

JUVOTEK JURNAL
Jurnal Vokasi Teknik | *J. Vok. Tek.*
https://mentech.id/jurnal/index.php/juvotek | e-ISSN 3025-1125
DOI: https://doi.org/10.53905/cf6rct53
Original Research Article

Development and Functional Evaluation of a Web-Based IT Attendance Service (ITAS) Using QR Codes and an Agile Approach

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Received: january 20, 2026| Accpeted: March 27, 2026 | Published: April 01, 2026

ABSTRACT

Manual attendance practices remain vulnerable to delayed recording, transcription errors, fragmented storage, and limited real-time access. This study developed and functionally evaluated the IT Attendance Service (ITAS), a web-based attendance application that uses QR codes to support attendance recording and monitoring in the Informatics Engineering Department of Samarinda State Polytechnic. A software-development research design was implemented using an Agile approach. Requirements were elicited through interviews, observation, and review of the existing attendance workflow involving students, lecturers, and administrators. The system was modeled through a context diagram, level-1 data-flow diagrams, and an entity-relationship diagram. The application was implemented with Python and the Django web framework and included role-based authentication, QR-code generation, attendance submission, attendance history, class management, and reporting. Verification addressed functional behavior, access control, usability, and response performance through scenario-based testing. ITAS produced operational interfaces for user administration, class management, QR-code creation, student attendance, attendance history, dashboard monitoring, and attendance reporting. All four reported verification categories were marked as passed. Core workflows—login, QR-code attendance, data management, and report access—operated according to the specified requirements. However, the source evaluation did not report sample size, execution counts, response-time measurements, security-penetration metrics, or standardized usability scores. The prototype demonstrates the functional feasibility of a Django-based QR-code attendance service for digitizing academic attendance administration. The findings support continued institutional piloting, but stronger evidence requires controlled field implementation, quantitative usability testing, performance benchmarking, security assessment, and comparison with the manual process.

Keywords:
attendance information system; QR code; web application; Agile development; Django; higher education.

Article Info

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To cite this article:
Seftianur, M., Rajib, M., Arisandy, M. R., Bunna , D. S., Mawarti, D., & Rahman, M. F. (2026). Development and Functional Evaluation of a Web-Based IT Attendance Service (ITAS) Using QR Codes and an Agile Approach. *Jurnal Vokasi Teknik (JuVoTek)*, 10-17. https://doi.org/10.53905/cf6rct53

INTRODUCTION

Digital transformation in higher education increasingly extends beyond teaching and learning to administrative processes that require timely, accurate, and auditable data. Attendance administration is one such process because it supports course monitoring, student participation records, academic reporting, and institutional accountability (Syahidi et al., 2025; Zulkifli et al., 2025). Nevertheless, paper-based attendance remains common and can consume instructional time, introduce transcription errors, complicate recap preparation, and delay access to attendance information (Aldabagh, 2024; Bowen et al., 2005).

Automatic identification and data-capture technologies offer practical alternatives to manual attendance. Barcode- and QR-code-based systems are comparatively inexpensive because they can use existing cameras and web-enabled mobile devices (Ayop et al., 2018, p. 1; Bhange et al., 2024). QR codes also provide rapid machine-readable access to encoded identifiers or session links and have been used in education for information access, registration, and attendance-related workflows (Law & So, 2010). Evidence from higher-education implementations indicates that automated identification can reduce data-

entry errors and improve administrative efficiency (Elaskari et al., 2021).

Previous studies have proposed QR-code attendance systems with web, mobile, geolocation, notification, and biometric components. Hamzah et al. (2021) developed a QR-code student attendance system that automated attendance percentages and warning-letter preparation. Sunaryono et al. (2019) combined QR-code session information with face recognition to strengthen identity verification. More recent engineering studies have continued to emphasize reduced attendance time and reduced opportunity for proxy attendance (Reddy et al., 2023; Srivastava et al., 2023)

Despite this growing body of work, three limitations remain relevant to the present institutional context. First, many studies emphasize the final interface while providing limited traceability from stakeholder requirements to process models, database structure, and test scenarios. Second, reported claims of accuracy, security, or usability are sometimes not accompanied by measurable indicators. Third, solutions developed for one institution may not directly represent the roles, network restrictions, class structures, and reporting practices of another institution.

