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Development and Evaluation of a QR Code-Based Student Attendance Information System for Improving School Attendance Management Efficiency

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Abstract
The development of digital technology in education has encouraged the implementation of modern information systems, one of which is a Quick Response Code-based attendance system. This study aims to design and develop a student attendance information system that uses Quick Response Code cards, connected to a mobile web application, to assist teachers in recording attendance at SMP Negeri 3 Gadingrejo. The method used in the development is a waterfall approach with the steps of needs analysis, design, implementation, testing, and maintenance. This system makes it easy for students to record attendance by scanning the prepared Quick Response Code, so that attendance data is immediately recorded automatically and in real time into the system. The results of the blackbox test method showed that all features functioned well without any problems. In addition, trials with teachers and students showed a high level of satisfaction with the ease and efficiency of the system. It is hoped that this system can replace the manual method that is still used, improve the accuracy of attendance recording, and support the digital transformation of school administration.

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I. INTRODUCTION

Digital technologies increasingly influence how educational institutions deliver teaching and manage routine administrative work. Attendance registration is a particularly relevant task because it occurs every school day, contributes to class monitoring and provides records for subsequent reporting. Attendance data are useful only when they are captured reliably, stored systematically and made accessible to authorized school personnel. In a manual process, teachers may need to call names, mark paper registers and consolidate the information at a later time. This sequence consumes instructional preparation time and allows delays or transcription errors. Attendance administration should therefore be

considered not only a clerical procedure but also part of the information infrastructure supporting the daily operation of a school [1].

Quick Response (QR) codes provide a practical means of linking a physical identifier with a digital record. Each code can represent a student identifier that is read by a scanner or compatible camera and checked against a database. When linked to an attendance application, the scan can initiate verification and record the associated presence event. The QR code is not, by itself, evidence of a student's identity; its value depends on how the application manages registered codes, repeat submissions, dates and access permissions. A previous school-based study described a web application that used QR-code scanning to manage student attendance and support reporting [2]. A web-based QR attendance application has also been reported as a way to improve accessibility and administration of student attendance data [3]. From an information-systems perspective, attendance management extends beyond decoding a card. An effective system coordinates data input, processing, storage and usable managerial information [4] [5]. These components must operate consistently so that student identifiers, attendance transactions and subsequent reports remain aligned [6]. The QR code therefore serves as an input mechanism within a broader school administrative process.

SMP Negeri 3 Gadingrejo is a public junior secondary school in Mataram Village, Gadingrejo District, Pringsewu Regency, Lampung Province, Indonesia. At the beginning of this study, the school relied on manually completed attendance records. Observation of the existing process and interviews with school personnel indicated recurring difficulties in recording attendance at the start of lessons, preparing recapitulations, identifying students with irregular attendance and accessing updated information efficiently. Teachers reported that the task became more demanding in larger classes and repeated manual entry could introduce inaccuracies. These observations established a local need for a school-specific solution rather than an assumption that every digital attendance application would work equally well in every setting.

Related studies offer a basis for this development. Nuryamin and colleagues described a website-based QR attendance information system that simplifies recording and recapitulation [7]. Saripuddin and colleagues examined a QR code attendance application for school use and emphasized the practical support it can give teachers and administrative staff [8]. Saputro and Kurniadi presented a mobile-oriented QR attendance application for secondary students [9]. Another school-based study developed a web attendance system for vocational students, illustrating the importance of connecting code recognition with managed student records [10]. Together, these studies suggest that QR technology can streamline the transaction of marking attendance, but the usability of a particular implementation still depends on its intended users, data structure and school workflow.

A further consideration is the interface through which attendance information is managed. Mobile web applications can adapt their presentation to phones, tablets and computers and can be accessed using a browser rather than requiring a separately installed native application [11]. For the present school, this approach was considered suitable for supporting teachers and operators who may access the system from different devices. However, browser accessibility does not eliminate dependence on a functioning network, adequate scanning equipment or sound data protection. The present article therefore concentrates on the implemented functions and the evidence available from functional and small-scale user testing rather than claiming that these wider operational challenges have already been solved. The choice of a sequential development model should also be

understood in context. Reviews of mobile application development describe Agile as an alternative when requirements evolve rapidly [12]. In this case, waterfall was selected for its clearly defined core functions and documented stages, not because it is universally superior to iterative approaches.

