Location-aware Event Attendance System using QR Code and GPS Technology

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Abstract—**Attendance process in a university's event is time consuming and tracking the attendance can be harder. In this paper, a smart event attendance system for a university using QR code and GPS technology is proposed with objective to speed up the process of taking students' attendance and tracking full attendance. The method of developing the system is based on two views; user view which is the mobile application used by the students, and admin view which is the web administration system used by the event organizer. From the evaluation, students' attendance can be traced from the GPS location combine with QR code. The results indicate that full attendance increases as the system validates attendance through users' identification, location and timestamp during user login and logout. The proposed system contributes to high satisfaction among the users that claim that the mobile application helps to speed up the event registration process.**

Keywords—Event attendance system; quick response (QR) code; global positioning system (GPS); android mobile application

I. INTRODUCTION

In this era, smartphones play a significant role in our daily lives. The emergence of mobile application, has been impacted by the convergent factors such as high-speed data network, relatively cheap devices, high-performing devices, easy-to-use market places for apps, and the need for simple, targeted applications while mobile [1].

Universiti Teknikal Malaysia Melaka (UTeM) is the 14th public university in Malaysia. This university consists of three campuses which are the main campus, technology campus, and city campus. The university organizes various events for the students from different campuses. Hence, there will be hundreds of students that will take part in the events, thus making the attendance taking process time consuming and may delay the start time of the event.

Therefore, the purpose of this study is two-fold: First, to investigate the requirements in event attendance for a university's event, and second, to develop a mobile application that utilizes the QR code and GPS location. A proof of concept for the proposed solution is developed. The system consists of admin view for event's organizer to create an encrypted QR code, and a user view for students to log in the university site by using unique matric number and password, scanning the QR code shown by the organizer and their current location which is tracked by the GPS as the attendance. The user view will then communicate the information collected to the admin view to confirm the attendance.

This paper is organized as follows. Section II discusses previous studies in attendance management system, QR code, and GPS solution. Section III describes the methodology used to develop the student attendance system. Section IV outlines the implementation of this study, the discussion on system evaluation is provided in Section V, followed by conclusion in Section VI.

II. RELATED WORKS

Conventional attendance system is still used in most universities. However, this type of attendance system suffers problem like missing name, false attendance, missing attendance sheet, and tedious management. The advancement in attendance system has incorporate technological tools to improve the shortcomings in conventional system. In this section, various technologies used to support current work in the attendance system will be discussed.

An efficient web-based application for attendance management system is designed to track students' activity in the class by using the electronic methods [2]. Besides, the attendance records are stored in the database and this system is developed with the usage of Model, View and Controller (MVC) architecture with the assistance of power of Laravel Framework. The purpose of this system is to differentiate the hours of theoretical and practical lessons since the calculation method for the absence rate of students for these lessons are different.

On the other hand, biometric technologies such as face [3], fingerprint [4], and iris [5] recognition have been introduced as students' identification and reduce the false attendance problem. Although biometric identification prevents fake attendance and proxies, it requires some efficient recognition algorithms [6] and higher computation power on the mobile phone, thus increasing deployment cost.

The emergence of sensors has innovated the technology in smartphones and Student Identification (ID) card which facilitate the authentication process. Technology such as barcode [7], Bluetooth [8], RFID [9] and NFC [10] are used in attendance system to improve the weaknesses in biometric system. However, there is concern in substantial additional cost to the university, namely hardware reader to track the ID [11].

