Applied Information Technology And Computer Science Vol. 2 No. 2 (2021) 073-084

AITCS

Homepage: http://publisher.uthm.edu.my/periodicals/index.php/aitcs
e-ISSN :2773-5141

Attendance Monitoring Application for Students using RFID

Hazirah Izzati Abdul Hanis, Sofia Najwa Ramli*

Faculty of Computer Science and Information Technology,
Universiti Tun Hussein Onn Malaysia, Parit Raja, 86400, MALAYSIA

DOI: https://doi.org/10.30880/aitcs.2021.02.02.005
Received 15 June 2021; Accepted 09 September 2021; Available online 30 November 2021

Abstract: Coronavirus Disease 2019 (COVID-19) is affecting different age groups including school students. The safety of those students needs to be put as a priority by our government when they attend the school for teaching and learning. However, Sekolah Menengah Kebangsaan Tun Habab is still gathering the attendance information using attendance book at the school entrance that may be a potential for spreading COVID19. Therefore, this project focuses on designing an application that helps the school to record student attendance data using RFID. The chosen methodology to develop the application is SDLC Waterfall Model. The application is developed using Arduino. The proposed application records the student's RFID ID, time, and date every time they check-in to the school via the application. In conclusion, the project may lessen the problem that has been facing by the school and the students such as using manual way to record the student's information before entering school that may put them on risk of spreading the virus of Coronavirus Disease 2019 (COVID-19) as they are using the same equipment to write down their information, the potential of losing the data due to natural disaster, and some of the students cannot afford to buy smartphones to use the existing application.

Keywords: Check-in, Application, Student's Attendance, RFID, SDLC Waterfall Model

1. Introduction

The proposed project is an application proposed for secondary school students. It is proposed to ease the process of students entering the school. It is because, in this new normal era, the process of entering a building needs to follow the Standard Operating Procedure (SOP). Other than that, the proposed project also allows teachers and parents to use it for monitoring. The main focus of the proposed project is to ease the process of recording student's attendance data before entering the school building. Radio Frequency Identification (RFID) technology will be implemented in this project. The radio wave is used in the RFID technology to exchange the data from the tag. Hence, RFID is chosen to use as a tag for students to enter the school area.

One of the problems is Sekolah Menengah Kebangsaan Tun Habab is still using a manual process to store the data when the students enter the school. The school is in Kota Tinggi, Johor, and this area

*Corresponding author: sofianajwa@uthm.edu.my

is known as a flood area during the flood season. Therefore, the potential of losing the data due to a natural disaster is possible. Next is the manual process may place students at risk because students are practicing direct contact with the equipment such as pen and notebook when writing down their information. Other than that, some the students do not afford to buy smartphones. Moreover, school students in Malaysia are prohibited to bring their phones to the school. Therefore, to reduce the risk, RFID is used to integrate with the system.

Then, the background study of related technology and terms that is used in the proposed system will be described. The Internet of Things (IoT) is a common technology that is widely used by many applications for daily use. There are many types of IoT technologies such as Bluetooth and Wi-Fi. Bluetooth is a technology that allows users to communicate between devices from short range. In old days, Bluetooth was used as a technology to transfer data between two devices in the wireless method. The architecture of the Bluetooth network is called master and slave [1]. For this project, Radio Frequency Identification is chosen to integrate with the proposed system. In this project, NodeMCU ESP8266 is used to integrate with RFID to send the data to the database. NodeMCU is using Wi-Fi to send the data that it receives from the RFID.

Radio Frequency Identification consists of three type of tags which are active, passive, and Battery-Assisted Passive (BAP). For active tags, it is using a battery as the source of the power [2]. Hence, it is normally used for detecting location systems. It is because the tag has a portable power source and may function by itself. A passive RFID tag is a tag that does not have its battery as a power source [3]. Therefore, the tag is inactive until it receives a signal from the reader. For Battery-Assisted passive (BAP) tags, the tags are built with an internal battery. Hence, it may self-startup even though without the reader to receive the signal [4]. There are three components in RFID which are tags, reader, and antenna. Tags are working as a component that allows the process of receiving and transmitting the information. For the antenna, it is a component that sends data from tags and also receives the data from readers. It uses radio waves in the sending and receiving process. The RFID technology can read data from certain range is one of the benefits of the technology [5]. Then, the reader will get the information accessed by a tag [6].