Against this background, the study addressed three research questions: how can a QR code card-based attendance information system be designed to digitize student attendance at SMP Negeri 3 Gadingrejo; how can the principal functions for scanning, managing school records and producing attendance reports be implemented; and what do internal functional tests and an initial trial with teachers and students reveal about its operation and acceptability? The objectives were to develop a functioning mobile-web attendance system using the waterfall approach, examine whether its key features behave as specified and obtain preliminary user evaluations. The anticipated practical benefits are less repetitive recording for teachers, a straightforward scan-based procedure for students and more structured information for school administration. The study also contributes a context-specific development example rather than a generalized effectiveness estimate.

II. RESEARCH METHODS

2.1. Research Context and Data Collection

The research was conducted at SMP Negeri 3 Gadingrejo and took the form of an applied information-system development study. Needs assessment combined direct observation, interviews and examination of relevant literature. Observation traced how student attendance was taken from arrival or the beginning of a lesson to the compilation of records. Particular attention was given to the teacher's recording tasks, the handling of attendance information and the delays associated with manual recapitulation. Interviews were used to clarify users' difficulties and required system functions. The literature review informed the selection of QR-based identification, mobile-web access and a sequential development process. These sources were used to define the proposed system rather than to establish a quantitative baseline for manual attendance duration. Guidance on observational and methodological approaches informed the needs assessment [13] and [14]; established interviewing guidance additionally informed interviews with school personnel [15]. Prior studies were reviewed to inform functional design; this was a focused narrative review rather than a systematic literature review with a formally documented search and screening protocol [16].

2.2. Waterfall Development Procedure

Development followed a waterfall sequence consisting of requirements analysis, system design, coding and integration, testing, and maintenance planning. This staged approach was chosen because the basic workflow and primary administrative functions could be specified in advance and documented systematically. Sequential software development has been used in several information-system projects and offers clear checkpoints for requirements, design and verification [17]. Similar waterfall-based educational information-system development highlights the importance of testing functions against the agreed design [18]. In this study, the sequence served as an organizing framework; it should not be interpreted as evidence that future changes or iterative revisions will be unnecessary. Other information-system projects have also used waterfall to organize requirements, implementation and verification [19]. Nevertheless, this sequence requires explicit change management when school workflows or reporting needs change after deployment.

During requirements analysis, the research team specified the need for user authentication, management of students, teachers, classes and schedules, unique QR codes, student check-in, attendance summaries and report generation. During design, the system's interactions and activity flow were represented with Unified Modeling Language (UML) diagrams, including use-case, sequence and activity views. UML modeling was used to express actors, responsibilities and expected application behavior before implementation [20]. Coding then produced the web application using PHP and a MySQL database, with responsive browser access for the operator and teacher functions. The testing stage focused on black-box verification of visible system behavior. The final stage considered maintenance, correction of defects and possible functional extensions.

2.3. Functional Verification and User Trial

The completed application was assessed using black-box tests that compared actual responses with expected outcomes, without examining internal source-code logic. Ten functional scenarios were recorded: valid scan, unregistered scan, duplicate scan, attendance dashboard, student creation, student editing, student deletion, teacher-account creation, attendance reporting and logout. Each scenario was recorded as successful or unsuccessful in the test checklist. The study also describes a small-scale classroom trial with 20 students in Grade VII.7 and a teacher evaluation. Students responded to five statements about independent operation, speed, ease of scanning, waiting time and willingness to continue using the system, with response categories ranging from strongly disagree to strongly agree. The teacher evaluated six dimensions on a five-point scale. The available material reports percentages and ratings but does not provide scan-time logs, a control-group comparison, inferential statistical testing or extended deployment observations. Accordingly, the analysis is descriptive and limited to the documented checks and evaluations.

