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MyAttend: A Development of Mobile-based Attendance System with Anonymization Approach to Preserve Location Privacy

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Abstract: A recent Covid-19 pandemic resulted in working from home which made it challenging to keep track of staff attendance. Users are required to store their personally identifiable information (PII) on online attendance applications. Therefore, a mobile based attendance system with location anonymization is developed to allow employers to track staff's attendance and at the same time protect their privacy. Prototyping model was used as the methodology to develop MyAttend with five phases which are planning, analysis, design implementation and testing. This application was developed using Android Studio and includes a login module, manage employer/ staff module, manage profile module, attendance module and payroll module. The system allows the admin to manage the employer and manage staff, employer to manage staff, review staffs' attendance record and calculate payroll and staff to record their attendance, view their payroll and update personal information. The significance of the project is to record user location data anonymously using generalization and masking out technique.

Keywords: Attendance, Anonymization, Personally Identifiable Information (PII)

1. Introduction

Nowadays, the adoption of web-based or online-based attendance systems are increasing as it can be used to record attendance and print payroll. Authentication and tracking location are two common features in online-based attendance systems. Therefore, authentication is important to prevent unauthorized login.

As an example, an attendance system proposed by Pichetjamroen et al. [1] includes a face validation feature along with a QR code to record attendance information. In this proposed system, students receive QR codes from staff and they need to enter the QR code together with their faces to record attendance. Other than that, Akram & Rustagi [2] propose an efficient attendance system that requires students to record attendance by connecting to the faculty's Bluetooth ID. There is also an attendance system that does not require authentication such as the system proposed by Iio [3], where to record attendance, the

*Corresponding author: hidayahar@uthm.edu.my participants just need to take a picture or draw a signature on a device that is distributed by their teacher. This proposed system might be inefficient for the current Covid-19 situation. Due to the Covid-19 pandemic, many workers must work from home. As a result of that, to monitor workers' attendance, a well-working attendance system is necessary.

Moreover, if an attendance system can record the current location of the user, it can identify the place where the attendance is taken. It should be noted that location data is one of the Personable Identifiable Information (PII). Therefore, a method that can be used to verify the exact location for attendance purposes as well as preserving privacy is needed.

Smart Reader Kids Bandar Meru Raya is a preschool located in Ipoh, Perak. The impact of Covid-19 resulted in the staff conducting online classes for students from home. To monitor the staff's attendance, an online attendance system is needed as before this, a logbook was used to record attendance. This method is not efficient as staff cannot record their attendance in the logbook from home.

Three main issues are identified based on Smart Reader Kids Bandar Meru Raya which are manually recording attendance are inefficient, time-consuming to calculate payroll and during online classes attendance cannot be recorded. On top of that, if a manual system is upgraded into an automatic application or system, it will be prone to online or privacy attacks. Hence, a mobile-based attendance system with location anonymization approach, MyAttend was proposed. There are three objectives of this project – to design a mobile based attendance system that can be used to record staff's attendance with users' location anonymization approach, to develop a mobile attendance system using the Android platform and to test the developed system by application functional testing and user testing.

2. Literature Review

2.1 Privacy and Personally Identifiable Information (PII)

Privacy is known as the right to be alone or to be free from intrusion. Privacy in information security is more to information privacy and how our personal information is gathered and used [4]. Due to social networking, personal data sharing, and data breach issues, however, an individual's privacy is becoming more exposed, and it can no longer be appreciated. As technology is getting more advanced day by day, it seems harder to protect privacy, but it is not impossible to be conducted.

The way to protect a person's privacy is associated closely with the cyber security domain as the domain is used to protect private data from malicious attacks. Malicious attacks can lead to the leaking of an individual's personal information which affects the privacy of an individual. An individual's confidential data is highly important as it is the fundamental right of a person. A person's or individual's confidential data is known as personally identifiable information (PII).

