STUDENT ATTENDANCE MONITORING SYSTEM USING RFID

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BORANG PENGESAHAN STATUS LAPORAN

JUDUL: [**STUDENT ATTENDANCE MONITORING SYSTEM USING RFID**]

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STUDENT ATTENDANCE SYSTEM USING RFID

MUHAMMAD HANIF BIN MD RAZMI

This report is submitted in partial fulfillment of the requirements for the Bachelor of Computer Science (Computer Networks) with Honours.

FACULTY OF INFORMATION AND COMMUNICATION TECHNOLOGY
UNIVERSITI TEKNIKAL MALAYSIA MELAKA
2024

DECLARATION

I hereby declare that this project report entitled

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STUDENT: DATE: 30 AUGUST 2024

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SUPERVISOR: DATE: 30 AUGUST 2024

(TS. DR. MOHD RIZUAN BIN BAHARON)

DEDICATION

This final year project I dedicated to my beloved family who encouraged and supported me to finish this project. I also dedicated this project for my supervisor, Dr Mohd Rizuan Baharon who help me in given me important information regarding this final year project. Not to forget my cheerful friends and classmate, who go through this project together with me. I genuinely appreciate the advice that you have given me as well as your continuous intellectual and moral support.

ACKNOWLEDGEMENTS

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ABSTRACT

This is a report on the development and deployment of the Student Attendance System with the aid of RFID technology. The system is designed for minimizing the issues that are inherent in the conventional methods of employee attendance tracking like sign in on paper and roll call, which is rather ineffective and may involve errors. The proposed RFID based system enhances the efficiency of attendance by eliminating paperwork and capturing data through RFID tags issued to the students. When a student inserts their RFID tag to the reader, the system captures the unique number assigned to the card and captures the attendance of the student in a database. In addition to cutting the time to take attendance, it also improves the efficiency and accuracy of attendance monitoring and has real-time functions. The report analyses the design, implementation and testing phases of the project and thus shows that the developed system can provide solutions for educational institutions in terms of accurate and secure attendance records maintenance.

ABSTRAK

Ini adalah laporan mengenai pembangunan dan penggunaan Sistem Kehadiran Pelajar dengan bantuan teknologi RFID. Sistem ini direka bentuk untuk meminimumkan isu yang wujud dalam kaedah konvensional penjejakan kehadiran pekerja seperti log masuk di atas kertas dan panggilan gulung, yang agak tidak berkesan dan mungkin melibatkan ralat. Sistem berasaskan RFID yang dicadangkan meningkatkan kecekapan kehadiran dengan menghapuskan kertas kerja dan menangkap data melalui tag RFID yang dikeluarkan kepada pelajar. Apabila pelajar memasukkan tag RFID mereka kepada pembaca, sistem menangkap nombor unik yang diberikan kepada kad dan menangkap kehadiran pelajar dalam pangkalan data. Selain mengurangkan masa untuk mengambil kehadiran, ia juga meningkatkan kecekapan dan ketepatan pemantauan kehadiran dan mempunyai fungsi masa nyata. Laporan itu menganalisis fasa reka bentuk, pelaksanaan dan ujian projek dan dengan itu menunjukkan bahawa sistem yang dibangunkan boleh menyediakan penyelesaian untuk institusi pendidikan dari segi penyelenggaraan rekod kehadiran yang tepat dan selamat.

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LIST OF ABBREVIATIONS

RFID	**-**	**Radio Frequency Identification**
UI	**-**	**User Interface**
AIDC	**-**	**Automatic Identification and Data Capture**
ID	**-**	**Identification**
LCD	-	**Liquid Crystal Display**
AMS	-	**Attendance Management System**
HTML	-	**HyperText Markup Language**
SQL	-	**Structured Query Language**
DB	-	**Database**
SCK	-	**Serial Clock**
IOT	-	**Internet Of Things**
IDE	-	**Integrated Development Environment**
SDLC	-	**System Development Life Cycle**

CHAPTER 1: INTRODUCTION

1.1 Introduction

Attendance is a important thing in our real life whether at work, school or other social contexts. Meanwhile, student attendance is important towards student success because it can determine student academy performance, whether they can take the examination or not based on their presence in class. This project is more focus on the automates attendance system using Radio Frequency Identification (RFID). The reason of use RFID system to slowly eliminate the manual student attendance method such as paper signatures, calling name or writing name on paper. This manual method tend to be time consuming and sometimes can lead to some errors.

RFID student attendance system works via distributing RFID tags to student and then the student shows these tags to the reader to mark their attendance. The tags respond to radio frequency signal from the reader by transmitting their unique identifying numbers. Then, the reader transmits the data to a computer, which logs the student's attendance. The system efficiently maintains data for years after accurately capturing it.

1.2 Problem Statement

The manual method of recording student attendance is quite inefficient for some reason. Manual attendance records such as writing names on paper, paper signatures or calling student names can be time consuming especially when there are many students in class. For example, a lecturer who manages many classes and student related to attendance can consume valuable hours that could be better spent on other tasks. Besides, manual records are less efficient, inaccurate, having the chance of mistakes and lack of real-time monitoring capabilities to identify attendance patterns promptly. To overcome this present attendance management system situation, digital strategy is needed. Therefore, an automated, reliable and secure attendance system based on RFID is proposed.

Table 1.1: Problem Statement

PS	Problem Statement
PS1	Manual attendance record such as writing name on paper, paper signatures or calling student name can be time consuming especially when there are many students in class.

1.3 Project Question (PQ)

There are several questions that need to be addressed from the problem statement. The summary of project question (PQ) shown in Table 1.2

Table 1.2: Project Question (PQ)

PS	PQ	Project Question
PS_1	PQ_1	How the system reduces the time consume when taking student attendance?
	PQ_2	Where the attendance will be recorded?

1.4 Project Objective (PO)

Appropriate project objectives (PO) are developed as follows.

Table 1.3: Project Objective (PO)

PS	PQ	PO	Project Objective
PS_1	PQ_1	PO_1	To develop automates system that can capture student attendance data using RFID and ESP 8266.
		PO_2	To develop web application for monitoring purpose.
		PO_3	To provide real-time monitoring and reporting.

1.5 Project Scope

The scope of this student attendance system is:

1) **Develop student attendance system using RFID**: This system development involves creating both the physical and software parts. For physical development, the project uses IOT devices such as Esp 8266, RC522 that act as RFID module and LCD display. For software development, a web server and database will be used to store the attendance data.
2) **Website Development**: A website will be created to act as user interface (UI) and for storage purposes. Storing attendance data on a website allows for efficient data management. Users can easily search, retrieve and update attendance records using the website interface. Hence, reduce time and effort required for manual data management.
3) **System testing**: Test the RFID attendance system thoroughly to find and fix any errors or problems. The purpose of the testing is to make sure that the hardware and software components work together seamlessly.

1.6 Project Contribution (PC)

Table 1.4: Project Contribution (PC)

PS	PQ	PO	PC	Project Contribution
PS_1	PQ_1	PO_1	PC_1	Proposed design and implementation of Student Attendance System using RFID
	PQ_2	PO_2	PC_2	Proposed database that can record the attendance

1.7 Report Organisation

Summary of each chapter presented in this report:

Chapter 1: Introduction

This chapter will outline introduction, problem statement, project questions, project objectives, project scope, project contribution and report organization for the Student Attendance System using RFID.

Chapter 2: Literature Review

This chapter will outline related or previous work, review of current problems, and proposed solution of the Student Attendance System using RFID.

Chapter 3: Methodology

This chapter will outline the project's methodology and provide an explanation of the tasks performed at each stage of the process.

Chapter 4: Analysis and Design

This chapter will outline the issue analysis of the current system, including a list of data, functional, non-functional, and other requirements, as well as a discussion of the project's high-level architecture.

Chapter 5: Implementation

This chapter will outline the hardware development, software development, software configuration management and implementation status.

Chapter 6: Testing

This chapter will outline the activities included in the testing phase, the test plan, which comprises the test environment, timeline, and strategy, as well as the analysis and results of the test.

Chapter 7: Project Conclusion

This chapter provides an overview of the project and addresses its strengths and weaknesses as well as its contributions and how the goal was accomplished.

1.8 Conclusion

In this chapter, problem statement, project questions, objectives, scope and expected outcomes of the project are clearly identified. Next chapter will discuss the related work of this project.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will focus on recent student attendance system research to assist with implementation of RFID module. Student attendance system using RFID is a system that can help lecturer organize their attendance taking become more efficient. Students will be given an RFID card that has their personal information such as a matric card. Students will use the RFID reader that is placed at the door to scan their cards when they want to enter the lecture hall or classroom. Next, the data of the attendance automatically recorded in system database. This allows lecturers or school administrators to monitor student attendance more efficient and easier as well reduces human error in the attendance taking.

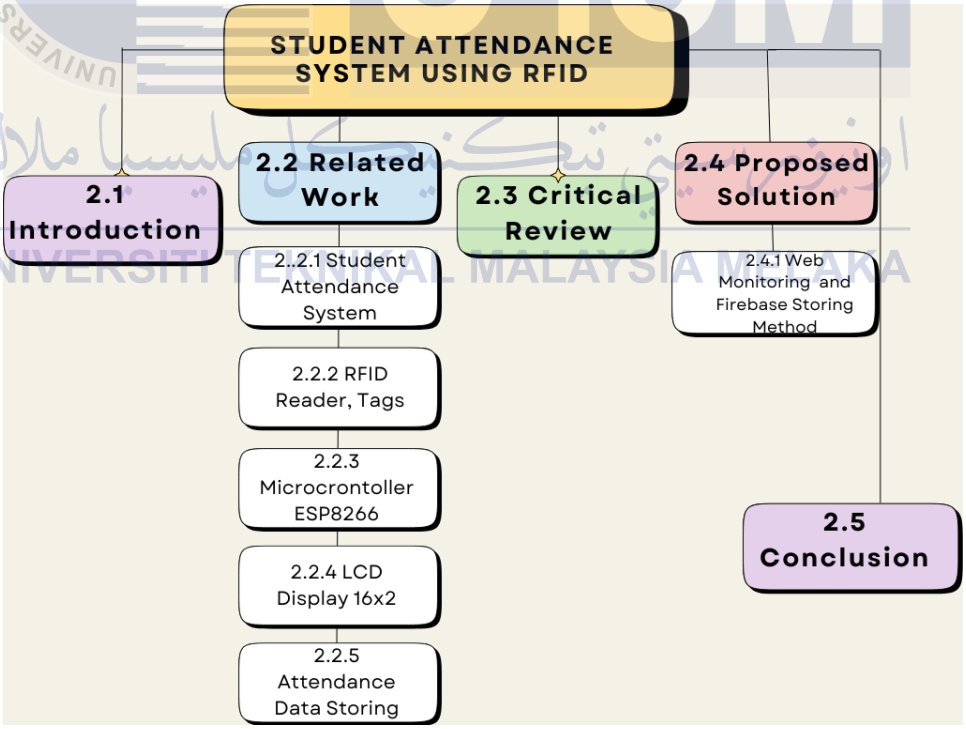


Figure 2.1: Summary of literature review structure

2.2 Related work/previous work

This subtopic will discuss about what component and how the system works based on the related title. The goal of this subtopic is to explore the previous system that can help in the selection of method, components and additional information about the system that wants to be developed.

2.2.1 Student Attendance System

The attendance system is one of the important systems that will be used in daily life either within educational institutions, corporate organizations or health care facilities. The goal of this system is to ensure that the people present can be monitored. For example, it can help monitor student attendance in classes, lectures and other educational activities. The system will record when students arrive, leave or are absent. This data is important for assessing student participation and academic achievement.

Based on journal from IoT Based Smart Attendance System Using RFID: A Systematic Literature Review (Kashif Ishaq, 2023), manual attendance is method used by all the educational institution and other organization facilities and it is more time consuming. The traditional way of taking attendance that involves calling out the names or having individuals write them on paper is time-wasting and unsafe. Furthermore, the manual attendance method consumes a lot of time and is the most dangerous thing as it is likely to lead to the loss of data. For example, lecturers teaching large classes may fail to get the students' manual signatures on the attendance sheet, and they may feel hampered when educating and attempting to get the students' full attention. Therefore, this journal proposed to use Radio Frequency Identification (RFID) to improve efficiency by automating the attendance process in educational institutions.

Next, A New Model of The Student Attendance Monitoring System Using RFID Technology journal (Mutammimul Ula, 2021), technology has advanced at a fast rate and is switching most manual activities into an automated system that was not seen before, like the college and school attendance system. RFID-based automatic attendance system can be considered more efficient in comparison with manual approach as well as other identification technologies

such as fingerprint and barcode systems. The RFID system is made of a reader and tags, allows for non-contact and efficient data transmission and since it is fast and accurate, it leads to a reduction in queues. Some of the common practices that are currently in use include signing a register, fingerprint scanning, which is slow and cumbersome since one must wait for a long time to get an opportunity to scan his or her fingerprints, among others compared to other techniques, RFID makes attendance easy since it compiles attendance data and stores it in a database. The purposed of this journal is to design an RFID based automated attendance system to enhance the productivity and quality of capturing the student attendance in classroom and laboratories.

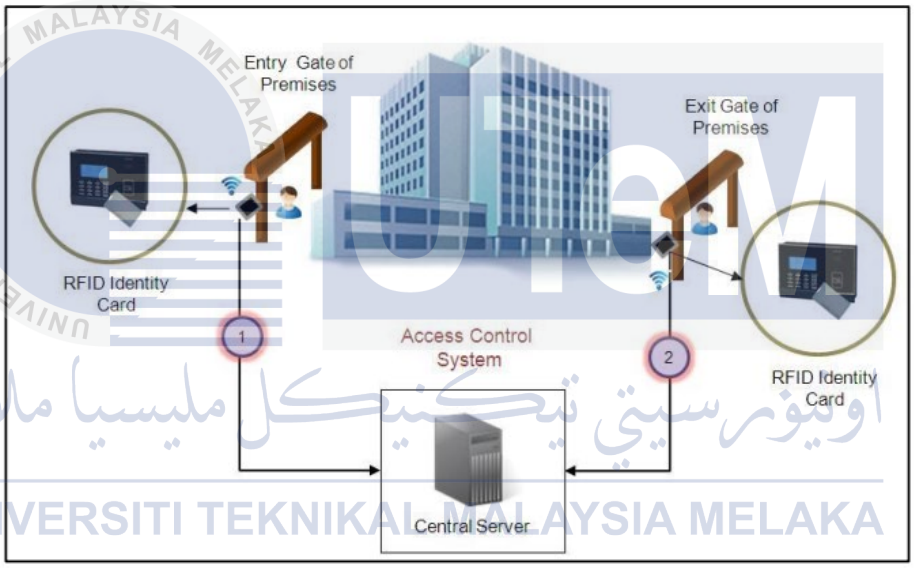


Figure 2.2: System Architecture

Journal from Design of Attendance Information System Using RFID (W.C.C.Choe, 2023), it suggests that system using RFID is more efficient than manual method. RFID integrated with microcontrollers is proven to have least cost and human interfence in automatic identification and tracking systems. RFID is a proven technology in the Automatic Identification and Data Capture (AIDC) technologies, and functions in low frequency, high frequency and ultra high frequency ranges of frequency. The general components of RFID systems are readers that send radio-wave pulse signals to tags within coverage zones and tags consisting of antennas and integrated circuits that store and send back identification information to the reader. Mobile RFID readers are portable, either as mobile computing or as RFID sleds interacting with smart devices and can be used anywhere.