The reader is a component used to receive data from tags and convert the signals to radio waves. The radio waves then will be converted into readable signals such as digital signals. The reader also will be receiving and sending data from the antenna. There are many types of RFID frequency. RFID consist of three types of frequency. Low-frequency types are usually implemented in the immobilization system of cars [7]. The system used it to prevent the hot-wiring technique which means to start the engine, it needs to use a correct key. High-frequency range is usually used in tracking applications. It is because of the high range of the frequency which is 13.553 to 15.567 megahertz [8]. It same goes for ultra-high frequency is mostly used in the tracking system. For microwave frequency, it usually comes in two types of tags which are active and semi-active RFID tags. These microwave frequency RFID tags are usually used in tolling systems.

2. Related Work

2.1 Study of Existing Systems

This section describes about the study of existing system. The first existing system is IoT based Smart Attendance Monitoring System using RFID [9]. It was proposed as an attendance system for employees and students [9]. It designed to change the manual method of recording attendance into a system that used RFID to record the attendance automatically [9]. The system used RC522 RFID and Arduino UNO board to integrate with the system [9]. LED lights used in the system as a signal to determine if the process is success or failure [9]. RFID's card number is stored in the database [9]. When a user swipes the card at the RFID scanner, if the system cannot find the RFID's card number in

the database, then the red-light glows. If the RFID's card number matched with the number stored in database, the green light glows [9].

Smart Attendance System (SAS) is the second existing system. It was proposed for student attendance data system [10]. It is a web-based system developed using the Hypertext Preprocessor (PHP) programming language [10]. The system has several users which are administrator, lecturer, student, university administrator, and guest [10]. Different users have different access and roles in the system. Admin is the only user who has the full access to manage the system [10]. The system has several modules which are home, attendance, notes, assignment, reminder, and report modules [10]. The Smart Attendance System (SAS) is using RFID as the hardware to record the student's attendance data. RFID database handling system is integrated with the Smart Attendance System (SAS) [10]. The attendance information are stored in the SQL database [10].

2.2 Systems Comparison

In this section, the comparison between the two existing systems and the proposed system will be describe. The features of the existing systems and proposed system will be compared and describe in this section.

Table 1: Comparison table of existing systems and proposed system

Features	IoT based Smart Attendance Monitoring System using RFID [9]	Smart Attendance System (SAS) [10]	Proposed System
Password protection	No	No	Yes
Database	Yes	Yes	Yes
Login	No	Yes	Yes
RFID	Yes	Yes	Yes
Attendance Log	Yes	Yes	Yes
Assignment Module	No	Yes	No

Table 1 shows the features comparison of existing systems and the proposed system. IoT based Smart Attendance Monitoring System using RFID is being used in Chikmagalur, India as an attendance system for students or employees [9]. The Smart Attendance System (SAS) is applied in Malaysia and was proposed to record student attendance [10]. Based on Table 1, the proposed system may have all the features in Table 1 except for the Assignment Module. Password protection is the security feature that will be implemented in the proposed system. The proposed system will hash the password stored in the database. The IoT based Smart Attendance Monitoring System using RFID does not have the login feature while the Smart Attendance System (SAS) has the login feature that allows different access for users [9][10]. The login feature included for the proposed system is to differentiate the role of the user which are admin, teacher, and parents. Then, the RFID is hardware that is be used to integrate into the proposed system. For the two existing systems, the user use an RFID card to record the user's attendance. The proposed system also uses the RFID card and tag to record the student's information such as RFID ID, date, and time when the student check-in to the school area. All data is stored in databases. Only Smart Attendance System (SAS) has the assignment module feature for lecturers and students [10].

