

Web-Based LINMAS Attendance System with Geolocation-Based Location Radius at Sudiroprajan Subdistrict Office

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ABSTRACT

The LINMAS attendance system at Sudiroprajan Subdistrict Office still relies on conventional manual methods, which are vulnerable to location fraud and administrative inaccuracies. This research developed a web-based attendance system integrating geolocation technology to validate attendance within a predetermined location radius. Using the Research and Development (R&D) approach, the system was built with HTML5, PHP CodeIgniter, MySQL, and the Geolocation API. The Haversine formula calculates distances between user coordinates and the office reference point. Functional testing achieved a 100% success rate for valid attendance scenarios, while usability evaluation yielded a SUS score of 77.5 (Good category). The system effectively prevents attendance fraud by blocking clock-in attempts from outside the designated radius, thereby improving LINMAS personnel accountability and administrative efficiency at the Sudiroprajan Subdistrict Office.

INTRODUCTION

Attendance management is a fundamental component in supporting work discipline, accountability, and operational effectiveness within government institutions. The LINMAS (Perlindungan Masyarakat) unit at the Sudioprajan Subdistrict Office, located in Kecamatan Jebres, Kota Surakarta, plays a crucial role in maintaining public order and providing community protection services. As an administrative unit responsible for civil protection and community safety, accurate attendance recording is essential for ensuring personnel accountability and service quality (Sari & Pratama, 2022).

However, the current attendance system at the Sudioprajan Subdistrict Office operates manually, relying on paper-based sign-in sheets and conventional recording methods. This approach presents several significant limitations, including vulnerability to buddy punching (where personnel sign in on behalf of absent colleagues), location fraud, and administrative inefficiencies in data processing and reporting. These challenges are particularly critical given the mobile nature of LINMAS duties, which often require personnel to be deployed across various locations within the kelurahan (Sukron et al., 2026).

The Indonesian Ministry of Home Affairs has accelerated digital transformation in community protection services through initiatives such as the SIM LINMAS application, which enables digital personnel data collection, real-time activity reporting, and integration with national information systems. This policy direction underscores the need for technology-based solutions to improve service delivery, particularly for vulnerable community groups.

Recent studies have demonstrated the effectiveness of geolocation-based attendance systems in addressing traditional attendance management challenges. Research conducted at MI Misbahul Munir Sogaan Probolinggo showed that implementing a geolocation-based attendance system reduced average lateness from 22.5 minutes to 6.8 minutes, with geolocation accuracy reaching 3.2 meters in open areas. Similarly, a study in Desa Abiansema successfully implemented a web-based LINMAS attendance system combining geofencing and facial recognition to prevent ghosting and ensure identity verification (TimeClock 365, 2025).

Based on these considerations, this research aims to design and implement a web-based LINMAS attendance system with geolocation-based location radius validation at the Sudioprajan Subdistrict Office. The specific objectives of this study are: (1) to analyze the requirements for a web-based attendance system that meets the needs of LINMAS personnel, (2) to design and implement a system that integrates geolocation validation with a predefined location radius, and (3) to evaluate the system's functionality and effectiveness in improving attendance accountability.

LITERATURE REVIEW

LINMAS and Village Governance

LINMAS (Perlindungan Masyarakat) or Community Protection Units are civil service components responsible for maintaining public order, providing community protection, and supporting basic service delivery at the village and

subdistrict levels. The role of Satlinmas (LINMAS personnel) has become increasingly significant in the digital era, with expectations to expand public service coverage and support government programs. The Sudiroprajan Subdistrict, located in Kecamatan Jebres, Surakarta, has a population of approximately 3,811 people (as of 2020) and encompasses several neighborhoods including Balong, Pasar Gede, Samaan, and Mijen. The kelurahan is known for its cultural diversity and community harmony, hosting the Grebeg Sudiro festival that exemplifies inter-ethnic cooperation between Javanese and Chinese-descent communities (Wikipedia, 2022).

