



Designing A Mobile-Based Attendance Application Using Location-Based Service for Activities Mosque

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Abstract.

Purpose: The purpose of this study is to design a mobile-based attendance application that uses Location-Based Services to support community-based religious institutions, namely mosques, which are simple to understand for all age groups, make it easier for participants to take attendance, and make it easier for administrators to manage participant data, schedules, and attendance.

Methods: Interviews and direct observations were conducted to identify problems and determine the new system required. This system utilizes the concept of geolocation by utilizing GPS and geofencing for location validation, which is described using UML and implemented in programming. The completed system was tested through blackbox testing for its features and GPS accuracy testing to determine the stability of the location tracking system.

Result: Blackbox testing results show that the functions integrated into the attendance application can run 100% as expected. The GPS accuracy system performance test results obtained are sufficient for semi-outdoor and outdoor spaces with 100% valid results.

Novelty: The uniqueness of this research lies in its contribution to community-based religious institutions, namely mosques, in digital attendance recording, as well as providing GPS accuracy evaluation results provided by the system to determine the most appropriate radius range. Further developments that can be made to the system include improving security procedures, as this application directly accesses the user's location, making improvements to the security system and fake location detection very important for attendance applications.

Keywords: Attendance, Location-Based service, Manage schedule, Mobile, Efficiency

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INTRODUCTION

Rapidly developing information technology can facilitate human work due to easy internet access and various types of smartphones, which most individuals now possess [1]. The use of information and communication technology has become a primary need in all aspects of life, making it easier to obtain information or even solve problems, such as attendance [2]. Attendance is an attendance management activity that aims to measure the attendance rate of participants in an activity within an organization, institution or company [3]. One institution that needs to implement attendance is a mosque, which aims to record the attendance of participants in religious activities. This is practiced at the Mulyo Abadi mosque, which uses a manual attendance book to record the attendance of participants by filling in the time of arrival and signing the attendance book at each activity held.

The Mulyo Abadi Mosque is a place of worship for Muslims located in Sleman, Yogyakarta, which organizes various religious activities attended by people from all walks of life, from children, teenagers, adults to the elderly. Participants include not only local residents, but also many newcomers such as students, university students, and migrant workers. All participants, both local and newcomers, will be registered as regular participants for attendance purposes, which will later be recorded and used as evaluation material at the end of each month.

Conventional attendance management is time-consuming, both for recording attendance and for recapitulation. In addition, manual attendance recording using attendance books is prone to fraud or data manipulation, resulting in inaccuracies [4]. Therefore, a simple digital attendance application or system is needed that can be used by people of all ages, does not interfere with current activities, and utilizes existing

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devices to support attendance management in community-based religious institutions, namely mosques, in order to make it easier for participants to record their attendance, minimize fraud, and reduce the risk of inaccurate recapitulation. Given these issues, a system will be developed that utilizes services available on smartphones, namely Location-Based Services (LBS), which is a technology that can detect the location of the device being used, which has two main elements, namely Location Manager (Maps API) and Location Provider (Location API). Location Manager (Maps API) can display maps, satellites, roads, or a combination of the three. Meanwhile, the Location Provider (Location API) is related to the Global Positioning System (GPS), enabling real-time location determination, tracking of movement or displacement, and identification of the distance between the current location and a specific location [5],[6].

Previous research by [7] and [8] shows that the use of Location-Based Services in educational institutions can help facilitate employee attendance, improve employee discipline, and enable easy, accurate, and efficient attendance recording. Research by [9], [10], [11], who implemented an attendance system using Location-Based Services in a company, shows that the designed system can minimize fraud, make it easier for HR to manage attendance, leave and overtime, and reduce employee indiscipline. Research conducted by [12] and [13] explains that using the concept of geolocation in attendance offers flexibility that does not require additional devices and is certainly more cost-effective than using other methods that require the purchase of equipment that also requires more maintenance costs. Research conducted by [14] and [15] explains that the use of GPS combined with geofencing makes the attendance system more stringent because the system provides specific virtual geographical boundaries for efficient and accurate attendance tracking with minimal hardware.

