J-INTECH (Journal of Information and Technology)
Accredited Sinta 4 Ministry of Higher Education, Science and Technology Republic of Indonesia SK No. 10/C/C3/DT.05.00/2025
E-ISSN: 2580-720X || P-ISSN: 2303-1425

Development of Geolocation-Based Employee Attendance Application on Android Mobile

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Keywords

Android mobile; Employee attendace; Geolocation; Flutter

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Abstract

The development of mobile-based systems in Indonesia has provided innovative solutions to improve the efficiency of conventional administrative processes, especially in employee attendance. This research aims to develop an Android-based employee attendance application that is integrated with geolocation technology to enable accurate and real-time attendance monitoring. This system is built using the Waterfall method, which includes the stages of needs analysis, system design, implementation using Flutter and Dart programming language, and testing using black box testing techniques. Black-box testing was conducted on six main functions, resulting in a 94% overall success rate. Most functions achieved a 100% pass rate, but two test cases for attendance check in/out failed due to GPS location inaccuracies, highlighting the impact of device and environmental factors. The average response time was 1.28 seconds, and the average GPS delay was 2.1 seconds. The implementation of real-time notifications and admin verification improved transparency and minimized attendance fraud. The results demonstrate that the application provides an effective and efficient solution for employee attendance management. Future work should focus on enhancing location accuracy, conducting non-functional testing, and expanding features to ensure broader adoption and system robustness.

1. Introduction

The implementation of the digitalization system in Indonesia at the beginning of the digitalization era changed the conventional way of working and increased time efficiency. Good use of computers and software will reduce errors, overcome delays, increase business assets, and increase employee productivity [1]. Mobile-based geolocation technology may be a breakthrough to improve the efficiency of employee data management, the process of determining the geographic location of an object in the real world known as geolocation. This process is closely related to positioning, but geolocation makes it possible to determine a location, such as an address, in more detail than positioning, which includes only a set of geographic coordinates [2].

Attendance is a mechanism for collecting data on employee attendance and absence in a specific location or activity, for example in the office. The purpose is to verify the fulfillment of employee obligations and provide records or proof of employee attendance status. To do an absence, there are several problems. One of them is the fingerprint machine that must be used and people have to come to the office on time. To do an attendance, employees have to queue at the door to do an attendance, but if the fingerprint machine can't detect a finger, it will hinder other employees and be time-consuming. Some of the disadvantages of fingerprint attendance include the difficulty of detecting a finger and the time it takes to queue for an attendance [3].

Android is a subset of mobile operating systems that includes middleware and operating system components.Android's danaplikasiintiy is a mobile operating system that supports the operating system, but it has been modified. There are various types of information available, such as information about iklim, kualitasudara, and information about igempaterkini.Additionally, the app provides information about the use of GPS and its benefits [4].

Several previous studies have attempted to address these limitations by utilizing mobile and geolocation technologies. For example, developed an Android-based attendance application using geolocation and photo capture to verify employee presence, which was proven to reduce attendance fraud and increase flexibility for employees to check in from various locations[5]. Similarly, implemented a mobile attendance system combining geolocation and fingerprint features, improving the accuracy and discipline of employee attendance, although the accuracy of geolocation was still dependent on device specifications[6]. Another study applied a prototype-based approach for an online attendance system leveraging geolocation, making the process more efficient compared to conventional fingerprint machines[7]. However, most of these studies have not fully integrated real-time monitoring and user-friendly interfaces for both employees and HR departments.

The mobile attendance app helps HR departments manage attendance data and employee data information. The benefits of geolocation for employee attendance include preventing attendance fraud, making it easier for employees to be absent outside the office. Therefore, it is hoped that the implementation of the mobile attendance application will improve overall employee performance, including the performance of the HR department in managing attendance data [8]. The purpose of this research is to develop a mobile-based application that has the ability to manage employee attendance, such as clocking in and also clocking out, showing location, and displaying time [9]. This application is an online abstraction where users may access mobile applications on their phones and computers using database servers as a means of storing data and connect to websites as a means of managing content that is managed by administrators [10].