At the Informatics Engineering Department of Samarinda State Polytechnic, the existing manual workflow created practical concerns related to efficiency, accuracy, attendance tracking, and rapid access to records. This condition provided the rationale for developing a locally aligned web-based system that supports students, lecturers, and administrators through differentiated access and centralized attendance data.

Accordingly, this study aimed to: (1) identify the functional and non-functional requirements of a digital attendance service; (2) design and implement ITAS using QR codes and a Django-based web architecture; (3) describe the resulting system components and interfaces; and (4) conduct scenario-based verification of functionality, access control, usability, and performance behavior. The study is positioned as a development and functional-evaluation study rather than an effectiveness trial.

MATERIALS AND METHODS

Study Design and Setting

This study used a software-development research design in the Informatics Engineering Department of Samarinda State Polytechnic, Samarinda, Indonesia. The unit of development was the IT Attendance Service (ITAS), a browser-accessible attendance application intended for three user roles: students, lecturers, and administrators. The study focused on requirements analysis, system modeling, iterative implementation, and functional verification.

Agile Development Procedure

An Agile approach was used because requirements could be refined iteratively as stakeholders reviewed system functions and interfaces. The development cycle comprised: requirements elicitation, backlog formulation, system and interface design, incremental implementation, verification, evaluation, and refinement. Each increment was reviewed against the defined attendance workflow before the next increment was developed.

Requirements Specification

Requirements were gathered through interviews with intended users, direct observation of the existing attendance process, and review of the information needed for attendance recap and monitoring. The original project documentation did not report the number, demographic characteristics, interview protocol, or sampling strategy of participants; therefore, the present article does not infer these details.

Table 1. Stakeholder roles and traceable system requirements.

User role	Primary need	Required system response
Student	Record attendance and view personal history	Scan/access a session QR code, submit attendance, and review attendance history.
Lecturer	Create attendance sessions and monitor course attendance	Generate a QR-code session, view class attendance, and access summaries.
Administrator	Manage users, classes, and institutional records	Create/edit/delete user records, manage classes, and access attendance reports.

Functional and Non-Functional Requirements

The functional requirements comprised secure login, role-based access, user and class management, QR-code attendance, real-time attendance monitoring, attendance-history retrieval, data storage, and report preparation. The non-functional requirements comprised usability, browser and platform compatibility, reliability, response performance, data backup, and network-based access restrictions. The proposed access restriction required attendance to be submitted through an authorized institutional or lecturer-provided network.

System Modeling

The system was modeled before implementation to support reproducibility and traceability. A context diagram defined the system boundary and exchanges among students, lecturers, administrators, student data, and attendance data. Level-1 data-flow diagrams described QR-code generation, attendance verification, and report retrieval. An entity-relationship diagram modeled the principal database entities and their relationships.

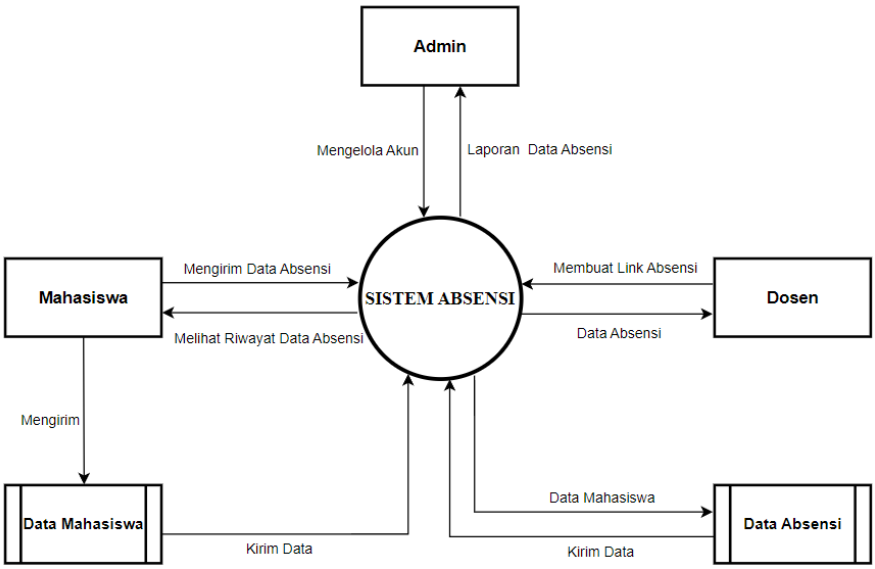


Figure 1. Context diagram of the IT Attendance Service (ITAS).

