



Location Validation and Server Time Synchronization for iOS-Based Attendance to Mitigate ASN Fraud in Lamongan

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Article Info	Abstract
Article History: <i>Submitted 10 Aug 2026</i> <i>First Revised 22 Sep 2026</i> <i>Accepted 30 Sep 2026</i> <i>First Available Online 30 Sep 2026</i> <i>Publication Date 30 Sep 2026</i> Keyword: <i>iOS Attendance Application;</i> <i>Geofencing;</i> <i>Server Time Synchronization;</i> <i>Location Validation;</i> <i>Civil Servant (ASN).</i>	The rapid advancement of information technology has driven government institutions to adopt digital attendance systems to improve the effectiveness of attendance management for Civil Servants (ASN). The Lamongan Regency Government has implemented an Android-based attendance application, but no equivalent service is available for iOS users, creating unequal access to digital attendance services among employees who use different devices. This study designs and implements an iOS-based attendance application equipped with geofencing-based location validation and server time synchronization to improve attendance-data accuracy and reduce the risk of fraud such as location or time manipulation. The application was developed using the Flutter framework and integrated with a Laravel REST API and a MySQL database for authentication, data storage, and real-time communication. Testing results show that the application successfully performs authentication, location validation, server time synchronization, and check-in/check-out processes according to the defined rules. Black-box testing confirmed that all functions operated as expected, geofencing testing verified that attendance could only be recorded within the designated work area, and GPS-spoofing testing showed that spoofed locations outside the designated radius were rejected, while spoofed coordinates placed inside the radius were accepted, indicating that the current geofencing mechanism validates reported coordinates rather than detecting spoofing itself. A System Usability Scale (SUS) evaluation yielded a score of 77.02 (Good), indicating that the application is easy to use. These results demonstrate that the proposed application supports more accurate, secure, and consistent attendance recording for Civil Servants.

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1. Introduction

The growing pace of digital transformation in government administration has pushed public institutions to move beyond conventional paper-based or device-bound processes toward integrated, accountable, and electronic service delivery. One concrete manifestation of this shift is the digitalization of personnel administration, particularly the recording of attendance for Civil Servants (Aparatur Sipil Negara, ASN). A digitized attendance system is expected to produce fast and accurate attendance records that can be used as an objective basis for evaluating employee discipline, rather than relying solely on manual supervision.

For several years, many government agencies have relied on fingerprint or face-recognition machines as the primary medium for attendance recording. Although such devices are reasonably effective for identity verification, they require employees to be physically present at a fixed machine, which often creates queues during peak clock-in and clock-out hours, and they depend on hardware that is costly to procure and maintain. These limitations show that conventional, device-bound attendance recording is poorly suited to the mobility requirements of a modern, technology-driven government workforce.

Lamongan Regency has increasingly emphasized public-facing government initiatives, from city-branding efforts intended to strengthen its regional image and public relations [1] to a long-standing tradition of close collaboration between local government and the community in addressing regional challenges [2], reflecting a broader institutional commitment to responsive, community-oriented governance. Similar digitalization efforts have been observed in other Indonesian regional governments, where e-government innovation has been used to accelerate public-service delivery at the district level [3]. As part of its personnel-service digitalization effort, the Lamongan Regency Government has deployed a mobile attendance application for the Android platform. The application allows ASN to record attendance using personal devices instead of a fixed fingerprint machine, and it already applies geofencing-based location validation together with server time synchronization to ensure that attendance is recorded at the correct place and time. However, this implementation is limited to Android; employees who use iPhone devices are still required to rely on alternative methods, such as borrowing an Android device or using the conventional attendance machine. A preliminary survey among ASN in the Lamongan Regency Government indicated a non-trivial proportion of iPhone users, showing that an iOS-based attendance service is no longer merely an individual preference but an organizational requirement for equitable digital service delivery.

Beyond platform availability, the validity of attendance data is a critical concern for any mobile attendance system. Without adequate safeguards, a mobile-based attendance process is vulnerable to location and time manipulation. Geofencing is one of the most widely adopted approaches for location validation: it constructs a virtual geographical boundary around a set of reference coordinates and a defined radius, and it only allows an attendance transaction to be recorded when the user's device is positioned inside that boundary. Related work has shown that geofencing combined with real-time verification and additional identity checks, such as face recognition, can increase attendance accuracy and reduce cheating practices such as proxy attendance [4]. A geofencing-based tracking

approach focused on precise geospatial boundaries has similarly been shown to reduce coordinate manipulation in conventional attendance systems while improving accuracy and efficiency [5].