III. RESULTS AND DISCUSSION

3.1. Requirements and System Architecture

The requirements analysis identified three principal actors: administrator or school operator, teacher and student. The administrator is responsible for maintaining core records, including student and teacher information, classes, subject and teaching schedules, and the QR codes used for attendance. Teachers review teaching schedules, monitor student presence and obtain attendance reports. Students interact with the system mainly through the scan transaction associated with their unique QR card. This separation is important because attendance events must be associated with registered student records while configuration changes remain the responsibility of authorized personnel. The design therefore organizes attendance around a record-management layer, a scanning workflow and a reporting interface rather than treating QR scanning as an isolated feature.

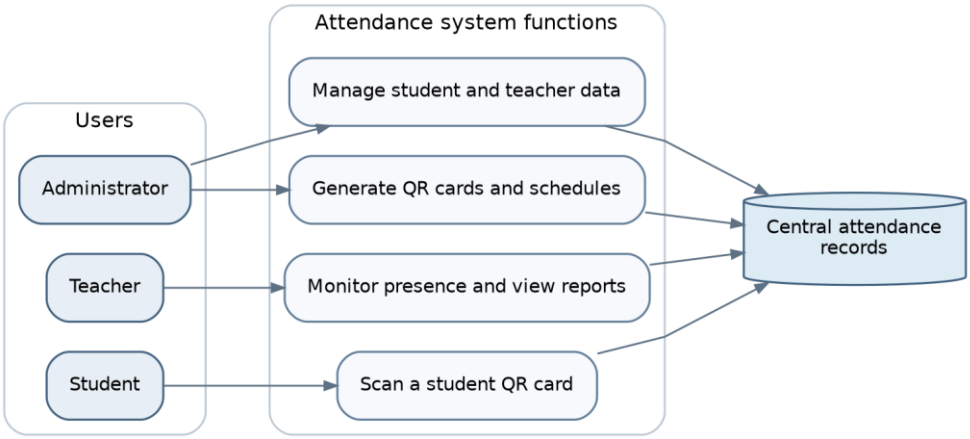


Figure 1. Main actors and core functions of the QR code attendance system.

Figure 1 shows the relationship among the principal actors and the functions exposed by the system. The administrator manages institutional data, schedules and code creation; the teacher reviews attendance and reports; and the student initiates a scan. The diagram provides a high-level specification rather than a detailed security model. For example, it does not establish whether the QR code is encrypted, whether all scans are supervised, or whether additional verification is performed before a student is marked present. Such matters should be addressed in any future production-scale deployment, especially because a code card could potentially be presented by a person other than its owner. System-analysis literature emphasizes that models should connect user needs to functional responsibilities and data flows [21]. Here, that connection is reflected in the separation of administrative privileges, teacher-facing monitoring functions and student scanning activities.

The implemented design uses PHP for the server-side application and MySQL for the database. A mobile-responsive web interface provides access through a browser without requiring users to install a dedicated application. Once a registered code is scanned, the system retrieves the associated student record, processes the attendance transaction and makes the updated information available for subsequent review. This architecture supports near-immediate entry and consultation within the application, subject to the network and server being available. The system also includes a dashboard showing summary categories such as present, permitted absence, illness and absence without explanation. These categories are valuable for practical monitoring because teachers need more than a single count of scanned cards. Web programming literature likewise distinguishes browser presentation from server-side processing and persistent storage [22]. This separation is relevant to maintaining consistent attendance records across devices, although the present study did not formally audit security or transaction concurrency.

3.2. Implemented Attendance Workflow and Features

The attendance process begins with student registration and generation of a unique QR code associated with the student record. The generated code is placed on a card that the student brings to the designated scanning point. During an attendance session, the card is presented to the scanning device, and the application checks whether the code is recognized. For a valid registration, the system displays the student information and attendance status and records the transaction. For a code that is not registered, the

application rejects the transaction and displays a corresponding message. The application also detects repeated scanning of the same student and returns an already-recorded notification rather than counting a second attendance event. These behaviors are central to the transition from paper records to digital attendance because they reduce unnecessary re-entry and basic duplicate transactions.