This mobile attendance application was created to provide an innovative and integrated solution. Geolocation technology allows organizations to monitor and report employee activities in real-time and know what is better in terms of their daily movements and activities. This research applies geolocation as a strategic approach to improve the security, efficiency, and productivity of the company's human resources.

2. Research Method

The Waterfall method is used as a system development approach in this study. With the Flutter framework, system coding is done using the dart language. This method is very popular for developing software applications. The waterfall method is easier to use and easier to understand. Nonetheless, this method must be implemented from start to finish of the process and will usually take longer even if the project is small. The stages of the waterfall method are, needs analysis, design, implementation, testing, and maintenance [11].

The Waterfall method was selected because the system requirements were well-defined from the beginning and the project scope was limited. This approach enabled a structured development flow and ensured each stage was completed before moving to the next, which is suitable for small to medium projects without frequent requirement changes.

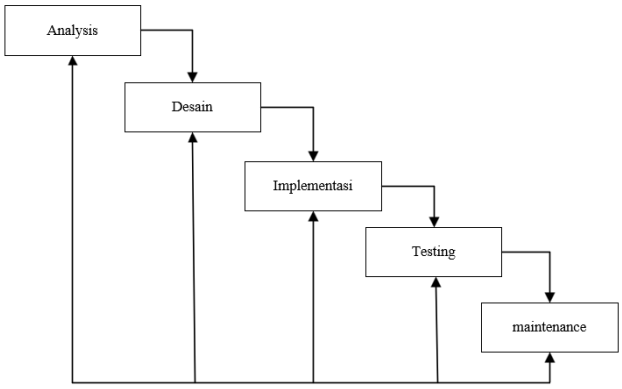

Figure 1. Waterfall Method

In the needs analysis stage, data is collected through interviews with the company's Human Resource Development (HRD) department. This stage lasts for approximately two weeks, where a series of interviews and discussions are conducted to understand the system's overall needs. The data collected includes employee profile information, positions, and employee attendance data.

The next step is to determine the appearance of the system interface to be used. The system design stage includes designing the system flow using UML diagrams such as use case diagrams, activity diagrams and sequence diagrams. This design process takes about two months, including the creation of various diagrams and user interface mock-ups.

This application is implemented using the Flutter framework and the Dart programming language, while the backend is developed using PHP and MySQL. Flutter was chosen because of its ability for rapid cross-platform development and an attractive user interface, while PHP and MySQL were chosen because of their popularity and ease of integration for web-based back-end development.

System testing is carried out using black box testing to ensure that all functions operate according to the specified requirements. This system includes displays such as clock in and clock out, location tracking using openstreetmap geolocation, and real-time notifications if users are present outside a predetermined radius. When users are outside the radius, they must submit a photo and explanation, which is then reviewed by the admin for approval or rejection.

After the testing is successfully completed, the maintenance phase is carried out to fix bugs or system problems found during the trial phase. System maintenance is planned to be carried out periodically during the application's use period.

3. Result and Discussions

Based on observations, the manual attendance system that runs requires employees to queue to make an attendance, which is then validated and the data is saved. If the validation fails, the employee must repeat the process. The admin then retrieves the stored attendance data to create and print reports. This system has potential obstacles in the form of queuing and repeating attendance if validation fails.

