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Smart Attendance System with QR Code and Location Verification for Student Monitoring and Analytics

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Abstract **Original Research Article**

This study developed and evaluated a Smart Attendance System that integrates QR code scanning and GPS-based location verification to improve the accuracy, efficiency, and integrity of student attendance monitoring in an academic institution. Traditional attendance procedures, such as manual roll calls and paper-based records, are often time-consuming, prone to human error, and vulnerable to proxy attendance. To address these concerns, the proposed system requires students to scan a session-specific QR code while physically located within a predefined geographic boundary. The study employed a developmental research design with descriptive evaluation. System-generated data, including student identifiers, timestamps, attendance status, GPS coordinates, and scan logs, were used to assess system functionality and attendance validation. The system was implemented through a mobile application for students and a web-based administrative panel for instructors. Functional testing showed that the major system modules performed according to expected use cases, including login, QR scanning, location validation, duplicate scan detection, invalid attempt rejection, and real-time log viewing. Attendance validation results showed that the dual-verification mechanism recorded valid attendance entries and rejected invalid location, invalid QR, and duplicate scan attempts. The usability evaluation yielded a mean System Usability Scale score of 81.25, indicating good usability and acceptable user experience. The findings suggest that combining QR code technology with location verification can support more reliable, efficient, and data-driven attendance management while observing privacy and ethical safeguards.

Keywords: Smart Attendance System, QR Code, Location Verification, Data Analytics, Student Monitoring, Educational Technology.

INTRODUCTION

Attendance monitoring is a fundamental component of academic management because it reflects student participation, engagement, and discipline in educational institutions. Accurate attendance records assist instructors and administrators in assessing student participation and identifying patterns of absenteeism. However, traditional attendance methods, such as manual roll calls and paper-based records, remain inefficient, susceptible to human error, and vulnerable to fraudulent practices such as proxy attendance (Alhothaily et al., 2018; Agripa & Astillero, 2022).

Advances in mobile computing, QR code technology, geolocation services, and data analytics provide opportunities to modernize attendance monitoring through automated and verifiable mechanisms. QR code-based attendance systems can improve the speed of attendance recording, but systems that rely only on QR scanning may still be bypassed when codes are shared or used remotely by unauthorized individuals (Al Amin et al., 2024; Journal of Hypermedia & Technology-Enhanced Learning, 2025).

To address these limitations, this study developed a Smart Attendance System that integrates QR code scanning with GPS-based location verification. Students are required to scan a dynamically generated, session-specific QR code within a predefined geographic boundary to confirm their physical presence. Authentication is handled through user credentials, while QR code validation and location verification reduce the possibility of remote check-ins, duplicate entries, and proxy attendance.

The system also incorporates data analytics to organize attendance records and support meaningful insights into student participation and attendance behavior. In this way, the proposed solution extends attendance monitoring from simple record keeping to a more secure, systematic, and data-informed process aligned with information systems quality and success principles (DeLone & McLean, 2003).

Although existing attendance systems have shown the usefulness of QR codes and location-aware technologies, limited studies in the Philippine higher education context have demonstrated an integrated QR-GPS attendance verification system with built-in analytics capabilities. This study therefore addresses a practical and contextual gap by developing and evaluating a dual-verification attendance system for academic monitoring.

OBJECTIVES OF THE STUDY

The primary objective of this study was to develop and evaluate a Smart Attendance System that enhances the accuracy, efficiency, and integrity of student attendance monitoring in an academic institution. Specifically, the study aimed to automate attendance recording, reduce opportunities for proxy attendance, validate student presence through QR code and GPS-based verification, and provide attendance analytics that can support academic monitoring and decision-making.

The study further aimed to process structured and semi-structured data, including student identifiers, session records, timestamps, QR scan results, and GPS coordinates, to generate reliable attendance logs and participation reports. Through this approach, the system sought to demonstrate how mobile technology, location verification, and analytics can support secure and data-driven attendance management while maintaining privacy and ethical safeguards.