2.2.2 RFID Reader and Tags

RFID (Radio-Frequency Identification) is an important technology in developing student attendance systems because it enhances effectiveness when taking student attendance. RFID is a technology which captures data that is attached to an object through an electronic tag or label fixed on the thing and uses radio waves to read and capture information about the thing, (Kashif Ishaq, 2023). It is particularly useful since, depending on the tag added, it can potentially label a person or a product.

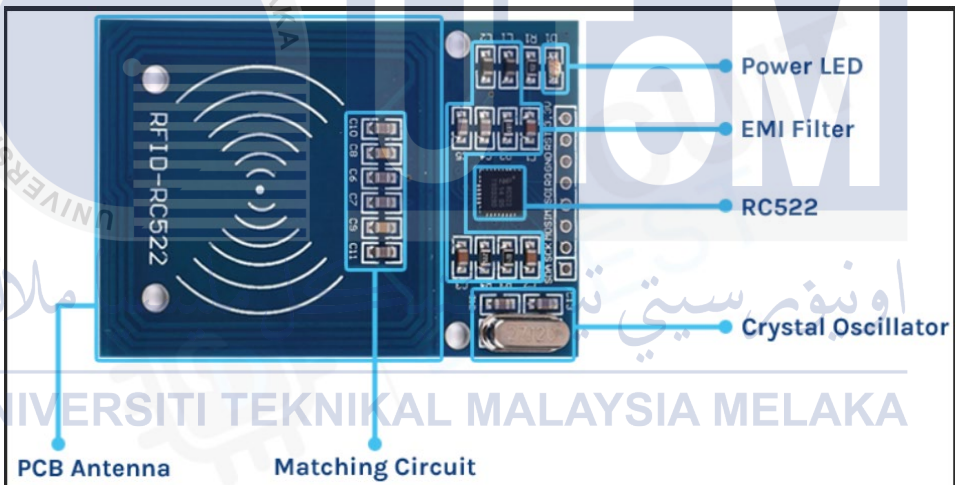


Figure 2.3: RFID Reader

RFID is a method that is used to recognize an object through broadcasting radio waves. RFID enables one to have information that is stored and received from a distance. Applying an RFID label or transponder tags that work as memory chips and readers that read the stored information without physically touching them or connecting them wirelessly, (Mutammimul Ula, 2021). Here are some function of RFID reader and tags:

RFID Reader

- Transmits radio wave pulses in order to capture RFID tags that are in its surroundings.
- Process the data received from tags to identify the specific ID in it.

- Transfer the data that has been collected to database system for storage it.

RFID Tags

- Unique ID number has been embedded on the tags.
- Enables identification without making physical contact with the reader, guaranteeing fast and easy data collection.
- This feature, which is usually integrated into student ID cards, makes it simple and automated to track attendance as students enter and exit from the classroom.

Figure 2.4: RFID Tags and Card

2.2.3 Microcontroller ESP8266

There are many microcontrollers that can be used for Internet of Things such as Raspberry Pi, ESP8266/ ESP 32 and Arduino Series. This microcontroller offer different features.

Table 2.1: Microcontroller Comparison

	Arduino	**Raspberry Pi**	**ESP 8266**
Purpose	Microcontroller designed for specific tasks.	Single-board computer.	Wi-Fi module with an integrated microcontroller.
Programming Language	Arduino C/C++, MicroPython.	Python, C/C++, Scratch, Java, Node.js/JavaScript, Bash.	Arduino C/C++, Lua (NodeMCU), MicroPython.
Connectivity	Basic I/O interfaces.	Wi-Fi, Bluetooth, USB.	Built-in Wi-Fi.
Use Cases	Simple attendance logging.	Complex applications.	Wi-Fi connected devices.

For this system, using microcontroller ESP 8266 is more convenient because it has integrated Wi-Fi. The Wi-Fi feature of the ESP8266 is used to connect the device to the internet and transfer data in real-time to remote servers or databases such as MySQL or Firebase for updating the attendance records in real-time and for accessing the records from anywhere it is needed. The multiple GPIO pins of the microcontroller can connect with RFID readers to capture the student ID data and the data transfer standard of serial communication makes the data transmission between the RFID reader and the microcontroller smoother. Furthermore, thanks to the possibility of programming through the Arduino IDE, ESP8266 is easy to use for many developers regardless of their experience, and its cost makes it reasonable for purchases in large quantities for multiple schools.

2.2.4 LCD Display 16x2

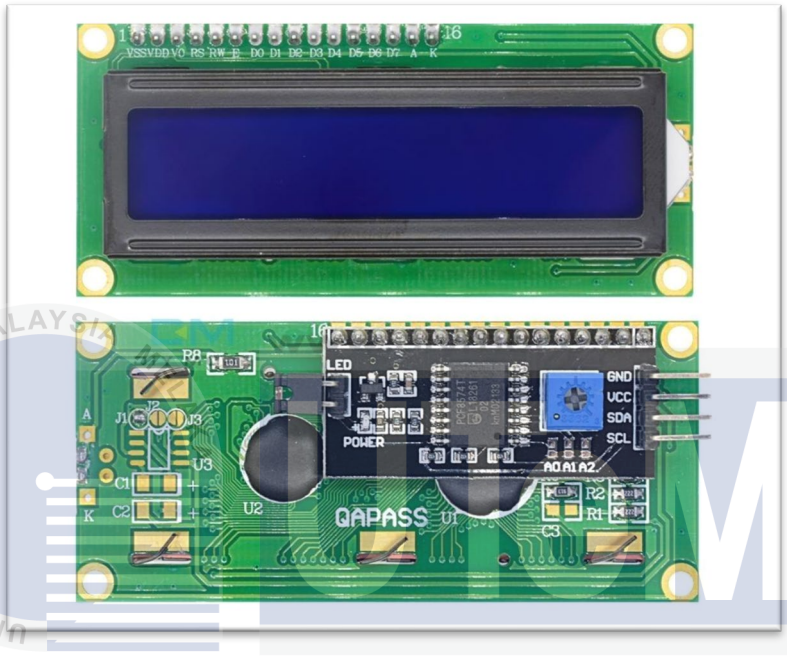


Figure 2.5: LCD Display

A student attendance system utilizing RFID and an ESP8266 microcontroller with an LCD display relays responses immediately, informs the user of successful scan and attendance entry, and presents system status, issues, and additional information. It can also indicate the current time and date which would augment the capabilities and practicality of the system. Furthermore, the LCD can be used for administrative messages and announcements and is an effective functional component that guarantees work and, at the same time, enhances the usability of the system by displaying readable, real-time information directly to the users. A 16x2 LCD indicates that it can display 16 characters per line and there are two lines it can display on. Here in this LCD each character is shown in 5 x 7 matrix that is five pixels horizontally and seven pixels vertically. It also has two registers, these are the Command Register and the Data Register. The command register contains the command signal that are sent to the LCD (Pratiksha Gajanan Langi, 2017).

2.2.5 Attendance Data Storing

For educational institutions to have thorough attendance records, effective data management is extremely crucial for the system to works. It is recommended that attendance data be securely kept in a centralized database for easy access and retrieval at any time. Educational institutions like universities can discover areas that need development and research attendance records over time by arranging the data. There are many databases medium that can be used to store the data such as MySQL, Firebase Realtime Database, Cloud-based approach and MongoDB. The important data is store in the database and the server-side software handles the backend processing of the frontend request. A web-based tool called the frontend framework offers a user interface to engage in system interaction (W.C.C.Choe, 2023).

Besides using microSD also can be used to store the attendance data safely. Flash memory, and MicroSD cards in particular, are very well suited for storing student attendance data collected through an RFID system. This includes low-access time, multiple write capabilities, minimized power consumption, and small size. MicroSD cards have the compact size of a fingernail, offering read/write speeds while supporting up to 3 to 5 MBps, which avails robust data transfer and security to make them best suited for portable applications. These cards communicate with an embedded microcontroller using the Serial Peripheral Interface in a master/slave configuration through standard lines, betokened as SDO, SDI, SCK, and CSN. This means that the storage and retrieval of data will be efficient and reliable, and data can be effortlessly transferred to a personal computer or other devices for further processing (Muhammad Haekal bin Md Haed, 2014). The advantages of use microSD is data can be access even without internet connection and it more simpler to setup and inexpensive. For the disadvantages, the limitation is SD card has finite storage capacity and the retrieving data from SD card can be slower than database.

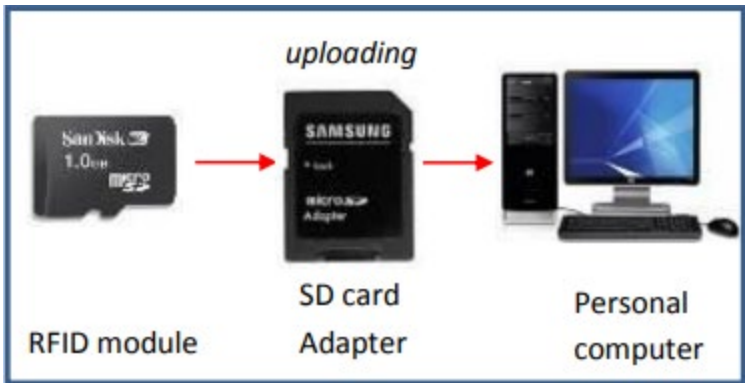


Figure 2.6: SD card used to store data

Therefore, the use of database such as MySQL and firebase Realtime Database is more convenient to develop student attendance system using RFID. It is because this database offers better scalability, real-time multi user access and robust security features. These databases ensure effective data management and retrieval by enabling remote access, smooth data integration, and automatic backups. MicroSD cards, on the other hand, are less effective for this application since they are not as well-suited for managing big datasets, concurrent access, and complicated data processes, even if they are portable and helpful for basic

2.3 Critical review of current problem and justification

Table 2.2: Critical review

No	Author / Year	Title Journal	Method / Component Uses	Overview
1	Kashif Ishaq (2023)	IoT Based Smart Attendance System Using RFID: A Systematic Literature Review	• RC522 (RFID Module) • RFID card and tag • Use Google Sheet to store data	This journal focus on development of smart attendance system that involved the use of RFID. The main goal is to

				improve efficiency by automating the attendance process in educational institutions. The students use RFID tags which automatically scan by RFID reader to record their attendance. The data then will stored in Google Sheets for easy use and management.
2	Mutammimul Ula, Angga Pratama, Yuli Asbar, Wahyu Fuadi, Riyadhul Fajri, Richki Hardi (2021)	A New Model of The Student Attendance Monitoring System Using RFID Technology	• RFID Reader • RFID Tag • LED • LCD • Microcontroller • Buzzer	The system consists of RFID tags assigned to students and RFID readers installed in classrooms. The data is then stored in database. The system also microcontrollers and ethernet modules for data processing and communication. The approach use is involved PC network in lecture halls with each PC connected to RFID readers and web cameras for additional verification.
3	W.C.C.Choe (2023)	Design of Attendance	• RC522 (RFID Module)	This journal discuss about

		Information System Using RFID	• RFID card and tag • DS 3231 Real-Time Clock (RTC) module • LCD Display • Network Adapter • Arduino Mega 2560 • Xampp, Apache HTTP Server, MySQL, PHP MyAdmin	development using RFID system for verifying student identification, location, time and date. The data is stored on a web server. The system has been tested in institution and prove 100% working. The interface device efficiently transmits attendance data and synchronized times with the web server. The front end of the system offers a user interface via web, while backend manages database and server-side operations.
4	Muhammad Haekal bin Md Haed (2014)	Student Attendance System Using RFID	• PN532 (RFID Module) • RFID card and tag • Arduino Mega 2560 • MicroSD Card • DS 3231 Real-Time Clock (RTC) module • LCD Display	This journal discuss about the benefits of using RFID system for attendance taking. Student cards will swapping to RFID module to be able the data taken. This system use Secure Digital (SD) card to store the attendance data. The data will be

				transferred to a personal computer either using a memory card or USB cable.
5	Mohammed Jamal Al-Mansor, Fatimah Zaharah Ali (2021)	Student Attendance Using RFID System	• PIC 18F452 • LCD Display • Arduino Mega 2560 • MicroSD Card • RFID Reader	This paper use SD card module, LCD display, Atmega2560, and RFID reader. The system stores the attendance data in a text file on the SD card, reads the data from the RFID tag when it is came near to the reader and shows the relevant student's information on LCD panel. Then, the data is moved too an Excel spreadsheet for simple handling and examination.
6	Nabeel, Hazim, Hasanein, Basheer. (2022)	Automated Attendance Management Systems: Systematic Literature	• RFID • Barcode • Biometric • Magnetic Stripe	This paper discuss about comprehensive review of attendance management systems (AMS). It explores the benefits and drawbacks of several technologies for AMS such as RFID, biometric and barcode system.

7	Bharathy, Bhavanisankari, Tamilselvi. (2021)	Smart Attendance Monitoring System using IoT and RFID	• Arduino Uno • Esp 8266 • MFRC522 (RFID Reader) • RFID Tags • GSM Module • Arduino IDE • PHP	This paper discuss about the use of RFID in student attendance system. The way of this system works is RFID reader will be places at entry point and when the student enter the places when carry RFID tags, it will automatically record the attendance in database. Besides, in this paper also mention that GSM module will be use to sends attendance notifications to their parents and GPS module will be use to track the student location.
8	Pratiksha Gajanan Langi, Leena Bhaskar Tumbre , Yogeshwari Jaganath Mali, Prof. Ankush M. Gund (2017)	RFID Based Attendance System	• Atmega 3284P Controller • RFID EM-18 • RFID Tags • 16x2 LCD • 7805 Regulater IC • RS232 Cable • Max 232IC • Buzzer	This paper goal is to use an 8051 microcontroller to develop RFID-based attendance system. The system will need user to touch their RFID cards when the power is on. The RFID reader captures the unique number that embedded to the card and send it to the

				microcontroller via a serial terminal. The microcontroller then compard the card number it received with numbers that are already stored in memory or connected database. If it match, the matching user's name will displayed on LCD and the attendance will be recorded. The information is continuously displayed until a button is pressed to end the recording session, after which the system resets and awaits the next card swipe.
9	Ajay Joshi, Aman Ahmad, Aprit Saxena, Poonam Juneja (2021)	RFID Based Attendance System	• RFID Reader • RFID Tags • Arduino Uno • DS 3231 RTC Module • Liquid Crystal Display	The component use in this paper for attendance system are RFID reader, tags, microcontroller Arduino, module real-time clock and liquid crystal. It effectively record attendance through RFID tags owned by the students, the data includes time

				stamp saved in an internal SD card and EEPROM.
10	Abdul Samad Shibghatullah, Kasthuri Subaramaniam, Zaheera Zainal Abidin, Kinusha Thamil Selvam, Nurul Azma Zakaria, Zuraida Abal Abas. (2020)	RFID Based Student Attendance System	• RFID Reader • RFID Tags • XAMPP (Web Server) • phpMyAdmin (Database) • PHP and MySQL (developing web application)	The goal of this paper is to develop an autonomous student attendance system for final examinations using RFID technology. The system is expected to minimize the limitation that related to manual recording of attendance such as inefficiency and errors. Therefore, the system utilizes RFID tags placed on student ID cards and RFID reader to enhance the efficiency of attendance taking process, reduce the time taken to record attendance. Web application will be use to monitor the attendance status.

2.4 Proposed solution/further project

A system development solution including the selection of the hardware, software, and technology as recommended in subtopics 2.2 through 2.2.5. The selection process will be based on the concepts and ideas discussed in the research papers related to the topic, and the choice will be made with reference to time and cost factor of the solution proposed.