3. Methodology

SDLC Waterfall methodology is implemented in developing this project. The reason of choosing the Waterfall methodology for this project because it is systematic and easy to understand the process to relate with the project. The model is linear-sequential, so the project must follow the sequence of the phases. For example, before moving to the next phase, the earlier phase needs to be completed. Hence,

the phases in the Waterfall model would not be overlapping. There are a few figures designed. These diagrams are needed to be designed to show the flow of the process. Then, it is also to show the flow and relationship of the data in the database. The programming language for the system is using Hypertext Preprocessor (PHP), Hypertext Markup Language (HTML), Cascading Style Sheet (CSS), and JavaScript.

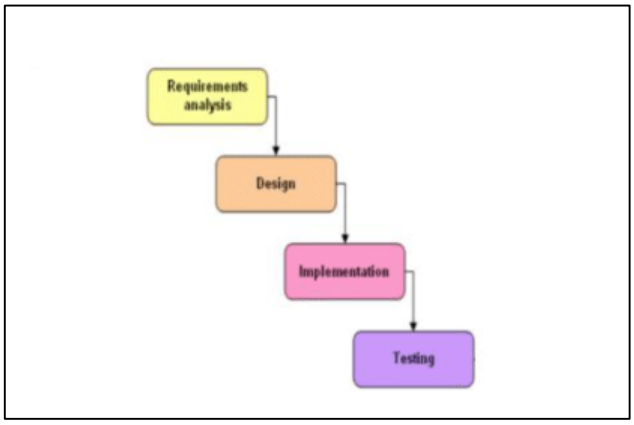

Figure 1: SDLC Waterfall model

Figure 1 shows the phases in the Waterfall model. The phase and activities are requirement analysis, design, implementation, and testing. The phases are described as in section 3.1, 3.2, 3.3, and 3.4.

3.1 Requirement Analysis Phase

In requirement analysis phase, the specification of hardware and software are identified. It is important to analyze the specification because to ensure the next process after this phase will be smooth. For example, hardware that has been identified for this project are laptop, RFID RC522, breadboard, jumper wires, and NodeMCU ESP8266. The software used for this project is XAMPP server, Arduino, and Notepad++. Other than that, it is also important to analyze the programming language used for this project. The programming language used to develop this project are Hypertext Preprocessor (PHP), Hypertext Markup Language (HTML), Cascading Style Sheet (CSS), and JavaScript.

3.2 System Design Phase

In design phase, few figures are designed. It is to ease the next process which is implementation. These designs are used for the reference when doing the implementation of the system. In this phase, the functionality of modules is discussed and identified using few figures. The figures are describing the data in the system including the data flow in the system. Then, the users in the system are also discussed in this phase. One of the processes in design phase is the process of designing related diagrams such as context diagram and Data Flow Diagram (DFD). These designs process is important because in the next phase, the designs are used for reference to develop the application. For example, in the implementation phase, these designs will help to writing code for the functionality in each module. Context diagram is a diagram that shows the relationship between the data and the external entities. For example, the external entities for this project are admin, parents, teacher, and students. Therefore, the diagram shows the relationship between the entities and the data for the application. The Data Flow Diagram (DFD) is the detailed diagram of the context diagram. In the Data Flow Diagram (DFD), it shows the relationship between the data, entities, and the data stores. The processes are also drawn in the Data Flow Diagram (DFD) to show the relationship of the data in the process. The data will flow from the entities and through the certain process and finally is stored in the data stored. The data in the data store also may be fetched for the certain process to be sent to the entities. Context diagram will be described in Figure 2. Then, the Data Flow Diagram (DFD) is described in Figure 3.