Based on previous studies, attendance systems built using Location-Based Services are intended for formal institutions and educational institutions used by employees or students with check-in and check-out features. Therefore, the purpose of this study is to design an attendance application using Location-Based Services (LBS) with a geolocation concept and apply geofencing for location validation that is integrated with a schedule that is simple and cost-effective by utilizing the mobile phones that participants already have. This application is intended for religious institutions or community-based organizations, namely mosques, whose users range from teenagers to the elderly, so that it is easy to understand for participants who are not familiar with technology. By utilizing existing activity schedule data as a reference, this application can provide additional benefits, namely that participants can find out information about upcoming activities and make it easier for administrators to manage them. This research also evaluates GPS accuracy to determine the stability of location tracking under various conditions. This attendance application is expected to support community-based religious institutions, especially mosques, by making it easier for participants to record their attendance with minimal fraud or data manipulation, as well as making it easier for administrators to manage participant data and activity schedules, and to recap attendance easily, quickly, and efficiently.

METHODS

This research was conducted in six stages, namely problem identification, system requirements analysis, system design, implementation, testing, and system performance analysis, as presented in Figure 1.



Figure 1. Research framework

Problems identification

This stage began with interviews and direct observation. Interviews were conducted with one of the administrators of the Mulyo Abadi Mosque to identify the problems faced. Observation was carried out by directly observing the system that had been implemented. The attendance system currently in use still employs conventional methods. This has led to many cases of participants cheating on attendance or manipulating data. It is also not uncommon for administrators to miss data when summarizing attendance, resulting in inaccuracies. With a large number of participants and various activities, administrators need a considerable amount of time to summarize the data. Therefore, a simple digital attendance system is needed that is easy for everyone to understand and can overcome the problems encountered.

System requirements analysis

This requirements analysis is carried out prior to the design phase to ensure that the system is tailored to user needs [16]. Comprehensively understanding functional and non-functional requirements can minimize errors and identify the limitations of the system to be developed. This will improve the quality of the system being built [17]. From the results of the interviews and observations, the system requirements were determined to have two users with the following roles for each user.

Table 1. System requirements

No	User	Role
1	Admin	Managing attendance and permission data Managing participant data Managing schedule data for different locations
2	Participant	Take attendance based on location View the schedule list Submit a permit application

System design

This stage presents the architecture of the attendance application system to be built. In addition, this stage also presents diagrams and structured data models to facilitate the implementation process [18]. This step is the process of creating a software representation of the requirements analysis results using Unified Modeling Language (UML) before implementing them into program code [19]. The Unified Modeling Language (UML) modeling design presented ranges from process flow, systems, up to databases [20]. (UML) Unified Modeling Language is a visual modeling language used as a design tool for object-oriented systems [21]. The UML diagrams presented include use case diagram, activity diagram, and class diagram. In addition, an architecture system and attendance process flow are provided.

System architecture

The architecture of the attendance application system can be seen in Figure 5. From the web admin side, it will be built using Laravel Filament because it provides various ready-to-use components such as Laravel, which provides Model View Controller (MVC), and Filament facilitates the master data system (CRUD) without having to build components from scratch [22]. The mobile application for participants will be developed using the Flutter framework with the Dart programming language. Flutter was chosen because it provides a variety of widgets and tools that can help developers create attractive, responsive, and flexible user interfaces (UI) [23]. The database will be built using MySQL, a relational database program used to create, read, update, delete, and analyze data using open source, so that data duplication is minimized, information is more secure, and easier to sort [24]. In order for the mobile side to communicate with the database, the use of REST API is a suitable choice due to its high flexibility and scalability [25]. REST-API is a web-based communication architecture standard used to develop services in applications that use the HTTP (Hypertext Transfer Protocol) protocol for data communication, enabling status transfers using GET, POST, PUT, and DELETE call methods [26].



Figure 2. System architecture

Attendance process flow

Figure 3 shows the main flow of the application, namely the attendance process with the concept of geolocation in a system that uses Location-Based Services and uses geofencing to validate the location of

participants in the attendance process. Attendance will be taken according to schedule, provided that GPS is active on the participants mobile phone. The system will track participants real-time locations by displaying accuracy and then calculating the distance between users and the specified location using the haversine formula. This accuracy limit minimizes system errors in determining locations caused by unstable signals.