A second and equally important concern is the trustworthiness of the timestamp used to record attendance. When an attendance system relies on the local clock of the user's device, that timestamp can be altered by changing the device's date and time settings, which threatens data integrity. Studies on time-synchronization security in distributed and time-sensitive systems emphasize that delay manipulation, time spoofing, and offset attacks are realistic threats whenever a system depends on device-reported time, and that timestamp accuracy is essential for applications that require strong data validity, such as digital attendance systems [6]. Related implementations of GPS-based and QR-code-based attendance recording in Indonesian government and healthcare settings further reinforce that location- and time-aware validation mechanisms are increasingly regarded as a baseline requirement, not an optional enhancement, for digital attendance platforms [7], [8], [9], [10], [11].

Building on these considerations, this study develops an iOS-based ASN attendance application for the Lamongan Regency Government that reuses the existing Laravel-based backend and database of the Android system while adding a native iOS front end built with the Flutter framework. The application retains the two core validation mechanisms already proven on the Android platform — geofencing-based location validation and server-time synchronization — and extends them with a rule-based attendance-analysis mechanism that classifies attendance records according to punctuality, lateness, and location conformity, to support the disciplinary evaluation of ASN. The main contributions of this study are: (1) the design and implementation of a cross-device-equivalent, iOS-native attendance application integrated with an existing government backend through a REST API; (2) the application of geofencing-based location validation and server-time synchronization to reduce location and time manipulation on iOS devices, together with an empirical characterization of the conditions under which coordinate-based geofencing does and does not resist GPS-spoofing attempts; and (3) an empirical evaluation of the resulting application through black-box functional testing, location- and time-validation testing, and a System Usability Scale (SUS) assessment involving 26 respondents.

2. Methods

This research develops an iOS-based attendance application for the Lamongan Regency Government, integrated with the existing Laravel REST API and MySQL database [12]. The application implements geofencing-based location validation and server time synchronization to ensure that attendance is recorded at the correct place and time, supported by a rule-based mechanism that classifies attendance records for discipline evaluation.

2.1 System Architecture

The system architecture consists of the iOS mobile application as the primary attendance interface, a Laravel-based REST API as the central processing layer, and a MySQL database that stores user, schedule, location, attendance, and rule-based analysis data. The relational structure of these tables was designed using an entity-relationship approach to ensure data consistency across the attendance, schedule, and location modules [13]. The mobile application sends the device's authentication credentials, GPS coordinates, and request timestamp to the API, which validates the request against the stored OPD coordinates and the server clock before persisting the attendance record. Three actor roles interact with the system: Employee (ASN), OPD Manager, and Regional

Civil Service Agency (BKD) Manager, each with access rights that correspond to their operational responsibilities. The overall architecture is illustrated in Figure 1.