MATERIALS AND METHODS

This study employed a developmental research design with descriptive evaluation (Richey & Klein, 2007). The developmental component covered the design, construction, and iterative testing of the Smart Attendance System, while the descriptive component focused on evaluating the system in terms of functionality, accuracy, usability, efficiency, and data integrity. This design was appropriate because the study involved the creation of a technological artifact and the assessment of its performance and user acceptability within a defined academic context.

The system was developed using the Prototyping Model (Pressman & Maxim, 2014), which supports iterative refinement throughout the development lifecycle. This model allowed continuous feedback from intended users, particularly students and instructors, during the refinement of the QR code generation module, GPS validation logic, administrative dashboard, and analytics reporting component. Each prototype iteration was reviewed against functional and usability criteria before moving to the next phase of development.

The Smart Attendance System used a mobile application for student attendance recording and a web-based administrative panel for instructor-level session management. The system captured structured data such as student identification numbers, session

identifiers, course sections, and attendance status. It also captured semi-structured data such as GPS coordinates, QR scan timestamps, and system logs. Institutional records, including student enrollment lists and class schedules, were used as reference data for validating attendance entries.

The core verification process required the instructor to generate a unique QR code for each attendance session and define the approved geographic boundary. Students were required to scan the QR code through the mobile application while physically present within the designated location. The system recorded attendance only when both the QR code and location validation requirements were satisfied. Attempts made from outside the approved location, attempts using invalid QR codes, and duplicate scans were rejected and logged by the system.

Participants and Sampling Technique

The participants of the study were students, faculty members, and an administrator from an academic institution. Student participants used the mobile application to submit attendance, faculty members used the administrative panel to manage attendance sessions, and the administrator provided institutional authorization and access to relevant records for validation purposes.

The study involved 100 student participants, 6 faculty members, and 1 administrator. System testing was conducted over a four-week period from March 2, 2026 to March 27, 2026. Inclusion criteria required student participants to be officially enrolled and to have access to GPS-enabled mobile devices. Participants without active institutional credentials or compatible hardware were excluded from system testing.

Purposive sampling was used because the study required participants who were directly involved in attendance monitoring within a controlled academic environment. The selection of participants was based on institutional enrollment records, class schedules, and the practical need to test the system in an actual classroom attendance setting. Participation was voluntary and supported by informed consent and institutional authorization.

System Design and Instruments

The Smart Attendance System was designed using a dual-platform architecture composed of a student mobile application and an instructor administrative web panel. The mobile application allowed students to authenticate, scan QR codes, and submit location-verified attendance. The administrative panel allowed instructors to create attendance sessions, generate QR codes, define geographic boundaries, monitor real-time attendance logs, and view attendance reports.

The dual-verification mechanism served as the main control for preventing invalid attendance entries. The system cross-referenced the QR scan result with GPS validation logs before recording attendance in the database. Attendance was considered valid only when the scanned QR code matched the active session and the student device location was within the approved boundary. This mechanism improved data integrity by reducing duplicate, invalid, and location-inconsistent submissions.

Evaluation Instruments

The system was evaluated using functional testing, usability assessment, software quality criteria, attendance validation logs, efficiency indicators, and user satisfaction measures. Instrument selection was guided by ISO/IEC 25010:2023, which identifies quality characteristics for software product evaluation.

Table 1. Evaluation Instruments

Evaluation Area	Instrument
Functionality	Functional testing checklist aligned with system use cases
Usability	System Usability Scale (SUS) by Brooke (1996)
Software Quality	ISO/IEC 25010:2023 evaluation checklist covering functional suitability, performance efficiency, usability, reliability, and security
Accuracy	Comparison of valid and rejected attendance attempts based on system logs
Efficiency	Time-motion comparison between manual roll call and system-based attendance recording
Data Integrity	GPS rejection logs and duplicate scan detection records
User Satisfaction	Structured user evaluation questionnaire using a 5-point Likert scale

The System Usability Scale, developed by Brooke (1996), was used to measure perceived usability. SUS is a 10-item usability instrument scored on a scale from 0 to 100. In this study, the SUS questionnaire was administered after the system testing period. The ISO/IEC 25010:2023 checklist was also used as a basis for assessing selected software quality attributes relevant to the system.