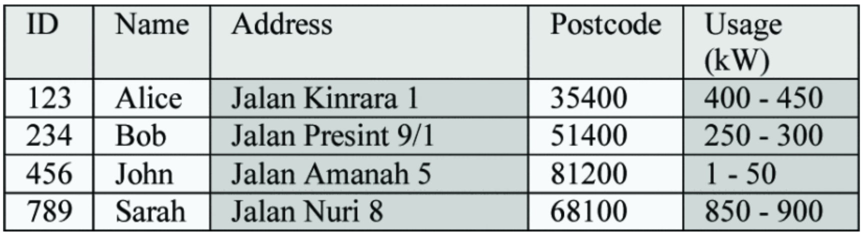
Personally identifiable information (PII) also known as personal data is any information that is related to a person who can be identified by their name, gender, date of birth and so on [5]. Personal information such as email address, bank account number, identity card number, IP address and location data are also can be categorized as PII. This PII is important as it is sensitive information of a person and if it is stolen, it can be used to commit a crime or to steal a person's identity. It is also crucial to protect these data as it ensures the integrity of an individual. Therefore, Malaysia introduced the Personal Data Protection Act in 2010 to protect Malaysians' data privacy.

Personal Data Protection Act 2010 (PDPA) is an act in Malaysia which protects personal data during commercial transactions [6]. PDPA 2010 act comprises seven (7) principles that must be complied by data or system owners to ensure its protection. The 7 principles under the PDPA 2010 act are: - general principle, disclosure principle, security principle, data integrity principle, retention principle, notice and choice principle and access principle. Under the security principle, the PDPA 2010 act is responsible for protecting the PII of a person from losses, misuses, modifications, unauthorized accesses, and alteration.

2.2 Masking Out and Generalization

As concern regarding data privacy is increasing, it is important to protect personally identifiable information (PII). Data masking techniques are known as an approach that is widely used to protect PII [7]. Masking out is one of the efficient ways of data masking. It prevents sensitive information from being viewed by replacing the value in a certain field using mask characters such as the letter X or asterisk (*). This technique is usually applied to credit card numbers, phone numbers, email addresses and IP addresses. By implementing masking out, it will functionally mask the content in the database.

Other than that, generalization is one of the methods that can be used to implement anonymization technique. In generalization, the real value of data is replaced with a less precise value but close to the actual value. This method is only suitable to be applied on certain types of data such as addresses [8].



ID	Name	Address	Postcode	Usage (kW)
123	Alice	Jalan Kinrara 1	35400	400 - 450
234	Bob	Jalan Presint 9/1	51400	250 - 300
456	John	Jalan Amanah 5	81200	1 - 50
789	Sarah	Jalan Nuri 8	68100	850 - 900

Figure 1: Data generalization applied to the Address column [8]

Based on Figure 1, data generalization is applied to the Address column where only the street name is saved in the database without the house number. This method preserves the user's location information.

2.3 Comparison with Existing System

Three existing attendance systems were studied and reviewed in this part. The purpose is to study how the system works and what are the security features that were implemented in the existing system. The systems that were reviewed are StaffAny, Infotech and Kakitangan.

StaffAny is a paid attendance system that is mainly used by large businesses such as restaurants, cafes, and petrol stations [9]. This platform is both web and mobile-based and is mainly used in Singapore. This platform provides onsite attendance clock-in, staff scheduling, leave application and work performance and auditing reports. To login into the system, users are required to enter their registered phone number. Then, a verification code will be sent to the respective phone number to make verification. This system uses the user's geolocation to record attendance.

Infotech is a company from Singapore that provides different kinds of applications for HR management and one of them is a mobile-based attendance system [10]. Infotech's mobile attendance system allows employees to clock-in and clock-out using their smartphones and it uses GPS information to detect an employee's location. The system has built-in face recognition technology that can be used to verify an employee's identity.

Kakitangan is a Malaysia based attendance system that allows users to record attendance and apply for leave on the same site [11]. The platform also collaborated with some banks to manage the staff's payroll. The payroll is calculated automatically and with the integration with local banks, the salary payment is automated and paid on time. Other than that, this platform is also a scheduling management system which is convenient for employers to schedule the roster for their workers.