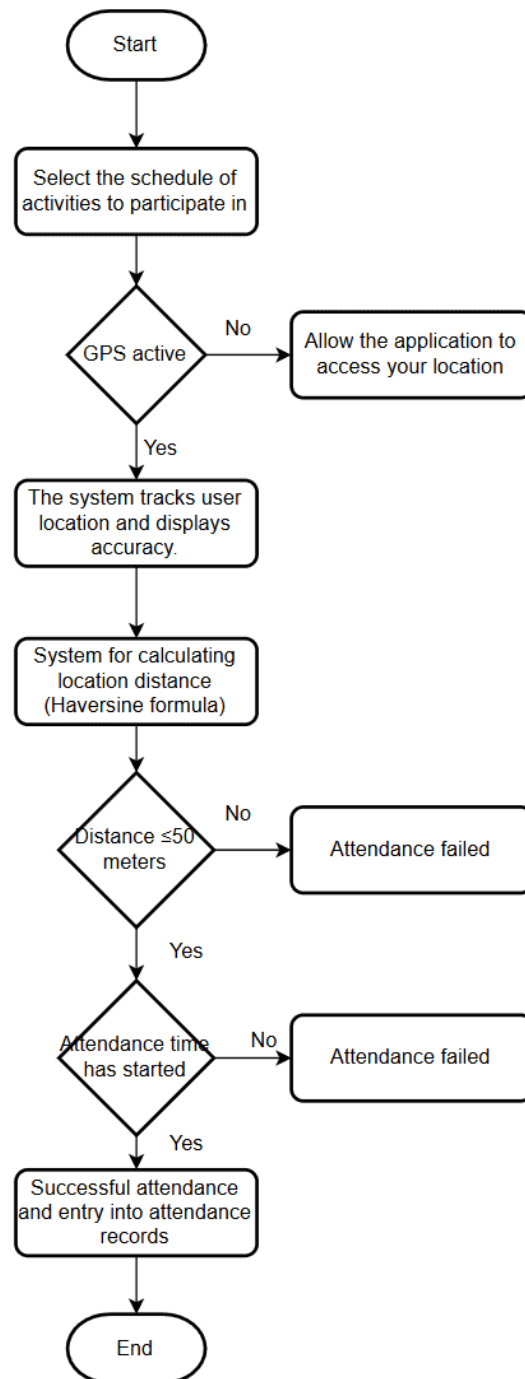


Figure 3. Attendance process flow

The application of real-time location tracking uses the geolocator package in the Flutter framework to obtain the user's real-time location. In Android, there is Fused Location Provider (FLP), which is a combination of GPS services and network location provider services by obtaining location data from GPS, cellular networks, WiFi, and sensors to provide more accurate location tracking [27]. With geofencing and the

Haversine calculation, the first step is to virtually limit a specific area that will be a condition for successful attendance if it is within the specified area or boundaries [28], [29]. The Haversine Formula calculates the latitude and longitude on the Earth's surface as input variables, based on longitude and latitude, assuming the Earth is a perfect sphere with a radius of R 6371 km [30].

Formula:

$$d = 2R \cdot \arcsin \left(\sqrt{\sin^2 \left(\frac{\Delta\varphi}{2} \right) + \cos(\varphi^1) \cos(\varphi^2) \sin^2 \left(\frac{\Delta\lambda}{2} \right)} \right) \quad (1)$$

d = great-circle distance between two geographic points (meters)

R = mean radius of the Earth (6,371,000 meters)

φ_1 = latitude of the first location (in radians)

φ_2 = latitude of the second location (in radians)

λ_1 = longitude of the first location (in radians)

λ_2 = longitude of the second location (in radians)

$\Delta\varphi$ = latitude difference ($\varphi_2 - \varphi_1$)

$\Delta\lambda$ = longitude difference ($\lambda_2 - \lambda_1$)

Use case diagram

A use case diagram is a representation of the functionality of a system and presents the interactions between actors and the system [31]. Use case contain descriptions of the actors involved and what the actors do in the system [32]. The elements contained in a use case diagram include use cases (actions performed by actors, represented by ellipses), actors (roles that interact with the system), and relationships (relationships between actors and use cases) [33]. Figure 4 is a use case diagram from the results of a requirements analysis for the attendance system at the Mulyo Abadi Mosque.



Figure 4. Use case diagram

Figure 4 explains the actions taken by administrators and participants in the system. Administrators will manage all participant data, schedules, attendance, and permissions requested by participants. Participants have access rights to view schedules, attendance data they have submitted, and their personal data. This use case design was carried out to help identify more detailed functional requirements for the system [34].