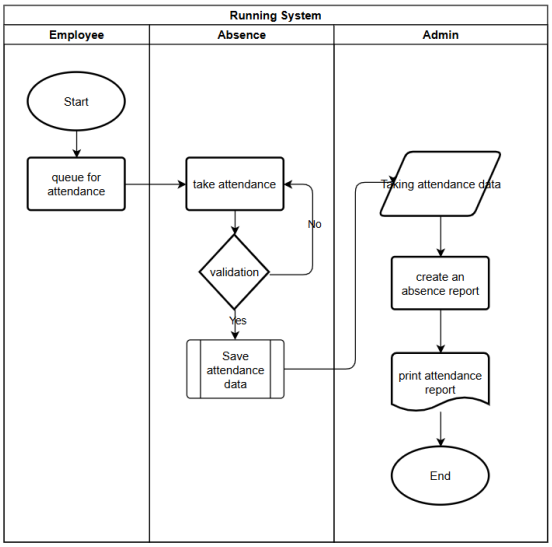

Figure 2. running system

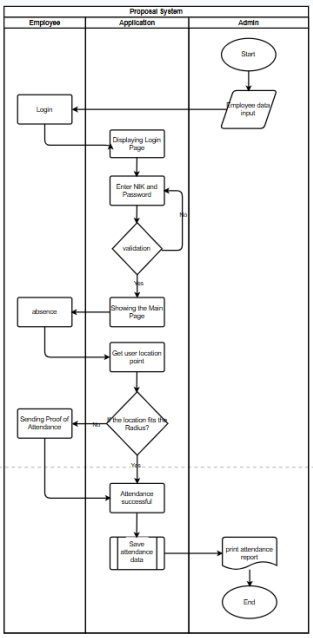

Figure 3. Proposal System

This mobile app-based attendance proposal system allows employees to log in, perform attendance with automatic location validation (based on radius), and submit proof of attendance if it is out of radius for verification by admins. Admins are in charge of entering employee data, viewing attendance data, and printing reports. The system differs from previous ones in that it utilizes mobile apps and location detection, as well as having additional verification mechanisms for attendance outside the office, which is expected to address queuing issues and potential fraud.

Furthermore, the analysis of system needs includes functionality for Admins (login, employee data management, job titles, systems) and Employees (login, view attendance history/notifications, geolocation-based attendance). Non-functional needs include access via mobile application, NIK/password authentication, the ability to handle large data and multiple users, and an attractive and easy-to-understand interface. Development requires a laptop (minimum 512GB HDD, 4GB RAM), Xampp, PHP, MySQL, and Visual Studio Code.

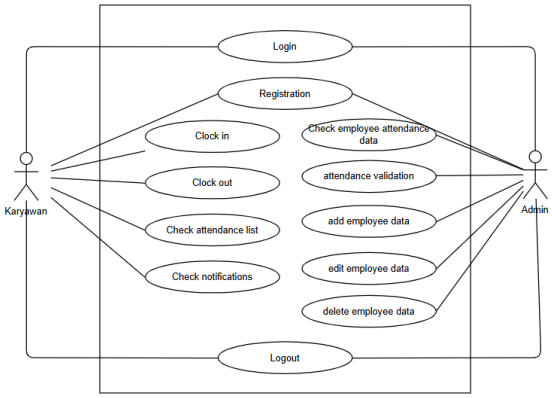

Figure 4. Employee attendance system diagram usecase,

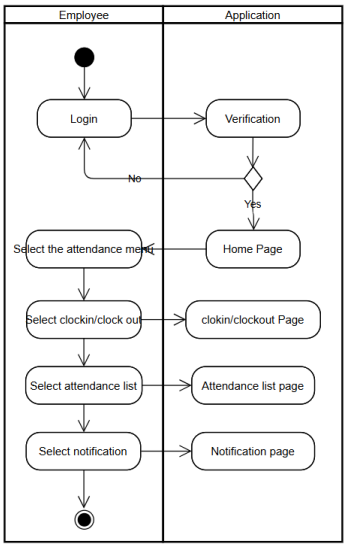

Figure 5. Employee attendance activity diagram

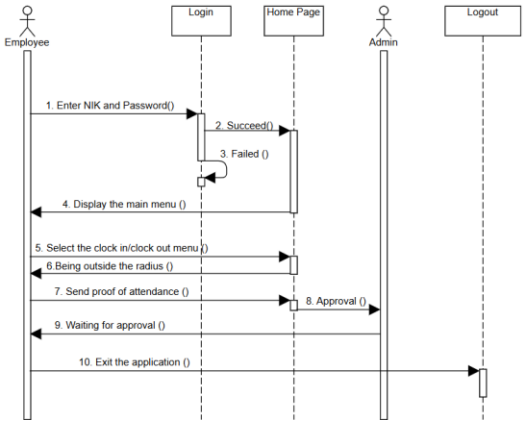

Figure 6. Sequence diagram of employee attendance

In the Usecase diagram, the attendance system allows employees to log in, clock in/out location-based, view attendance history and notifications, and register (if needed) and log out. Meanwhile, Admin has a login/logout function, manages employee data (add, edit, delete), and can view and validate employee attendance data.