Hence, QR code based system which is a combination of mobile devices to display and scan the QR code is introduced. An online student attendance monitoring system (SAMS) based on QR code and mobile devices is developed in [11]. It

seems quantitatively easier to discern the students based on their diligence in attending classes and predict their performance due to the correlation between the attendance and academic performance. Besides, the main advantage of this system is to record and monitor student attendance in a more accurate and quicker way. There are two main components in this system, which are SAMS server and SAMS application. The system itself is available online and designed for access via mobile devices. A unique QR code is generated and sent for each student by email and it is used to record attendance. These QR code are presented by students to their lecturer either using their smart phone or with a print out, and later scanned by the lecturer using the SAMS application. However, we noticed that SAMS requires lecturers' intervention which can disturb the class delivery. Therefore, in order to avoid interruption, a proposed solution is offered by Masalha and Hirzallah [12], where students are required to scan the QR code by using a specific mobile application before or during the class. The QR code is pasted on each displayed lecture slide. The identity of the student is identified when he or she scans the generated QR code, and the attendance is taken and sent to the university's server [12]. Other solution in [12] also includes face recognition that is applied to perform identity verification. A location check will be performed to verify the users' location. However, lecturer need to design and develop a specific QR code for each student and this method is not suitable for the process attendance of event.

Nonetheless, the main weakness in current works in attendance system is the current location of students is not tracked when they take the attendance by using the student attendance system. This weakness can be seen in SAMS [11], the attendance checking system using QR code in University Sulaimaniyah in Iraq [13] and the smart attendance system in Institute of Hydropower Engineering and Technology [14]. Hence, cheating phenomena could have happened among students when they used these systems. Besides, the SAMS [11] is inappropriate for the process of students' attendance in event because a unique QR code is generated and delivered to each student by email, which is not suitable due to high overhead when the students coming from different faculties.

Consequently, we propose to develop an improved Event Attendance System which based on the features that has been discussed above. The event attendance system implemented in this project is a software application created using Android Studio to ensure only the authorized students can login into the system by using their unique matric number and password. Besides, the login and logout time of students and their current location which is tracked by GPS sensor will be recorded and stored in database as the attendance. In addition, the process of taking attendance can be speed up as the event organizer only needs to create an encrypted QR code with the event information provided.

III. METHODOLOGY

A. Requirement Analysis

Prior to this project, we performed requirement analysis in a meeting with the IT Operation officers from IT Centre (PPPK) in the UTeM. Based on the discussions, the functional requirements specification for the proposed system has been identified (refer Table I). Hardware and software requirement has been specified in Table II and Table III.

TABLE I. FUNCTIONAL REQUIREMENT

Event Attendance System	
Purpose	Event Attendance
Platform	Android, Web
Student information	• Name • Student Matric Number • Faculty • Course
Event Information	• Event name • Event Location • Event Date • Event Start Time, End Time

TABLE II. HARDWARE REQUIREMENT

Event Attendance System	
Hardware	Purpose/Usage
Laptop with 2GHz CPU, 4GB RAM	Specification for system development
Mobile phone with Android 4.4 system	Mobile application settings for testing and deployment

TABLE III. SOFTWARE REQUIREMENT

Event Attendance System	
Software	Purpose/Usage
Android Studio 3.0	Official IDE for system development
Android SDK v19	Mobile application platform for testing

To meet the requirements set by PPPK, the non-functional requirements will evaluate [15]:

1) Performance: The system is capable to scan the QR code based on various setting of lighting, angle and distance.

2) User Acceptance: To demonstrate how the design affects the usage of the application by the user, a preliminary study is conducted that use a quantitative methodology. A structured questionnaire is used to collect data survey from 20 students who have different levels of IT skill. The objective of this study is to measure the user satisfaction toward the application.

B. System Flow

Figure 1 shows the flow chart of user view for Event Attendance System. The android application allows a student