Table 1: Difference between Staff any, Kakitangan Infotech and MyAttend

Features	Staffany	Infotech	Kakitangan	MyAttend (Proposed system)
Two factor authentication	Yes (Login using phone number and OTP password)	No (Login using email or phone number and password)	No (Login using email and password)	Yes (Login using username, password and OTP password)
Platform	Web and mobile based	Mobile based	Web and mobile based	Mobile based
Calculate payroll	Yes	Yes	Yes	Yes
Leave application	Yes	No	Yes	No
Schedule management	Yes	Yes	Yes	No
Data Protection (PDPA)	Yes (PDPA 2012)	Yes (PDPA 2010)	Yes	Yes (PDPA 2010)
Location anonymization	No	No	No	Yes

3. Methodology

The prototyping model is a software development lifecycle (SDLC) model that is selected to develop MyAttend. The prototyping model mainly focuses on initiating an agreement between the system requirements, developer's idea, and stakeholder's prototype idea [12]. Specifically, the evolutionary prototype model is chosen as it evolves from the prototype that was made by adding improvements and functionality as shown in Figure 2. The activities conducted and the outcome are summarized in Table 2.

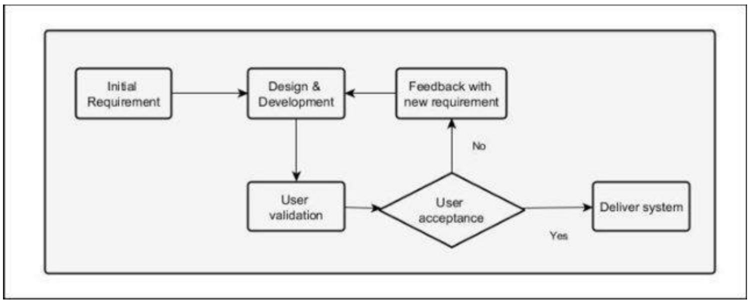


Figure 2: Flowchart on how the prototyping model works [13]

Figure 3, Figure 4 and Figure 5 shows the use case diagram for user admin employer and staff. Admin is required to login into the system first. Then, the admin is able to add a new employer, update employer's information and delete the employer's record. Admin is also able to view staff's information and payroll. Same as admin, employers are required to login to the system. After the employer is authenticated, the employer is able to add new staff and delete staff records. An employer also can view staff's attendance. The employer can calculate staff's payroll and proceed to generate payroll. The employer is also able to manage their account by updating their information. Staff main module is to record attendance by clocking in and clocking out. Furthermore, staff can view their payroll information. Staff are also able to manage their account by updating their information.

Table 2: System development tasks and outcome

Phase	Task	Outcome
Planning	1. Define problem statement, objective and scope 2. Propose selected title 3. Establish project planning and schedule	1. Project proposal 2. Gantt Chart
Analysis	1. Research more on the proposed system 2. Design UML diagram and threat modelling 3. Identify software and hardware requirement	1. Use-case diagram 2. Sequence diagram 3. Class diagram 4. System Architecture 5. Activity diagram 6. Abuse case diagram 7. STRIDE threat model
Design	1. Database is designed 2. System user interface and functionality is developed	1. Data dictionary 2. User interface
Implementation	1. Prototype is developed and implemented 2. End user gives feedback for improvement	1. Developed prototype 2. User's feedback
Testing	1. Check test plans 2. Identify bugs 3. Test the security features	1. User testing 2. Application functional testing 3. Scenario testing 4. Finalized system