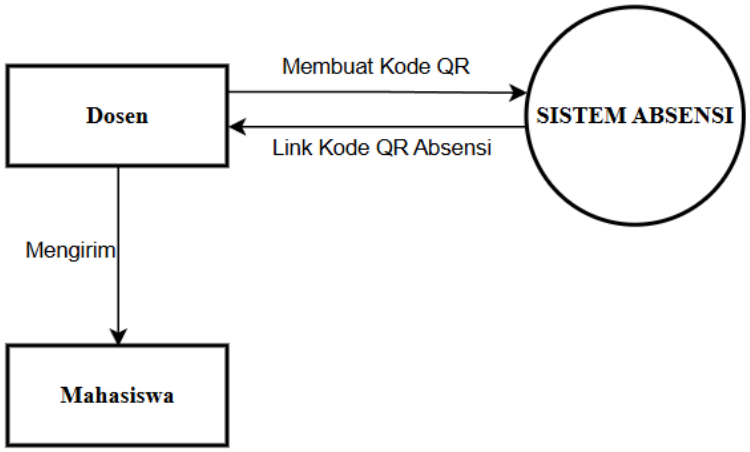


Figure 2. Level-1 data-flow diagram for lecturer QR-code generation and distribution.

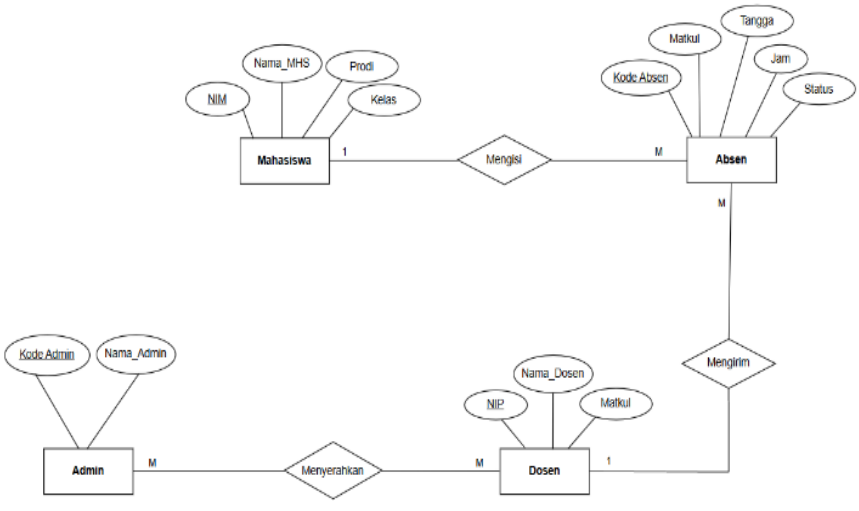


Figure 3. Entity-relationship diagram used as the basis for the ITAS database structure.

System Architecture and Implementation

ITAS was implemented as a web application using Python and the Django framework. Django's model-template-view structure was used to separate database interaction, interface templates, and request-processing logic. The client layer consisted of browser-accessible pages for smartphones and computers. The application layer handled authentication, role authorization, class and user operations, QR-code generation, attendance validation, and reporting. The data layer stored user, class, and attendance records.

Table 2. Logical architecture of the ITAS application.

Layer	Implementation	Responsibility
Presentation	HTML/CSS templates rendered in a web browser	Login, dashboards, forms, attendance history, QR-code display, and reports.
Application	Python/Django	Authentication, authorization, business rules, QR-session logic, attendance processing, and report queries.
Data	Relational database represented by the ERD	Persistent storage of users, classes, attendance sessions, and attendance records.