to login into the system. After successfully login into the system, the student will select 'SCAN THE QR CODE' button to scan the QR code which is generated by the university's event organizer. After the scanning process, the information about the event which is included in the QR code, the student's location, and student identity will be sent to database server. This is to ensure that the student is within the event hall/location when he or she is registering their attendance. The attendance will only be saved in database when the student scans the QR code 15 minutes before the event starts, and needs to logout within 15 minutes after the event ended.
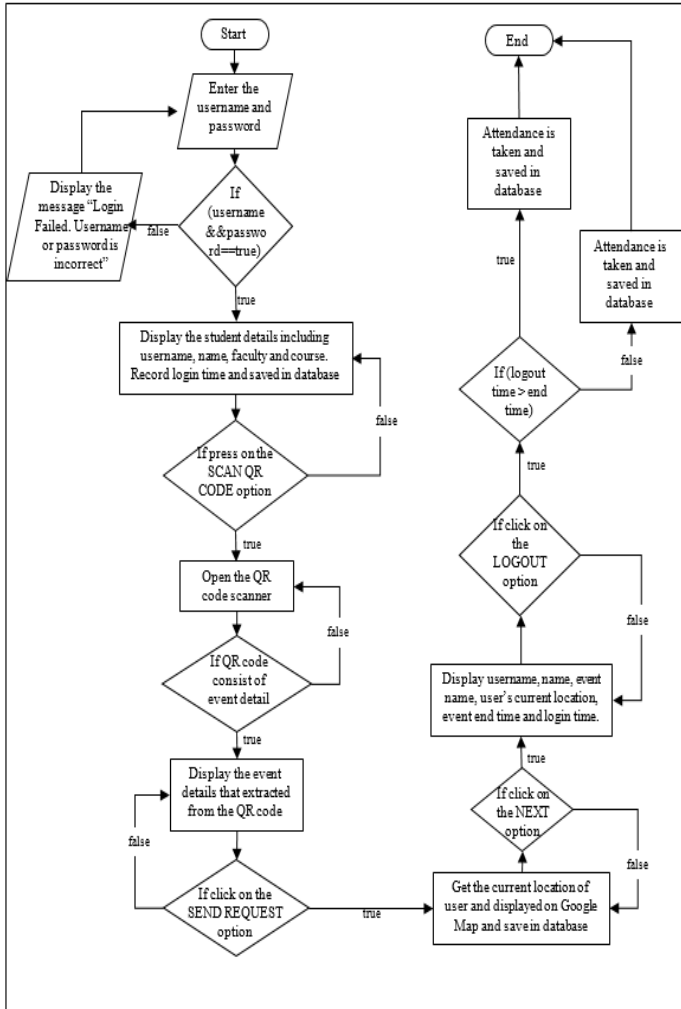
Fig. 1.   Flow chart of user view

Figure 2 shows the flow chart of the admin view. The system administor is able to choose different options in the main menu page. If administrator select the Student Attendance option, he or she can search an event name for viewing all students' attendance who participated in the event. Besides, administrator is allowed to view the particular event details if he or she indicates the Event Details selection. In addition, administrator is able to add a new event details which will be saved in database and generate a QR code that consists of the event data in Add Event and QR code generator respectively. Lastly, administrator is capable to view the student details on Student Details page according to the searched matric number.
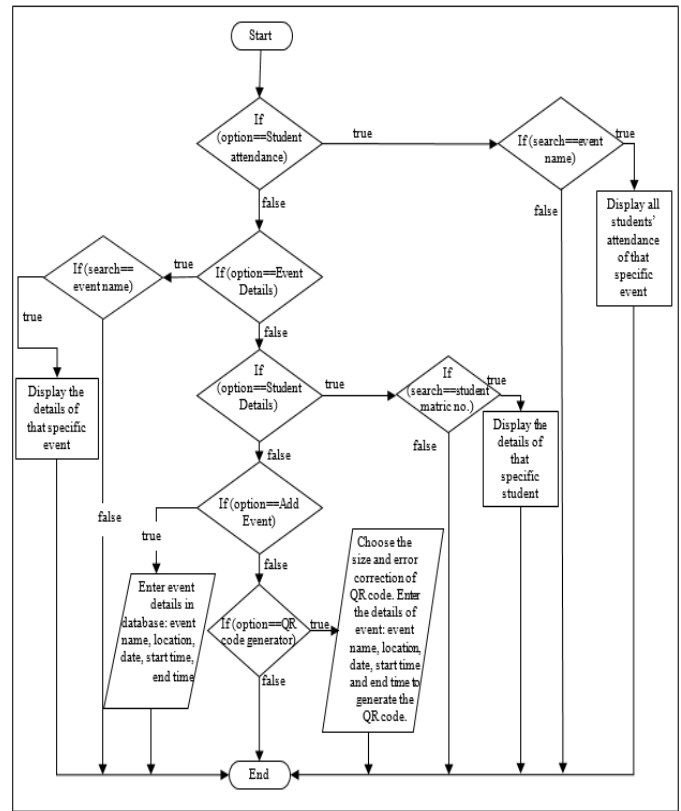