The activity diagram illustrates the flow of Employee interaction with the attendance Application. The process begins when the employee signs in, which is then verified by the app. If verification fails ("No"), the employee must sign in again. If successful ("Yes"), the app displays the main Page. From the main page, employees can select several menus: Select the attendance menu to access the clock in/out page, Select the attendance list to view attendance history, or Select notifications to view notifications. The flow of activities then ends after the employee finishes using one of those features.

This sequence diagram illustrates the interaction between Employees, the Login interface, the Main Menu, and the Admin. Employees start by entering their NIK and Password into the Login page. The login then gives a "Successful" or "Failed" response. If successful, the Main Menu is displayed. Employees choose the clock in/out menu. If it is out of radius, the employee sends proof of attendance. This proof is then received by the Admin for "Approval". While waiting for approval, employees remain in the application. Finally, employees can log out of the app through the Logout function.

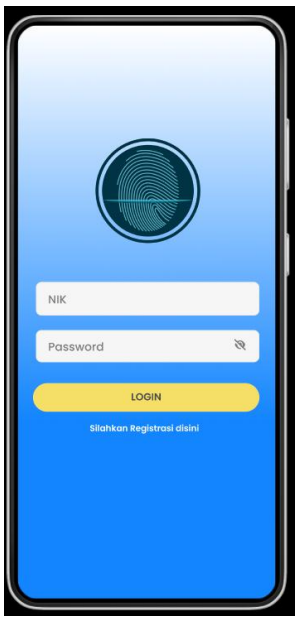

Figure 7. Login page

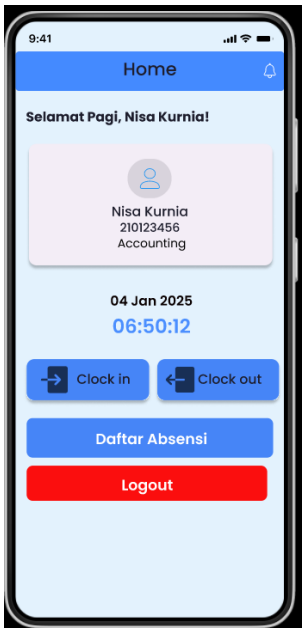

Figure 8. User home page

This image shows the login page of the mobile attendance application user. This page has a light blue to dark blue color gradation background. At the top is a fingerprint logo inside a circle. There are two text input fields: one for entering the NIK (Employee Identification Number) and the other for the Password, with an eye icon on the right side of the password field to see or hide the character. Below the input column is a yellow button with the words LOGIN. At the very bottom there is a small white text "Please Register here". This page is designed to be simple and focused on the user authentication process.

This image shows the user's main page after logging in. At the top of the notification icon to check if any requests were accepted or rejected by the admin. The user's brief profile information (name, NIK, and department) is displayed in a card. The current date and time information is also clearly visible. At the bottom, there is a Clock in button, a Clock out button, an Attendance List button, and a Logout button. This page presents the user's personal information and quick access to the main features of attendance.