Verification Procedure

Verification was scenario based and covered four categories reported in the source project: functional behavior, security/access control, usability, and performance. For each scenario, the tester initiated the specified input or user action, observed the system response, and compared the response with the expected outcome. A test was marked as passed when the observed response matched the expected behavior without a blocking error.

Table 3. Reconstructed verification protocol based on the reported test categories.

ID	Category	Procedure	Expected outcome	Decision rule
T1	Functional	Authenticate and complete a QR-code attendance workflow.	Valid users enter the correct dashboard; a valid attendance record is stored.	Pass when login and QR attendance complete without a blocking defect.
T2	Access control	Attempt protected functions with an unauthorized role or invalid access.	Protected functions and data are not available to unauthorized users.	Pass when access is rejected or redirected.
T3	Usability	Navigate principal pages and complete common tasks.	Labels, navigation, and task sequence are understandable and operable.	Pass when intended users can complete the scenario and no critical navigation obstacle is reported.
T4	Performance	Load principal pages and submit attendance under the available test environment.	The application responds and completes requests without failure.	Pass when the scenario completes without timeout or application crash.

No inferential statistical test was applied because the study did not compare groups, estimate an intervention effect, or report repeated quantitative measurements. Descriptive synthesis was therefore limited to the number and proportion of reported test categories that passed. Response time, error rate, concurrent-user capacity, security vulnerability counts, and standardized usability scores were not available.

Ethical and Data-Protection Considerations

The prototype handled academic identity and attendance information. Accordingly, development emphasized authenticated access, role separation, and restricted access to protected functions. However, the source manuscript did not report formal ethics approval, informed-consent procedures, a privacy-impact assessment, encryption configuration, retention rules, or penetration-testing procedures. These items should be specified before operational deployment.

RESULTS

Requirements Analysis

The requirements analysis identified five principal functional capabilities: authenticated access, QR-code attendance, real-time attendance monitoring, accurate attendance-data management, and structured attendance history. The non-functional requirements emphasized usability, network-based access restriction, response performance, multi-platform compatibility, integration readiness, reliability, and backup capability. These requirements were translated into user-management, class-management, attendance-session, monitoring, and reporting modules.

Implemented Interfaces and Workflows

The implemented application included an administrator form for adding users, a student attendance-status view, an attendance-history table, a lecturer form for creating an attendance session, class and user lists, an attendance recap page, and a lecturer dashboard displaying a QR code. Together, these components operationalized the role-specific workflows specified during requirements analysis.



Figure 4. Administrator interface for adding an ITAS user.



Figure 5. Lecturer form for creating a QR-code attendance session.



Figure 6. Student attendance-history interface.



Figure 7. Lecturer dashboard displaying the generated QR code.



Figure 8. Attendance recap table generated by ITAS.

Functional Verification Outcomes

Table 4. Objective summary of the reported ITAS verification results.

Test category	Targeted component	Reported result	Observed implication	Evidence boundary
Functional	Login and QR-code attendance	Pass	Core attendance workflow was operational in the test environment.	No execution count, defect log, or branch-level coverage was reported.
Security/access control	Protection of user data and restricted functions	Pass	The system reportedly prevented unauthorized access attempts used in the project test.	No vulnerability scan, attack taxonomy, or penetration-test metrics were reported.
Usability	Navigation and access to attendance information	Pass	Users provided favorable qualitative feedback and could access principal functions.	No sample size or standardized scale such as SUS was reported.

Performance	Page loading and request handling	Pass	The application remained operational during the available scenarios.	No response-time distribution, load level, throughput, or concurrency threshold was reported.

All four reported verification categories were marked as passed, corresponding to a descriptive category-level pass proportion of 100% (4/4). This proportion should not be interpreted as a software accuracy estimate or as evidence of institutional effectiveness because the underlying number of test executions and observations was not reported.

Significant Findings

1. The requirements were translated into a coherent role-based web workflow for students, lecturers, and administrators.
2. The QR-code mechanism connected lecturer-created attendance sessions with student attendance submission and centralized record storage.
3. The database and data-flow models supported traceability between actors, processes, and stored attendance information.
4. The available functional evidence supports prototype feasibility, but not yet comparative superiority over manual attendance.