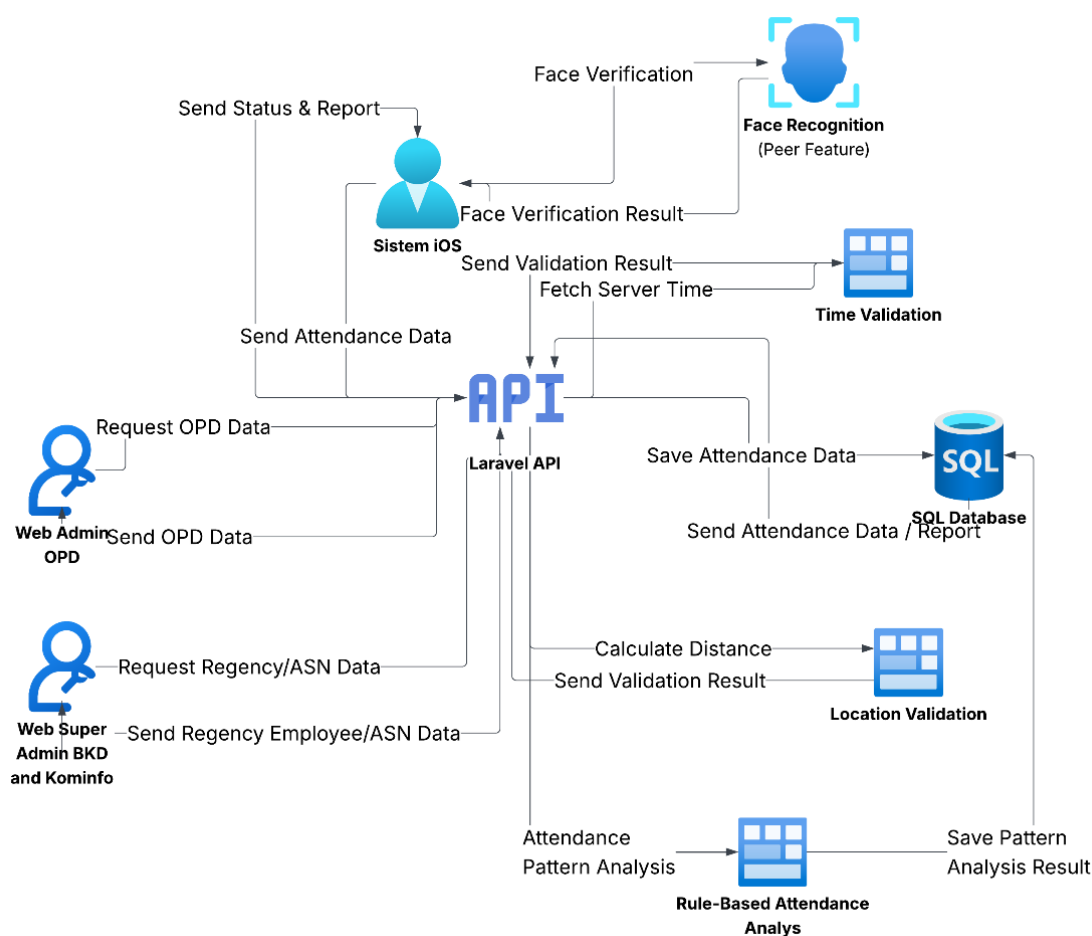


Fig. 1. System architecture connecting the iOS application, the Laravel REST API, and the MySQL database.

2.1.1 Location Validation Using Geofencing

Geofencing is implemented by comparing the real-time coordinates obtained from the device's location service with the reference coordinates and radius stored on the server for each OPD. When the application is opened for an attendance transaction, it retrieves the current latitude and longitude of the device and sends them to the API together with the attendance request. The server computes the distance between the reported coordinates and the OPD reference point; if the distance is within the configured radius, the attendance request is accepted [14], otherwise it is rejected and the application displays a location-error message. Because GPS accuracy can be affected by signal quality, weather conditions, and surrounding structures, the geofence radius is configured with a tolerance margin so that minor positioning deviations do not unnecessarily block legitimate attendance.

2.1.2 Server Time Synchronization

To prevent timestamp manipulation, the application does not use the device's local clock as the attendance time reference. Instead, prior to every check-in or check-out transaction, the application requests the current time from the server through the REST API, and this server-issued timestamp is what gets persisted as the attendance time. This design follows the general principle that time-sensitive, distributed applications should

rely on a single authoritative time source rather than individually configured device clocks, since device-side time can be freely altered by the user [6].

2.1.3 Rule-Based Attendance Analysis

A rule-based mechanism running on the server side classifies stored attendance records according to predefined thresholds — for example, on-time arrival, lateness beyond a configured tolerance, and location conformity relative to the geofence boundary. This mechanism does not perform artificial-intelligence or machine-learning inference; it applies deterministic rules to convert raw attendance and location data into administrator-facing indicators that support discipline evaluation, following the general principle that rule-based classification can substitute for manual, case-by-case review in operational monitoring tasks [15].

2.2 Use Case Design

Figure 2 presents the use case diagram of the system [16]. The Employee actor performs attendance check-in and check-out, views attendance history, submits issue reports, and accesses monthly attendance and performance reports, while the OPD Manager and BKD Manager actors focus on employee-data management, location and schedule configuration, and attendance monitoring and reporting. Shared processes, such as login, are consolidated across actors to keep the diagram readable while still reflecting each actor's distinct set of permissions.