2.4.1 Web Monitoring and Firebase Storing Method

The suggested approach to implementing a student attendance system by RFID is to employ ESP8266 microcontrollers to collect data from special RFID tags assigned to students when they enter the classroom. For the immediate feedback, the ESP8266 analyzes the RFID data and prints out the name of the student and the confirmation of attendance on the LCD. All the acquired data is then sent live to a Firebase Realtime Database, which enables safe storage through a Wi-Fi connection. HTML, CSS, JavaScript, and a web dashboard provides a user interface to the administrator where lecturer can view and control the attendance records of the student in real-time, filter them based on dates, get reports, or even set alerts for abnormal attendance. The system is intended to be implemented at a large scale and can accommodate many classrooms or a large number of students with little adjustments. It is also cheap to build, incorporating commonly available parts like the ESP8266 and free or cheap web tools. This approach helps in avoiding the troubles of manual recording of attendance, time consuming, and reduces errors in recording, the system has an interface both in the student and the administrator's side which makes the recording of the attendance easy.

2.5 Conclusion

In conclusion, this chapter has given a good insight of the current technologies and methods that could be applied to the implementation of a student attendance system using RFID. A review was made of the benefits of applying RFID technology in taking attendance such as efficiency, reliability and simplicity. It also analyzed different approaches to data storing, including such basic solutions as microSD cards, as well as the more advanced ones, such as MySQL and Firebase. The findings confirmed the advantage of owning a cloud database for real-time data access, flexibility in expanding the size of the database and improved security functions. Also, the literature review explained how devices such as the ESP8266 can help in conveying information wirelessly and processing data. Another consideration studied was the inclusion of an LCD display for immediate user feedback since it enhances interaction with the user. Combined these considerations serve as a basis for the proposed solution for the selection of hardware, software, and technologies that would highlight the student attendance system and make it efficient, reliable, and user-friendly.

CHAPTER 3: METHODOLOGY

3.1 Introduction

Methodology is the step or process on how the Student Attendance System (SAM) works in real life. This chapter will tell in detail what approach is used to develop an efficient SAM. This chapter also will tell the function of using RFID technology in taking the attendance. This chapter briefly describes the approach used in design and development of the RFID based attendance system. It includes details about the system development lifecycle, tools, technologies used and testing process to ensure the system's effectiveness.

3.2 System Development Life Cycle (SDLC) Model

There are three models that will be discussed which is waterfall model, agile model and lastly, spiral model.

3.2.1 Waterfall Model

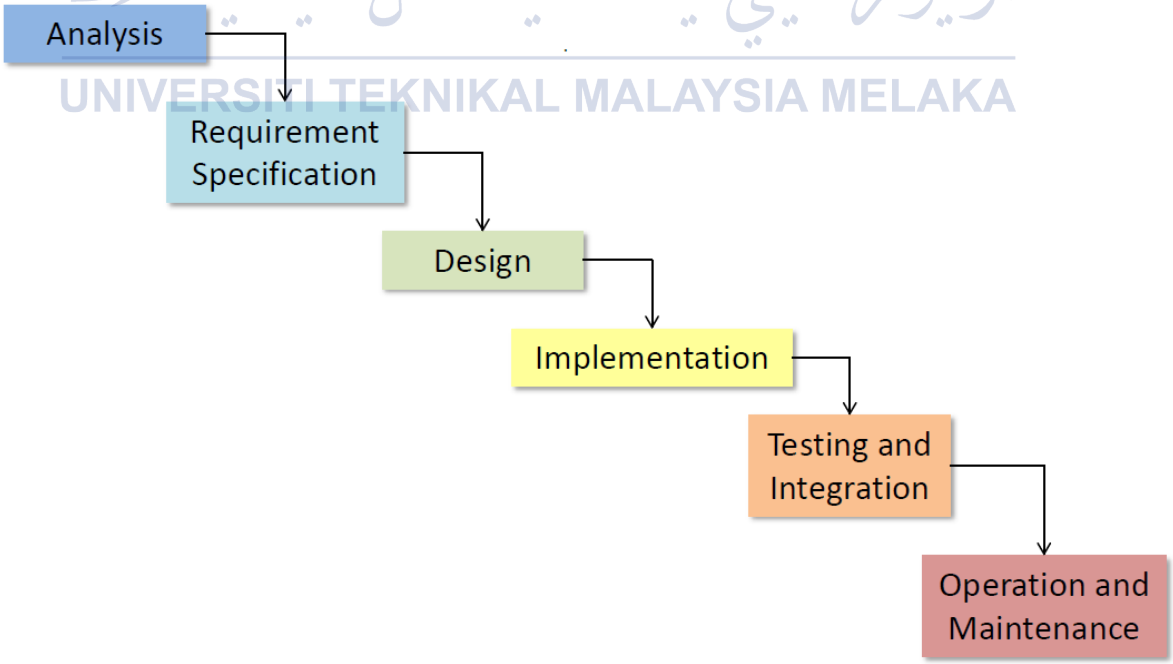


Figure 3.1: Waterfall Model

Waterfall model is the most common and traditional SDLC model used for system development. Many projects still use this approach in the development process. This model is commonly used because it is easy to understand and use any kind of development system. The steps that make up this SDLC model must be finished one at a time and then be followed by additional stages. This may indicate that each step needs to be completed sequentially. This approach will also have a well-organized procedure and documentation, making it simple to track down the documentation from earlier stages. The limitation of this approach is the difficulty it can be to modify the project requirements.

3.2.2 Agile Model

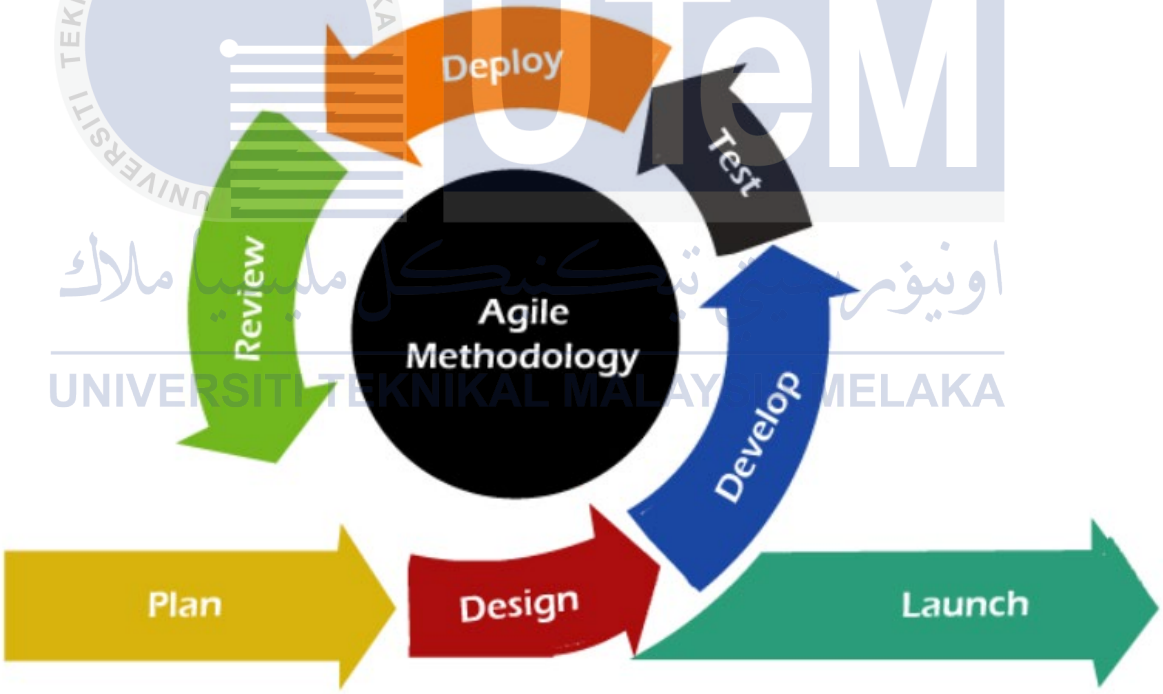


Figure 3.2: Agile Model

The second model is an agile model. Agile model main goal is to quicker project completion. By adapting the process to the project and eliminating steps that might not be necessary for a particular project, agility can be obtained. Also, anything that is a waste of time and effort is avoided. The advantage of agile model is faster delivery and reduces total

development time, but the drawback is agile model lack of documentation. It will cause confusion for future maintenance.

3.2.3 Spiral Model

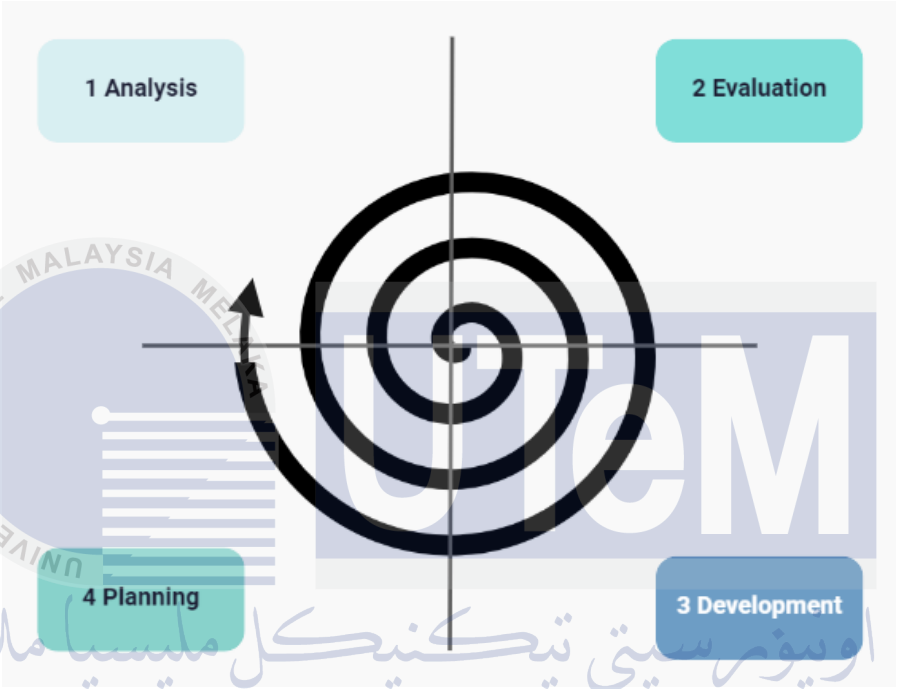


Figure 3.3: Spiral Model

The last model is the spiral model. The Spiral Model is a software development process, which features some aspects of design and prototyping in stages. It is planned to be an iterative process of risk management and to be improved with the help of feedback from stakeholders. The development in the Spiral Model is done in cycles, and it is more appropriate for large, complex, and high-risk projects. Each loop in the model represents a stage of the software development cycle, and the model is shown as a spiral.

3.2.4 Model Suitable for This Project

For this project, the most suitable model is the agile model. The Agile Model's built-in flexibility and iterative methodology, which enable quick adaptation to changing requirements and continuous feedback from stakeholders, make it especially well-suited for developing student attendance systems using RFID. This approach places an important priority on tight communication between users and developers, allowing the system to change and improve over time in response to feedback from users and real-world use. Agile guarantees that any problems can be found and fixed immediately by releasing small, functional increments of the system regularly. This results in an attendance tracking system that is more reliable, user-centered, and efficient.

3.2.4.1 Planning

The implementation of a student attendance system with the help of RFID can be outlined in terms of phases, where the initial phase is the project initiation and planning phase where the objectives of the project are outlined and defined in detail.

3.2.4.2 Design and Prototyping

In this phase, a simple and basic design of the RFID based attendance system is developed to illustrate fundamental capabilities such as tag detection and attendance recording. This phase ensures that the final system design is user-centered and satisfies the end users' real needs and objectives.

3.2.4.3 Implementation

The development and integration of the RFID-based attendance system's fundamental elements is the main goal of the implementation phase. This involves making sure student tags are properly communicating with the central system and placing RFID readers at the entrances to

identify student tags. For the safe storage of student data and attendance logs, a strong database is created.

3.2.4.4 Testing

These are quality assurance tests as well as quality control that are aimed at improving the integrity, security, as well as functionality of the system. These problems are solved continuously and regularly and are an integrated part of the system's operation.

3.2.4.5 Deployment

The deployment phase consists of identifying and implementing strategies for the installation of the RFID-based attendance system in the school. This involves the identification of the hardware to be installed, which in this case may include RFID readers, installation of software, and data migration.

3.2.4.6 Maintenance

After the deployment process, the system undergoes the maintenance and update process, which seeks to offer constant support and update to ensure the system's optimal functionality. Constant feedback is provided by the users and to determine what needs to be done for the betterment of the system and to fit the system to new demands and revolutions in technology.

3.3 Project Milestones

Project milestones are defined as major deliverables or events that refer to specific project events and which indicate that the project has reached certain stages of its development. It is crucial for monitoring the general time, cost, and resource constraints of the project. Each of the milestones is a significant event in the project life cycle normally referring to the end of a phase, delivery of product or achievement of a goal. These are activities that are marked with particular target dates or deadlines and help to determine the project progress against the schedule set. Project

milestones are orientated towards outcomes and quantifiable, which means that it demonstrate the progress achieved and is in line with the project objectives.

NO	Task	Start Date	Due Date	Weeks
				1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
1	Project Proposal	11/03/2024	29/03/2024	
2	Report Writing Progress 1	25/03/2024	10/05/2024	
3	Project Progress 1	15/04/2024	19/04/2024	
4	Project Progress 2	13/05/2024	18/05/2024	
5	Report Writing Progress 2	20/05/2024	24/05/2024	
6	PSM 1 Draft Report Preparation	27/05/2024	07/06/2024	
7	Report Evaluation	10/06/2024	14/06/2024	
8	Demonstration	17/06/2024	21/06/2024	

Figure 3.4: Project Milestones

3.4 Conclusion

In conclusion, this chapter describes the methodology used to achieve the project goals. Agile model is one of the methodologies that suitable for the student attendance system using RFID. It is because the agile model is more flexible and has dynamic way of working on projects like attendance record. The phases involved are planning, design, prototyping, implementation, testing, deployment and maintenance. Each phase has its own function that can be useful to develop a system. For project milestones, it's important to follow it because it provides accomplishments and progress during the deployment. It also helps to track timelines, manage resources effectively, identify risk early and ensure alignment with goals.

CHAPTER 4: ANALYSIS AND DESIGN

4.1 Introduction

This analysis and design chapter will cover the problem analysis, requirements, high-level design and detailed design of the project. In the problem analysis topic, it will explain the limitations and challenges of current attendance tracking method. Followed by requirements analysis, that will tell about primary functional and non-functional requirements that are required in the new system. The high-level design section provides an overview of how the system would fit into the current situation. Lastly, the detailed design section tell about the final perspective of the system in terms of fine-gained design and the interaction between the components.

4.2 Problem Analysis

The existing student attendance systems that are based on manual tracking, fingerprint or barcode technologies are far from being perfect which are full of potential errors, inefficiencies and administrative burdens. The manual processes are slow and inaccurate, while fingerprint and barcode processes cause delays and need proper positioning or single scanning of the barcode. These approaches also do not give up-to-date information and are prone to fraud such as proxy attendance. Moreover, it tends to face issues with integration, extensibility, and they require a constant maintenance cost. Meanwhile, RFID technology provides a reliable solution by providing the quick and simultaneous scanning of multiple tags without contact thereby eliminating formation of queues and reduced human errors, constant real time updating, and accurate data. This makes RFID suitable to be adopted as a solution for updating attendance systems in schools and other learning institutions.