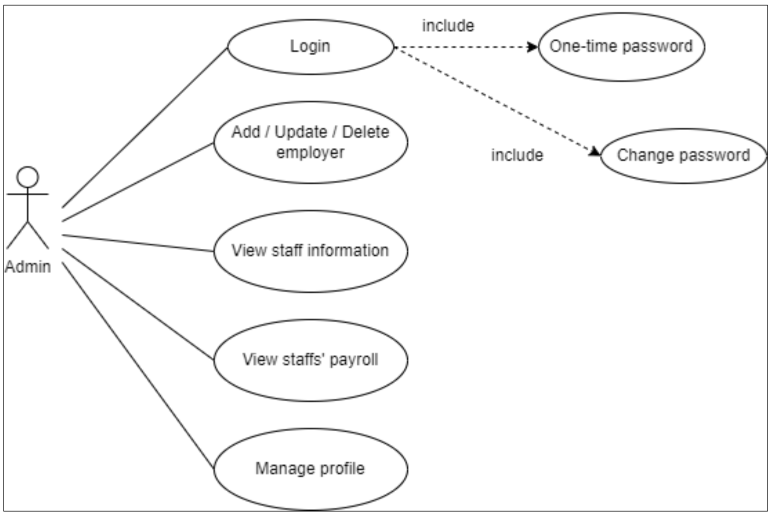


Figure 3: Use case diagram for admin

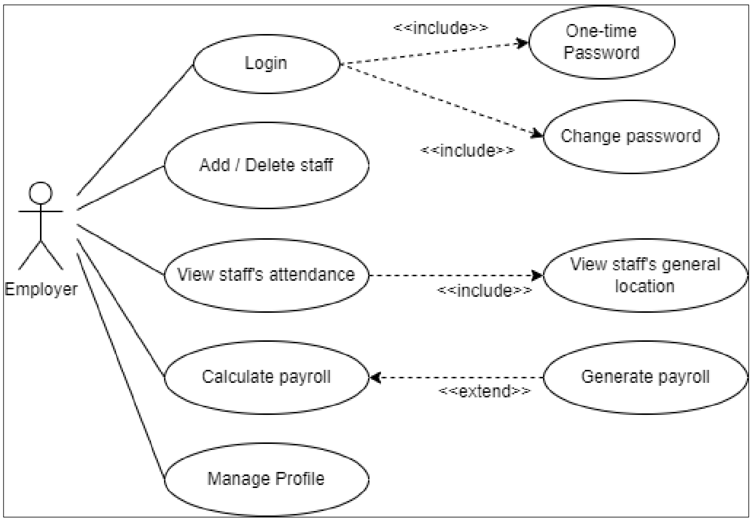


Figure 4: Use case diagram for employer

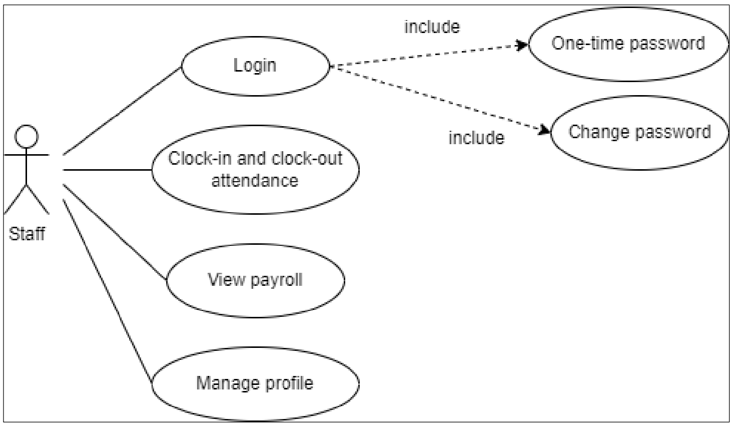


Figure 5: Use case diagram for staff

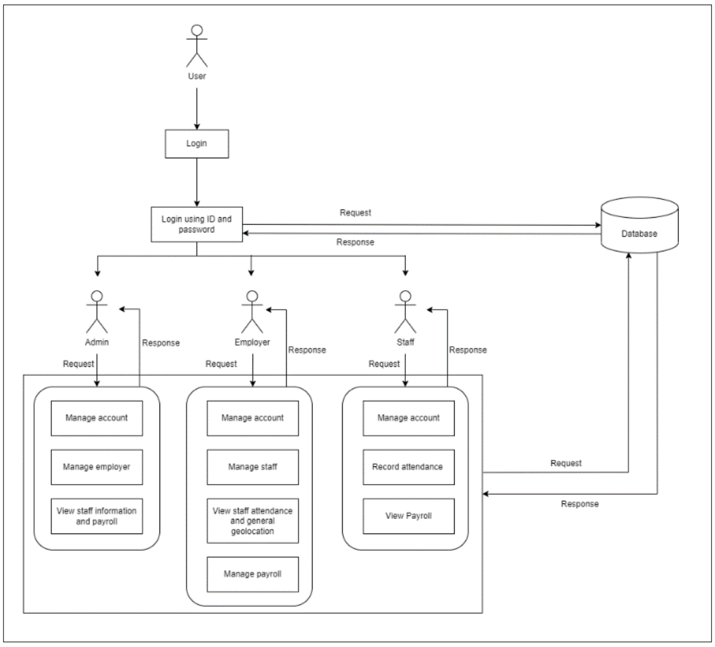


Figure 6: System architecture for MyAttend

4. Results and Discussion

The main focus in this system is on implementing the anonymization technique on the user's location data. The anonymization technique that was implemented on the user's location data is generalization and masking out. These techniques are implemented at the database where the geolocation, latitude and longitude of the users are anonymized to preserve users' location privacy.