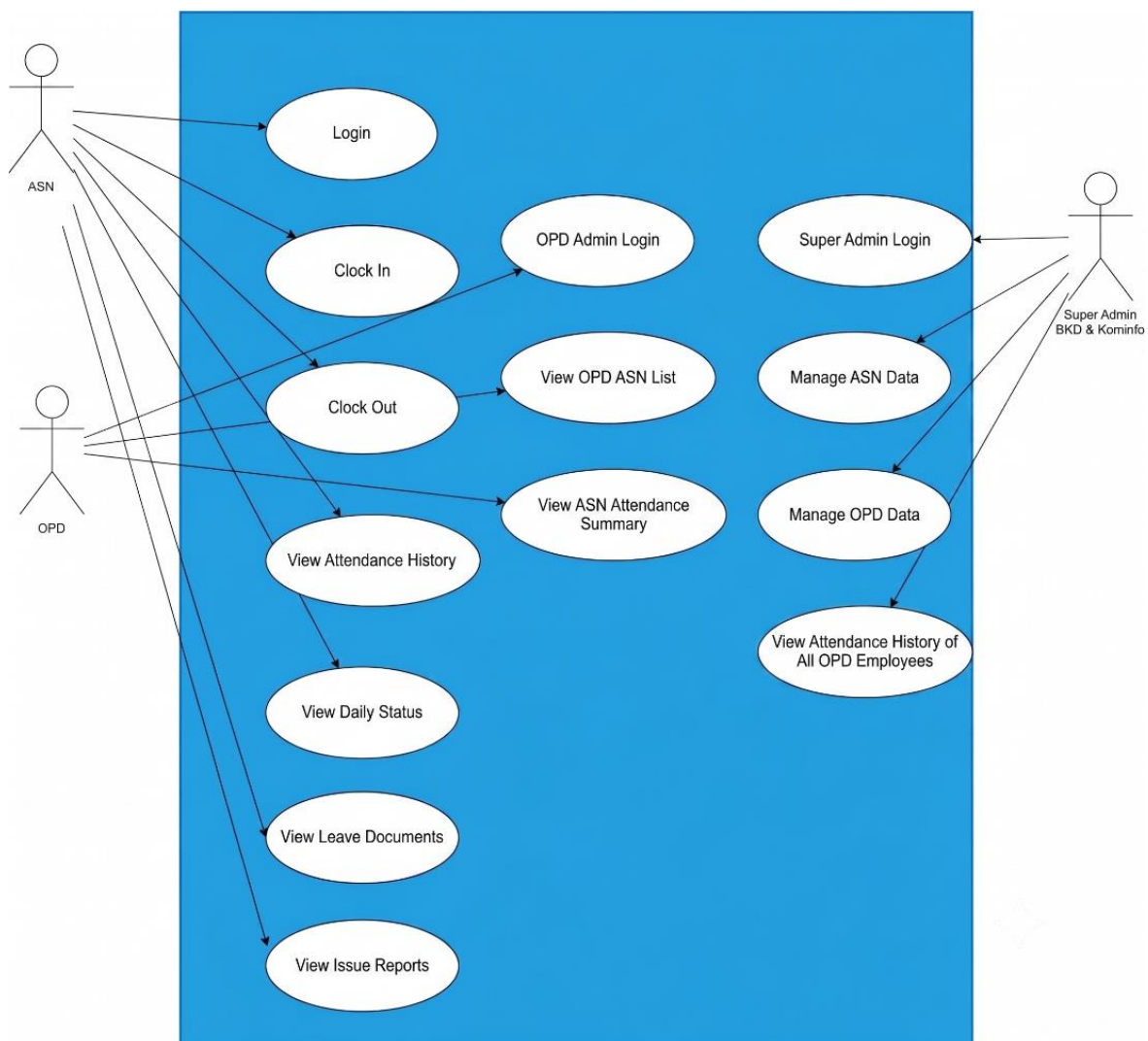


Fig. 2. Use case diagram showing the interaction between actors and the attendance system.

3. Results and Discussion

3.1 System Implementation

The iOS attendance application was successfully implemented using Flutter and integrated with the existing Laravel-based backend of the Lamongan Regency Government through a REST API. All planned interfaces were realized, including the login screen, dashboard, check-in and check-out screens, attendance history, monthly reports, absence-document access, issue reporting, and a performance-analysis view based on employee-allowance (TPP) rules, alongside super-admin modules for managing employees, facial-reference data, work schedules, attendance categories, office locations, and devices [17]. Because the mobile application consumes the same API and database as the Android version, employee, schedule, and location data remain consistent across both platforms without requiring changes to the existing data model or business process.