Fig. 2.   Flow chart of admin view

IV.   IMPLEMENTATION

A. System Architecture

Figure 3 shows the architecture of the proposed system. First, the user needs to log in the system by using their email address and password. After that, the student needs to scan the QR code that is provided by the organizer. When the student uses the android application to scan the QR code, the application will request the location of the student to ensure he or she is at the correct location to take the attendance.
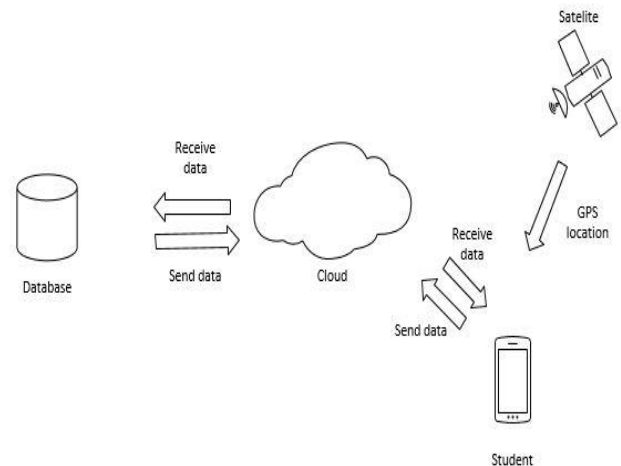

Fig. 3.   System Architecture

B. Experimental Setup

The system evaluation is conducted in Universiti Teknikal Malaysia Melaka (UTeM). 20 students who have different levels of IT skill from different faculties were selected to test the system. We created two events for the purpose of evaluation; Hacking Event and Workshop 2 Briefing, with different location for each event. We conducted three types of evaluation to meet the system requirements, namely system functionality, system performance and user acceptance.

The system consists of two views; user view which accessible through mobile application and admin view from web administration system. Further discussion on both views is provided in the Section C and D.

C. User View: Mobile Application

Mobile application contains four modules: Login, QR code Scanner, GPS and Attendance modules. In Figure 4, the details of the student such as username, name, faculty, course and login time which are stored in database will be displayed if they successfully log into system. For attendance input, the student needs to press on the 'SCAN THE QR CODE' button for scanning the QR code.

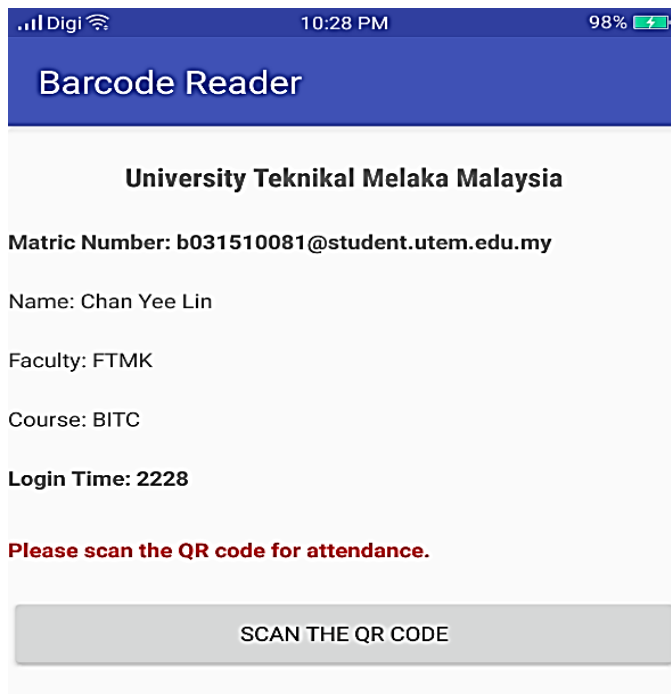Fig. 5.   Activity Scan Barcode Interface