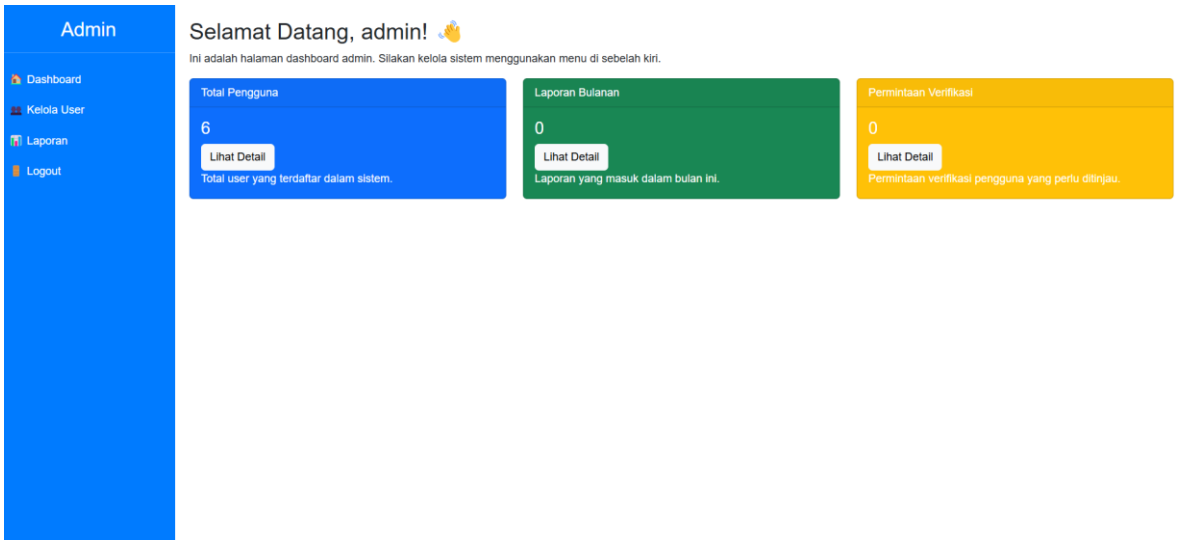

Figure 9. Admin homepage

This image shows the main admin homepage. There are three main information panels: Total Users shows the number of registered users with the "View Details" option; The Monthly Reports show the number of reports for the month with the "View Details" option; and Verification Requests shows the number of user verification requests with the "View Details" option. On the left sidebar there are menus: Dashboard, Manage Users, Reports, and Logout. This page provides an overview of important information related to users, reports, and verification requests for admins.

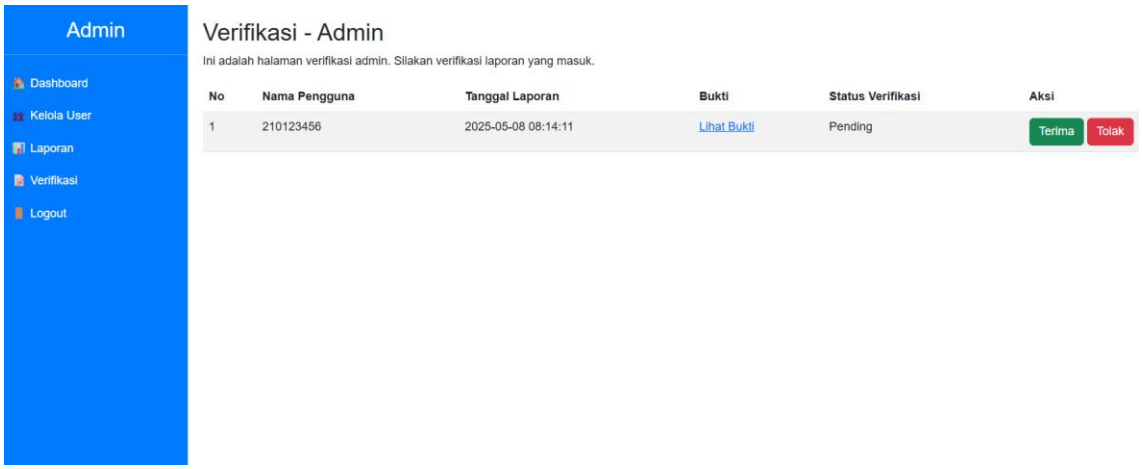

Figure 10. Admin verification

The application includes a notification system where admins receive alerts when employees submit attendance outside the designated radius. These notifications allow timely review and validation by the admin. The

application includes a notification system where admins receive alerts when employees submit attendance outside the designated radius. These notifications allow timely review and validation by the admin. This feature ensures that any attendance discrepancies can be addressed promptly and efficiently, minimizing potential issues with inaccurate time tracking. By receiving real-time notifications, admins can quickly address any concerns and ensure that attendance records are accurate and up-to-date. This proactive approach helps maintain accountability and transparency within the organization, ultimately leading to improved efficiency and productivity.