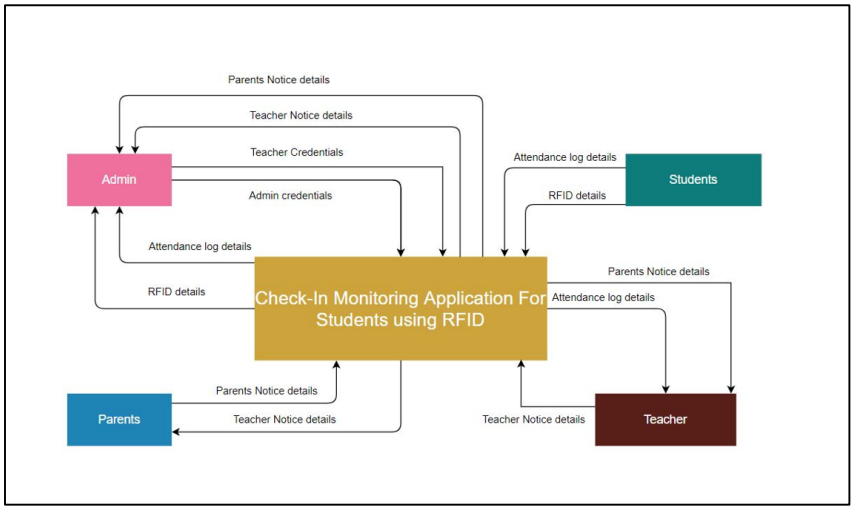

Figure 2: Context Diagram

Figure 2 shows the interaction between four entities which are admin, teacher, parents, and students. Teacher credentials, admin credentials, parents notice details, attendance log details, RFID details, and teacher notice details are the data in the system. Teacher send the teacher notice details data to related entities. The data will interact with the related entity such as the teacher notice details may be fetched by admin, teacher, and parents. Parents notice details may be fetched by admin, teacher, and parent's entities. Students' entity may send the attendance log details and RFID details. The data may be retrieved by admin and teacher.

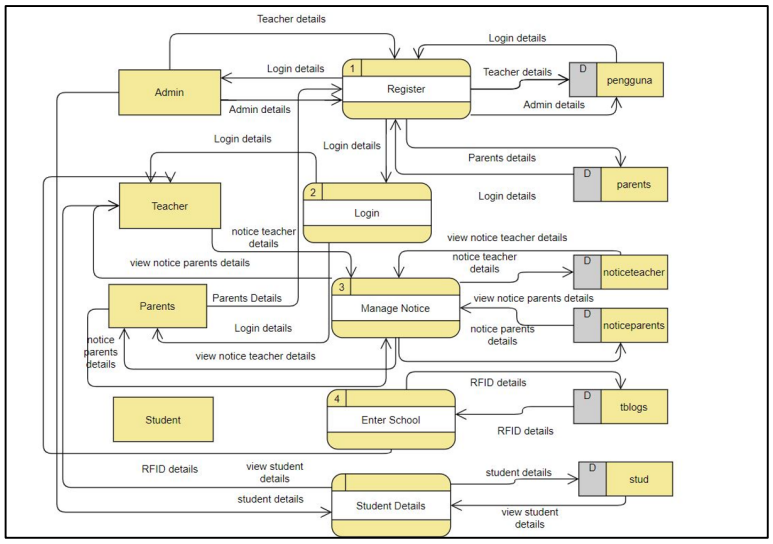

Figure 3: Data Flow Diagram (DFD)

Figure 3 shows four entities which are admin, teacher, parents, and student. The processes for the system consist of Register, Login, Manage Notice, Enter School, and Student Details. The data such as the notice teacher details flow from the entities and the data stores. There are six data stores for the system. The data stores store the data, and the data may be retrieved and fetched to be used in the processed and to be send or retrieve to the entities.

3.3 Implementation Phase

In the implementation phase, the development process of the system is started. The code is written in the Notepad++. Jumper wires are used to connect the RFID and the NodeMCU ESP8266. The coding for the application interfaces is written in the Notepad++. Coding for the hardware is written in the Arduino. To run the application, XAMPP server is used to deploy the application.