4.2.1 Manual Attendance Tracking

Taking attendance manually is particularly time-consuming since it requires reading names aloud or asking students to write their names on attendance papers. This process might take several minutes, especially at the beginning of each lesson. This repetitive process takes time away from

teaching and learning, hence, adding up to the total time that is lost in teaching. Moreover, it is also time-consuming and has a tendency to involve human errors like wrong marking, missing entries and misidentification. These errors can occur when the teacher is not very attentive and failed to hear the responses of the students or when the students signed in wrong positions. Besides, manual systems can easily be manipulated by students to sign in for their colleagues who are absent from class.

4.2.2 Lack of Real-Time Data

One of the major difficulties in manual and semi-automated attendance systems is the absence of real-time information. These systems do not offer real-time attendance data and it takes some time for the data to appear, which can be problematic for teachers and administration to recognize and resolve attendance-related issues. Furthermore, the lack of updated attendance information affects decision-making since the educators and other supporting staff do not have the necessary data to make the right choices on how to engage students and allocate resources appropriately. It also results delays in obtaining data which could compromise the overall effectiveness of intervention strategies that aim to enhance students' performance and other factors that relate to classroom management.

4.2.3 Cost and Maintenance

The operational costs of maintaining and updating manual or semi-automated systems for tracking attendance are significant. These systems depend mostly on physical assets, for instance papers and printing items which are continually being utilized thus resulting in constant costs. However, there are other costs that are associated with this system such as administrative costs that are required to handle and process attendance records which are also a part of the operational costs. Another important factor is that the equipment is not very durable. For example, barcodes or fingerprint scanners require constant maintenance to work properly and with high accuracy.

4.3 Requirement Analysis

In this subtopic, it will discuss about data requirement, hardware and software requirements of the project. This requirement is very important to ensure that the project student attendance system using RFID will function properly. This subtopic also will highlight hardware and software use in this project.

4.3.1 Data Requirement

The RFID based student attendance system will involve data collection in many categories that will help in making the system efficient, accurate and useful. Basic information involves the student identification numbers, first names/last names, class and grade, and course registration. This information should include time in and time out, present, absent, on-time, or tardy, and reason for absence or lateness, locations and the sessions that the employees attended. RFID tag data involves tag identification number, mapping to the student identification number, and tag status as active, inactive, or damaged. Reader information consists of, but not limited to, reader identifiers, locations, and their interaction history. User information is related to the instructor and administrative staff of the online learning environment. Access control, backup and the recovery plans are some of the things that need to be provided in system configuration. Lastly, reporting and analytics include attendance summary reports and generating triggers for alerts and notifications for any unusual circumstances taking place in the campus so that the attendance is reported and recorded accurately and any errors which may occur are minimized at all the campus.

4.3.2 Hardware Requirement

For this project, determination of hardware use is crucial to ensure the chosen hardware is compatible with other system components. The hardware that will be use are ESP 8266, RFID tags, reader and more.

4.3.2.1 Microcontroller ESP 8266

ESP 8266 is an affordable WIFI module that connects microcontrollers to the internet. It is used in the internet of things (IOT) and the working voltage of this module is 3V This module can be used with Arduino development boards that are used in simple as well as complex projects for providing Wi-Fi to Arduino development boards as no Arduino development board comes with in-built Wi-Fi feature. So, in short, every ESP8266 module is already built-in with AT command set firmware and can be interfaced with any other development board to work as a Wi-Fi shield.

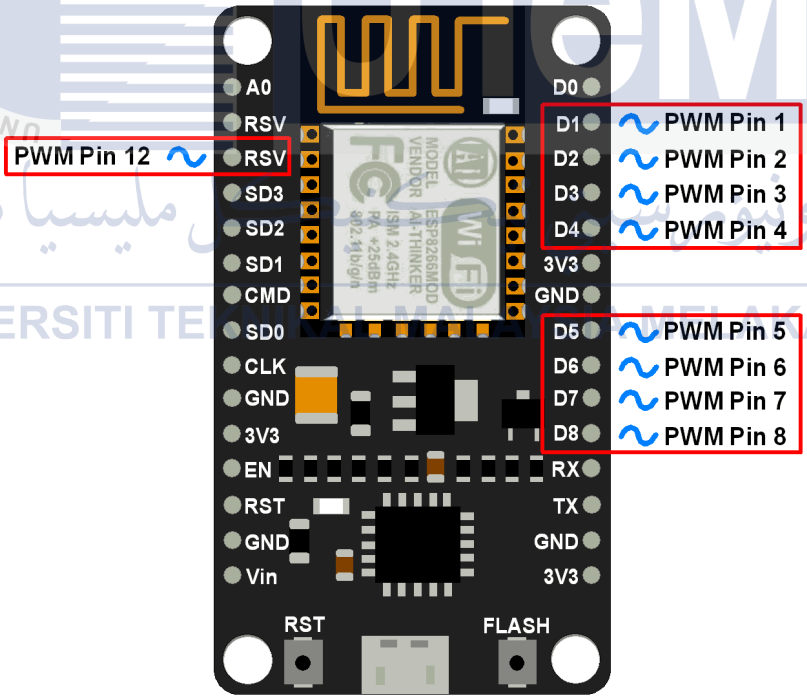


Figure 4.1: ESP 8266

Table 4.1: ESP8266 Specification

Specification	Details
Model	NodeMCU V2 ESP 8266
Operating Voltage	3.3V
WI-FI Standard	802.11 b/g/n
Interfaces	UART, SPI, I2C
USB Interfaces	Micro-USB
Development Environment	Arduino IDE, NodeMCU firmware

4.3.2.2 RFID Reader (RC522)

The RC522 is an affordable RFID module working at the 13.56 MHZ, which is commonly applied for contactless communication in the identification and authentication initiatives. It supports ISO/IEC 14443 Type A cards, RFID reader IC (MFRC522) is integrated with an antenna. It has integrated SPI, I2C, and UART interfaces and works at 3.3V, and the ability to read from a distance of up to 5cm. It is commonly seen in access control and attendance systems because of the reliability of data transfer between the two or more systems.

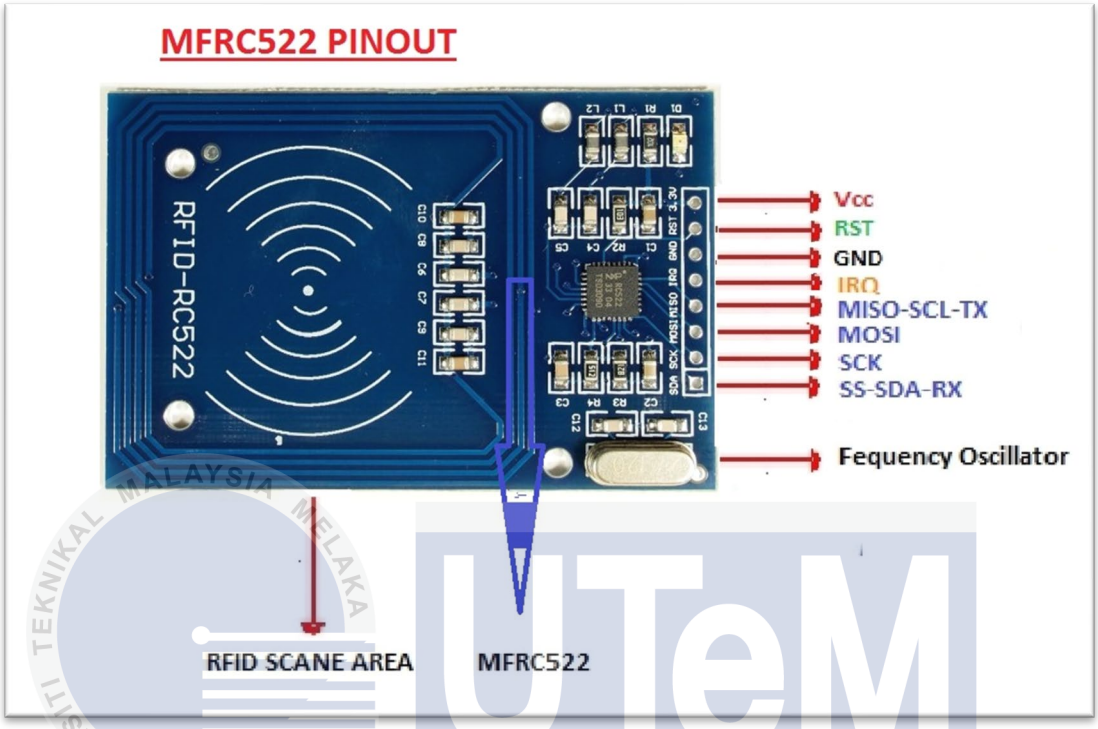


Figure 4.2: RFID Reader RC522

- **VCC** – Supplies power to the module between 2.5 to 3.3 Volts.
- **RST** – An input for reset and power-down. The module enters power-down mode when this pin becomes low. whereas the input pins are isolated from the external environment and the oscillator is switched off. On the other hand, the module is reset on the signal's rising edge.
- **GND** – The ground pin and need to be connected to GND pin on ESP 8266.
- **MISO/SCL/Tx** - When an SPI interface is enabled, pin functions as master-in-slave-out; when an I2C interface is enabled, pin functions as serial clock and when a UART interface is enabled, pin functions as serial data output.
- **MOSI (Master Out Slave In)** – The SPI input to the RC522 module.
- **SCK (Serial Clock)** - Accepts the clock pulses provided by SPI bus master.
- **SS/SDA/Rx** - When the SPI interface is enabled, it serves as a signal input; when the I2C interface is enabled, it serves as a serial data input; and when the UART interface is enabled, it serves as a serial data input. To designate it as a reference point for other pins, this pin is typically identified by encasing it in a square.

Table 4.2: RC522 Specification

Specification	Details
Operating Frequency	13.56 MHz
Operating Voltage	2.5V – 3.3V
Host Interface	SPI / I2C / UART
Read Range	5 cm

4.3.2.3 RFID Tags and Cards

RFID tags and cards are typically used in contactless data transfer through the use of radio waves. RFID system is comprised of a tag and an antenna where the RFID tag contains a microchip for storing information and the RFID antenna for receiving and transmitting information to the RFID reader. They come in two types: The type that is active, that is it has a battery power as well as the passive type that relies on the electromagnetic field of the reader. RFID cards, also known as passive tags, are mostly small cards with the size of the credit cards which are used in access, identification and payment. It operates at 13.56 MHz and has the read range that may go up to several meters for active tags and up to one meter for passive ones.

Figure 4.3: RFID Tags and Cards

Table 4.3: RFID Tags and Cards Specification

Specification	Details
Frequency Range	13.56 MHz
Read Range	A few centimeters to a meter for passive tags, and up to several meters for active tags.
Data Capacity	SPI / I2C / UART
Read Range	5 cm

4.3.2.4 Liquid Crystal Display 16x2 (LCD)

A Liquid Crystal Display (LCD) 16×2 is a display module which can display 16 characters right from the same line and 2 lines of characters on the same screen and is used for displaying basic texts. It employs the use of liquid crystals to display visible text and symbols so long as there is an electric current passing through it. The 16x2 LCD is usually a 5x8 character dot matrix display, includes an onboard controller that may be the HD44780 or one of its clones, and uses a standard 16-pin interface to connect to microcontroller or Arduino or similar boards. It supports multiple cursor movement control commands, display control commands as well as user defined graphic character generation commands.

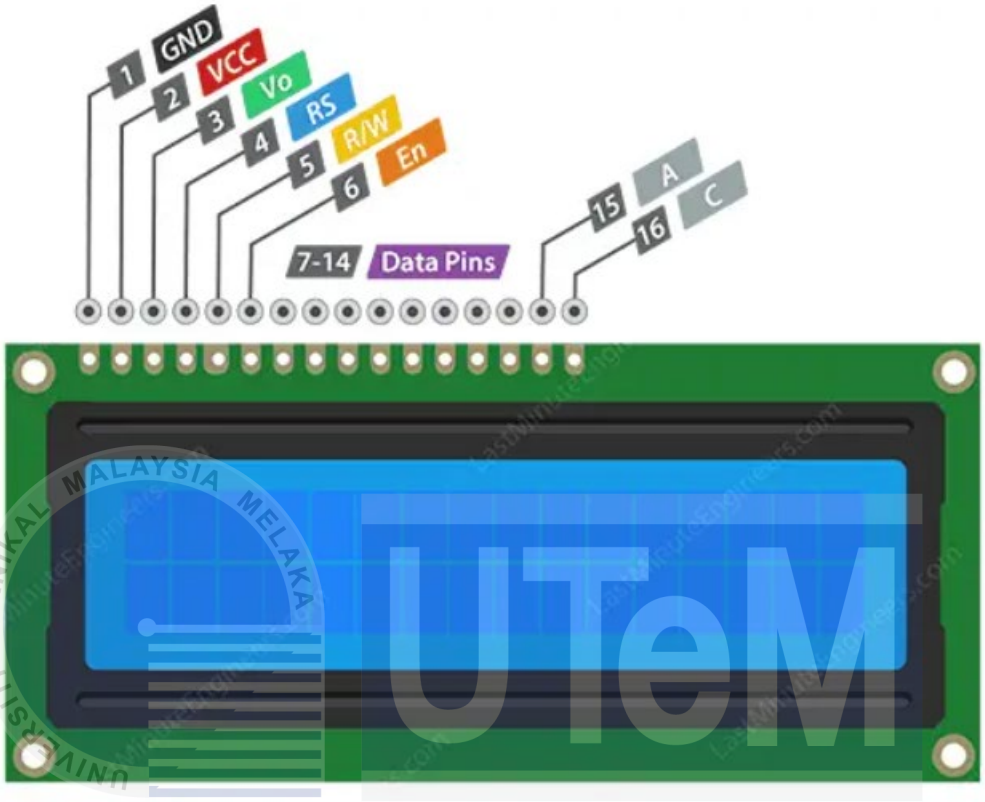


Figure 4.4: LCD 16x2

Table 4.4: LCD 16x2 Specification

Specification	Details
Display Type	LCD (Liquid Crystal Display)
Character Capacity	16 Characters per line, 2 lines
Interface	16-pin
Operating Voltage	4.7V to 5.3V

4.3.2.5 Jumper Wire

Jumper wires are used in electronics to provide temporary connection between various sections of a circuit. They are utilized in breadboards and development boards to enable the development of prototypes or testing. These jumper wires are in different lengths and sorts are male to male, female to female and male to female to suit the various pin connections. They provide simple and reversible connections with no soldering required and therefore can be used for temporary circuits or to teach basic principles of electricity.

Figure 4.5: Jumper Wire

4.3.3 Software Requirement

In this subtopic, it will discuss the software use to develop student attendance system using RFID such as Arduino IDE and firebase DB.

4.3.3.1 Arduino IDE

Arduino IDE stands for Arduino Integrated Development Environment, which is a programming software used to write instructions for Arduino microcontrollers. it is an open-source software that enables users to write and upload code into Arduino microcontroller boards. It has a code editor for writing programs, a message area, a text window, a row of buttons for basic operations, and a set of menus. It is used for uploading programs into the Arduino and for communicating with the Arduino hardware. The software that is created for Arduino are referred to as sketches. These sketches are written in the text editor and are saved with the file extension .ino.