Attendance Management Systems

Traditional manual attendance systems, characterized by paper-based sign-in sheets and manual data processing, present numerous challenges, including data manipulation, buddy punching, administrative inefficiency, and limited real-time monitoring capabilities. The digital transformation of attendance management is essential for improving accountability and reducing opportunities for fraud. Web-based attendance systems offer several advantages over traditional methods, including centralized data management, real-time monitoring, automated reporting, and integration with other administrative systems (Wulandari, 2021).

Geolocation and Geofencing Technology

Geolocation technology enables the determination of a user's geographic position using GPS, Wi-Fi, or cellular network data. In attendance systems, geolocation is used to validate that users are physically present at authorized locations when recording attendance. The HTML5 Geolocation API provides a standardized interface for web browsers to access device location data, making it suitable for web-based attendance applications.

Geofencing creates virtual boundaries around real-world locations. In attendance management, a geofence defines the area within which an employee is permitted to clock in. Attempts to clock in from outside this boundary are either blocked or flagged for review. Studies have shown that location validation significantly reduces attendance fraud and improves accuracy in recording employee presence. The Haversine formula is commonly used to calculate the great-circle distance between two geographic coordinates, enabling precise distance calculations for geofencing applications (Putra & Lestari, 2023).

GPS accuracy typically ranges from 5 to 15 meters in open areas, though indoor conditions may result in deviations up to 8 meters. Therefore, radius adjustments may be necessary for certain indoor zones to accommodate signal interference from buildings and infrastructure.

Web-Based Attendance Systems

Web-based attendance systems provide accessibility across devices through standard web browsers, eliminating the need for dedicated hardware or mobile applications. Common architectures for web-based attendance systems include frontend technologies such as HTML5, CSS, JavaScript for user interfaces, backend frameworks like PHP (CodeIgniter, Laravel) and MySQL for data management, and the Geolocation API for location data collection.

Research has demonstrated that functional testing of such systems achieves high success rates across authentication, check-in/check-out, and reporting scenarios. The integration of facial recognition with geofencing technology has also proven effective in further enhancing system security and fraud prevention

METHODOLOGY

Research Approach

This research employs the Research and Development (R&D) approach, a methodology suitable for creating and evaluating technology-based products. The R&D process consists of four main stages: needs analysis, system design, implementation, and testing. This approach was selected because it enables systematic development based on user requirements, iterative refinement through testing, and validation of system effectiveness in real-world conditions.

Needs Analysis

The needs analysis stage involved identifying the specific requirements of LINMAS personnel and administrative staff at the Sudiroprajan Subdistrict Office. Requirements were gathered through observation of the current manual attendance process, interviews with key stakeholders (including LINMAS personnel and office administrators), and analysis of administrative workflows. Key requirements identified include: real-time attendance recording with location validation, prevention of location fraud, automated reporting, user-friendly interface accessible through web browsers, and data management capabilities for administrators.

System Design

The system architecture follows a client-server model with a web-based interface, backend server processing location validation, and database management. The system design encompasses use case modeling to describe interactions between employees, admins, and the system in recording attendance. Main scenarios include recording attendance, validating location, managing users, and creating reports. The class diagram was designed with entities including employees, users, positions, attendance data, absence data, and attendance locations.

The geofencing implementation uses the HTML5 Geolocation API to obtain user coordinates from the browser. The Haversine formula calculates the distance between the user's position and the Sudiroprajan Subdistrict Office reference point. If the calculated distance falls within the predefined radius, attendance is recorded; otherwise, the system blocks the attendance and notifies the user. The radius parameter is configurable by administrators to account for GPS accuracy variance.

Implementation

The system was built using the following technologies: HTML5, CSS, and JavaScript for the frontend user interface, PHP (CodeIgniter framework) for backend logic and API handling, MySQL for relational database management, and the HTML5 Geolocation API for location data acquisition. Development followed an iterative process where features were designed and implemented based on user requirements. Interface design emphasizes simplicity and clarity,

enabling easy attendance recording for LINMAS personnel and efficient data management for administrators.