3.4 Testing Phase

All modules in the application are tested. There are two types of testing which are functional test and user acceptance test. In the testing phase, the modules are tested to see if there is an error or failure in the system's function.

4. Results and Discussion

This section describing about the implementation and testing that was conducted for Attendance Monitoring Application for Students using RFID.

4.1 Implementation of the System

The implementation process starts with creating the database and the tables using PHPMyAdmin. PHP, HTML, and JavaScript are the language used to develop the system. Notepad++ is the software used to write the code. Then, for the hardware, RFID RC522 and NodeMCU ESP8266 are used to connect with the system. Arduino is the software needed to configure the hardware. The system is using XAMPP as the server. Parents as the user needs to register accounts to start using the application. Then, for admin and teacher, the admin will create accounts for the teacher and admin users.

In the enter school module, student's attendance will be recorded using RFID tag and scanner. The ID, time, and date will be recorded as an attendance log. Admin needs to log in to the system using the username and password. The admin may create, update, and delete the student details. Admin also may view notice parents and notice teacher. Other than that, admin also may view the student's attendance log. The admin also may create the student's details such as the student's name, class, and ID. Then, the teacher also needs to log in to the system using the username and password. The teacher may create, update, and delete notices in the Notice Teacher module. The teacher may view the parent's notice and student's attendance log. Moreover, parents can log in to the system and the parents may view the teacher's notice that has been created by the teacher. Then, the parents may create, update, and delete notices in the Notice Parents module.

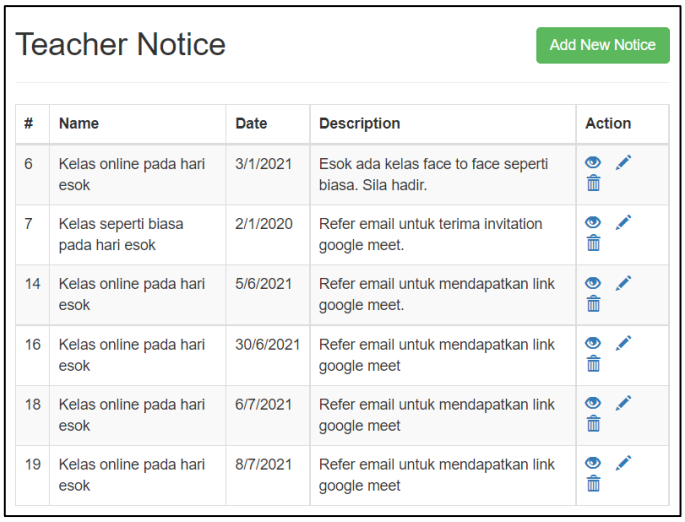

Figure 4: Teacher Notice

Figure 4 shows the Teacher Notice module. This module will allow a user to create a notice. The user may create notice if the teacher wants to conduct online classes or face-to-face classes. The notice may be viewed by parents. For example, the figure shows online classes will be conducted on 3/1/2021. Moreover, the students may access the google meet link through email as mentioned in the notice. The user may manage the notice by updating or deleting it.