Activity diagram

The activity diagram contains an overview of the workflow activities of a system or business process. It should be noted that the activity diagram describes the activities of the system, not what the actors do [35]. Activity diagrams aim to explain system activities or processes, whether sequential or parallel [36].



Figure 5. Activity diagram

Figure 5 shows an overview of the flow or process of the attendance application when used by administrators or participants. This activity shows how the system can verify the real-time location of participants when they check in to calculate the radius. Using an activity diagram makes it easier for developers to visually and structurally understand the system's workflow from start to finish [37].

Class diagram

Class diagrams describe the data and information of a system as a whole. In relation to database structure, class diagrams can be used as a substitute for Entity Relationship Diagrams (ERD) to describe the flow of data throughout the system [38].

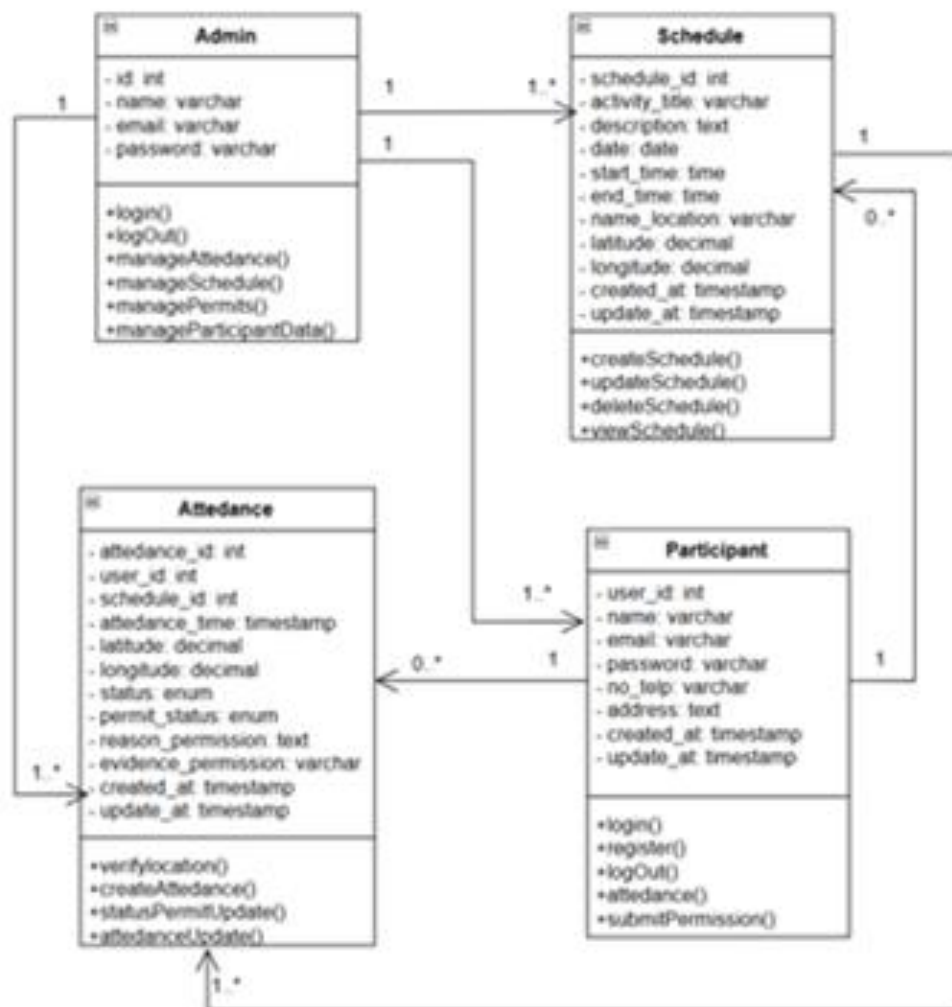


Figure 6. Class diagram

Figure 6 can be used to illustrate the database structure built in an attendance application that uses location-based services. There are four interconnected classes, there are class admin, class schedule, class attendance, and class participant. The class diagram design helps visualize the class structure in the system and can explain the object type and its relationship with other objects [39].

Implementation

The implementation step is the application development step based on the design results that have been made in the form of diagrams previously [40]. At this step, developers will implement the system design by starting to write program code. The system will be built using Filament with the Laravel framework as the backend for the admin side. For mobile, it will be built using Flutter with the Dart programming language and using REST API configuration to interact with the database.