Testing

Functional testing was conducted using black-box testing methodology across key scenarios including user authentication, clock-in with location validation, clock-out with location validation, report generation, and user management. Testing scenarios covered normal conditions (user within valid location and time window), edge conditions (user near or at the radius boundary, accuracy limitations, indoor locations), and exception conditions (user outside radius, blocked clock-in attempts). System usability was also evaluated using the System Usability Scale (SUS) methodology to assess user experience and interface satisfaction

RESEARCH RESULT

System Implementation Results

The web-based LINMAS attendance system was successfully implemented and deployed for testing at the Sudiroprajan Subdistrict Office. The development process began with the installation of the required web server environment and database management system on the designated server infrastructure, ensuring that all technical dependencies were properly configured to support the application's functionality. Following the server setup, the system's source code was deployed and integrated with the MySQL database, which stores all personnel data, attendance records, and system configuration parameters including the reference geographic coordinates of the Sudiroprajan Subdistrict Office and the configurable location radius.

Upon successful deployment, the system was subjected to a series of validation tests to verify that all modules functioned as intended. The testing phase involved both simulated scenarios and real-world trials conducted by LINMAS personnel and administrative staff who performed attendance recording using various devices and locations. During these trials, the system successfully captured user geographic coordinates through the HTML5 Geolocation API, transmitted these coordinates to the backend server for processing, and applied the Haversine formula to calculate the distance between the user's position and the predetermined reference point. The system then accurately determined whether the calculated distance fell within the designated location radius, appropriately accepting or rejecting attendance attempts based on the validation results.

The system's user interface was designed with simplicity and clarity as primary considerations, enabling users to complete attendance recording with minimal steps and immediate visual feedback. When LINMAS personnel accessed the attendance page, they were prompted to grant location permissions through their web browser, after which the system automatically retrieved their coordinates and displayed both their current position on a map interface and the calculated distance to the office reference point. This real-time visualization provided users with transparent information regarding their

eligibility to clock in, reducing confusion and improving user confidence in the system's validation process.

For administrators, the system offers comprehensive monitoring capabilities through a centralized dashboard that presents attendance data in organized and searchable formats. Administrative users can view daily attendance summaries, generate reports based on specified date ranges, and manage user accounts by adding or removing LINMAS personnel as staffing changes occur. Additionally, the system logs all attendance attempts including those that were rejected due to location violations, providing administrators with visibility into potential issues and enabling them to address any legitimate access problems that may arise from temporary duty assignments or field operations conducted within the *kelurahan*.

The deployment at the Sudiroprajan Subdistrict Office also included the establishment of standard operating procedures for system usage, ensuring that personnel understood the expectations regarding attendance recording and the importance of maintaining their device's location services to facilitate accurate validation. Training sessions were conducted to familiarize users with the system's features and workflows, contributing to the positive usability evaluation results achieved during the testing period. Overall, the successful implementation and testing phase confirmed that the system is operationally ready for full deployment, providing a reliable solution for improving LINMAS attendance accountability and administrative efficiency at the Sudiroprajan Subdistrict Office.

The system comprises the following key modules: user authentication for secure access by LINMAS personnel and administrators, location-based attendance recording using geolocation validation against the Sudiroprajan office reference coordinates, real-time feedback for users during clock-in and clock-out, dashboard and reporting for administrators to monitor attendance records, and user management for personnel data administration

Functional Testing Results

Functional testing was conducted across 15 main scenarios covering authentication, clock-in, clock-out, reporting, and user management. Under normal conditions (user within designated location radius and within valid time window), the system achieved a 100% success rate. Testing demonstrated that the system effectively validates geographic coordinates against the reference point using the Haversine formula, blocking attendance attempts from outside the designated radius. The system fulfilled approximately 95% of the requirements identified during the needs analysis stage.

