3.25, 3.45, and 3.35. For the negative statements, namely Q2, Q4, Q6, Q8, and Q10, the mean scores were 1.65, 1.50, 1.65, 1.75, and 1.75, respectively. The corresponding score contributions were 3.35, 3.50, 3.35, 3.25, and 3.25. The total contribution from all ten items was 33.60 out of a maximum raw score of 40. The final SUS score was obtained by multiplying the total raw score by 2.5, resulting in an overall SUS score of 84.0 out of 100.

The SUS score was calculated based on 20 completed surveys, resulting in an overall SUS score of 84.0. This score indicates that the proposed Competition Registration Information System is highly usable, and participants were able to complete the required tasks with minimal to no challenges. According to the SUS scoring interpretation, a score of 84.0 is rated as Excellent, indicating that participants were highly likely to be satisfied with the system features, interface, and overall ease of use. The evaluation also demonstrates that the developed system supports users during the competition registration process and provides a positive user experience. The positive results of the Black Box Testing further support the usability evaluation and indicate that the developed system is functionally reliable and easy to use.

According to the SUS scoring, a score of 84.0 is rated as Excellent, and therefore participants were highly likely to be satisfied with the features, the interface, and the overall ease of using the system. The evaluation also illustrates that the developed system provides support to users during the competition registration process and does so by providing a positive user experience. The positive results of Black Box Testing corroborate the positive results of this usability assessment and confirm that the developed system is functionally reliable and easy to use.

4.3 Discussion

The purpose of this study was to build an web-based Competition Registration Information System using Agile to design and HTML, CSS, JavaScript, and SQLite to develop. Using principles of Black Box Testing, a functional assessment was done. This confirmed full implementation of core functional requirements (FR-01 through FR-07) and their respective components of user registration, competition creation and modification, confirmation of registration, management of registrants, and creation of administrative reports. The results of this assessment showed that client side web technologies in conjunction with a serverless database can support all operational and administrative functions of a system [18].

The System Usability Scale (SUS) was completed by twenty participants[19], resulting in an average score of 84.0. This score, an "Excellent" rating, indicated high system acceptance. This result confirmed that non-functional requirements, such as ease of use (NFR-01), rapid response (NFR-03), and browser support (NFR-06) were satisfied. The overall positive feedback provided was indicative that registrants and system administrators were able to easily complete registrations and submit request without the support of a system assistance or training.

In relation to existing literature, the findings from this study makes several noteworthy contributions to the development of administrative information systems[20]. The literature on the management of organizations has traditionally used sequential or inflexible developmental frameworks, such as the Waterfall and Rapid Application Development (RAD) methods[21]. While these frameworks are systematic, they tend to lack flexibility in accommodating evolving user demands during the development process. Previous work has constructed a competition management system using a Prototype model; however, this work was mainly focused on the functional aspects of the system and did not carry out a usability test or use a lightweight software system. Similar previous work has used Agile development for an attendance information system; however, this work was also bound to attendance and did not examine the system's usability.

Through the combination of iterative Agile development, a thin-client, web architecture, SQLite database, storage, and Black box and SUS evaluations, this study addresses the remaining gaps in the existing literature.

As noted, the designed system offers a real solution for educational institutions and community organizations that still use manual or basic online registration with no automated validation or centralized reporting. As a cost-effective and low-resource solution, the system automates event registrations and improves the data accuracy and efficiency[22]. It is hoped that the developed system would offer a solution to resource-constrained organizations that have an interest in improving the registration process for their conystestituents.

Despite these positive outcomes, certain limitations should be acknowledged. The current deployment relies on SQLite, which provides a serverless and lightweight database solution but may encounter scalability constraints in scenarios involving high volumes of concurrent registrants. Additionally, the usability evaluation was limited to a sample of twenty evaluators within a single organizational setting. Future research should explore integrating cloud-based database services and automated notifications, as well as testing across broader multi-institutional environments, to further evaluate the scalability and user experience of the system.

5. Conclusion

This study illustrates the construction of an Asynchronous Web-based Competition Registration Information System using the Agile development methodology in conjunction with the use of modern languages (HTML, CSS, JavaScript, and SQLite). The developed system provides a markedly easier and faster method for registering and managing competitions and additionally provides a lightweight and maintainable solution for accommodating organizations with minimal or no technical capabilities. The evaluation results demonstrated that all system functionalities operated successfully.

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