Design and Development of a Progressive Web App-Based Student Attendance System for High Schools

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Abstract

Tracking student attendance is one of the key administrative tasks within a school, as attendance data serves as an indicator of discipline and enables the evaluation of student activities. However, the attendance tracking process, which still relies on traditional methods, has certain limitations, such as inefficient data collection, a time-consuming evaluation process, and restrictions on direct monitoring of attendance by the school or students' parents. The goal of this study is to develop an application for managing student absences in the form of a Progressive Web App (PWA) that can digitize the attendance tracking process through the use of dynamic QR codes and validation via geolocation. The prototyping method was used to develop the system, comprising the following steps: communication, rapid planning, rapid design, prototype creation, and subsequent deployment, delivery, and evaluation of user experience. The system was developed for four user groups: the administrator, the teacher, the student, and the parents. The results of this research led to a PWA-based application for managing student attendance, which offers functions for managing user data, logging in for attendance tracking, generating dynamic QR codes, recording student attendance, requesting absences and sick leave, and allowing parents to monitor attendance. Quality testing of the software was conducted in accordance with the ISO/IEC 25010 standard, which covers the following aspects: functional suitability, performance efficiency, compatibility, ergonomics, reliability, security, maintainability, and portability. The test results show that the system meets user requirements and supports the process of digitizing student attendance management.

Keywords: *Progressive Web App, Student Attendance System, QR Code, Geolocation, Prototype.*

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A. INTRODUCTION

The development of information technology has a significant impact on administrative processes in various fields, particularly in the education sector. As educational institutions, schools not only need technology to support the learning process but also information systems that help make administrative tasks more efficient and effective.

Student attendance management is an administrative procedure that plays an important role. Data on student attendance serves as a reference for disciplinary matters and as a basis for evaluation. In some schools, however, attendance is still recorded manually, which leads to various problems, such as the risk of data entry errors, a time-consuming analysis process, and delays in transmitting attendance information to parents.

The use of digital technologies can provide a solution to these problems. In some previous studies, attendance management systems using QR codes, web applications, or mobile devices have been developed (Vitriani et al., 2023; Saripuddin et al., 2022; Setiawan et al., 2022). The use of QR codes can speed up the check-in process, as the user simply needs to scan the code to check in (Vitriani et al., 2023; Sitorus et al., 2023; Alief & Rianto, 2025). However, the use of static QR codes still has limitations, as the codes can be reused without additional validation mechanisms.

Furthermore, some studies use geolocation technologies to improve the validation of user attendance (Natasiya et al., 2024; Syamaidzar & Sutopo, 2024; Hasian et al., 2023). Integrating QR code technology with geolocation can provide a more robust verification mechanism, as the system not only verifies the user's identity but also confirms their location at the time of attendance registration.

Based on these previous studies, there is still potential for developing an attendance management system that integrates multiple technologies simultaneously. Therefore, as part of this study, an attendance management application for students, based on a progressive web app (PWA), was developed. It combines dynamic QR codes, geolocation verification, and an attendance tracking feature for parents or guardians.

The objective of this study is to develop an attendance tracking system for students that enables digital attendance recording, improves the validation of the attendance process, and provides attendance information that is more easily accessible to both the school and parents or guardians.

B. LITERATURE REVIEW

Numerous studies have been conducted on digital attendance tracking systems to improve the efficiency of attendance tracking in the education sector. Various approaches have been developed, ranging from the use of QR codes, web applications, and mobile devices to the use of geolocation technologies.

Studies on attendance tracking using QR codes show that this technology reduces the effort required for manual data entry, as attendance data can be captured by digitally scanning the code. However, some studies still use static QR codes, which have limitations because they can be reused by other users outside of the designated attendance times (Vitriani et al., 2023; Fahlevi, 2022; Sitorus et al., 2023) (Vitriani et al., 2023; Fahlevi, 2022; Sitorus et al., 2023; Saripuddin et al., 2022; Setiawan et al., 2022; Dangkua, 2023; Perwitasari et al., 2024; Januartika et al., 2023).