Figure 4.6: Arduino IDE

4.3.3.2 Firebase DB

Firebase is a product of Google which helps developers to build, manage, and grow their apps easily. It enables developers to create apps more quickly and securely. Because there is no need for programming on the Firebase end, using its capabilities more effectively is simple. It offers services for web, unity, iOS, and Android. It offers cloud-based storage. It stores data in a database that is NoSQL based. Some of the common ones include offline support, rich querying, and compatibility with other services from Firebase. It is widely employed for building applications for mobile devices and the Web when real-time data exchange is significant, for example, in online messaging, feeds, and collaboration tools. In an RFID-based student attendance system, the ESP8266 microcontroller captures RFID data and sends it to a Wi-Fi module to the Firebase real-time database where the records of attendance are saved and updated. This

information can then be retrieved by a web application so that the administrators/teachers can monitor and manage it in real-time. The use of ESP8266 for data acquisition and sending, Firebase for real-time data storage and sharing, and a web interface for attendance tracking guarantees efficient, cost-effective, and almost real-time attendance tracking.

Figure 4.7: Firebase DB interface

4.4 High-Level Design

The high-level design is the process of explaining the architecture, components and modules of a system in conceptual perspective. It includes describing the major elements and their connections, the interfaces and data flow, as well as the structure and interactions of the system. This design phase is more about the overall structure of the system rather than the specifics of the parts that make it up.

4.4.1 System Architecture

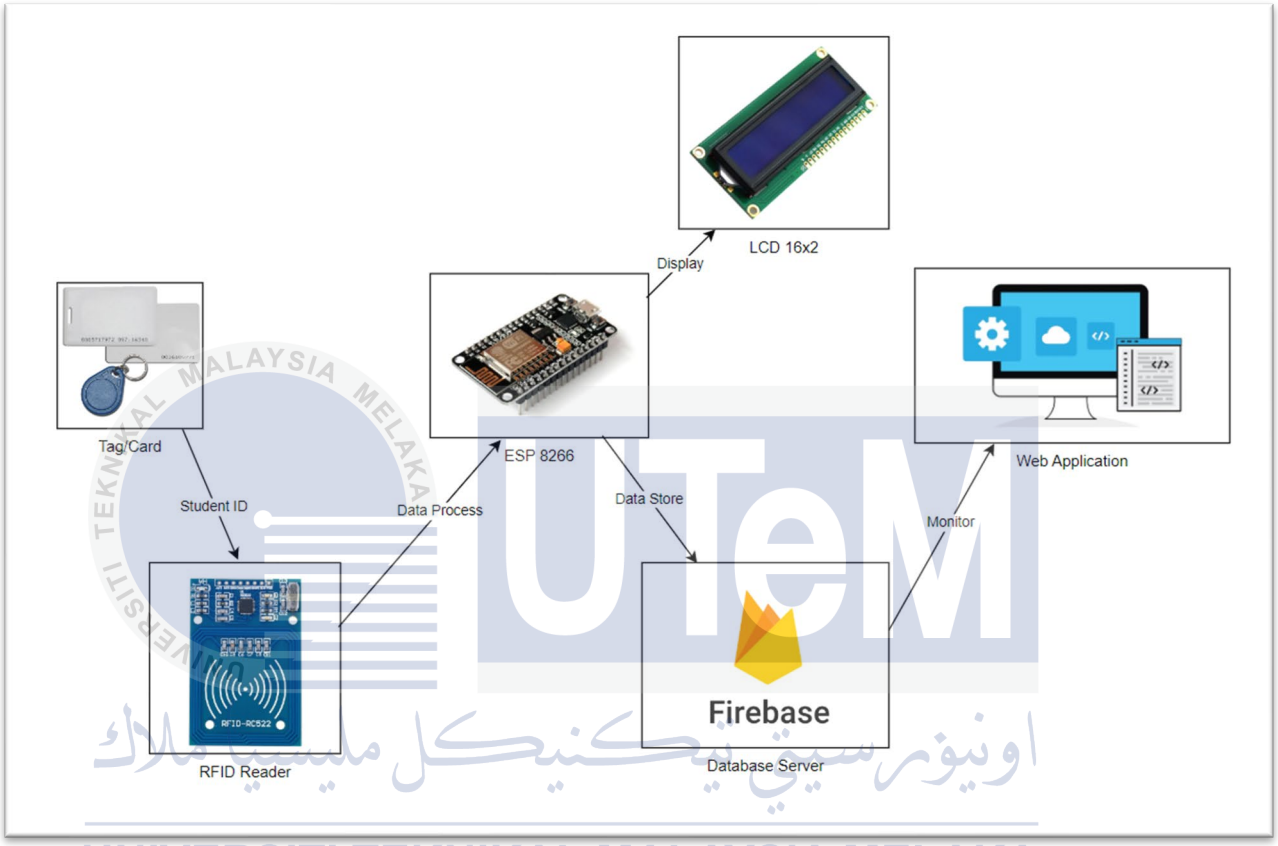


Figure 4.8: System Architecture

Based on the diagram, each student needs to scans their RFID tag on a RFID reader when entering the classroom. The RFID reader then captures the unique ID that embedded in the tag and send the data to the ESP 8266 microcontroller, which then connects to a Wi-Fi network to transmit the data to the Firebase Realtime Database. Firebase stores and synchronizes the data making it accessible instantly. An LCD connected to the ESP 8266 then displays the student's attendance status immediately. Finally, a web application retrieves data from Firebase, allow lecturer and administrators to monitor attendance, generate report and manage records efficiently.

4.5 Conclusion

An RFID-based student attendance system solves the problems with the existing paper-based and partially automated methods to track student attendance by providing an improved approach in terms of efficiency, reliability, and instant result. This chapter explained the analysis and design of the project where the problem analysis was performed which identified the problem of the existing systems like inefficiency, error prone, lack of real time data, and highly expensive in terms of maintenance. Previous section on requirement analysis highlighted the kind of data, hardware and software that is required for the smooth running of the system. Hardware components include the ESP8266 microcontroller, RFID readers and tags, and LCD displays, with the Arduino IDE providing the programming language, and Firebase for real-time data management. The high-level design explained how RFID readers collect data from the students, how data is sent from the ESP8266 to the Firebase and how the attendance details are displayed on the LCD, while the web application was for monitoring and management. This allows for a comprehensive design that can provide a reliable and efficient attendance system that is free from major human interference, and this makes it ideal for educational institutions.

CHAPTER 5: IMPLEMENTATION

5.1 Introduction

This chapter is about the development and implementation of the student attendance system using RFID both in software and hardware. This chapter will discuss how the system work and the important part of configuration to make it run properly and effectively. Thus, the correct approach in this case is to have the developer and the end user conduct the test to assess the performance of the system. The activities involved in this chapter are development environment setup, hardware environment setup, software setup, coding implementation and implementation status.

5.2 Development Environment Setup

To make a effective Student Attendance System using RFID technology, it involved both hardware and software development environment setup. The development environment setup needs to be done one by one or step by step. The hardware and software specification has been shown in chapter 4.

5.2.1 Hardware Development Setup

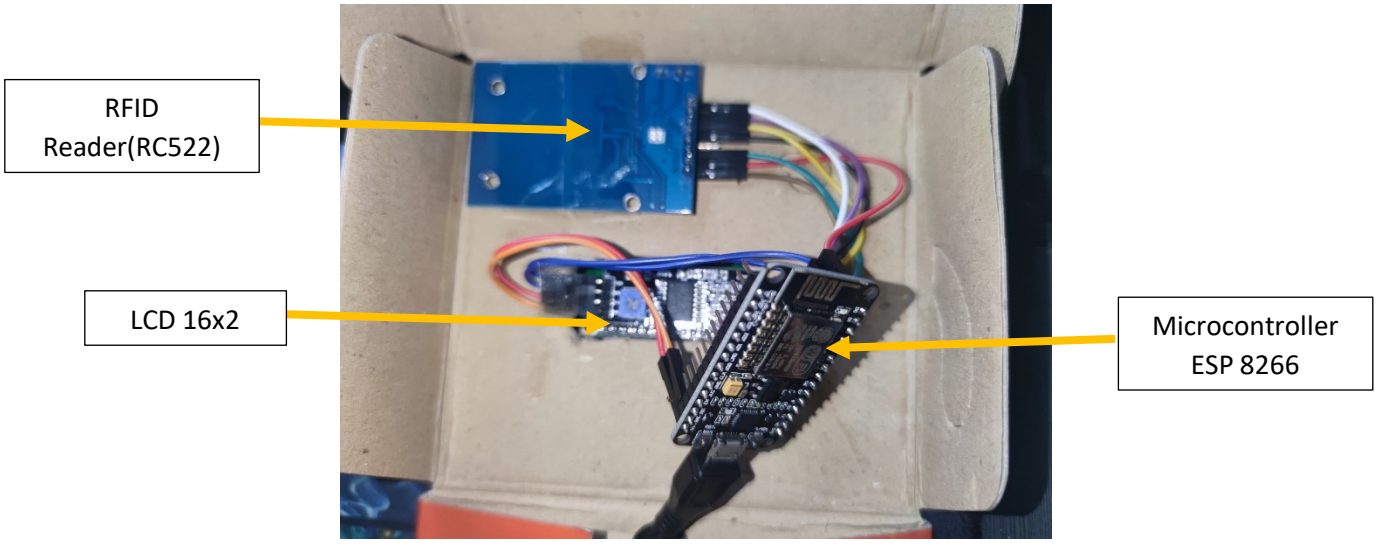


Figure 5.1: View of hardware prototype

The figure above shows installation of hardware setup. Both LCD and RFID reader will attach to microcontroller ESP 8266 using jumper wire. When the RFID tags or card touch the reader, it will display on lcd such as attendance recorded and date of the attendance.

5.2.1.1 Hardware Installation

As for connecting the hardware, it will be employing primarily male-female jumper wire for both LCD and RFID Reader. Both of this hardware will be connected to ESP 8266 Microcontroller to make it properly function. The connection of the pins shows as below:

Table 5.1: RFID and LCD Connection

LCD Pins	ESP 8226 Pins
GND	GND
VCC	3V3
SDA	D2
SCL	D1
RC 522 Pins	**ESP 8226 Pin**
RST	D0
SCK	D5
MISO	D6
MOSI	D7
SDA	D8
GND	GND
3V3	3V3

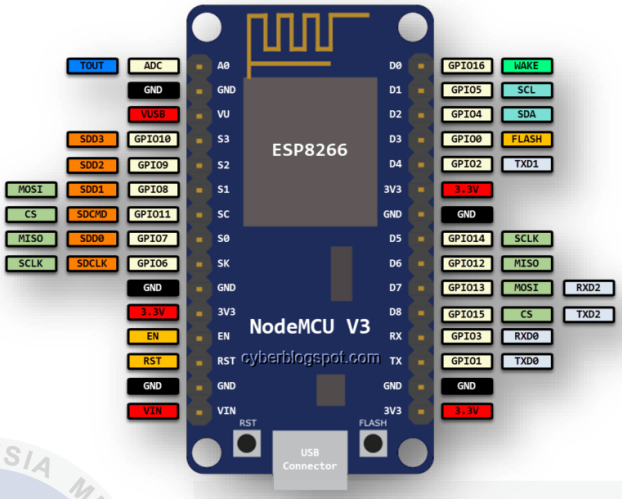


Figure 5.2: ESP 8266 pin diagram

Figure 5.3: Final Product

5.3 Software Installation and Setup

This subtopic will discuss about software installation and setup required for the student attendance system using RFID technology. It covers the important steps to install, configure and deploy the software components that enable the system to function seamlessly.

5.3.1 Arduino IDE Installation

Arduino Integrated Development Environment commonly known as the Arduino IDE is an open-source tool that connects to the Arduino boards for uploading programs and for interfacing with them. It can write, compile, and upload code to nearly all Arduino modules. Sketches are the programs written with the help of Arduino Software (IDE) and they are composed in the text editor of the software and are saved with the file extension. Ino. Below shows the step on how to configure Arduino IDE:

Step 1: Visit official Arduino website (Software | Arduino) and download the latest version of Arduino IDE compatible OS such as Window, macOS or Linux.

Figure 5.4: Arduino Official Website

Step 2: After installation is done, install necessary libraries such as MFRC522, ESP8266 WIFI, FirebaseESP8266 and LCD.

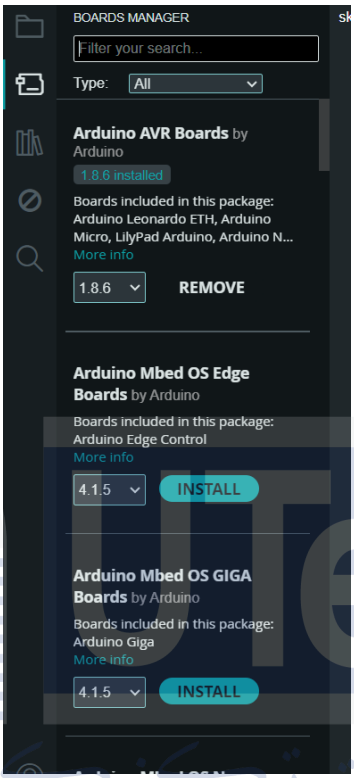


Figure 5.5: Libraries Installation

Step 3: Go to Tools > Board, and choose what type of Arduino board that use.

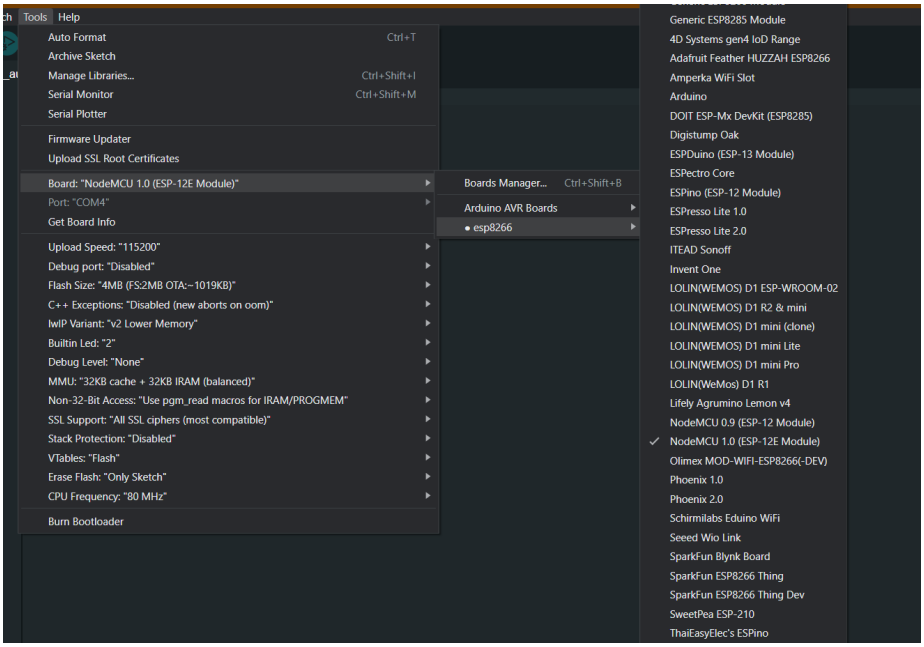


Figure 5.6: Type of Boards

Step 4: If use ESP8266, Additional Board Manager URLs need to put in preference settings. This URLs allows the IDE to access and download necessary files for ESP 8266 board support. Go to Files > Preferences and paste this URL 'https://arduino.esp8266.com/stable/package_esp8266com_index.json'.

Figure 5.7: Preferences Setting

Step 5: This is called sketch. All code that needs to be tested and upload will write here.