4.1 Implementation

All users need to login to enter their account. Users are required to insert valid username and password to login to the system. The implementation of the login module is to authorize and authenticate the user. Figure 7 shows the interface of the login page.

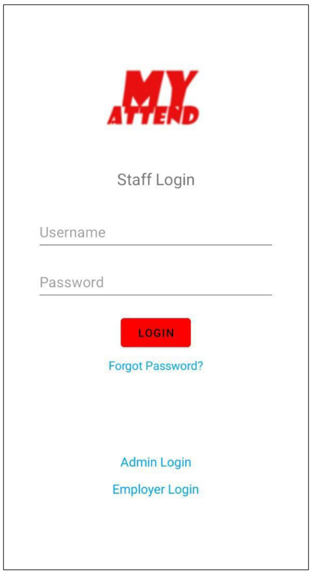
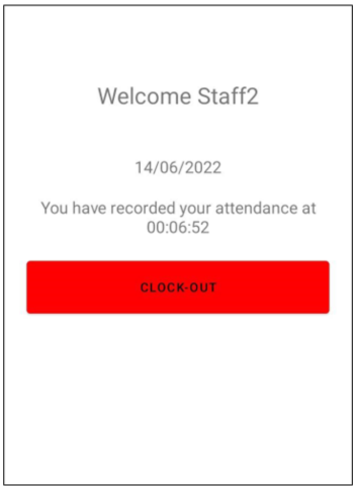


Figure 7: Interface of login page

Attendance module is only implemented for user staff. In this module, user staff can record their attendance which includes clock-in time, clock-out time, date and general location. The interface of attendance recording is shown in Figure 8.

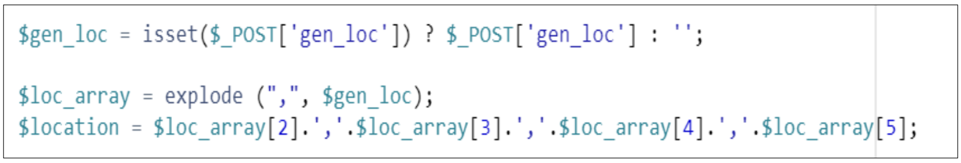

Welcome Staff2

14/06/2022

You have recorded your attendance at 00:06:52

Figure 8: Interface of attendance recording

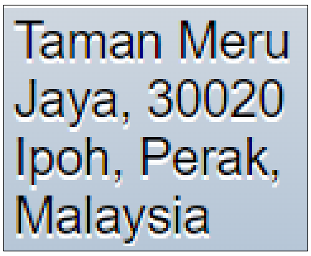
The generalization method is implemented at the user's current location data. User's location data will be generalized where only the general location will be saved in the database.



```
$gen_loc = isset($_POST['gen_loc']) ? $_POST['gen_loc'] : '';

$loc_array = explode (",", $gen_loc);
$location = $loc_array[2].','.$loc_array[3].','.$loc_array[4].','.$loc_array[5];
```

Figure 9: Implementation of generalization

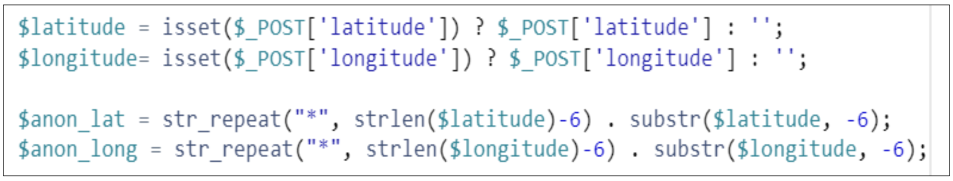


Taman Meru Jaya, 30020 Ipoh, Perak, Malaysia

Figure 10: Example of generalized location

Figure 9 shows the implementation of the generalization technique on the users' location. By implementing the code, the location data saved in the database will be generalized where only a part of the address will be saved. Figure 10 shows the example of a generalized location which is saved in the database.