Testing

At this stage, testing is carried out using the blackbox testing method, where testing is only performed on functional parts or external features without looking at the design or code inside [41]. Testing is conducted when the system has been completed with the aim of ensuring that the system operates in accordance with user requirements.

System performance analysis

In this section, we will present the results of the system testing, including the accuracy and stability of location tracking under various environmental conditions, GPS errors, response time and performance, as well as the results of the geofencing system and its presence validation.

RESULTS AND DISCUSSIONS

Implementation

Based on the analysis of system requirements and system design that has been carried out, implementation will be done through programming using VSCode, which will produce the following functions and displays for each page.

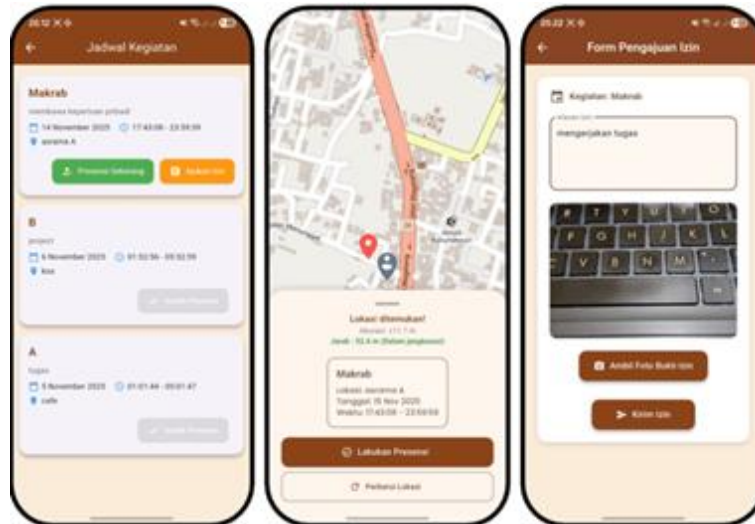


Figure 7. Schedule page, attendance page, and permission request page

Figure 7 shows the schedule, attendance, and permission request page. The first step in attendance is to select the schedule of the activity being attended. On the attendance page within the map, there are two markers: red for the activity location and gray for the user's real-time location as an estimate of the participant's distance from the activity location. In addition, information is provided about the activities participated in by the participants, as well as information about the accuracy and radius range calculated by the system as information for participants whether the location obtained is within the specified area. The permission page is also integrated with the schedule to make it easier for participants to request permission for activities they cannot attend.

```
1 double _calculateDistance(double lat1, double lon1, double lat2, double lon2) {  
2     const double R = 6371000;  
3     final double dLat = _degreesToRadians(lat2 - lat1);  
4     final double dLon = _degreesToRadians(lon2 - lon1);  
5     final double a = sin(dLat / 2) * sin(dLat / 2) +  
6         cos(_degreesToRadians(lat1)) *  
7         cos(_degreesToRadians(lat2)) *  
8         sin(dLon / 2) *  
9         sin(dLon / 2);  
10    final double c = 2 * atan2(sqrt(a), sqrt(1 - a));  
11    return R * c;  
12 }  
13  
14 double _degreesToRadians(double degrees) => degrees * pi / 180;
```

Figure 8. Implementasi formula haversine pada code

Figure 8 shows the implementation of the haversine formula in the program code to automatically calculate the distance between participants and predetermined locations. This will make it easier for participants to determine the likelihood of their attendance being recorded.

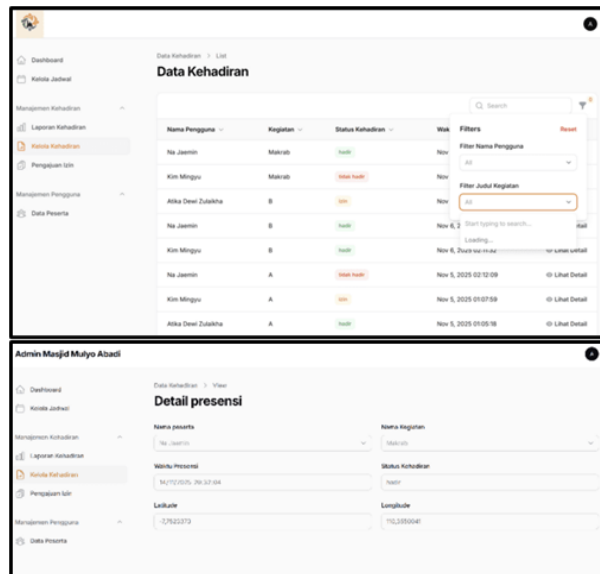


Figure 9. Attendance management page

Figure 9 shows the attendance management page, where admin can view details of participants attendance, such as attendance time, location, and attendance status. The system provides a search feature to help administrators find data quickly and efficiently.