DISCUSSION

The development results indicate that ITAS can operationalize the essential administrative sequence of creating an attendance session, presenting a QR code, recording student attendance, and retrieving attendance data through a web interface (Shrivastava, 2024, p. 8; Siew et al., 2023, p. 206). This finding is consistent with earlier QR-code attendance studies that describe reduced dependence on paper records and automated preparation of attendance information (Hamzah et al., 2021; Reddy et al., 2023)

The use of a web architecture is particularly relevant in a higher-education environment because it permits access from common browsers without requiring a platform-specific installation (jogu & Lal, 2025; Siew et al., 2023, p. 200). The role-based structure also reflects the different information needs of students, lecturers, and administrators. Similar automated identification studies have shown that digital capture can reduce data-entry errors and administrative effort, although the magnitude of improvement depends on actual field conditions and implementation quality (Elaskari et al., 2021).

The QR-code design provides operational simplicity, but a static or shareable QR code can create opportunities for proxy attendance (Benesa et al., 2024; Pantilon, 2025). The present design partially addresses misuse through authenticated access and a proposed same-network restriction. Nevertheless, stronger controls may be required, including time-limited tokens, nonce-based QR regeneration, geofencing, device binding, or an additional identity factor. Research combining QR codes with face recognition illustrates one possible higher-assurance approach, although it introduces additional privacy, computational, and governance considerations (Generosi et al., 2022, p. 426; Nwabuwe et al., 2023, p. 2).

The reported pass outcomes have practical value as evidence that the prototype's principal workflows operated in the available development environment. However, the absence of test counts and quantitative measurements limits interpretation (Ng et al., 2025, p. 10; Wong et al., 2019, p. 923). A category-level 100% pass result does not establish reliability under repeated use, resistance to realistic attacks, usability across diverse users, or performance under concurrent access (Schäfer et al., 2023, p. 100). Future evaluation should align quality characteristics with a recognized software-quality model, such as ISO/IEC 25010:2023, and should report test cases, repetitions, devices, browser versions, server specifications, data volume, response-time percentiles, failure rates, and security finding (Enriquez, 2026; Enriquez et al., 2025, p. 27539; Oriol et al., 2014, p. 1185).

From an institutional perspective, ITAS may improve the accessibility and structure of attendance records and reduce the time needed for manual recap. These benefits remain plausible rather than causally demonstrated because the study did not include a baseline comparison. A field trial should compare manual and ITAS workflows using attendance-processing time, error frequency, missing-data rate, lecturer workload, student task-completion rate, and user-satisfaction measures.

The study has several limitations. First, stakeholder sample characteristics and requirements-elicitation instruments were not documented. Second, the software versions, deployment environment, database engine, server configuration, and QR-code library were not specified. Third, security, usability, and performance were evaluated qualitatively without standardized instruments or benchmark thresholds. Fourth, no controlled comparison with manual attendance was conducted. Fifth, the study was conducted in a single departmental context, limiting transferability. Finally, formal privacy governance and ethical procedures were not reported.

CONCLUSION

This study developed and functionally evaluated ITAS, a web-based academic attendance service that integrates QR-code attendance with role-based access, class management, attendance history, dashboard monitoring, and reporting. The implemented workflows and the reported pass outcomes support the technical feasibility of the prototype and address the study objectives related to requirements identification,

system design, implementation, and initial verification. The evidence is consistent with the proposition that QR-code and web technologies can structure attendance administration and reduce reliance on fragmented manual records. However, the present findings do not yet demonstrate comparative efficiency, security robustness, scalability, or institutional effectiveness. Future studies should conduct a controlled field pilot, quantify time and error reductions, apply standardized usability measurement, benchmark concurrent performance, perform independent security testing, and document data-governance safeguards. Authors and future developers are encouraged to submit evidence-based suggestions for improving token security, network validation, integration with academic information systems, accessibility, and long-term maintainability.

Acknowledgments

The authors acknowledge the Informatics Engineering Department of Samarinda State Polytechnic and the lecturers, students, and administrative personnel who provided input during the identification of attendance-system requirements. The authors should revise this statement to include any specific institutional, laboratory, supervisory, or funding support before publication.

Conflict of Interest

The authors declare that they have no conflict of interests related to the development, evaluation, or publication of this study. This declaration should be confirmed by all authors before submission.

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