3.2 Testing Methods

The application was evaluated using four complementary testing approaches, covering functional correctness, location and time validation, and usability.

3.2.1 Black-Box Testing

Black-box testing was performed on every major feature authentication, location validation, time synchronization, check-in, check-out, attendance history, and reporting to confirm that each function produces the expected output for a defined input scenario, independent of the underlying code structure.

3.2.2 Geolocation, Geofencing, and GPS-Spoofing Testing

All tests in this subsection were performed on an iPhone 11 running iOS 26. Geolocation testing verified the application's ability to obtain accurate device coordinates, including behavior when location services are disabled or permission is denied. Geofencing testing evaluated attendance requests at multiple distances from the reference point (10-30 m inside the radius, at the ~100 m radius boundary configured for the tested OPD, and 120-200 m outside the radius; the geofence radius itself is configurable per OPD by the system administrator rather than fixed globally), including two scenarios using a fake-GPS application (Lexa) to spoof the device's reported coordinates to a point outside the geofence (~250 m) and a point inside the geofence (~10 m) to assess resistance to location manipulation.

3.2.3 Server Time Synchronization Testing

The reference time source is the system clock of the Laravel backend server, issued to the application on request through the REST API; synchronization of that server clock against an external Network Time Protocol source is outside the scope of this study. Server-time-synchronization testing altered the device clock forward and backward and compared the resulting attendance timestamp against the server time, and also verified system behavior when no internet connection was available.

3.2.4 Usability Testing (System Usability Scale)

A usability evaluation was conducted using the System Usability Scale (SUS), a ten-item, five-point Likert questionnaire. Following the standard SUS scoring procedure, for odd-numbered items the score contribution is the respondent's rating minus one, and for even-numbered items the contribution is five minus the respondent's rating; the ten per-item contributions are summed and multiplied by 2.5 to obtain each respondent's final score Eq. (1), and the mean of all respondents' final scores is reported as the overall SUS score Eq. (2).

$$\begin{aligned}
 SUS\ score = & [(Q1 - 1) + (5 - Q2) + (Q3 - 1) \\
 & + (5 - Q4) + (Q5 - 1) + (5 - Q6) \\
 & + (Q7 - 1) + (5 - Q8) + (Q9 - 1) \\
 & + (5 - Q10)] \times 2.5
 \end{aligned}
 \tag{1}$$

$$Overall\ SUS\ score = (\Sigma\ final\ scores) \div (number\ of\ respondents)
 \tag{2}$$

The resulting overall score was interpreted using the standard SUS adjective-rating scale, where scores above 80.3 are graded “Excellent,” 68–80.3 are graded “Good,” approximately 68 is “Okay,” 51–68 is “Poor,” and below 51 is “Awful.”

3.3 Black-Box Testing Results

Table 1 summarizes the black-box testing performed on the application's core functions. All tested scenarios produced the expected results, indicating that authentication, location validation, time synchronization, check-in/check-out logic, and the supporting history and reporting features operate correctly according to the functional requirements defined during system design.

Tab. 1. Black-Box Testing Results (Summary)

No	Feature	Test Scenario	Expected Result	Status
1	Login	Valid NIP and password	Dashboard is displayed	Valid
2	Login	Invalid password	Login-failure message is displayed	Valid
3	Login	Empty NIP/password field	Required-field validation is displayed	Valid
4	Location validation	User inside geofence radius	Attendance is permitted	Valid
5	Location validation	User outside geofence radius	Attendance is rejected with a location message	Valid
6	Time synchronization	Application requests server time	Attendance timestamp uses server time	Valid
7	Check-in	Valid check-in at a valid location	Check-in record is stored	Valid
8	Check-in	Duplicate check-in attempt	Second check-in is rejected	Valid
9	Check-out	Check-out after a valid check-in	Check-out record is stored	Valid
10	Check-out	Check-out without a prior check-in	Check-out is rejected	Valid
11	History / reporting	Open history, monthly report, absence documents, issue report	Corresponding data is displayed / submitted	Valid

3.4 Geolocation, Geofencing, and GPS-Spoofing Testing Results

Table 2 summarizes the results of location-validation testing across multiple distances from the reference coordinate, as well as two scenarios using GPS-spoofing tools. The application consistently permitted attendance when the reported location was within the configured radius and rejected attendance when the location was outside it. In the spoofing scenarios, the system evaluated the spoofed coordinates using the same geofencing rule as genuine coordinates: a spoofed location placed outside the geofence was rejected, while a spoofed location placed inside the geofence was accepted, showing that the current validation logic constrains attendance strictly by reported coordinates rather than by detecting spoofing itself.