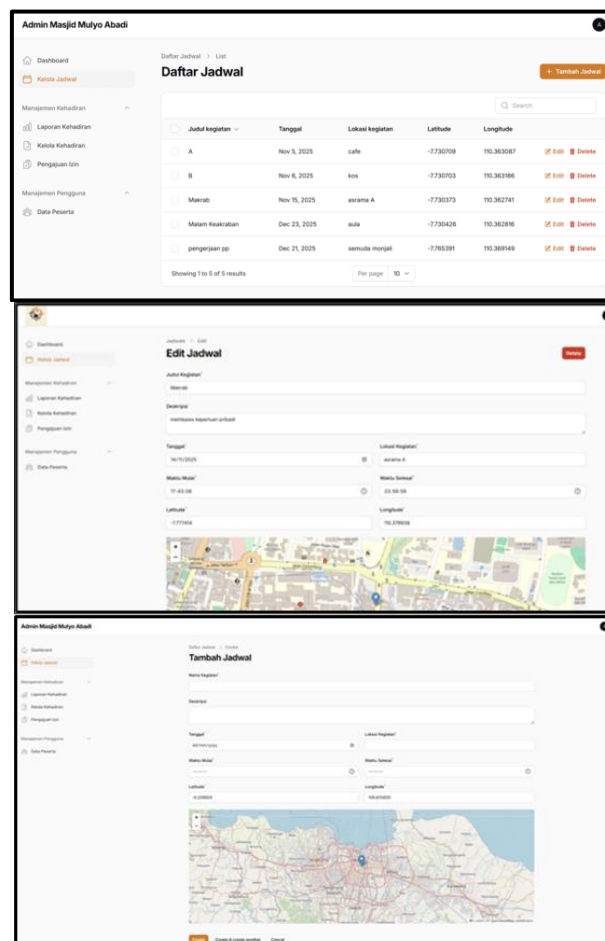


Figure 10. Schedule management page

Figure 10 shows the page for administrators to fully control schedule data, such as viewing, adding, editing, and deleting schedule data. Using Open Street Map and Leaflet on the add and edit pages, the map can be displayed properly so that administrators can determine the location of activities for reference points for attendance. The longitude and latitude columns will be filled in automatically when administrators select a location on the map, making it more accurate and efficient

Testing

System testing was conducted using the blackbox testing method, focusing on testing functions within the application with the aim of finding errors in the interface design and data structure [42]. The following are the results of the system testing that has been conducted.

Table 2. Web testing

No	Features	Testing scenario	Expected results	Status
1	Add schedule	Fill out the schedule input form and select the coordinates of the location	The system can display a map with real-time locations. When the marker is moved, the latitude and longitude fields are automatically filled in and the data can be saved	Successful
2	Update schedule	Changing the form content from existing schedule data	The system can save changes to the schedule data	Successful
3	Delete schedule	Click the delete button for the selected schedule	The system can save changes and not display them back to the user. Deleted attendance data according to the schedule is also lost	Successful
4	View schedule	Click the manage schedule menu	The system can display schedule data that has been added or updated	Successful
5	View attendance summary	Click the attendance summary menu	The system can display charts and attendance summary tables	Successful
6	View attendance data	Click the attendance management menu and select the data filter to be displayed	The system can display attendance data for both present and absent participants and can use filters to display data based on activity type or participant name	Successful
7	View list of participant permit applications	Click the permit application menu	The system can display a list of participants who have submitted permits and the status of their applications.	Successful
8	Update permit status and see photo evidence	Select the data to be changed	The system can display application details and provide access to change permit status and display permit photos. If the permit application is approved, the attendance status becomes permitted, and otherwise	Successful
9	View and delete participant data	Select the delete or edit data button on the participant list display	The system can display a list of participant data and access to delete selected data. The system can save data changes	Successful
10	Login	Input the registered email address and password	The system can validate the input data and display the main page	Successful
11	Logout	Select the exit option on the profile	The system can return to the login page	Successful