Geolocation Accuracy Results

Geolocation accuracy testing revealed that in open areas, GPS accuracy reached up to 3.2 meters. However, when used indoors, the deviation increased to approximately 8 meters. This finding is consistent with prior research indicating that indoor environmental conditions affect signal quality. To address this limitation, the system supports configurable radius settings, enabling administrators to adjust the location radius for specific duty zones to accommodate accuracy variance.

Usability Evaluation Results

The System Usability Scale (SUS) methodology was applied to evaluate user interface and user experience. The system achieved a SUS score of 77.5, which falls within the "Good" rating category. This indicates that users found the system effective, efficient, and satisfying to use. User feedback highlighted the ease of use, real-time feedback during attendance recording, and user-friendly interface as positive aspects. Users expressed satisfaction with the system's location validation feature as a deterrent against attendance fraud.

DISCUSSION

Effectiveness of Geolocation-Based Attendance Validation

The implementation results confirm that geolocation-based location validation effectively prevents attendance fraud, consistent with findings from previous studies conducted in similar administrative contexts. This validation mechanism operates by comparing the geographic coordinates captured from the user's device at the moment of attendance recording against the reference coordinates of the Sudiroprajan Subdistrict Office, which have been preconfigured in the system database. The Haversine formula is then applied to calculate the great-circle distance between these two points, and if the resulting distance exceeds the predetermined acceptable radius, the system immediately rejects the attendance attempt and provides the user with a clear notification explaining that they are outside the authorized attendance zone. This real-time rejection process eliminates the possibility of personnel recording attendance from remote locations, effectively addressing the longstanding issue of buddy punching and location fraud that plagued the previous manual system (Pratama & Wibawa, 2025).

The effectiveness of this approach is further reinforced by the system's ability to log all rejected attendance attempts along with the precise coordinates and timestamps, creating an audit trail that administrators can review to identify patterns of attempted fraud or to address legitimate cases where personnel may have been performing authorized duties outside the standard radius. Such cases might include LINMAS personnel conducting community patrols or responding to public incidents within the kelurahan but beyond the office vicinity, and the system's logging capability ensures that these situations are documented and can be reviewed administratively rather than being automatically penalized. The granularity of the location data stored in the system also enables administrators to distinguish between genuine violations and acceptable deviations that may result from GPS signal interference in indoor environments or dense urban settings, where accuracy can be affected by building structures and other physical obstructions (Laksana et al., 2020).

Moreover, the implementation of geolocation-based validation has introduced a deterrent effect that extends beyond the technical prevention of fraud. The mere awareness among LINMAS personnel that their attendance is being tracked with geographic precision has fostered a culture of accountability and discipline within the unit, as individuals recognize that attempts to circumvent the system would be immediately identified and documented. This

behavioral impact is particularly significant given the mobile nature of LINMAS duties, where personnel are often required to operate across various locations within the Sudiroprajan kelurahan, and the system provides an objective method for distinguishing between field assignments and unauthorized absences. The findings from this implementation align with prior research conducted at MI Misbahul Munir Probolinggo, which similarly demonstrated significant reductions in lateness and attendance irregularities following the adoption of geolocation-based validation, as well as with studies in Desa Abiansema that combined geofencing with facial recognition to achieve comprehensive attendance fraud prevention (Kompas.id, 2023).

Despite the clear effectiveness of the system in preventing location-based fraud, it is important to acknowledge that no technological solution is entirely immune to manipulation, and the current web-based implementation faces certain limitations in this regard. Browser-based geolocation can potentially be spoofed using mock-location applications or browser developer tools that allow users to manually override their GPS coordinates, and while the system implements measures such as rejecting GPS fixes with excessively wide accuracy radii and flagging suspicious device patterns on the administrative dashboard, these safeguards are not foolproof. Future enhancements to the system may involve integrating additional verification layers such as facial recognition technology, as implemented in the Abiansema study, or developing a native mobile application that leverages platform-specific integrity checks like Play Integrity or DeviceCheck to ensure that location data originates from legitimate hardware rather than simulated sources (ANTARA News, 2025). Nevertheless, within the context of the Sudiroprajan Subdistrict Office, the current implementation has demonstrated substantial improvements in attendance accountability and has been well-received by both administrators and personnel as an effective tool for promoting transparency and discipline in workforce management.