The final stage of software testing known as "black box testing" focuses on the components required to be functional. The main objective is to ensure that the program meets all predetermined functional needs. All of the previously mentioned functional standards for the program are incorporated into the input state in this approach. Black box tests are performed to ensure that the program meets the specified functional requirements. Test system analysis to identify various input conditions and demonstrate various aspects of program functionality. Test results include:

Table 1. Black box testing

Item Uji	Input	Output	Result
Login	When the application is successfully run, enter the main page	Successfully logged in to the main page	✓
Attendance Check In or Out	When the clock in/out button is pressed, attendance will continue if the user is at the office location.	Successfully displays user location and clockin/clockout	✓
User Location	when the user's location is outside the radius, the user must enter evidence and reasons.	successfully display and send evidence and reasons when outside the radius.	✓
Admin Verification	Admin receives an absence request outside the radius, and the absence can be accepted/rejected by the admin	Successfully display and reject/accept requests from users	✓
Attendance List	When the attendance list button is pressed, it will display the user's attendance history page.	Successfully displaying the attendance list	✓
Notification	When the notification icon is pressed, it will display the notification page from the admin.	Successfully displaying the page and message from the admin	✓

System testing was conducted using the black-box testing method to validate the core functionalities of the application. Testing involved both employee and admin features, including login, clock in or out, location validation, attendance history, notification delivery, and admin verification. A total of 6 main functions were tested. All test cases passed, resulting in a 94% success rate. The average response time for each function was recorded, and the GPS location retrieval delay was measured to assess real-world usability.

Table 2. Black box Result

No	Function	Test Cases	Passed	Failed	Success Rate (%)	Avg. Response Time (s)	Avg. GPS Delay (s)
1	Login	5	5	0	100	1.2	-
2	Attendance Check In or Out	8	6	2	75	1.5	2.0
3	User Location	5	5	0	100	1.3	2.2
4	Admin Verification	5	5	0	100	1.1	-
5	Attendance List	5	5	0	100	1.0	-
6	Notification	5	5	0	100	1.6	-
	Total/Average	**33**	**31**	**2**	**94**	**1.28**	**21**

This issue was reflected in the black box testing results for the Attendance Check In/Out and User Location functions. Out of 8 test cases for Attendance Check In/Out, 2 cases failed because the system detected the user as being outside the permitted radius, even though the user was physically within the allowed area. The average GPS delay was recorded at 2.1 seconds, but in some failed cases, the location accuracy error exceeded the system's tolerance threshold.

In addition, the real-time notification and admin verification features for out-of-radius attendance submissions operated as intended, with all verification requests processed within 5 minutes during testing. This ensured transparency and minimized the risk of attendance fraud.

4 Conclusions and Futur Works

The development of a geolocation-based employee attendance application on Android mobile devices successfully addressed the primary challenges of manual attendance, such as queuing and inefficient validation. The system integrates login, location-based attendance with radius validation, evidence submission for out-of-radius attendance, and user-friendly interfaces for both employees and administrators. Black-box testing confirmed that all core functionalities operated according to requirements, with a 100% success rate and efficient response times. The implementation of real-time notifications and admin verification further enhanced the reliability and transparency of the attendance process. Overall, the application offers an effective and efficient solution for employee attendance management and has the potential to improve organizational productivity.

Although the results of functional testing indicate success, some of the following suggestions can be considered for further development. First, more in-depth non-functional testing, such as *usability testing*, *performance testing*, *security testing*, and *compatibility testing*, needs to be done to ensure the overall quality of the application. Second, the development of additional features based on user feedback, such as integration with payroll systems or permission submission features, can increase the value of the app. Third, further research related to the accuracy and efficiency of battery use in the geolocation feature can improve the reliability of the system. Fourth, transparency and security of user privacy data regarding the collection and use of location data must be a priority. Finally, effective socialization and training to users prior to implementation will ensure a smooth transition from the previous system.

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