Table 3. Mobile testing

No	Fitur	Testing scenario	Expected results	Status
1	Registration	Enter the name, email, phone number, password, address, and confirm the password	The system can verify the accuracy of the data and match the password and password confirmation	Successful
2	Login	input email and password	The system can verify the data input and match it with the database	Successful
3	View list schedule	Click the view schedule menu	The system can display a list of schedules that have been added by the admin as well as any changes made to them	Successful
4	Take attendance	Click the attendance menu	The system can display a map with the real-time location of participants along with information about the activities they are participating in, showing accuracy and radius range. If within a 50-meter radius, participants have successfully attended with a present status, and otherwise. The automatic attendance button will be disabled if the schedule has passed.	Successful
5	View attendance history	Click the attendance history menu	Displaying information on schedules that have been completed along with attendance status	Successful

6	Submit permission	Click the submit permission menu	The system can display a permit application form that allows users to upload photos directly using their camera without accessing the gallery, and the data can be stored in a database.	Successful
7	View progress and permit application history	Click the permit application history menu	The system can display the status of permit applications and updates made by the admin	Successful
8	Edit profile	Click the profile menu	The system can grant users access to update data except for email addresses and can save changes.	Successful
9	Log Out	Click the logout button on the profile page	The system can return to the welcome page	Successful

Table 2 shows the test results for the web admin with test results using a laptop device that was successful in all the requested features. Thus, it can be concluded that the backend for the mobile application is fully operational according to user needs. Table 3 shows the test results for the mobile application with testing on 10 participants using various types of Android devices with all test results successful. The test results presented show that the mobile-based attendance application using Location-Based Service has been successfully developed and all the necessary features are functioning properly. Therefore, this application is suitable for use as a digital attendance tool as a solution to replace the manual attendance system that was previously implemented.

System performance analysis

Table 4. System Performance Analysis

Environment	Sample	Average GPS error	Average accuracy	Success Rate
Indoor (0 m,10 m)	20	16.56	30.26	100% (Valid)
Semi Outdoor (30 m)	10	0.703	19.28	100% (Valid)
Outdoor (>50 m)	20	3.7725	10.525	100% (Rejected)

Table 2 was obtained from testing on 10 participants, using various types of mid-range Android smartphones, with testing from 5 points, namely 0 m, 10 m, 30 m, 50 m with a radius of 50 m. Under cloudy conditions after rain, indoor GPS testing yielded very weak signals, resulting in low accuracy of 20-30 m. In contrast, semi-outdoor and outdoor GPS signals were stronger, yielding more stable and accurate results of 10-20 m for location tracking.

The design applied in programming produces interactive and functional pages that meet the needs of both administrators and participants. The main focus or core of the overall display lies in the attendance page, which is integrated with the activity schedule and uses geolocation with a Location Based Service mechanism combined with geofencing to minimize fraud. Real-time location readings are fairly stable with relatively low accuracy values for semi-outdoor and outdoor locations. By comparing the results of research conducted [43], which also developed an attendance application using the Location-Based Service method, with results in the form of a system that can display real-time location information of users when they are present, this research is more innovative by applying a location radius for attendance. This opinion is supported by the findings of study [30], which shows that the application of the haversine formula can minimize attendance fraud because attendance success depends on real-time location and the specified radius. However, there is a possibility of fraud occurring through location spoofing or GPS spoofing. Security risks also need to be considered because the system will track users' real-time positions. Another challenge of this research is that participants lack knowledge about technology, especially the elderly. This system is ideal for users of all ages, but its success will depend on environmental conditions and signal strength.

CONCLUSION

Based on the results of the study, the researchers concluded that the mobile-based attendance application built using Location-Based Services integrated with the activity schedule is simple and easy to understand for all age groups, utilizing available devices that make it easy for participants from community-based religious institutions to take attendance with minimal cheating. In addition, with the features provided in the application, administrators can manage data more easily, including participant data, schedule data, and attendance data. The time required to summarize attendance has become faster and more efficient because it has been integrated into the attendance feature. Testing using the blackbox testing method produced satisfactory results, with the features needed by users running 100% according to the design. Based on the

performance testing data for this system, the use of a 50m radius is also an appropriate measure to increase the success rate of attendance tracking indoors, with 100% valid results. This research is expected to encourage future studies to apply false location detection and improve system security to protect user privacy. In addition, it is hoped that there will be multiple methods that can track locations more accurately when indoors.

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