Tab. 2. Geolocation, Geofencing, and GPS-Spoofing Testing Results

No	Scenario	Distance to reference point	Expected Result	Observed result
1	Inside radius	10–100 m	Attendance permitted	Valid
2	At radius boundary	≈100 m	Attendance permitted	Valid
3	Outside radius	120–200 m	Attendance rejected	Valid
4	GPS-spoofed location outside geofence	≈250 m (spoofed)	Attendance rejected	Rejected – outside radius
5	GPS-spoofed location inside geofence	≈10 m (spoofed)	System validates as if inside area	Accepted – within geofence

3.5 Server Time Synchronization Testing Results

Table 3 shows that regardless of how the device clock was altered — advanced or set back relative to the actual time — the recorded attendance timestamp consistently matched the server time. When the internet connection was unavailable, the application could not retrieve the server time and correctly blocked the attendance transaction rather than falling back to the device clock, which preserves the integrity of the timestamp source.

Tab. 3. Server Time Synchronization Testing Results

No	Scenario	Device clock	Expected Result	Observed result
1	Normal device time	21:00 (matches server)	Timestamp follows server time	Valid
2	Device clock set forward	08:30 (server: 21:00)	Timestamp remains 21:00	Valid
3	Device clock set backward	07:30 (server: 21:00)	Timestamp remains 21:00	Valid

4	No internet connection	Data/Wi-Fi disabled	Attendance is blocked (server time unavailable)	Valid
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3.6 Usability Testing (System Usability Scale)

The SUS questionnaire was administered to Aparatur Sipil Negara (ASN) employees of the Lamongan Regency Government who had trialed the iOS application during the pilot testing period. Respondents were recruited through non-random, purposive sampling from this pilot pool rather than a randomized sample of the full ASN population. The questionnaire instrument (Table 5) collected each respondent's name, OPD/agency, job position, and prior experience using the application, alongside the ten SUS items; it did not collect gender or age, so a demographic breakdown by these variables is not available and is noted as a limitation of this evaluation.

A SUS questionnaire was distributed to 26 respondents who had used the application. Individual per-item scores were converted following Eq. (1) and averaged following Eq. (2), yielding an overall SUS score of 77.02. According to the adjective-rating scale in Table 4, this score falls within the “Good” category (68–80.3), indicating that respondents generally found the application easy to learn, well-integrated across its features, visually consistent, and something they felt confident using without requiring external assistance.

Tab. 4. SUS Score Interpretation

No	SUS score range	Grade	Adjective rating
1	> 80.3	A	Excellent
2	68 – 80.3	B	Good
3	≈ 68	C	Okay
4	51 – 68	D	Poor
5	< 51	E	Awful

Table 5 lists the ten SUS items presented to respondents, translated from the original Indonesian-language instrument administered via the questionnaire form.

Tab. 5. SUS Questionnaire Items

Code	SUS Item (translated from the Indonesian instrument)
Q1	I think that I would like to use this application frequently.
Q2	I found this application unnecessarily complex.
Q3	I thought this application was easy to use.
Q4	I think that I would need the support of a technical person to be able to use this application.
Q5	I found the various functions in this application were well integrated.
Q6	I thought there was too much inconsistency in this application.
Q7	I would imagine that most people would learn to use this application very quickly.

- Q8 I found this application very cumbersome/awkward to use.
 Q9 I felt very confident using this application.
 Q10 I needed to learn a lot of things before I could get going with this application.

To allow independent verification of the reported overall score, Table 6 lists the individual final SUS score obtained by each of the 26 respondents (computed following Eq. (1)-(2)). Across these 26 scores, the mean is 77.02 (SD = 13.75), with a minimum of 50.0 and a maximum of 97.5.