Beyond scanning, the administrator can add, modify and delete student records and create teacher accounts. The dashboard provides a consolidated overview of attendance statuses, while reporting functions allow authorized personnel to retrieve attendance information for selected periods. Teachers can use these records to follow student participation and support class-level reporting. The existence of a digital record reduces the need to copy the same information from a classroom sheet into a separate recap, although the study did not quantify this reduction. The main user interfaces include the login page, the administrator dashboard, individual data-management pages, the attendance scanner, the reporting page and the student QR code card. Together these interfaces support the end-to-end attendance workflow and address the school's need for reliable access to updated records.

The use of a physical QR card is also a design choice with practical implications. It can simplify the student interaction because students do not need to type an identifier or operate their own smartphone to register their presence. At the same time, card distribution, replacement after loss, scanner availability and management of inaccurate student records become operational responsibilities of the school. A workable implementation therefore requires both appropriate software functions and clearly assigned procedures for maintaining the identity information attached to each code. The current study provides evidence for the basic scanning and management functions but does not report systematic testing of card loss, damaged codes, network outages or unauthorized card use.

3.3. Black-Box Test Results

The functional verification recorded successful outcomes for all ten tested scenarios. Table 1 groups the scenarios according to their contribution to the attendance process while retaining the original checklist's outcome. A correct student card was recognized and produced a successful attendance status; an unknown code was rejected; and a duplicate scan returned a notification that attendance had already been registered. The data-management operations for students and teacher accounts were also recorded as successful, as were dashboard display, report access and logout. The reporting scenario was marked successful in the test checklist, although its expected-output column contained no detailed acceptance criterion. This limits the precision with which the completeness of the report function can be judged.

Table 1. Summary of the documented functional test scenarios

Functional area	Scenarios covered	Recorded outcome
QR transaction	Valid code; unregistered code; duplicate scan (3 tests)	3 passed
Attendance monitoring	Dashboard attendance summary (1 test)	1 passed
Student records	Add, edit and delete a student (3 tests)	3 passed
Staff and session control	Create teacher account; logout (2 tests)	2 passed

Reporting	Open attendance report for a selected date (1 test)	1 passed

The result is 10 recorded passes in 10 functional scenarios. This is a meaningful indication that the principal user-facing operations were working under the conditions in which they were tested. However, a black-box pass does not directly establish the absence of all software defects, security vulnerabilities or future operational errors. The tests did not include a stated number of repeated scans per scenario, scanning performance under high simultaneous demand, long-duration network interruptions or independent verification of database consistency. Consequently, the appropriate conclusion is that the system satisfied the documented functional checks in the limited trial, not that its reliability or efficiency has been exhaustively demonstrated.

3.4. Student Responses During the Classroom Trial

The initial classroom trial involved 20 students from Grade VII.7. Their responses were strongly favorable across five aspects of the attendance experience. For the statement that the system was easy to use without teacher assistance, 65% strongly agreed and 30% agreed, yielding 95% favorable responses. All students either strongly agreed (75%) or agreed (25%) that attendance was quicker and more practical. For ease of QR scanning, 70% strongly agreed and 30% agreed. On the statement that they did not have to wait long, 60% strongly agreed, 35% agreed and 5% disagreed. Finally, 70% strongly agreed and 25% agreed that they wanted the system to continue being used, with the remaining 5% disagreeing. No strongly disagree responses were reported for these items.

These figures describe perceived usability rather than directly measured time savings. The results suggest that most participating students could complete the scan process with little assistance and regarded it as convenient. They also indicate that favorable acceptance was not universal: one response category included a small proportion of disagreement concerning ease of independent use, waiting time and continued use. Such feedback matters because a system may be functionally correct while some students still require guidance or encounter problems with card presentation and scanner positioning. The trial was restricted to one class and involved only 20 students, so the findings should be treated as initial evidence of acceptance within that classroom rather than a representative estimate of attitudes throughout the school.