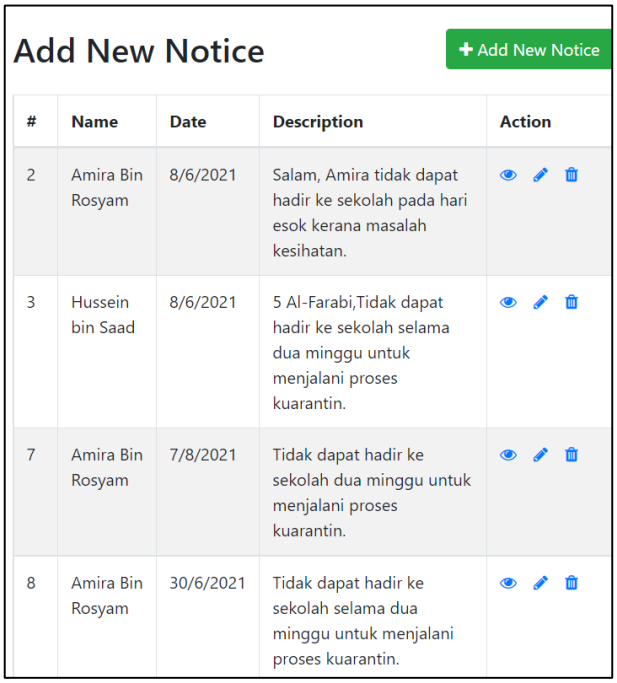

Figure 5: Parents Notice

Figure 5 shows the Parents Notice module. This module will allow a user to create a notice. The user parents may create notice if they want to inform the teacher if their children cannot go to school due to quarantine or other causes. The notice may be viewed by the teacher. For example, the figure shows that the parents created notice to inform the school that the student cannot go to the school on 8/6/2021 because it needs to go under quarantine process. The user may manage the notice by updating or deleting it.

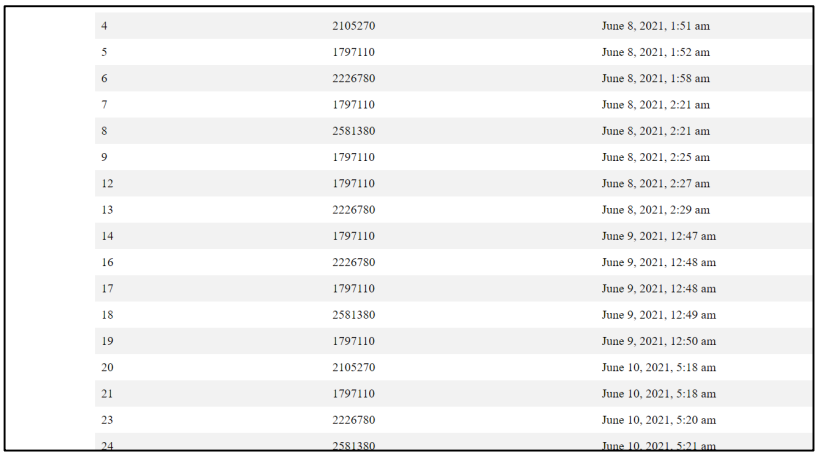

Figure 6: Enter School

Figure 6 shows the interface of Enter School module. In this module, the student will use the RFID cards to scan. Hence, the ID, date, and time when the students entering the school will be recorded.

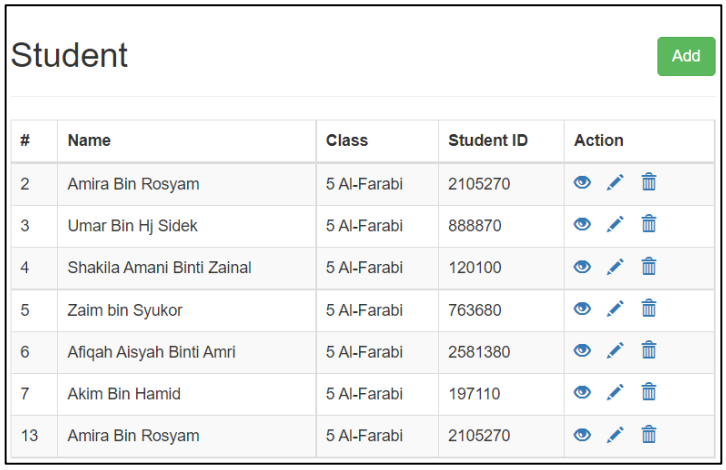

Figure 7: Student Details

Figure 7 shows the Student Details module. In this module, the admin may add the student's information. The student's name, class, and ID will be added in this module. Then, in the Enter School module, the ID will be recorded with the date and time when they check-in to the school.