Tab. 6. Individual Final SUS Scores by Respondent (n = 26)

Respondent	Final SUS score	Respondent	Final SUS score
R1	72.5	R14	87.5
R2	75.0	R15	85.0
R3	52.5	R16	62.5
R4	50.0	R17	57.5
R5	97.5	R18	85.0
R6	82.5	R19	62.5
R7	77.5	R20	50.0
R8	75.0	R21	85.0
R9	92.5	R22	70.0
R10	82.5	R23	92.5
R11	85.0	R24	85.0
R12	85.0	R25	95.0
R13	80.0	R26	77.5

3.7 Discussion

Taken together, the results indicate that the iOS application achieves functional parity with the existing Android attendance system while reusing the same backend, which limits the operational overhead of maintaining two independent data models. The geofencing mechanism performed reliably across the tested distance range, but the GPS-spoofing results highlight an inherent limitation of coordinate-only geofencing: because validation depends solely on the coordinates reported by the device's location service, a sufficiently convincing spoofed coordinate that falls inside the configured radius will be accepted. This is consistent with the broader literature on location-based attendance, which frames geofencing as an effective first line of defense against out-of-area attendance rather than a complete anti-spoofing solution [4], [5], [18]. Combining geofencing with device-integrity checks or spoofing-detection APIs is therefore a reasonable direction for strengthening location assurance in future iterations. This limitation also distinguishes the present system from related geofencing-based attendance systems that pair coordinate validation with an additional identity check such as face recognition to curb proxy attendance [4], [5]: because this study's validation layer relies on coordinates alone, it inherits the same spoofing exposure documented in Table 2, whereas combining geofencing with the kind of biometric checks explored in that related work would be expected to close part of this gap by tying a valid attendance event to the physical presence of the enrolled employee, not merely to a reported coordinate.

The server-time-synchronization results, in turn, confirm that anchoring the attendance timestamp to a single authoritative server clock is an effective and low-complexity way to remove device-time manipulation as an attack surface, aligning with prior findings on the importance of trustworthy timestamps in time-sensitive systems [6], [19]. Finally, the “Good” SUS score suggests that extending an already-familiar attendance workflow to a new platform, rather than redesigning it, helped preserve usability for ASN who may already be accustomed to the Android version, which is consistent with observations that reusing established interaction patterns supports faster adoption of new government digital services [9], [20], [21].

3.8 Privacy and Ethical Considerations

The application processes several categories of personal and sensitive data, including employees' GPS coordinates at the moment of attendance, attendance timestamps, and facial-reference images used for identity verification. Access to these records follows the role-based structure described in Section 2.1: Employee, OPD Manager, and BKD Manager accounts are granted different levels of access according to their operational responsibilities, rather than open access to the full dataset. Facial-reference images and location data are used solely to support attendance verification and disciplinary evaluation within the Lamongan Regency Government and are not shared with external parties.

This study did not implement a formal data-retention policy or a documented consent procedure for the SUS evaluation participants. Future development should establish an explicit retention period for location, attendance, and facial-reference data, together with a documented consent process for research participants, in line with the principles of Indonesia's Personal Data Protection Law (Law No. 27 of 2022).

4. Conclusion

This study designed, implemented, and evaluated an iOS-based ASN attendance application for the Lamongan Regency Government that reuses the existing Laravel REST API and MySQL backend while adding geofencing-based location validation, server time synchronization, and a supporting rule-based attendance-analysis mechanism. Black-box testing showed that all core functions performed as expected, geofencing testing confirmed that attendance could only be recorded within a defined work-area radius, server-time-synchronization testing confirmed that recorded timestamps consistently followed the server clock regardless of device-time manipulation, and a SUS evaluation with 26 respondents yielded a “Good” usability score of 77.02. These results indicate that the proposed application meets its functional objectives and provides ASN using iOS devices with an attendance service equivalent to that already available to Android users, supporting more accurate, consistent, and equitable digital attendance recording.

The main limitation observed during testing is that coordinate-based geofencing alone cannot reliably distinguish a spoofed location from a genuine one when the spoofed coordinate falls inside the configured radius; this remains an open area for improvement. Future work should therefore explore combining geofencing with device-level spoofing detection or additional biometric authentication (e.g., Face ID or Touch ID), evaluate the application under larger user populations and varied network conditions, and pursue closer feature parity between the Android and iOS platforms to further streamline ASN attendance management across the Lamongan Regency Government.

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