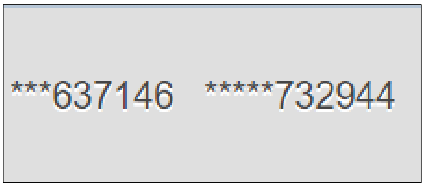
Masking out is applied at the latitude and longitude data. The users' location is derived from the latitude and longitude. By implementing masking out, some of the values in latitude and longitude will be replaced with the asterisk (*) symbol.



```
$latitude = isset($_POST['latitude']) ? $_POST['latitude'] : '';
$longitude= isset($_POST['longitude']) ? $_POST['longitude'] : '';

$anon_lat = str_repeat("*", strlen($latitude)-6) . substr($latitude, -6);
$anon_long = str_repeat("*", strlen($longitude)-6) . substr($longitude, -6);
```

Figure 11: Implementation of masking out



***637146 *****732944

Figure 12: Example of masked out latitude and longitude

After implementing the codes that is shown in Figure 11, the latitude and longitude will be masked out and saved in the database as shown in Figure 12.

4.2 User Acceptance Test Results

Through an online survey, 15 respondents participated in completing the user acceptance test. The survey is distributed through Google Form. The user acceptance test is conducted to test the functionality of the system. The user acceptance is conducted for the login module and other modules which includes the manage employer/ staff module and attendance module.

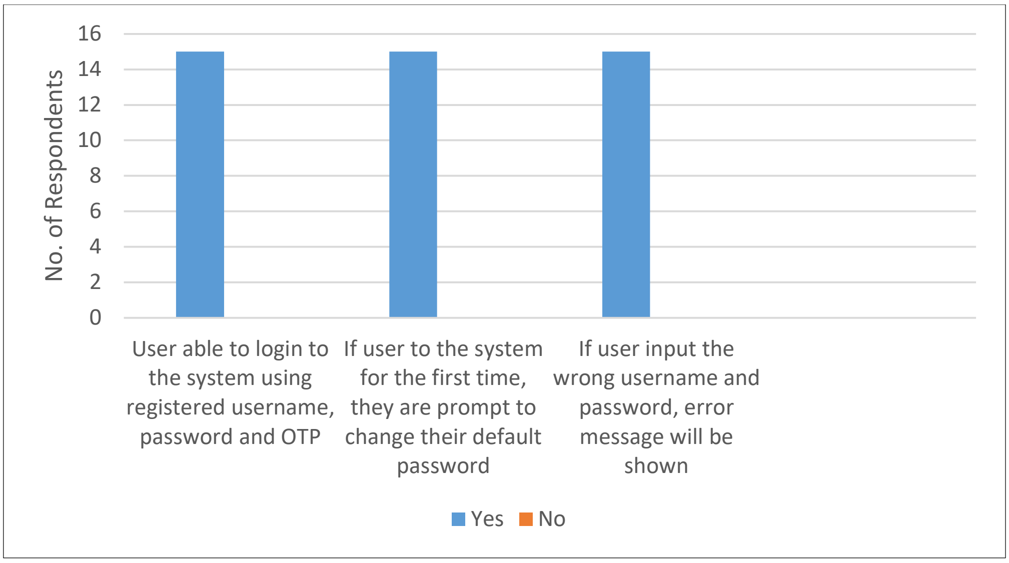


Figure 13: User testing on the login module

Figure 13 shows the results of user testing on the login module. All respondents are able to login to the system using registered username, password and OTP. They are also able to change their password upon logging in and an error message is shown when user input wrong username and password.