4.2 Functional Test

After the development of the application completed, testing is conducted to test the function of the application. It is to identify if there are any errors when using the application. The test will be described in Table2, Table 3, Table 4, Table 5, Table 6, Table 7, and Table 8.

Table 2: Test for Register Module

Item	Test Case	Expected Results	Results
1	Users leave field empty	Shows error message	Success
2	Users enter wrong email format	Shows error message	Success
3	Users enter wrong repeated password	Shows error message	Success

Table 2 shows the functionality test for register module. The first test case is if the user leave field empty, it will show an error message. The result for the first item is success. For the second item, error message is shown as the expected result if the user enters wrong email format. The result for the second test case is success. The third test case is when the user enters wrong repeated password, an error message is shown. The result for the third test case is success.

Table 3: Test for Login Module

Item	Test Case	Expected Results	Results
1	Users leave the field empty	Shows error message	Success
2	Users enter correct username but wrong password	Shows error message	Success
3	Users enter wrong password but correct username	Shows error message	Success

Table 3 shows the test for login module. There are three test cases. The first test case is if the user leaves the field empty, it will show an error message. The result for the first item is success. For the second item, error message is shown as the expected result if the user enters correct username but wrong password. The result for the second test is success. The third case which is when the user enters wrong password but correct username, an error message is shown. The result for the third test case is success.

Table 4: Test for Enter School Module

Item	Test Case	Expected Results	Results
1	Students scan the RFID card at the reader	Collect ID, time, and date	Success
2	Students did not scan the RFID card at the reader	Did not collect the ID, time, and date	Success

Table 4 shows the test for the enter school module. There are two test cases. The first test case is if the students scan the RFID card at the reader. The expected result is the system collects the ID, time, and date. The result for the first test case is success. The second test case is if students does not scan the RFID card at the reader. The expected result is the system would not record the ID, time, and date.

Table 5: Test for Create User Module

Item	Test Case	Expected Results	Results
1	Admin enters wrong email format	Shows error message	Success
2	Admin enters wrong repeated password	Shows error message	Success
3	Admin leaves the field blank	Shows error message	Success

Table 5 shows the test for create user module. The module is for admin. If admin enters wrong email format, the expected result is the system will show error message. The result for the first test case is success. The second test case is if admin enters wrong repeated password. It shows the error message, and the result is success for the second test. The third item of the test case is if admin leaves the field blank, an error message is shown. The result for the third test case is success.

Table 6: Test for Teacher Notice Module

Item	Test Case	Expected Results	Results
1	Allow user to add, update, read, and delete notice	User can add, update, read, and delete	Success
2	Submit button	User can create notice	Success

Table 6 shows the test case for teacher notice module. The module is for teacher. The first test case is the system allows user to add, update, read, and delete notices. The expected result for the first test case is the user can add, update, read, and delete notices. The result for the first test case is success. The second item of the test case is the submit button in the module. The submit button should allow user to create notice. The result for the second test case is success.

Table 7: Test for Parents Notice Module

Item	Test Case	Expected Results	Results
1	Allow user to add, update, read, and delete notice	User can add, update, read, and delete	Success
2	Submit button	User can create notice	Success

Table 7 shows the test for parents notice module. The module is for parents. The first case is the system should allow user to add, update, read, and delete notices. The expected result is the user can add, update, read, and delete notices. The result for the first test case is success. The second item for the test case is the submit button in the parents notice module. The button should allow user to create notices. The result for the second test case is success.

Table 8: Test for Student Details Module

Item	Test Case	Expected Results	Results
1	Allow user to add, update, read, and delete student details	User can add, update, read, and delete	Success
2	Submit button	User can create new student details	Success

Table 8 shows test for student details module. This module is for admin to add the student details such as ID, name, and class. The first test case it the system should allow user to add, update, read, and delete the student details. The expected result is the user can add, update, read, and delete. The result for the first test case is success. The second test case is the submit button in the module. The expected result is the user can create new student details by clicking the submit button. The result for the second test case in Table 8 is success.