Fig. 4.   Event Selection Interface

In Figure 5, the student needs to scan the QR code which contains the event's information by using the QR code scanner. The event's details that is extracted from the QR code will be displayed in this page and saved in database (refer Figure 6). Additionally, student can request their current GPS location by pressing Send Request button. The current location of the student will be tracked and later saved in database. The acceptance of student attendance is notified by displaying the username, student name and event's details on the mobile page.
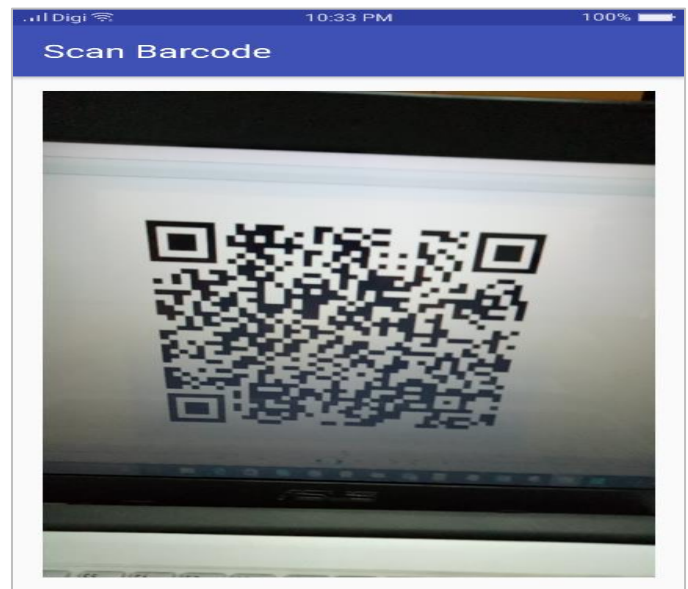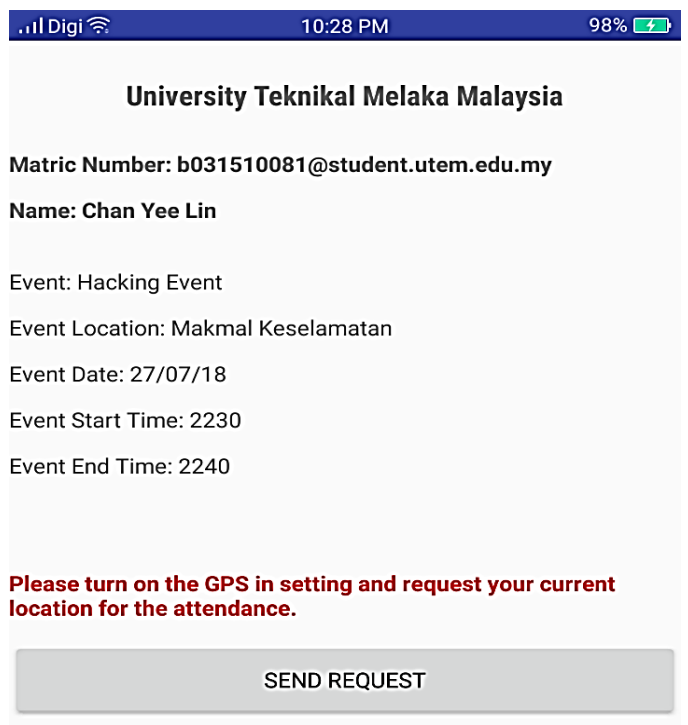