The development of web-based and mobile-based attendance management systems has also been widely implemented to facilitate user access. Nevertheless, some systems still have limitations regarding flexibility of use, as they require the installation of an app or only work on certain devices (Saripuddin et al., 2022; Setiawan et al., 2022; Alief & Rianto, 2025) (Saripuddin et al., 2022; Setiawan et al., 2022; Alief & Rianto, 2025; Januartika et al., 2023).

Progressive Web Apps (PWAs) offer a way to overcome these limitations, as they provide a user experience similar to that of a mobile app via a browser (Karli et al., 2023; Hudianti et al., 2023; Faisol & Noertjahjono, 2019). PWAs allow access to the application from various devices without requiring additional installation, making them particularly well-suited for educational settings.

Furthermore, integrating geolocation into the attendance management system can improve the accuracy of attendance data by ensuring that check-ins actually occur at the correct location. Previous studies show that integrating QR codes, geolocation, and web-based systems can increase the efficiency of the attendance management process (Natasiya et al., 2024; Syamaidzar & Sutopo, 2024) (Natasiya et al., 2024; Syamaidzar & Sutopo, 2024; Hasian et al., 2023; Hidayah & Marhalim, 2023; Utomo et al., 2025).

Previous studies show that the majority of research continues to focus on a specific technological approach, such as QR codes or web applications. For this reason, this study develops a PWA-based attendance management system for students that combines dynamic QR codes, geolocation, and a parent tracking feature into a single integrated system (Vitriani et al., 2023; Karli et al., 2023; Natasiya et al., 2024) (Vitriani et al., 2023; Karli et al., 2023; Natasiya et al., 2024; Dangkua, 2023).

C. METODE

1. System Development Methods

The system development method used in this study is the prototype method (Atmaja et al., 2023; Syukron et al., 2023; Pressman & Maxim, 2015). This method was chosen because it allows for a phased development process, involving the creation of an initial draft, user evaluation, and system optimization based on the identified requirements (Atmaja et al., 2023; Syukron et al., 2023).

The phases of the prototyping method include “communication,” “rapid planning,” “rapid design,” “prototype creation,” as well as “deployment,” “delivery,” and “feedback.” The “communication” phase serves to determine the system requirements. The “rapid planning” and “rapid design” phases are used to define the system’s design. Next comes the “prototype creation” phase, involving the implementation of the application, while the “deployment,” “delivery,” and “feedback” phases are used to evaluate the system.

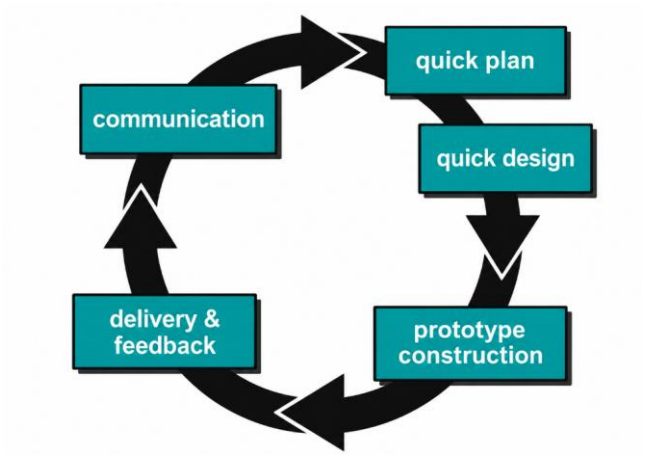


Figure 1: Stages of the Prototyping Method

2. System Development

The system was designed using UML modeling to describe the system's requirements and processes.The system has four main actors: Admin, Teacher, Student, and Parent. Each actor has different access rights based on the needs of the attendance process (Atmaja et al., 2023).