4.3 User Acceptance Test

Table 9: Acceptance Requirements for User Acceptance Test

Item	Acceptance Requirements	Strongly Disagree	Disagree	Agree	Strongly Agree
1	User can login and register	0	0	2	2
2	Module in admin is functioning well	0	0	1	3
3	User can create, update, and delete, notice parents, and notice teacher when login as parents and teacher	0	0	1	3
4	User can view notices parents, student details, and student attendance log when login as teacher	0	0	0	4
5	User can view notices from parents and teacher, and student attendance log	0	0	0	4
6	User can view notices from teacher when login as parents	0	0	0	4
7	User can create, update, and delete, student details when login as admin	0	0	0	4
8	The system recorded the ID, date, and time correctly when user scan the RFID card at the reader.	0	0	0	4

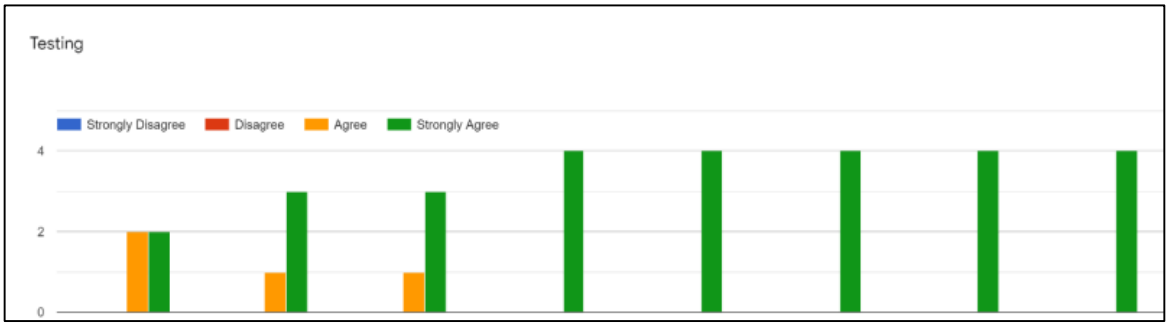

Figure 8: Graph of User Testing

Based on Figure 8, it shows the graph result based on the volunteer's answers. The total of volunteer testing the system are four. On the left side of the graph starting by the acceptance requirement number

one until the acceptance requirement number eight that can be referred in Table 9. Table 9 shows the list of acceptance requirements for the volunteers to answer. The answer is in a scalable form which consist of strongly disagree, disagree, agree, and strongly agree. For the first acceptance requirement, there are two volunteers voting for agree and another two voted for strongly agree. For acceptance requirement number two, one people voted for agree and another three voted for strongly agree. One volunteer voted agree and three volunteers voted strongly agree for acceptance requirement number three. Four volunteers voted strongly agree for the acceptance requirement number four. For the acceptance requirements number five, six, seven, and eight, four volunteers voted for strongly agree.

5. Conclusion

The objectives of the Attendance Monitoring Application for Students using RFID are achieved. RFID was used for the check-in process, and it records the availability of students. Other than that, the application allows the school and parents to track the student's information using the notice function in the application. The password stored in the database are hashed to add security layer for the application. It may prevent and mitigate any modification of the data.

There are several limitations of the system. For example, the system does not have notifications feature that may notify the user when the notice is updated. Other than that, it does not have search and filter function that allows the user to search the notice. Therefore, some improvements may be implemented. One of the improvements that can be made is by allowing the system to send notifications to the user through email. Then, the search and filter function may be implemented in the system to ease the user in finding and sorting the notice.

Acknowledgement

The authors would like to thank the Faculty of Computer Science and Information Technology, Universiti Tun Hussein Onn Malaysia for its support. Other than that, I would like to thank my supervisor, Dr. Sofia Najwa Binti Ramli for her advice, time, and guide through this project.

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