Fig. 6.   Barcode Result and Request GPS Interface

Figure 7 shows the application tracking the current location of the student. In Figure 8, the event's details such as event name, current location and event end time will be displayed in this page. Besides, the username, student name, and login time of the student will be called from database and displayed on the page. To ensure the attendance is taken, Logout button should be pressed once the event ended for student to logout from the system. However, if student logout from the system before the event ended, the attendance will not be taken.
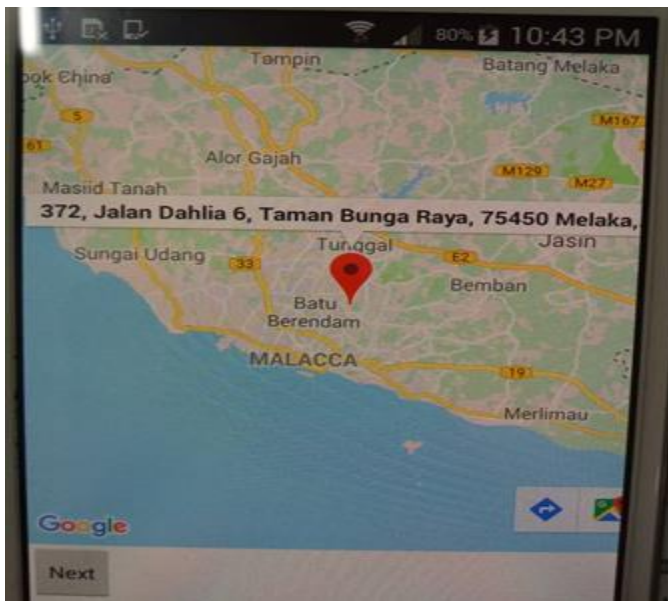
Fig. 7.   Detect GPS Location Interface

Fig. 8.   Logout page Interface

D. Admin View: Web Administration System

On Web Administration main menu page (refer Figure 9), there are five modules that needs to be manage; Add Event (refer Figure 10), QR Code Generator (refer Figure 11), Event Details (refer Figure 12), Student Attendance (refer Figure 13), and Student Details (refer Figure 14).

To register new event, administrator can add the event details and save to the database as in Figure 10. Administrator will generate the event QR code on the page. Besides, administrator can choose the size and error correction of the QR code (refer Figure 11). Event details will be displayed on the page (refer Figure 12).

Fig. 9.   Web Administration Main Menu
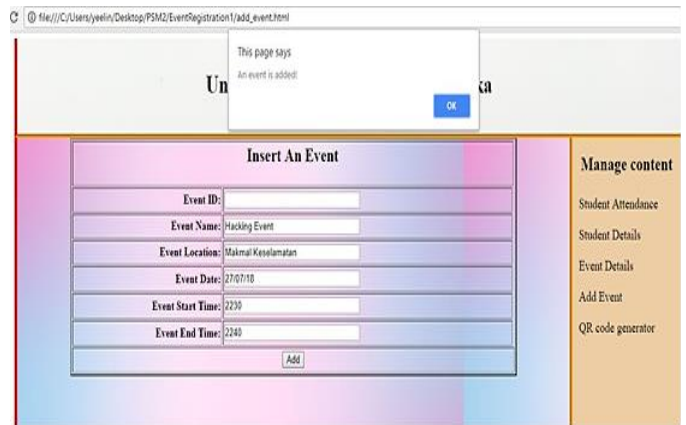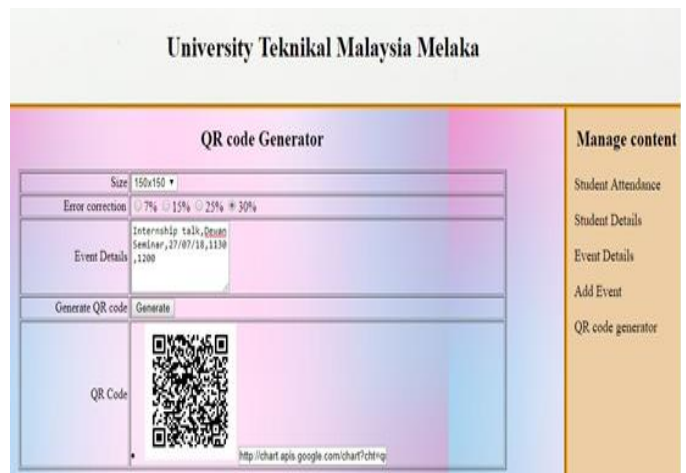