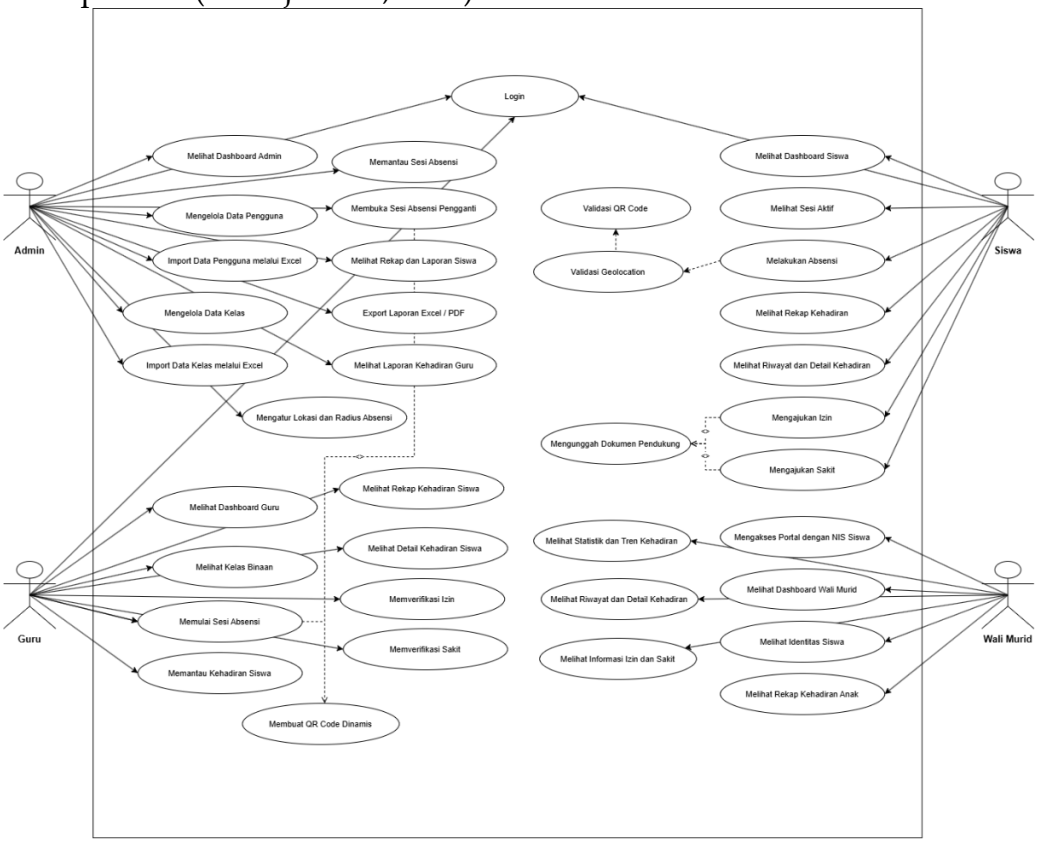


Figure 2. System Use Case Diagram

D. RESULTS AND DISCUSSION

1. System Implementation

The implementation resulted in the development of a Progressive Web App for managing student attendance, which can be accessed from both a computer and a mobile device. The system offers several key functions depending on the users' access rights.

The administrator can manage user data, classes, attendance reports, and the configuration of locations for attendance tracking within the institution. Teachers can take attendance, start an attendance tracking session, and generate a dynamic QR code used to track student attendance.

a. Admin Implementation

Admins have access to manage user data, classes, attendance reports, and system configurations.