Data Collection Procedure

Data collection was conducted during the actual operation and testing of the Smart Attendance System. During each attendance session, the mobile application captured QR scan results, timestamps, student identifiers, and GPS coordinates from student devices. The administrative panel simultaneously generated session-specific data, including QR codes, session identifiers, and approved geographic boundaries. System logs from the mobile and web platforms were collected to assess functionality, attendance validation, duplicate scan detection, and invalid attempt rejection.

User evaluation data were collected through a structured questionnaire administered to student and faculty users after the four-week testing period. Institutional records such as enrollment lists and class schedules were used only for validation of attendance entries and were handled according to authorized academic procedures.

Data Analysis

The collected data were analyzed using descriptive statistics and system log analysis. Functional testing results were summarized using pass or fail outcomes. Attendance validation data were analyzed using frequency counts and percentages for valid attendance entries, invalid location attempts, invalid QR attempts, duplicate scan attempts, and total rejected attempts. Usability results were analyzed using the standard SUS scoring procedure, while user satisfaction data were summarized using weighted mean scores.

Table 2. Performance Metrics Used in the Study

Metric	Formula or Description
Attendance Recording Accuracy	Correctly validated attendance entries / total attendance attempts x 100
Fraud Rejection Rate	Rejected invalid attempts / total invalid attempts x 100
Average Attendance Processing Time	Total attendance processing time / number of students per session
Time Savings	Manual roll call time - system processing time per session
GPS Validation Success Rate	Successful GPS validations / total scan attempts x 100
User Satisfaction Mean	Weighted mean score derived from the student and instructor evaluation questionnaire
SUS Score	Standard SUS computation based on the 10-item usability instrument

Where applicable, independent comparisons between manual and system-based recording time may be used to further validate efficiency gains. However, any efficiency claim should be interpreted according to the actual data collected during testing.

Ethical Considerations

The study observed ethical safeguards because it involved student data and location-based information. Participants were informed about the purpose of the system, the type of data collected, and the limited use of GPS coordinates for attendance verification only. Written informed consent was obtained from participants before system deployment.

The system was designed in accordance with the Philippine Data Privacy Act of 2012, or Republic Act No. 10173. GPS coordinates were collected only during attendance submission and were not used for continuous location tracking. Access to attendance logs and location data was restricted to authorized academic personnel. The principle of data minimization was observed by collecting only the data necessary for attendance verification, audit, and reporting. Data retention and deletion procedures were communicated to participants during the consent process.

RESULTS AND DISCUSSION

The implementation of the Smart Attendance System generated real-time datasets consisting of structured and semi-structured information. The system used student identifiers, course sections, session identifiers, timestamps, QR scan results, and GPS validation logs to automate attendance recording. Attendance was recorded only when the QR code matched the active session and the student location was within the approved geographic boundary. The administrative panel provided instructors with real-time access to attendance logs, validation outcomes, and system-generated records.

Table 3 presents the functional testing results across the core modules of the Smart Attendance System.

Table 3. Functional Testing Results

Module	Test Case	Expected Result	Actual Result	Status
Student Login	Student logs in using valid credentials	Access granted to valid user	Access granted to valid user	Passed
QR Scan	Student scans a valid session QR code within the boundary	Attendance recorded with timestamp	Attendance recorded with timestamp	Passed
Location Verification	Student scans inside the designated geographic boundary	Attendance recorded as valid	Attendance recorded as valid	Passed
Invalid Location	Student scans from outside the approved boundary	Attempt rejected by the system	Attempt rejected by the system	Passed
Duplicate Scan	Student scans the QR code more than once in the same session	Duplicate scan rejected	Duplicate scan rejected	Passed
Admin Dashboard	Instructor views real-time attendance logs	Logs displayed correctly in real time	Logs displayed correctly in real time	Passed

Functional testing showed that the major system modules performed according to their expected use cases. The results indicate that the system was able to authenticate users, validate QR scans, check location boundaries, reject duplicate or invalid attempts, and display real-time attendance logs for instructor monitoring.