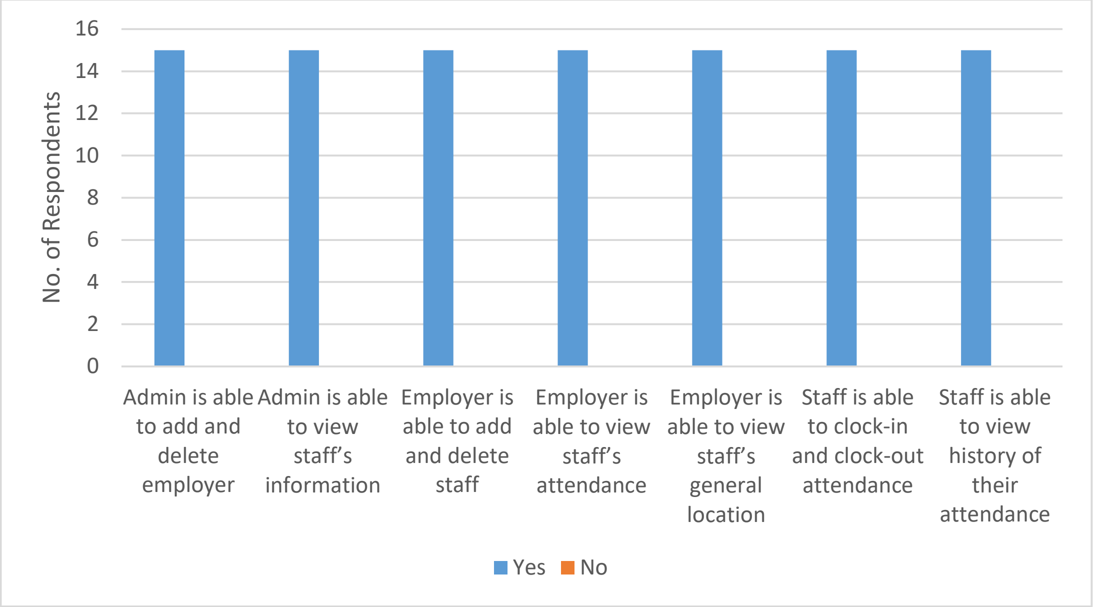


Figure 14: Testing on system’s manage employer/ staff module and attendance module

Figure 14 shows the testing on the system’s managed employer/ staff module and attendance module. Based on the results, all respondents are able to manage employers, manage staff, record attendance and also view attendance history.

The application functional testing is conducted to make sure that the system is working fine and all the functional and non-functional requirement are fulfilled. The results of the application functional testing is displayed in Table 3. Other than that, the application functional testing is done based on the scenario test plan. Table 4 displays the results of functional testing based on scenario test plan.

Table 3: Test report of Application Functional Testing

Application Functional Testing Checklist	Expected Outcome	Actual Output
User is able to login into the system with valid username, password and OTP	Login successfully	As expected
All user input such as user's personal information and attendance record is validated	Input validated	As expected
Error message is shown for invalid input	Toast message is shown for invalid input	As expected
The buttons in the system are visible and working well	User can navigate from page to page without difficulties	As expected
All pages in the system working properly	User can view the pages in the system	As expected
User staff's clock-in and clock-out record is recorded accurately	User can view their clock-in and clock-out time	As expected
All passwords are hashed	Passwords that are saved in database are hashed using SHA256 algorithm	As expected
The system is able to record staff's geolocation anonymously	The staff's location is stored in database anonymously	As expected

Table 4: Test report of Functional Testing based on scenario test plan

Scenario Test Plan Checklist	Expected Outcome	Actual Output
Users' login into the system using wrong username and password	Toast message will be shown	As expected
Users' receive one-time password through email	OTP is sent to registered email	As expected
Employer view staff's geolocation when checking staff's attendance	Location is displayed in a generalization form	As expected
Employer's location's latitude and longitude is saved in the database	Latitude and longitude value is masked before saving in database	As expected
Employer calculate staff's payroll	Staff's salary is calculated	As expected
Staff clock-in their attendance	Clock-in time and general location is saved in database	As expected
Staff clock-out their attendance	Clock-out time is saved in database	As expected
Staff view their payroll information	Staff can view their salary	As expected

5. Conclusion

MyAttend system has contributed to location anonymization where the users' location are preserved by implementing anonymization techniques which are masking out and generalization. The anonymization techniques are applied in the record attendance module, where when user staff record their attendance, their current location, latitude, and longitude will be saved in the database. Moreover, MyAttend's main functionality is to record staff attendance and calculate payroll. The attendance system is successfully developed by making sure the system records attendance accurately and calculate payroll detailly. In the end, the system is successfully developed, and all the objectives are achieved.

There are several limitations of the system. First of all, the system is only available for the Android mobile application platform and not available for the iOS mobile application platform. Next the system is unable to send notifications to remind users to clock out and the system is unable to record the absent days.

For future implementation, the MyAttend system should implement a notification alert for the user to record their clock-out time in the system at the correct time. Face recognition can be implemented as a two-factor authentication on the login page. Another functionality that can be included is the auto salary payment method that allows the employer to pay staffs' salaries through the system. Another aspect that can be implemented is the availability of the system for iOS mobile application users as the system is currently available only for Android mobile application users. As for the security features implemented, they should be enhanced more to prevent new kind of attacks in the future.

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