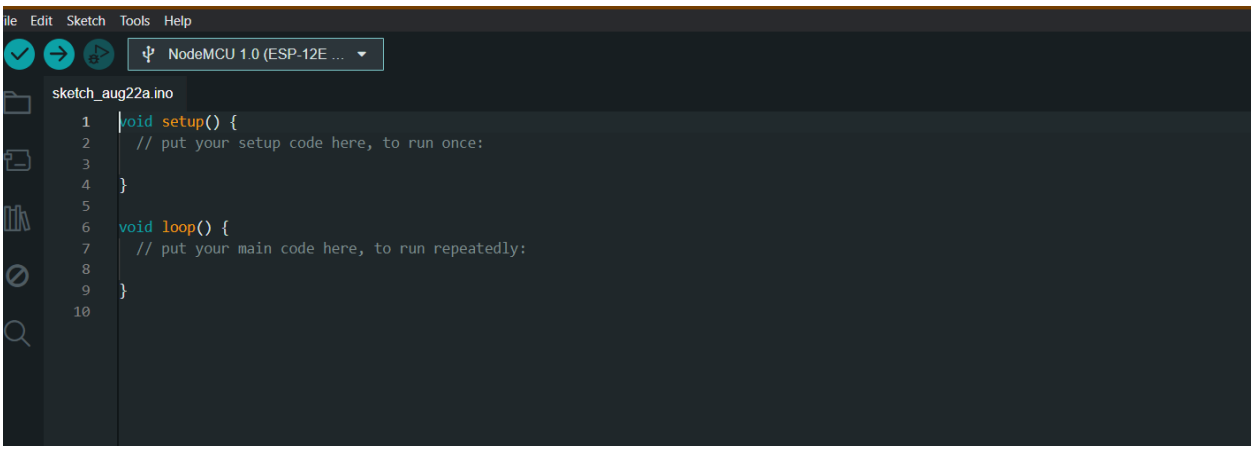


Figure 5.8: Sketch Interface

5.3.2 Firebase Setup

Firebase is a cloud database that stores and controls attendance records. The setup process involves developing a Firebase project and integrating it into the Arduino.

Step 1: Visit Firebase Console '[Firebase console (google.com)]' and add new project.

Figure 5.9: Firebase Interface

Step 2: After done create project, go to Realtime Database. The data will be store here.

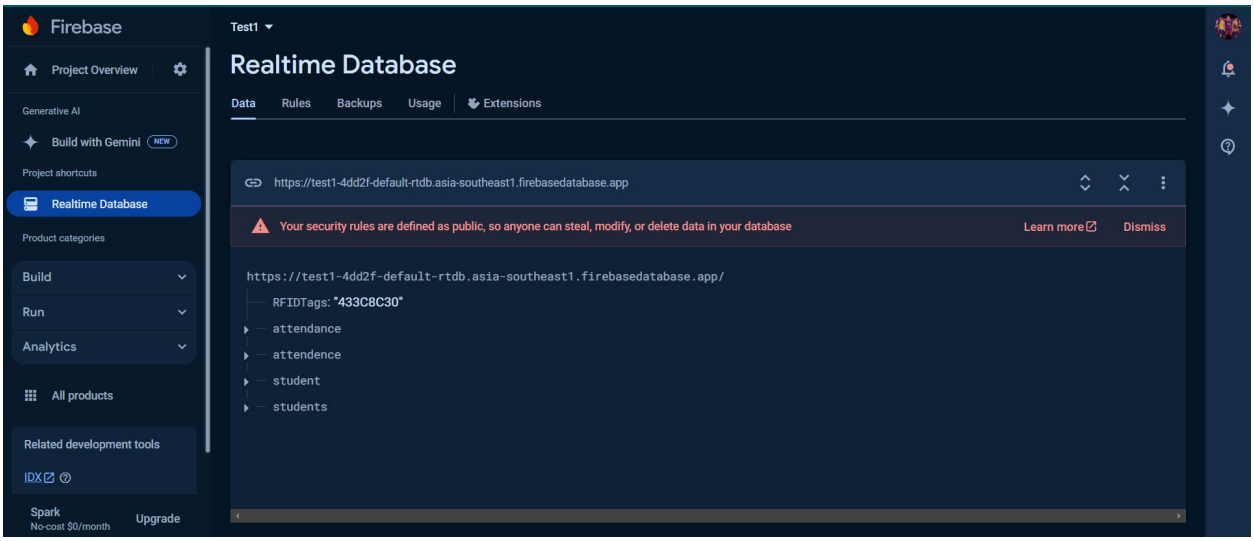


Figure 5.10: Data will stored here

5.3.3 Web Interface Deployment

The web-based interface is also used where the administrators can view and manage the attendance records from the web in real time. The setup process is to design, customize and implement the web application.

Step 1: Install code editor such as Visual Studio code '[Visual Studio Code - Code Editing. Redefined]'

Figure 5.11: Visual Studio Code Installer

Step 2: All code will write here and save it as .html file.

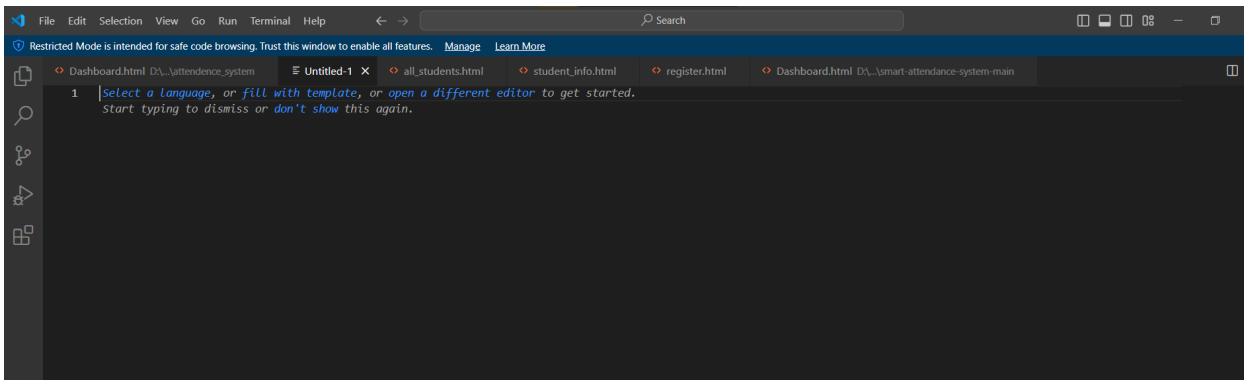


Figure 5.12: Visual Studio Code Interface

5.4 Coding Implementation

This subtopic will discuss important code that is used in both Arduino IDE and Visual Studio Code for making the Student Attendance System using RFID technology. Firebase is interfaced with the Arduino or ESP8266 microcontroller which is programmed using Arduino IDE. Web technologies and Visual Studio Code as a development environment equipped with extension features are used to create the web frontend through which administrators manage records of attendance.

5.4.1 Arduino Code

This figure below shows library code that used in Student Attendance System using RFID technology. #include <ESP8266WiFi.h> is used to allows ESP8266 to connect to WIFI network. #include <MFRC522.h> is used to read RFID tags. #include "FirebaseESP8266.h" used to allows interaction between ESP8266 and Firebase DB.

```
#include <ESP8266WiFi.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SPI.h>
#include <MFRC522.h>
#include "FirebaseESP8266.h"  // Install Firebase ESP8266 library
#include <NTPClient.h>
#include <WiFiUdp.h>
```

Figure 5.13: Library Code

This code below specifies the unique address of Firebase DB and secret key that allows the ESP8266 securely connect and interact with database. This code is important for the ESP8266 to log and retrieve student attendance data from Firebase.

```
#define FIREBASE_HOST "test1-4dd2f-default-rtdb.asia-southeast1.firebasedatabase.app"
#define FIREBASE_AUTH "sa3NjMOxoPnbVvwF4RZNAh5NTzPihUGTSuNpk3ay"
```

Figure 5.14: Firebase Code in Arduino

```
const char ssid[] = "mann-2.4Ghz";
const char pass[] = "nasigoreng14";
```

Figure 5.15: WIFI ID and password

This code below for what message will appear on LCD screen.

```
lcd.setCursor(0, 0);
lcd.print("SCAN MATRIC CARD");
lcd.setCursor(1, 1);
lcd.print("RECORD ATTEND");
delay(500);
lcd.clear();
```

Figure 5.16: LCD code

This code below show RFID code. It handled in 'loop()' function, where it checks for new RFID cards, reads the UIDs, process access with 'checkAccess' function and updates the UID in Firebase.

```
void loop() {
  // Reset the loop if no new card is present on the sensor/reader. This saves the entire process when idle.
  if (rfid.PICC_IsNewCardPresent() && rfid.PICC_ReadCardSerial()) {
    Serial.print(F("PICC type: "));
    MFRC522::PICC_Type piccType = rfid.PICC_GetType(rfid.uid.sak);
    Serial.println(rfid.PICC_GetTypeName(piccType));

    // Check if the PICC is of Classic MIFARE type
    if (piccType != MFRC522::PICC_TYPE_MIFARE_MINI &&
        piccType != MFRC522::PICC_TYPE_MIFARE_1K &&
        piccType != MFRC522::PICC_TYPE_MIFARE_4K) {
      Serial.println(F("Your tag is not of type MIFARE Classic."));
      return;
    }

    String rfidUID = "";
    for (byte i = 0; i < rfid.uid.size; i++) {
      rfidUID += String(rfid.uid.uidByte[i] < 0x10 ? "0" : "");
      rfidUID += String(rfid.uid.uidByte[i], HEX);
    }
    rfidUID.toUpperCase();

    Serial.print("RFID UID: ");
    Serial.println(rfidUID);

    checkAccess(rfidUID);
```

Figure 5.17: RFID code

```
Firebase.setInt(firebaseData, uidPath + "/student/" + temp, 0);

json.add("time", formattedTime);
json.add("id", device_id);
json.add("uid", temp);
json.add("status", 0);

if (Firebase.pushJSON(firebaseData, uidPath + "/attendence", json)) {
  Serial.println(firebaseData.dataPath() + firebaseData.pushName());
} else {
  Serial.println(firebaseData.errorReason());
```

Figure 5.18: Code for Firebase store method

5.4.2 Visual Studio Code

This code below is for initializing and connecting to Firebase project in a web application. It includes various credentials and identifiers to interact with Firebase services.

```
const firebaseConfig = {
apiKey: "AIzaSyClXgP-ksyNPSIzXlV96PvTp3v64ksb6gY",
authDomain: "test1-4dd2f.firebaseapp.com",
databaseURL: "https://test1-4dd2f-default-rtdb.asia-southeast1.firebasedatabase.app",
projectId: "test1-4dd2f",
storageBucket: "test1-4dd2f.appspot.com",
messagingSenderId: "811470294095",
appId: "1:811470294095:web:99c4ace790ac7cd7d22e3a",
measurementId: "G-GZZR5WWD82"
};
```

Figure 5.19: Initialize and Connecting to Firebase

```
<title>Dashboard - Student Attendance System</title>
<meta charset="UTF-8">
<link href="https://maxcdn.bootstrapcdn.com/bootstrap/4.4.1/css/bootstrap.min.css" rel="stylesheet">
<link rel="stylesheet" href="https://cdnjs.cloudflare.com/ajax/libs/font-awesome/4.7.0/css/font-awesome.min.css">
<link href="https://cdn.datatables.net/1.10.20/css/dataTables.bootstrap4.min.css" rel="stylesheet" crossorigin="anonymous"/>
<link href="https://cdn.datatables.net/responsive/2.2.6/css/responsive.dataTables.min.css" rel="stylesheet">
<link href="https://cdn.datatables.net/buttons/1.5.2/css/buttons.dataTables.min.css" rel="stylesheet">
<style>

#myPieChart {
width: 400px;
height: 400px;
}
body {
display: flex;
height: 100vh;
font-family: 'Roboto', sans-serif;
}
.sidebar {
height: 100%;
width: 250px;
position: fixed;
top: 0;
left: 0;
```

Figure 5.20: CSS code

5.5 Implementation Status

This subtopic will discuss the progress of the Student Attendance System using RFID technology during implementation time.

Table 5.2: Project Implementation Status

No	Activity	Description	Duration
1	Identify component	Identify component that used in this system and buy it online.	7 Days
2	Download necessary installer	Install Arduino IDE, Visual Studio Code and setup Firebase DB.	4 Days
3	Assemble Hardware	Setup ESP 8266 and integrate it with LCD, RFID reader.	8 Days
4	Implement all source code project in Arduino IDE	Implement code for all part which is ESP8266, RFID reader, WIFI connection, Firebase DB.	35 Days
5	Develop web application	Develop web application using Visual Studio Code, combines HTML, CSS and JavaScript to create user interface	30 Days
6	Test prototype	Test the prototype to see it properly function or not and add additional features if necessary.	4 Days

5.6 Conclusion

In conclusion, this chapter discusses the development environment setup, hardware environment setup, software installation setup, coding implementation and implementation status. The discussion also includes the connection of other important components that include ESP 8266, firebase and RFID module by explaining the operation of the system in making record and managing student attendance effectively. By done this implementation phase, the system is ready for the next stage which is testing phase.

CHAPTER 6: TESTING

6.1 Introduction

This chapter is focused on testing phase of the student attendance system using RFID technology. This is crucial to confirm that the system is indeed correctly recording attendance as well as managing it and this involves testing both the hardware and the software. The emphasis will be made on the most important features like RFID tags reading performance, real-time data sharing with the Firebase DB, and the availability of the Web-Interface for attendance tracking and management. Hence, the objective of this chapter is to test each aspect of the system systematically and determine any problem so that the system will be stable, accurate and can be used in an educational environment.

6.2 Test Plan

The objective of this subtopic is to ensure that the Student Attendance System using RFID is functioning well and meets all specified requirements. This test plan also helps in identifying the problem that may occur during operation of the device.

6.2.1 Test Organization

The test organization identifies the activities that will be performed on the Student Attendance System using RFID as well as the roles and responsibilities of people who will be involved in testing the various components. The test manager supervises the whole testing process and manages the communication between the project teams as well as between the test teams and the test plan. It is a test engineer's role to run test cases, report defects and ensure the fixes for both hardware and software domains. Developers help in the identification of problems during testing and in the testing of solutions to the problems. Usability testing is done by end users like lecturer and other administrative staff where they give feedback on the real-life usage of the system thus pointing out the problems they may encounter in using the system in their practical activities. This

structured approach comes in handy in identifying problems during testing and issues that require addressing as well.

6.2.2 Test Environment

The test environment emulates the actual deployment environment of the system with a view of testing the system's functionality. This involves RFID readers, RFID tag or cards, ESP8266 microcontrollers, LCD displays and internet connection to the firebase database. The context of the environment should be such that it closely resembles a class or a school to put the system through its usual tests. It should also test various network conditions for reliable data transmission and synchronization with the Firebase database.

6.2.3 Test Cases

Test scenarios and test cases are created to address all aspects of the system in order to provide complete coverage. Key scenarios include:

i. RFID Scanning: Ensure that the RFID reader is properly able to name and write the RFID tag given to it.

ii. Wi-Fi Connectivity: Make sure that the ESP8266 module establishes connection with the Wi-Fi network and sustains the connection during data transfer.

iii. Data Synchronization: Make sure the attendees' data is real-time synchronized with the Firebase database.

iv. User Interface Testing: Confirm that the LCD shows the messages appropriately and the web application interface meets its intended functionality and shows the correct information.

v. Error Handling: Check different error scenarios which can be encountered with the system including network failure, invalid RFID tags, and problems with database connectivity.