Table 4 presents the attendance validation outcomes observed during system testing. The original validation categories were treated as separate attendance-related events. Based on the reported values, the total number of attempts was corrected to 110 because valid entries, invalid location attempts, invalid QR attempts, and duplicate scan attempts summed to 110.

Table 4. Attendance Validation Summary

Indicator	Result
Total attendance attempts	110
Valid QR and valid location entries recorded	75
Valid QR but invalid location attempts rejected	20
Invalid QR attempts rejected	5

Duplicate scan attempts rejected	10
Successfully recorded attendance entries	75
Total rejected attempts	35
Rejection rate	31.82%

The attendance validation results show that the dual-verification mechanism was able to distinguish valid attendance entries from invalid attempts. Of the 110 attendance-related attempts, 75 were recorded as valid, while 35 were rejected due to invalid location, invalid QR code, or duplicate scan conditions. The corrected rejection rate was 31.82%. These results suggest that QR code validation combined with GPS verification can strengthen attendance data integrity under the tested conditions.

Efficiency and Accuracy

The system supported more accurate attendance monitoring by requiring both digital and geographic validation before recording an attendance entry. This approach reduces the risk of proxy attendance and remote check-ins compared with QR-only or manual attendance systems. The rejection of invalid location attempts demonstrates the value of location verification in confirming physical presence during the attendance event.

The system also has practical value for improving efficiency because it automates attendance recording and provides real-time logs to instructors. However, future reports should include a complete manual-versus-system time comparison to quantify time savings more precisely. Without detailed time-motion results, efficiency should be interpreted as a functional advantage of automation rather than a fully quantified outcome.

User Experience and Satisfaction

The dual-platform design supported the needs of both students and instructors. Students used the mobile application for attendance submission, while instructors used the administrative panel to create sessions, generate QR codes, define boundaries, and view attendance logs. This workflow simplified attendance monitoring and reduced the need for paper-based checking.

Table 5. User Evaluation Summary

Usability Measure	Result
Number of respondents	100
Lowest SUS score	72.50
Highest SUS score	90.00
Mean SUS score	81.25
Standard deviation	4.58

SUS interpretation	Good usability
Acceptability range	Acceptable

The mean SUS score of 81.25 indicates that the system had good usability and was acceptable to its intended users. The score suggests that users generally perceived the system as understandable, usable, and appropriate for attendance monitoring. Nevertheless, future evaluations may include separate SUS results for students and instructors to provide a clearer view of user experience across different roles.

Theoretical Integration

The study integrates educational technology and information systems principles by transforming attendance monitoring into a data-driven process. The dual-verification framework synchronizes structured data, such as student identifiers and schedules, with semi-structured data, such as GPS coordinates and timestamps, to validate physical presence. This strengthens the reliability and traceability of attendance records.

The system may be contextualized within the Technology Acceptance Model proposed by Davis (1989), which explains user acceptance through perceived usefulness and perceived ease of use. The mobile scanning interface supports ease of use, while real-time monitoring and fraud reduction support perceived usefulness. The DeLone and McLean (2003) Information Systems Success Model also supports the evaluation of system quality, information quality, and net benefits, particularly in relation to reliable validation, timely attendance records, and reduced administrative workload.

Implications

The study has practical implications for academic institutions seeking to modernize attendance management. By integrating QR code scanning, location verification, and real-time reporting, the system provides a more reliable alternative to manual attendance records. It can help instructors reduce administrative tasks and focus more on instructional delivery while maintaining more accurate student participation records.

The study also has policy and managerial implications because the use of location-based attendance data requires clear privacy safeguards. Institutions adopting similar systems should establish policies on informed consent, data access, data retention, audit trails, and the limited use of GPS data. These safeguards are necessary to ensure that attendance monitoring remains ethical, proportionate, and compliant with the Data Privacy Act of 2012.