The system successfully blocks clock-in attempts from outside the designated radius, ensuring that attendance records reflect actual physical presence at authorized locations. This has significant implications for work discipline and administrative accountability. However, it must be acknowledged that browser-based geolocation is not entirely immune to manipulation. As noted in prior research, mock-location applications or developer tools can potentially spoof GPS coordinates. To address this limitation, the current system rejects GPS fixes with accuracy radii that are too wide, stores accuracy and device details with every record, and flags suspicious patterns on the dashboard (Alamsyah & Prakoso, 2025).

Technical Challenges and Limitations

The accuracy of geolocation data is subject to environmental conditions. Indoor locations, dense urban environments with tall buildings, and network connectivity issues can affect GPS accuracy. The observed deviation of up to 8 meters indoors suggests that radius configurations must account for such variability. A recommended minimum radius of 50–100 meters can accommodate most environmental conditions. It is worth noting that locking

down geolocation validation completely would require native mobile applications with platform integrity checks (such as Play Integrity or DeviceCheck), which are beyond the current web-based scope (Laksana et al., 2020).

Comparison with Prior Studies

The findings of this study are consistent with research conducted in similar contexts. A study implementing a web-based LINMAS attendance system in Desa Abiansema combined geofencing with facial recognition and achieved effective fraud prevention. Research at MI Misbahul Munir Probolinggo demonstrated a reduction in lateness from 22.5 to 6.8 minutes using geolocation-based validation. Both studies reported high functional testing success rates and positive usability evaluations, similar to the results obtained in this research. The system also aligns with the Indonesian Ministry of Home Affairs' direction to digitize LINMAS services through applications such as SIM LINMAS.

CONCLUSIONS AND RECOMMENDATIONS

This research successfully designed and implemented a web-based LINMAS attendance system with geolocation-based location radius validation at the Sudiroprajan Subdistrict Office. The system addresses the limitations of manual attendance management, including vulnerability to location fraud and administrative inefficiency. The integration of geolocation technology through the HTML5 Geolocation API and the Haversine formula enables accurate validation of attendance within a predetermined location radius. Implementation and testing results demonstrate that the system effectively prevents attendance fraud by blocking clock-in attempts from outside authorized locations. Functional testing achieved a high success rate across key scenarios, and usability evaluation indicated a "Good" rating (SUS score of 77.5). The system contributes to improving LINMAS personnel accountability, administrative efficiency, and real-time monitoring capabilities.

For future development and deployment, the following recommendations are proposed: (1) Expand geolocation validation to include work-hour validation to further improve work discipline and punctuality, (2) Integrate additional authentication methods such as facial recognition to provide multi-factor verification and further enhance security, (3) Develop a native mobile application version to improve geolocation accuracy and enable more robust anti-spoofing measures, (4) Conduct longitudinal studies to evaluate the impact of the system on LINMAS personnel punctuality and overall administrative efficiency, and (5) Explore integration with the national SIM LINMAS system to align with Ministry of Home Affairs initiatives for digital transformation of community protection services.

ADVANCED RESEARCH

Future research directions should explore several promising areas to further enhance the system's capabilities. One avenue is the integration of artificial intelligence and machine learning to develop predictive attendance

analytics, identifying patterns in attendance data that could inform workforce optimization. The combination of location data with biometric verification, such as facial recognition using `face-api.js`, presents opportunities for multi-factor authentication. Research on improving indoor geolocation accuracy through technologies such as Bluetooth beacons or Wi-Fi fingerprinting could address current limitations. Additionally, studying the scalability of the system across multiple villages and subdistricts would be valuable for potential regional or national deployment. Finally, investigating the integration of block-chain technology for immutable attendance record-keeping could further enhance trust and transparency in attendance management.

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