6.3 Test Strategy

The test strategy for the Student Attendance System using RFID aims to establish the dependability, validity and feasibility of the system in all possible facets from the physical, software component up to the integrated system. The strategy entails both manual and automated testing to ensure all the functional and non-functional characteristics are tested.

6.3.1 Functional Testing

Functional testing in this case is designed to make sure that the RFID attendance system is capable of performing all its required functions. This involves checking the various elements of the system, for example, RFID, Wi-Fi, Firebase, and real-time data updates. Each function will be accompanied by the test cases that will check the normal, boundary and erroneous behaviors. The RFID readers will be verified to prove that they are properly reading and transmitting the card information to the microcontroller while the ESP8266 board will be verified for network stability and successful interfacing with the Firebase database.

6.3.2 Integration Testing

Integration testing is aimed at checking how the components interact with each other in a system. This includes conducting a series of checks to determine the proper working of RFID reader with ESP8266 microcontroller and the Firebase DB. Some of the scenarios may involve

streamlining data captured from RFID scanning and the data captured being uploaded to Firebase then displayed on the web interface. The purpose of the test is to define whether there are some problems with data transfer or integration that may impact on the system.

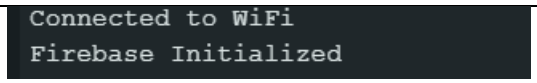
6.4 Test Description

The purpose of this section is to identify parts of the Student Attendance System using RFID that requires testing. In this project, tables are employed to list all the test cases. This section includes all the components and modules that were implemented to achieve accurate and successful results. It is important to have abundant knowledge about the components of the system in order to comprehend the testing procedures and the anticipated results. The test cases are described, following a systematic approach, in the table below

i. Table 1 shows the results of Network testing

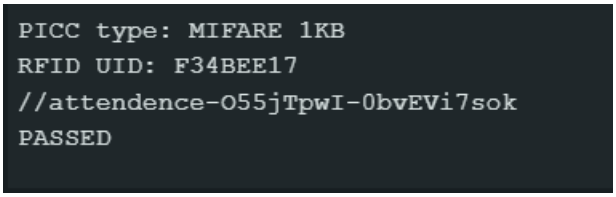
Table 6.1: WI-FI Module

Test	Test of Wi-Fi Module/ESP 8266
Test Purpose	To ensure that the ESP8266 module is connected to the Wi-Fi network and ensure that the device communicates with the Firebase database.
Test Environment	The test needs to have a stable internet connection, an ESP8266 module that is properly set up and an active Firebase account.
Test Setup	• Install Arduino IDE • Create new sketch and upload WI-FI connection code • After upload and setup the user and password, internet connection properly work.
Expected Result	Internet connection work properly.

	 ***Figure 6.1: Successfully Connected to the internet***
Error Message	None
Result	Pass

ii. Table 2 shows the results of the RFID module testing

Table 6.2: RFID Module

Test	Test of RFID module functionality
Test Purpose	To ensure RFID module read and process tags or cards properly.
Test Environment	The test requires setting up the RFID module and connecting it to the ESP8266 microcontroller
Test Setup	• Download Arduino IDE and install necessary libraries • Write and upload source code to ESP 8266 • Place RFID tag near reader to read the process.
Expected Result	RFID module should detect the tags and cards.  **Figure 6.2: RFID detect the tags/cards**
Error Message	None
Result	Pass

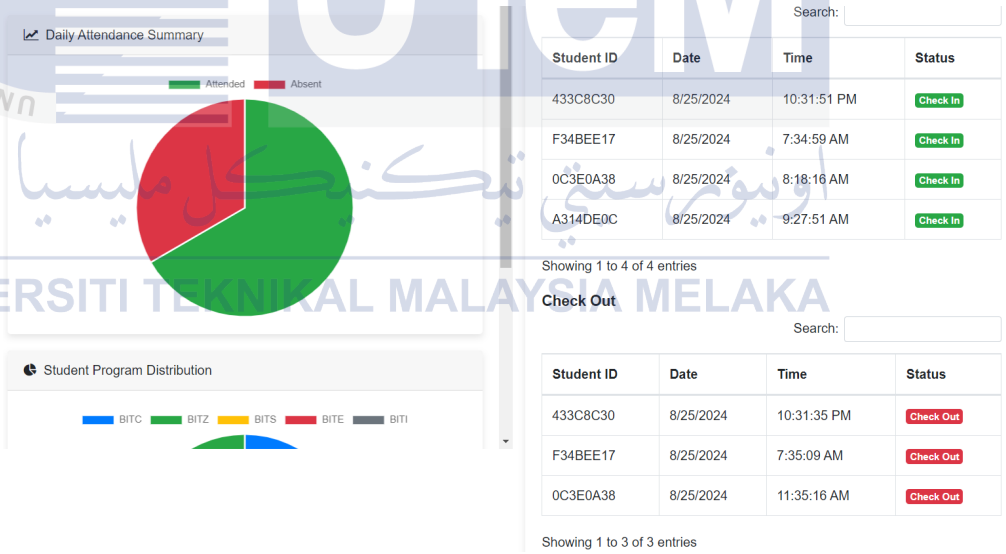
iii. Table 3 shows the results of database connectivity.

Table 6.3: Database Connectivity

Test	Test of Firebase DB connectivity
Test Purpose	To ensure that the system can connect to the Firebase database and effectively update the records in real time.
Test Environment	The test requires a stable internet connection and correct Firebase API credentials configured in the ESP8266 code.
Test Setup	• Ensure Wi-Fi module is works. • Upload code with Firebase integration to ESP 8266 • Check the Firebase console for data change when an RFID tag is scanned.
Expected Result	The system should update the Firebase DB with the scanned RFID tag data.  ***Figure 6.3: The data when the card touch RFID reader will store in Firebase console***
Error Message	None
Result	Pass

iv. Table 4 shows the results of Web Application

Table 6.4: Web Application

Test	Test of web application interface and functionality
Test Purpose	To ensure the web application displays real-time attendance data correctly and allows users to generate reports.
Test Environment	The test assumes a functional web server hosting the web application and permission to the Firebase database.
Test Setup	• Access the web application from web browser. • Record the RFID readings and verify the real-time data on the web interface.
Expected Result	The attendance data should be updated in the web application and users should be able to generate reports without any errors.  ***Figure 6.4: The web successfully update the data***
Error Message	None
Result	Pass

v. Table 5 shows the results of LCD Display

Table 6.5: LCD display function

Test	Test of LCD display functionality
Test Purpose	To ensure that the LCD correctly displays attendance status and prompts based on RFID scans.
Test Environment	The test requires a connected and configured LCD display and a functional RFID module.
Test Setup	• Connect LCD display to ESP 8266. • Upload the code on Arduino IDE. • Scan RFID tag and see the messages displayed on LCD
Expected Result	The LCD should display "CHECKED IN" or "CHECKED OUT" based on the scanned RFID tag status.  ***Figure 6.5: LCD display the status***
Error Message	None
Result	Pass

6.5 Test Results and Analysis

This chapter covers other aspects of the project after the previously described test cases, a test strategy, and a test description. This is followed by test case identification and results of the test case that can be passed or failed. The findings from the research and testing of the components in this project are as follows:

I. ESP 8266 Wi-Fi module

Table 6.6: ESP 8266 result and analysis

Test Case Identification	Test Identification	Result Expectation	Success/Fail
1	Wi-Fi connection	The ESP 8266 should connect to Wi-Fi network after upload the code in Arduino IDE.	Success
2	Reconnection after Wi-Fi disconnection	The ESP8266 should be able to reconnect to the Wi-Fi network in case it is disconnected without upload the code again.	Success

This project used ESP 8266 Wi-Fi module to send and receive data to web applications. Without this module, data unable to receive any update regarding the attendance data.

II. RFID Reader RC522

Table 6.7: RC522 result and analysis

Test Case Identification	Test Identification	Result Expectation	Success/Fail
1	Scan RFID tag/card	The system should be able to capture the RFID tag, record the students' attendance and store them in the database.	Success
2	Scan unregistered RFID tag/card	The system should not record that the student has attended the class and it should either give an error message or a popup.	Success
3	Scan multiple RFID tag/card	The system should be able to handle multiple RFID scans by creating a list of requests that has to be served in a first-in first-out manner.	Success

This reader is used to capture student IDs for attendance taking purposes. The results validate that the reader accurately identifies and processes RFID tags in real-time, as well as addressing invalid tags and multiple scans.

III. LCD Display

Table 6.8: LCD display result and analysis

Test Case Identification	Test Identification	Result Expectation	Success/Fail
1	Display initial status	When system is switched on, the LCD should show a welcome message for instance: Please Scan Matric Card	Success
2	Display time status	After valid RFID tag is scanned, LCD should display the real time.	Success
3	Display error message for unrecognized RFID tag	In case a registered RFID tag is not recognized, the LCD should show a message like "Tag Not Registered."	Success

The LCD provides users with real-time feedback in form of the attendance status and other errors or connection problems. The findings confirm that the display effectively changes with necessary information during the operation of the system, thus making the user informed of the system status.

IV. Web Application

Table 6.9: Web Application result and analysis

Test Case Identification	Test Identification	Result Expectation	Success/Fail
1	Attendance data display	The web application should also contain a dynamic attendance list that is pulled from the database to show student's name, their ID, and their attendance record.	Success
2	Attendance report generation	The web app should enable users to produce reports by date, student, class and should be able to export in CSV formats.	Success
3	Dashboard with attendance summary	This web app should include a panel that presents the overall number of students in the class and the number of students that have not attended the class.	Success

The web application enables the admins to view attendance data, produce reports, as well as control the students' records. The results proved that the web app performs well with real-time data, well-generated reports, and UI responsiveness.

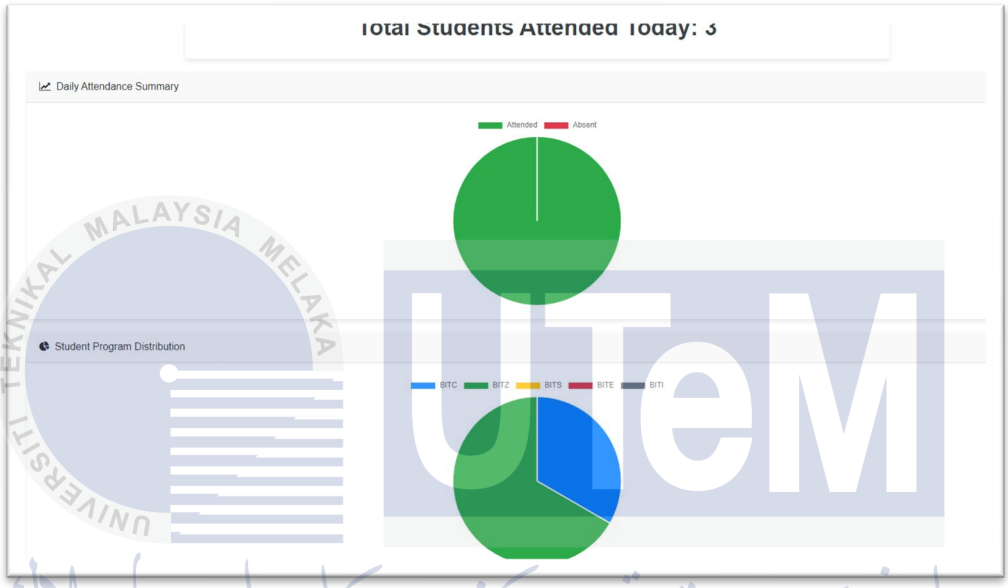


Figure 6.6: Shows how many student attend the class

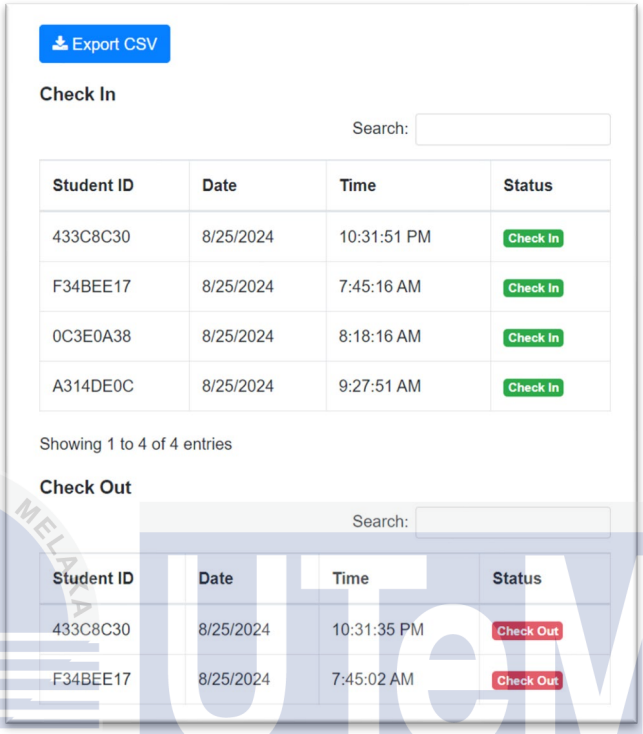


Figure 6.7: Shows Real-Time of the student in and out

6.6 Conclusion

In conclusion, testing was done in several phases and some of the tests carried out include the unit tests where each component of the system such as the RFID reader, Wi-Fi module or even the web interface was tested separately before the integration tests which ensured that the entire system operated seamlessly. A thorough assessment of each component was conducted to review any possible complications and ensure that all the functionalities of the system were met. From the test results it can be seen that the system works fine with all the activities that are essential for its proper functioning running as expected under normal conditions. Some minor problems were reported, including occasional UI issues and slight delays in data synchronization, which can be considered as weaknesses. Finally, the results, which were obtained during the testing phase, confirmed that the system is highly efficient and meets the goals that were set at the beginning of the project implementation. However, current performance monitoring and further optimization would be required

CHAPTER 7: PROJECT CONCLUSION

7.1 Introduction

This chapter is about the conclusion of the project and covers all aspects of the work. A review of all the aspects of the project and its positive and negative aspects in relation to its achievements. The impact of the project to the field is explained as well as any issues experienced throughout the course of the project. The future work and research directions to improve and develop the system and solve any unsolved issues are discussed.

7.2 Project Summarization

This project focuses on developing Student Attendance System using RFID technology by using ESP 8266 and Firebase DB to store the data. The main objective was to design a system that would reduce the time spent on taking attendance since this would be done by scanning the RFID cards belonging to students. The system consists of RFID readers that connected to ESP 8266 which communicates with Firebase to store attendance data in real time. A web application also develops to allows administrators which is lecturer to monitor and manage attendance data easily.

7.2.1 Project Objective

In the process of fulfilling this project, all the project objectives (PO) mentioned in Chapter 1 have been fulfilled. The first objective is PO1, which aims at establishing an automated system that can take the students' attendance record through RFID and ESP8266, is achieved in Chapter 5 under the Implementation. This section outlines the structure and implementation of the system, specifically with the RFID technology to the Arduino or ESP8266 microcontroller. The use of the RFID system ensures that the identification number of each students' card is captured electronically when swiped on the reader thus minimizing the amount of work to be done and errors related to other traditional methods of taking attendance. The automation of the process of taking attendance means that the teacher spends less time managing the class and more time teaching.

Secondly, PO2 which is to develop a web application for monitoring purposes has been fulfilled in chapter 5 under the implementation subtopic (5.4). This section outlines the process of constructing a simple website interface for accessing the attendance records of the users in real-time where the users include administrators and lecturers. It is connected to the RFID-based attendance system that allows users to access the stored data in the Firebase database. They can view all the records and attendance of students, make reports and trends, which makes it easier to notice any abnormalities or take appropriate measures. This web application makes monitoring of attendance effective and easily accessible hence improving the management of student attendance data.