Limitations and Future Work

The study was conducted within a limited testing period and a specific academic setting. The findings should therefore be interpreted in relation to the sample, device conditions, network availability, and GPS performance during the testing period. GPS accuracy may vary depending on device quality, indoor signal strength, and environmental conditions. Future studies should test the system across multiple classrooms, devices, course schedules, and network conditions.

Future development may include clearer geofence calibration, stronger protection against GPS spoofing, integration with institutional learning management systems, expanded analytics dashboards, and optional secondary verification methods. If facial recognition or biometric validation is considered, stronger ethical review and privacy safeguards must be implemented because such technologies involve more sensitive personal data.

CONCLUSION

The study developed and evaluated a Smart Attendance System designed to improve the accuracy, efficiency, and integrity of attendance monitoring in an academic setting. Functional testing showed that the system successfully performed its major functions, including student login, QR code scanning, GPS-based location verification, duplicate scan prevention, invalid attempt rejection, and real-time attendance log viewing.

Attendance validation results showed that the dual-verification mechanism can help reduce invalid, duplicate, and proxy attendance attempts under the tested conditions. The system recorded 75 valid attendance entries and rejected 35 invalid or duplicate attempts from 110 attendance-related attempts, resulting in a corrected rejection rate of 31.82%. The usability evaluation further showed that the system achieved good usability, with a mean SUS score of 81.25.

Overall, the Smart Attendance System provides a practical and data-driven solution for improving attendance management in academic institutions. It supports real-time monitoring, strengthens the reliability of attendance records, and provides a foundation for analytics-based student participation monitoring. Future work should focus on improving location accuracy, testing the system in broader deployment conditions, strengthening data privacy safeguards, and exploring integration with institutional academic systems.

REFERENCES

Al Amin, I. H., Lusiana, V., Hartono, B., & Wahyu, D. (2024). QR code-based attendance system for contact tracking post-pandemic. CogITo Smart Journal, 10(1), 436-450. https://doi.org/10.31154/cogito.v10i1.490.436-450

Alhothaily, A., Alradaey, M., Oqbah, M., & El-Kustaban, A. (2018). Location-aware event attendance system using QR code and GPS technology. International Journal of Advanced Computer Science and Applications, 9(9). https://doi.org/10.14569/IJACSA.2018.090959

Agripa, D. J. B., & Astillero, S. F. (2022). Development of employee attendance and management system using Quick Response (QR) code in Sorsogon State University, Castilla Campus, Philippines. European Journal of Education Studies, 9(11), 307-320. https://doi.org/10.46827/ejes.v9i11.4545

Brooke, J. (1996). SUS: A quick and dirty usability scale. In P. W. Jordan, B. Thomas, B. A. Weerdmeester, & I. L. McClelland (Eds.), Usability evaluation in industry (pp. 189-194). Taylor & Francis.

Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. MIS Quarterly, 13(3), 319-340. https://doi.org/10.2307/249008

DeLone, W. H., & McLean, E. R. (2003). The DeLone and McLean model of information systems success: A ten-year update. Journal of Management Information Systems, 19(4), 9-30. https://doi.org/10.1080/07421222.2003.11045748

International Organization for Standardization. (2023). ISO/IEC 25010:2023: Systems and software engineering: Systems and software Quality Requirements and Evaluation (SQuaRE): Product quality model. ISO.

Journal of Hypermedia & Technology-Enhanced Learning. (2025). A dual-validation mobile attendance application for discipline-oriented vocational schools. Journal of Hypermedia & Technology-Enhanced Learning, 3(3), 283-295. https://doi.org/10.58536/j-hytel.200

Pressman, R. S., & Maxim, B. R. (2014). Software engineering: A practitioner's approach (8th ed.). McGraw-Hill Education.

Republic Act No. 10173. (2012). Data Privacy Act of 2012. Republic of the Philippines. https://www.officialgazette.gov.ph/2012/08/15/republic-act-no-10173/

Richey, R. C., & Klein, J. D. (2007). Design and development research: Methods, strategies, and issues. Lawrence Erlbaum Associates. https://doi.org/10.4324/9780203826034