3.5. Teacher Evaluation and Administrative Implications

The teacher evaluation used six aspects rated on a five-point scale. The highest scores, five out of five, were given to overall ease of system use and the reduction of teachers' attendance-related burden at the beginning of lessons. The remaining four aspects—time efficiency, accuracy of attendance recording, ease of accessing attendance reports and interface presentation—each received four out of five. Together, these values correspond to a descriptive mean of 4.33 out of 5 across the six rated aspects. The evaluation documents feedback from the teacher of Grade VII.7; it does not document a larger teacher sample. Accordingly, the average should be understood as a compact summary of one documented evaluation, not as a statistically estimated school-wide teacher satisfaction score.

The teacher responses address the study's most immediate practical motivation: reducing the repetitive administrative activity associated with daily attendance. The ability to scan a card, automatically associate the result with student data and generate a report can make classroom routines less dependent on hand-written lists. The finding is consistent

with the functional design and the favorable student responses. Nevertheless, a stronger assessment of administrative effectiveness would require measurement of time per class before and after implementation, comparison of transcription-error frequencies, documentation of corrections by school operators and observation across multiple teachers and grades. These measures were not reported in this study, and no numerical performance improvement should be inferred from the reported acceptance ratings alone.

3.6. Discussion, Contribution and Limitations

The study demonstrates how a relatively straightforward combination of QR code cards, database-driven attendance management and mobile-responsive web access can be organized around the needs of a particular junior secondary school. Its immediate contribution is the integration of identity-linked scanning with routine school functions, including account management, attendance summaries and reporting, under a documented development and test process. This emphasis complements earlier work on web-based and mobile attendance applications [7], [8], [9]. The use of UML representations helped clarify the interactions of the actors, a common objective in structured system design [23]. Rather than presenting QR technology as novel in itself, the contribution lies in adapting known components to a local attendance workflow and checking whether the implemented functions perform as intended.

The main finding is convergence between the internal test checklist and initial user feedback. The software passed all ten recorded functional scenarios; most students expressed agreement with statements about usability and speed; and the teacher rated the principal functions favorably. Taken together, these results support a cautious conclusion of initial functional feasibility and acceptable user experience. They do not establish a causal relationship between system deployment and improved learning outcomes, nor do they demonstrate gains in attendance discipline. This study also does not report a longitudinal implementation period, the number of classroom sessions observed, measured network uptime or a formal analysis of data security. These omissions are relevant because administrative systems contain student information and must continue operating during ordinary school disruptions. The findings are consistent in direction with earlier QR-based attendance designs for higher-education settings, which identify digital capture and report access as useful administrative functions [24] [25]. However, contextual differences matter: this study involved a single junior secondary school, only 20 students in the classroom trial and an internal functional checklist. Therefore, the evidence supports initial feasibility and perceived convenience rather than a measured causal reduction in teachers' workload.

Several priorities follow for subsequent development. The school should define a role-based access and data-retention policy, ensure secure storage and transmission of student identifiers, establish procedures for lost or damaged cards and prepare an alternative attendance mechanism for network outages. Future software revisions could add protected parental notifications, more detailed lateness and excused-absence workflows, and interfaces with other authorized school-management records. Such extensions were proposed as future possibilities in the development recommendations and should not be mistaken for features already evaluated. A broader implementation study could then assess the system in several classes, record objective attendance-processing times and error rates, and examine teachers' experiences over an extended period.

IV. CONCLUSION

This study produced a QR code card-based student attendance information system for SMP Negeri 3 Gadingrejo using the waterfall development approach. The mobile-web application provides core administrative functions, unique QR code registration, automatic attendance recording, student and teacher data management, dashboard summaries and reporting. All ten documented black-box test scenarios were recorded as successful. In a small Grade VII.7 trial, 20 students reported predominantly positive experiences with independent use, scanning, waiting time and willingness to continue using the system, while the teacher's six ratings ranged from four to five on a five-point scale. The evidence therefore supports the feasibility of the implemented functions and favorable initial acceptance, but does not yet quantify actual time savings or establish school-wide reliability. Further evaluation should combine broader deployment, objective performance measurements, stronger data-protection arrangements and procedures for operational interruptions before routine full-scale adoption.

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