Fig. 10. Add Event

Fig. 11. QR Code Generator

Fig. 12. Event Details

In Figure 13, administrator can view the students' attendance according to a specific event. Students' attendance will be displayed on the page. Students' attendance list can be downloaded in Excel format.

In Figure 14, administrator can view the student's details according to a specific matric number and the student details will be displayed.
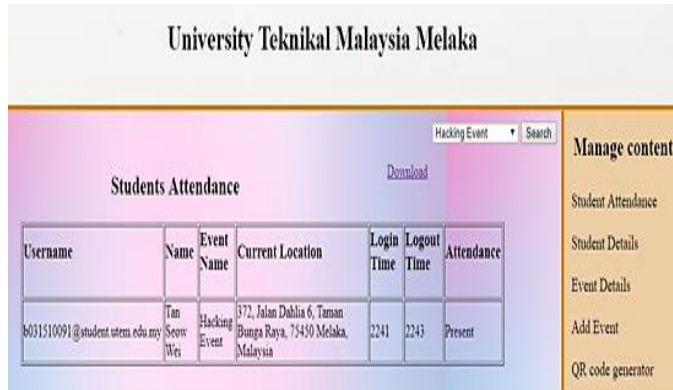

Fig. 13. Student Attendance Filtered By Events

Fig. 14. Student Details

V. EVALUATION AND DISCUSSION

System evaluation is conducted to verify system functionality, system effectiveness, and user satisfaction.

A. System Functionality

User view and admin view are evaluated in integration test to examine the functionality of all the components together. Testing used wireless services provided by the university without increment of bandwidth from the IT Center and also mobile service provider. All modules in mobile application successfully connected to the database in the Web Administration system. This concludes that the user view and the admin view are functionally capable to operate.

Authentication for the system is unique as they used email which consists of student matric number. The application will check the identity based on the student database stored in the Firebase cloud. Registration of the event is design to make sure the student will participate in the event to the end. In this case, unless the student did not logout, their attendance will not be counted. In addition, there is condition to be met; they can only logout after the event ended.

B. Performance Evaluation

Three parameters are used to evaluate the performance of the system:

1) Angle degree: the angle degree for handling the device when scanning the QR code.

2) Distance: the distance between the device and QR code

3) Brightness level: the level of brightness of the device

These performance parameters are selected to ensure the system can be performed in a high effectiveness [15].

Table IV, V and VI illustrate the performance of each parameter selected in this study. In Table IV, four angle degrees are evaluated namely 30, 45, 90 and 120 degrees. From the table, it can be seen that successful QR scanning applies only for 90 degrees' angle.

TABLE IV. RESULT FOR ANGLE DEGREE

Angle for handling the device (degree)	Status (Pass/Fail)
30	Fail
45	Fail
90	Pass
120	Fail

The results from Table IV shows that 90 degree is the preferred angle to handle the device when scanning the QR code. However, the status is Fail when user handle the device by using 30 degree, 45 degree, and 120 degree. This may be due to handling the device using these three angles will produce partial view of the QR code, thus making the system unable to detect the QR code. Besides, distance between the device and QR code plays an important role in this test.