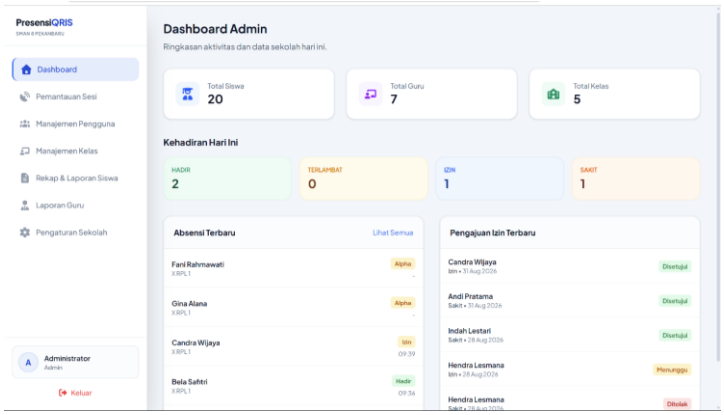


Figure 3: Admin Dashboard

The Admin Dashboard provides a summary of system data, enabling administrative tasks to be performed centrally.

b. Teacher Implementation

Teachers play a key role in the attendance process. They can check in, start an attendance session, and generate dynamic QR codes.

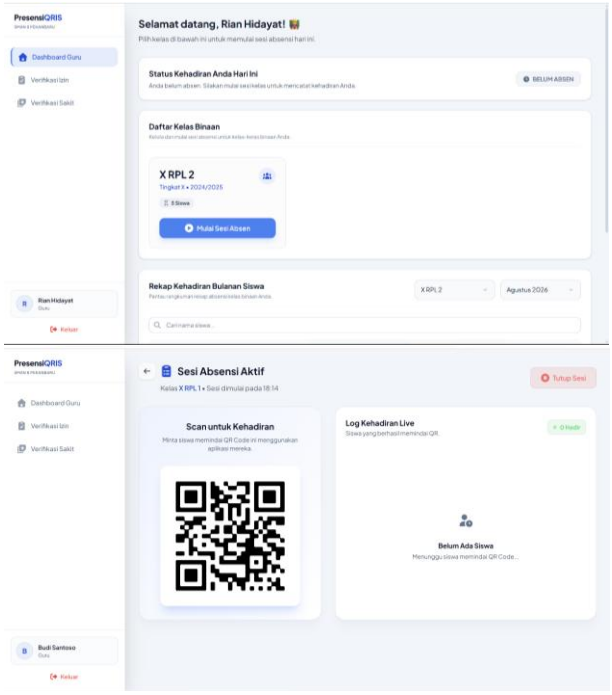


Figure 4. Teacher Dashboard and Attendance QR Code

QR codes are generated based on the currently active attendance session, so the codes cannot be reused outside the specified time frame.

c. Student Implementation

Before this system was introduced, student absences were still recorded manually, so attendance data was not presented in a standardized format and was not easy to review.

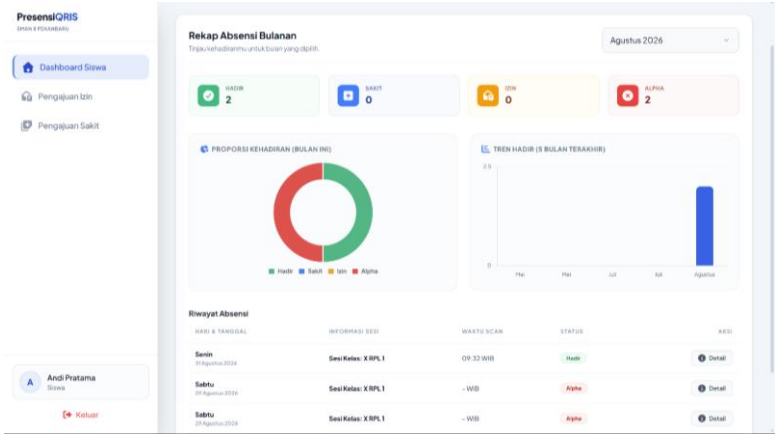


Figure 5: Student Dashboard

Once set up, the dashboard provides an integrated overview of student attendance through data on attendance, excused absences, sick leave, and unexcused absences. The data is also presented in graphs illustrating attendance rates and trends, as well as in tables tracking changes in absences, making it easier to monitor attendance data in a more structured way.

d. Implementation by Parents

Before this system was introduced, homeroom teachers did not have a centralized tool that allowed them to track and view students' attendance in real time.