Lastly, for the last objective PO3 of providing real-time monitoring and reporting of attendance data, the goal has been accomplished. In the implementation subtopic of chapter 5, the integration of RFID system with Firebase is explained with an example illustrating that the attendance records are updated as soon as the student scans their card. This feature enables the administrator or teacher to check attendance at once and it provides real-time information about attendance and absence. Also, in the same chapter, it is described how the web interface for the creation of detailed attendance reports for analysis and decision-making support was developed and deployed. This also make sure that the system is not only designed to capture attendance data effectively but also to turn the data into useful information for the enhancement of the attendance policies and practices.

7.2.2 Project Weakness and Strength

7.2.2.1 Project Strength

The student attendance system using RFID technology has several advantages that indicate that the system is important for educational institutions. The above solutions reveal that one of the key benefits is its automation function as it saves much time and effort for manual attendance recording. This includes the use of RFID readers connected to microcontrollers such as Arduino or ESP8266 and use of Firebase for the real time storage and management of attendance data. This automation not only helps in the attendance process but also reduce the error and give a reliable solution to the organization for operational efficiency. Besides, the web application that was created for monitoring purposes can grant instant access to attendance information and help educators, as well as administrators, create the necessary reports and identify attendance patterns. This feature is useful for making appropriate decisions and enhance student activities and behaviors.

7.2.2.2 Project Weakness

However, the project also has its drawbacks which should be solved in order to ensure its wider application. One limitation is that the update of data from Firebase has to be done in real-time and therefore requires a stable internet connection. When using the system, the internet connection is required for updating and accessing the information about attendance, and in case of weak or unstable connection it may be problematic to update and access all the necessary information at once. Next, the cost of RFID hardware at the start and the process of integrating RFID will be a challenge to some institution. Another factor to consider is data privacy and security, recording attendance in a cloud base will be needed to protect the data from unauthorized access and or misuse. Solving these issues is crucial to improve the system's stability and protect it from attacks for its use by the public.

7.3 Project Contribution

The student attendance system using RFID technology also enhances the effectiveness and reliability of attendance records in educational facilities. With the application of the attendance taking system, the time spent by teachers in this process is minimized and at the same time, the data collected is accurate. Apart from real-time data sharing, the combination of RFID with microcontrollers like Arduino or ESP8266 and cloud platform like Firebase helps promote the application of IoT in education. This project is a perfect example of how the use of modern technologies can help to develop an intelligent environment of a classroom that can set the tone for future technological advancement that aims at automating processes in education while at the same time providing real–time analytics.

7.4 Project Limitation

The student attendance system using RFID technology has some limitations that may affect the usage of the system. The limitation is that the system requires a constant internet connection to connect with Firebase for real-time data updating. When internet connectivity is poor or unavailable at certain times, the system might take some time to update the attendance records or even fail to record the data properly, which would make the system less useful. Furthermore, RFID technology can be expensive, the initial installation of RFID readers and purchasing RFID cards for all the students may be burden in some schools or institutions that have little financial might meaning that not all institutions or schools may be able to afford installing the system.

Another drawback is that students rely on RFID cards which can be easily lost, damaged or left at home by students. This may result in poor recording of attendance, or it may mean extra work in having to accommodate for replacements, and to remind the students about their RFID cards. However, the operation of the system is based on automatic attendance tracking, and it lacks the sophistication of attendance behavior, for example, students may come late and leave early that can be tracked in more detail or may require integration with other tracking systems. Finally, there are issues to do with privacy when it comes to storing and managing student data in cloud, there is need to put in place measures that will ensure that data is secured from hackers and other malicious persons.

7.5 Future Works

Improvements can be made in the future to ensure the Student Attendance System using RFID technology can be more efficient and reliable. These are some improvements can be made:

i. **Enhancement of Offline Functionality**: One of the most significant future improvements for the system is to develop the offline mode of the system. Enhancing the function that enables the system to record the attendance data on the microcontroller when the connection to the internet is lost and upload such data to the Firebase server when the internet connection is regained would enhance the reliability of the system. This would enhance the flexibility of the system especially when the access to the internet is limited or non-existent.

ii. **Mobile Application Development**: The other suggestion would be to have a mobile application that would allow more convenience in using the student attendance system for both the educators, as well as the students. There could be a notification to students' mobile devices regarding their attendance status, notifications for students who forget to scan their RFID card and real-time attendance access for teachers and administrators. This would improve the usage of the system by users and would also make sure that every user would always be updated on any issue concerning attendance.

iii. **Enhanced Privacy and Security Features**: It could also be another important area of future development to enhance the privacy and security of the system. This may include adopting secure data transmission procedures such as encryption, standard and secure procedures of accessing the web application, and meeting the requirements of data protection laws. It will also ensure the protection of user's' data, especially students' information, that if compromised might lead to major losses.

7.6 Conclusion

In conclusion, the development and implementation of the student attendance system using RFID technology has effectively solved the problem of searching for a more efficient and effective method to track student attendance in educational institutions. The project has met its goals to help automate the process of tracking attendance, monitor and report in real time, and give a simple web-based interface to administrators and educators. Although the system has proven to be effective in eliminating such problems, there are still areas that could be improved further such as minimizing the administrative burden and errors. Future improvements could focus on enhancing offline capabilities, mobile application development, enhanced privacy and security features. Altogether, the project has established a clear basis for following developments and provides a versatile solution that can be extended in further evolution to suit the changes in educational settings.

REFERENCES

Kubieniec, M. (2022, March 11). *Software development Life cycle models – What are SDLCs?* Kambu. https://www.kambu.pl/blog/software-development-life-cycle-models-what-are-they/

Lab, M. (2019, March 23). *INTRODUCTION TO ESP8266 module*. Microcontrollers Lab. https://microcontrollerslab.com/esp8266-getting-started-tutorial/

LME Editorial Staff. (2023, May 10). *What is RFID? How It Works? Interface RC522 RFID Module with Arduino*. Last Minute Engineers. https://lastminuteengineers.com/how-rfid-works-rc522-arduino-tutorial/

Software. (2024). Arduino. https://www.arduino.cc/en/software

GeeksforGeeks. (2021, July 15). *Firebase Introduction*. GeeksforGeeks. https://www.geeksforgeeks.org/firebase-introduction/

Firebase Realtime database. (2024). Firebase. https://firebase.google.com/docs/database/

Stevenson, D. (2020, May 7). What is Firebase? The complete story, abridged. - Firebase Developers - Medium. *Medium*. https://medium.com/firebase-developers/what-is-firebase-the-complete-story-abridged-bcc730c5f2c0

RFID based Smart Attendance System. (2024). projecthub.arduino.cc. https://projecthub.arduino.cc/team_chkr/rfid-based-smart-attendance-system-beff99

Almansor, M. J., & Ali, F. Z. (2021). STUDENT ATTENDANCE USING RFID SYSTEM. *ResearchGate*. https://www.researchgate.net/publication/348163330_STUDENT_ATTENDANCE_USING_RFID_SYSTEM

Pireva, K. R., Siqeca, J., & Berisha, S. (2013). RFID: Management System for students' attendance. *IFAC Proceedings Volumes*, *46*(8), 137–140. https://doi.org/10.3182/20130606-3-xk-4037.00057

Almansor, M. J., & Ali, F. Z. (2021). STUDENT ATTENDANCE USING RFID SYSTEM. *ResearchGate*. https://www.researchgate.net/publication/348163330_STUDENT_ATTENDANCE_USING_RFID_SYSTEM

Ishaq, K., & Bibi, S. (2023). IoT Based Smart Attendance System Using RFID: A Systematic Literature Review. *ResearchGate*. https://www.researchgate.net/publication/372962352_IoT_Based_Smart_Attendance_System_Using_Rfid_A_Systematic_Literature_Review

Web-based student attendance system using RFID technology. (2012). IEEE Conference Publication | IEEE Xplore. https://ieeexplore.ieee.org/document/6287164

Ali, N. S., Alhilali, A. H., Rjeib, H. D., Alsharqi, H., & Sadawi, B. A. (2022). Automated attendance management systems: systematic literature review. International Journal of Technology Enhanced Learning, 14(1), 37. https://doi.org/10.1504/ijtel.2022.120559

APPENDICES

Source code from Arduino IDE

```
#include <ESP8266WiFi.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SPI.h>
#include <MFRC522.h>
#include "FirebaseESP8266.h"  // Install Firebase ESP8266 library
#include <NTPClient.h>
#include <WiFiUdp.h>

#define FIREBASE_HOST "test1-4dd2f-default-rtdb.asia-southeast1.firebasedatabase.app" // Without http:// or https:// schemes
#define FIREBASE_AUTH "sa3NjMOxoPnbVvwF4RZNAh5NTzPihUGTSuNpk3ay"

#define RST_PIN D0     // Configurable, see typical pin layout above
#define SS_PIN D8      // Configurable, see typical pin layout above

MFRC522 rfid(SS_PIN, RST_PIN);       // Create MFRC522 instance

LiquidCrystal_I2C lcd(0x27, 16, 2);

WiFiUDP ntpUDP;
const long utcOffsetInSeconds = 28800; // (UTC+8:00 for Malaysia)
NTPClient timeClient(ntpUDP, "pool.ntp.org", utcOffsetInSeconds);

//const char ssid[] = "mann-2.4Ghz";
//const char pass[] = "nasigoreng14";

//const char ssid[] = "UTeM-Net";
//const char pass[] = "1UTeM@PPPK";

const char ssid[] = "BeGrateful";
const char pass[] = "dontgiveup";
```

```
String uidPath = "/";
FirebaseJson json;

FirebaseData firebaseData;
FirebaseConfig firebaseConfig;
FirebaseAuth firebaseAuth;

const int red = D4;
const int green = D3;
String alertMsg;
String alertMsg2;
String device_id = "uid";
boolean checkIn = true;

void connectToWiFi() {
  Serial.print("Connecting to WiFi");
  WiFi.begin(ssid, pass);
  while (WiFi.status() != WL_CONNECTED) {
    Serial.print(".");
    delay(1000);
  }
  Serial.println("\nConnected to WiFi");
}

void setup() {
  Serial.begin(115200);
  delay(10);

  pinMode(red, OUTPUT);
  pinMode(green, OUTPUT);
  lcd.init();
  lcd.clear();
  lcd.backlight();
```

```
  SPI.begin();
  rfid.PCD_Init();
  connectToWiFi();

  timeClient.begin();

  firebaseConfig.host = FIREBASE_HOST;
  firebaseConfig.signer.tokens.legacy_token = FIREBASE_AUTH;

  Firebase.begin(&firebaseConfig, &firebaseAuth);
  Firebase.reconnectWiFi(true);

  Serial.println("Firebase Initialized");
}

void checkAccess(String temp) {
  lcd.setCursor(0, 0);
  lcd.print("SCAN MATRIC CARD");

  if (Firebase.getInt(firebaseData, uidPath + "/student/" + temp)) {
    timeClient.update();
    String formattedTime = timeClient.getFormattedTime();
    lcd.clear();
    lcd.setCursor(4, 0);

    if (firebaseData.intData() == 0) {
      alertMsg = "RECORDED";
      alertMsg2 = "SUCCESSFULLY";

      //lcd.setCursor(0, 0);
      lcd.print(alertMsg);
```

```
      lcd.setCursor(4, 1);
      lcd.print(formattedTime);

      delay(2000);
      lcd.clear();

      lcd.setCursor(2, 0);
      lcd.print(alertMsg2);

      lcd.setCursor(3, 1);
      lcd.print("CHECKED IN");

      delay(2000);

      json.add("time", formattedTime);
      json.add("id", device_id);
      json.add("uid", temp);
      json.add("status", 1);

      Firebase.setInt(firebaseData, uidPath + "student/" + temp, 1);

      if (Firebase.pushJSON(firebaseData, uidPath + "/attendence", json)) {
        Serial.println(firebaseData.dataPath() + firebaseData.pushName());
      } else {
        Serial.println(firebaseData.errorReason());
      }
    } else if (firebaseData.intData() == 1) {
      alertMsg = "RECORDED";
      alertMsg2 = "SUCCESSFULLY";

      lcd.print(alertMsg);
```

```
        lcd.setCursor(4, 1);
        lcd.print(formattedTime);

        delay(2000);
        lcd.clear();

        lcd.setCursor(2, 0);
        lcd.print(alertMsg2);

        lcd.setCursor(3, 1);
        lcd.print("CHECKED OUT");

        delay(2000);

        Firebase.setInt(firebaseData, uidPath + "/student/" + temp, 0);

        json.add("time", formattedTime);
        json.add("id", device_id);
        json.add("uid", temp);
        json.add("status", 0);

        if (Firebase.pushJSON(firebaseData, uidPath + "/attendence", json)) {
          Serial.println(firebaseData.dataPath() + firebaseData.pushName());
        } else {
          Serial.println(firebaseData.errorReason());
        }
      }
    } else {
      Serial.println("FAILED");
      Serial.println("REASON: " + firebaseData.errorReason());
      lcd.setCursor(0, 0);
     lcd.print("NEW CARD DETECT");
     lcd.setCursor(0, 1);
```

```
    }
  } else {
    Serial.println("FAILED");
    Serial.println("REASON: " + firebaseData.errorReason());
    lcd.setCursor(0, 0);
  lcd.print("NEW CARD DETECT");
  lcd.setCursor(0, 1);
  lcd.print("PLEASE REGISTER");
  delay(4000);
  lcd.clear();
  }
}

void loop() {
  // Reset the loop if no new card is present on the sensor/reader. This saves the entire process when idle.
  if (rfid.PICC_IsNewCardPresent() && rfid.PICC_ReadCardSerial()) {
    Serial.print(F("PICC type: "));
    MFRC522::PICC_Type piccType = rfid.PICC_GetType(rfid.uid.sak);
    Serial.println(rfid.PICC_GetTypeName(piccType));

    // Check if the PICC is of Classic MIFARE type
    if (piccType != MFRC522::PICC_TYPE_MIFARE_MINI &&
        piccType != MFRC522::PICC_TYPE_MIFARE_1K &&
        piccType != MFRC522::PICC_TYPE_MIFARE_4K) {
      Serial.println(F("Your tag is not of type MIFARE Classic."));
      return;
    }

    String rfidUID = "";
    for (byte i = 0; i < rfid.uid.size; i++) {
      rfidUID += String(rfid.uid.uidByte[i] < 0x10 ? "0" : "");
      rfidUID += String(rfid.uid.uidByte[i], HEX);
    }
```

```
    }
    rfidUID.toUpperCase();

    Serial.print("RFID UID: ");
    Serial.println(rfidUID);

    checkAccess(rfidUID);

    // Store RFID UID to Firebase
    if (Firebase.ready()) {
      if (Firebase.setString(firebaseData, "/RFIDTags", rfidUID)) {
        Serial.println("PASSED");
        Serial.println("PATH: " + firebaseData.dataPath());
        Serial.println("TYPE: " + firebaseData.dataType());
      } else {
        Serial.println("FAILED");
        Serial.println("REASON: " + firebaseData.errorReason());
      }
    }

    // Halt PICC
    rfid.PICC_HaltA();
    // Stop encryption on PCD
    rfid.PCD_StopCrypto1();
  }

  lcd.setCursor(0, 0);
  lcd.print("SCAN MATRIC CARD");
  lcd.setCursor(1, 1);
  lcd.print("RECORD ATTEND");
  delay(500);
  lcd.clear();
}
```