In Table V, four distance evaluation is performed namely 3, 6, 9 and 12 cm. From the table it can be seen that successful QR scanning applies only on distance of 3 cm and 6 cm.

TABLE V. PERFORMANCE TEST OF DISTANCE BETWEEN THE DEVICE AND THE QR CODE

Distance between the device and QR code (cm)	Status (Pass/Fail)
3	Pass
6	Pass
9	Fail
12	Fail

From the results in Table V, 3cm and 6cm are the most suitable distance among these distances during the scanning of the QR code, whereas the status of 9cm and 12cm are Fail. These two distances of device are too far away from the QR code and the system is unable to detect the QR code.

In Table VI, four level of brightness evaluation is performed namely 10%, 30%, 60% and 100%. From the table, it can be seen that successful scanning applies on 60% and 100% brightness.

TABLE VI.   PERFORMANCE TEST OF BRIGTNESS LEVEL OF THE DEVICE WHEN SCANNING THE QR CODE

Level of brightness of device (%)	Status (Pass/Fail)
10	Fail
30	Fail
60	Pass
100	Pass

From Table VI, 60% and 100% are the ideal brightness for the device to detect the QR code and extract the data inside it. Nevertheless, 10% and 30% of brightness is not suitable for device to detect the QR code because there is not enough light to decode the data that encoded in the QR code.

C. User Acceptance Evaluation

Upon data collection, the level of acceptance was investigated by evaluating the application user interface quality, reliability, satisfaction and future use.

TABLE VII.   USER ACCEPTANCE TEST

Description	Mean	St. Dev.	Avg Mean
Interface Quality			
The way I interact with the application is pleasant.	4.80	0.51	4.90
The application is intuitive and user friendly and easy to understand.	4.95	0.21	
I think that I would not need the support of a technical person when using this application.	5.00	0.00	
I found that various functions in this system were well integrated.	4.85	0.36	
Reliability			
Time is saved and the purpose to avoid the event start lately is achieved.	4.50	0.74	4.52
The QR code scanner of the application is able to scan the QR code in high efficiency.	4.90	0.30	
User's current location is tracked correctly by using the application.	4.15	0.85	
Satisfaction and Future Use			
I feel convenient and confident when using the application for taking the attendance.	4.75	0.62	4.80
This application is an acceptable way for taking the students attendance.	4.75	0.54	
Overall, I am satisfied with the application for taking the attendance.	4.90	0.30	

Table VII shows the feedback received from the users after they used the application. The highest average mean among three categories is the interface quality of the application which is 4.90. Besides, all users agree that they do not need technical support when using the application, hence the mean is 5.00. This application is accepted by most of the users because the system is user friendly and convenient to use, as the mean is 4.95. In terms of reliability, the average mean is 4.52. We conclude that this application is able to scan the QR code in high effectiveness due to its highest mean of 4.90. For tracking user's current location, this application score 4.15. Certain smartphones are slow to display GPS location; thus the score is low. The average mean of the satisfaction and future use category is 4.80. Therefore, it can be concluded that most of the users are satisfied with this application for taking the attendance as its mean is 4.90.

VI.   CONCLUSION AND FUTURE WORK

Location-aware Event Attendance System using QR code and GPS technology is implemented using android application and Firebase database in cloud to manage the attendance information. From the evaluation, the proposed system was capable to take the student attendance by scanning the QR code. The GPS location, time login and logout were tracked to ensure full attendance. We found positive feedback for the system in the user acceptance test. However, this system can only support android application which makes it inconvenient for iOS users. Furthermore, the proposed system is only capable of tracking the location without calculating the distance to the event venue. In addition, the application also needs strong Internet connection.

For future work, we plan to improve the application operability to support both android and iOS smart phone. To calculate the distance between the user and the venue, we propose to incorporate Google Maps Distance Matrix API in the application. To decrease false attendance and secure authentication, the authors also plan to apply factor-based authentication scheme with low cost method in the application [16]. This study can be extended to other areas such as recommender system.

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