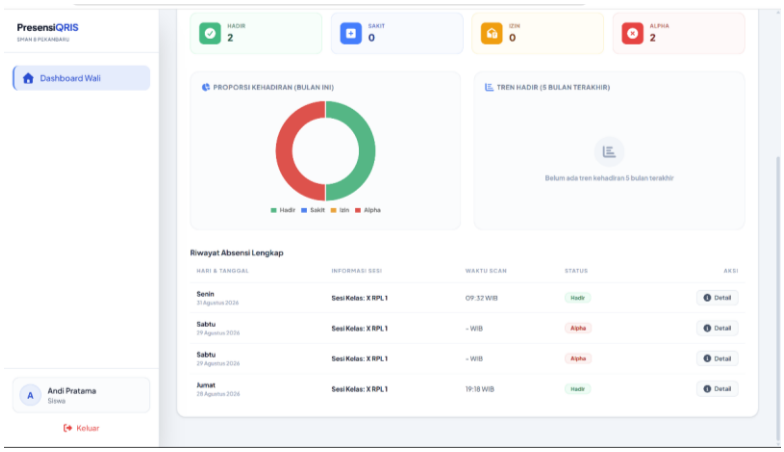


Figure 6: Parents Dashboard

Once set up, the homeroom teacher's dashboard displays a comprehensive overview of attendance, including the number of students present, approved absences, absences due to illness, and unexcused absences. The data also includes a graph illustrating the attendance rate, as well as a complete history of absences, which can be accessed through the details of each individual absence entry.

2. System Testing

The functional adequacy verification was conducted using "black-box" testing, with the main functions tested according to the needs of the system's various users: the administrator, the teacher, the student, and parents or guardians. The tests covered the user authentication process, the management of user and class data, the teacher's initiation of the attendance session, the creation of dynamic QR codes, students' scanning of these codes, requests for excused absences and sick leave, as well as attendance tracking by legal guardians. According to the test results, all of the application's main features function in accordance with the defined scenarios, meaning that the system meets the requirements for functional adequacy.

The performance test was conducted to evaluate the application's responsiveness during user interaction. During this test, response times and application performance were monitored while executing key processes, such as opening the home page, logging in, accessing the dashboard, and recording attendance. The test results show that the application responds well, thereby facilitating the use of the system for daily attendance recording.

The compatibility and portability test was conducted by running the application on various devices and in different browsers. The objective of this test was to ensure that the application, based on a Progressive Web App (PWA), could be used in different environments without significant functional differences. The test results show that all of the application's main functions work perfectly in the tested environments.

Usability tests were conducted using the System Usability Scale (SUS) to determine the application's usability level based on user evaluations (Aisyah et al., 2021; Hasibuan et al., 2023; Andriyani & Sari, 2023). The tests were conducted with

users involved in the system, namely administrators, teachers, students, and legal guardians. The test results show that the application is well accepted by users, who find the system easy to understand and user-friendly. (Aisyah et al., 2021; Hasibuan et al., 2023; Andriyani & Sari, 2023; Pradiktha et al., 2023).

Table 1: Usability Test Results

No	Parameters	Results
1	Number of respondents	42
2	Total SUS score	3447,5
3	Average SUS score	82,08
4	Median	86,25
5	Minimum score	32,5
6	Maximum score	100
7	Not Acceptable	4 Respondents
8	Marginal	8 Respondents
9	Acceptable	30 Respondents
Final interpretation		**Acceptable**

Reliability, security, and maintainability testing has been conducted to determine the system's levels of reliability, security, and maintainability. This testing included an analysis of application stability, user access security, and the quality of the source code structure. The test results show that the system operates stably, is equipped with authentication mechanisms that align with user access rights, and has a structure that supports future development.

Based on the results of the implementation and testing conducted to date, the student attendance management application—which is based on a Progressive Web App (PWA)—is able to address issues related to traditional attendance management processes, which previously had limitations in terms of recording, managing, and transmitting attendance information. This developed system not only digitizes the attendance recording process but also provides a validation mechanism that contributes to improving the accuracy of student attendance data.

The use of Progressive Web App (PWA) technology offers advantages in terms of system usability, as the app can be accessed from various devices via a browser, without requiring additional installation as is the case with traditional mobile apps (Karli et al., 2023; Faisol & Noertjahjono, 2019). This provides high flexibility for users, particularly teachers and students, since attendance can be recorded using readily available devices, without relying on a specific operating system (Karli et al., 2023; Hudianti et al., 2023; Faisol & Noertjahjono, 2019).

Additionally, the use of dynamic QR codes offers higher security compared to manual attendance recording methods or the use of static codes (Vitriani et al., 2023; Sitorus et al., 2023; Setiawan et al., 2022). QR codes can only be used during an active attendance session, thereby reducing the risk of attendance codes being reused outside the specified period. This mechanism supports a more controlled attendance recording process, as code generation is based on sessions opened by the teacher.

The integration of geolocation functionality is also a key contribution of this research. Location validation allows the system to verify a user's position before attendance data is recorded. Thanks to this mechanism, the attendance tracking process relies not only on QR code scanning but also considers the alignment between the user's location and the predefined boundaries within the school environment.

In terms of information management, this system offers ease of use for every user, in accordance with their respective access rights. Administrators can manage user data, classes, and attendance reports. Teachers can open attendance sessions and monitor student attendance in the classes they teach. Parents, on the other hand, have access to their children's attendance data, which enhances transparency between the school and parents.

Test results, which comply with the ISO/IEC 25010 standard (ISO/IEC, 2011), indicate that the system meets the quality criteria for the software under test. The testing covered the following aspects: functional conformance, performance efficiency, compatibility, usability, reliability, security, maintainability, and portability. Based on these results, the application operates in accordance with functional requirements and possesses the quality necessary to support the implementation of a digital attendance system in a school setting.

Overall, this study demonstrates that the combination of PWA technology, dynamic QR codes, and geolocation-based validation can be an appropriate approach for developing a more effective attendance system for educational institutions. This system not only replaces manual processes with digital ones but also provides improvements in terms of accessibility, attendance validation, and the provision of more structured information.

E. CONCLUSION

Based on the results of the study, it can be concluded that the attendance app for high school students, which is a Progressive Web App, has been successfully designed and implemented using a prototype-based development method. This method allows for the gradual development of the system, from the requirements analysis stage, through design and implementation, to system evaluation based on user requirements.

This application enables the digitization of the attendance process through the use of dynamic QR codes and location verification. The dynamic QR code mechanism allows teachers to initiate attendance recording sessions in a controlled manner, while location verification provides an additional layer of security to ensure

that attendance is recorded within designated areas. Thanks to these features, the attendance recording process is more structured compared to manual recording.

In addition, the system successfully offers features tailored to the needs of each user. Administrators can manage user data and system-related information; teachers can open attendance sessions and manage student attendance; students can digitally record their attendance; and parents can view information regarding their children's attendance history.

Based on testing conducted in accordance with the ISO/IEC 25010 standard (ISO/IEC, 2011), this application meets verified quality criteria for software. The test results show that the system functions in accordance with its planned features and can be used as a solution to improve the effectiveness and efficiency of student attendance management.

For future development, this system can be enhanced with additional features, such as integration of automatic notifications to parents, analysis of student attendance trends, and the development of additional security features, to enable the system's use on a broader scale.

ACKNOWLEDGMENT

The author would like to thank all those who have supported and contributed to this research project. The author extends special thanks to the Computer Science Undergraduate Program, Faculty of Engineering, University of Riau, for providing facilities and academic support throughout the conduct of this research. The author also thanks the high school that provided the opportunity to gather information and offered support in data collection and the development of the student attendance management system. Furthermore, the author thanks the thesis advisor and all those involved who guided the author throughout the research process, up to the writing of this article, by providing advice, suggestions, and assistance.

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