RFID-Powered Automated Attendance System

By

Elijah Roshan GaneshKumar

21002637

Dissertation submitted in partial fulfilment of

the requirements for the

Bachelor of Information Technology (Hons)

(Information Technology)

SEPTEMBER 2025

Universiti Teknologi PETRONAS

Bandar Seri Iskandar 3

2610 Tronoh

Perak Darul Ridzuan

CERTIFICATION OF APPROVAL

RFID-Powered Automated Attendance System

By

Elijah Roshan GaneshKumar

21002637

A project dissertation submitted to the

Information Technology Programme

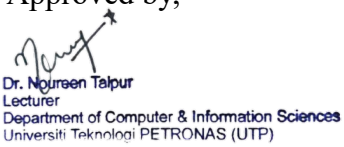
University Teknologi PETRONAS

in partial fulfilment of the requirement for the

BACHELOR OF INFORMATION TECHNOLOGY (Hons)

(INFORMATION TECHNOLOGY)

Approved by,



Ts Dr Noureen Talpur

UNIVERSITI TEKNOLOGI PETRONAS

BANDAR SER ISKANDAR, PERAK

September 2025

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my won except as specified in the reference and acknowledgement, and that the original work contained herein have not been undertaken or done my unspecified sources or persons.

ELIJAH ROSHAN GANESHKUMAR

Abstract

In these modern times, traditional manual attendance methods in educational institutions can be inefficient, prone to errors and consume valuable time during the class lectures. The project proposes the design and development of an Internet of Things (IOT) based solution which would be a portable Automated Attendance Systems by utilizing Radio Frequency Identification (RFID) technology. The system primary objective is to automate the attendance process by allowing the students to scan with an RFID card in which will trigger real-time logging of the Student ID, Name and Time/Date into a cloud repository which would be Google Sheets. The portable device will be designed and made around a ESP32 microcontroller, RC522 reader, and an Organic Light-Emitting Diode (OLED) screen which would be an 0.96 inch to display real-time feedback. The attendance data is to be transmitted to a cloud-based Google Sheet through a web Application Programming Interface (API) which will enable the data to be stored, retrieved and export to a PDF format after each session.

Table of Contents

1.0 Chapter 1: Introduction

1.1 Background of Study

Higher education institutions commonly rely on various methods of manual attendance such signing sheets and calling out names. The necessity or requirements for efficient and accurate administrative process drives the adoption of technologies in institutes to utilize proper attendance monitoring directly to improve the academic performances. Even though the current use of the highly used Power Apps mobile application to track students' attendance may have some setbacks despite it being one of the most used apps in some institutions for attendance tracking.

The shift from conventional paper-based formalities to digital automated processes not only saves time but also provides the reliability required accurate student attendance record. The current study aims to use RFID technology to integrate attendance monitoring and ensure a more accurate and smooth record. The proposed system utilizes the RFID technology which will recognise the simplicity, speed, compact, portable and data reading ability. (Azmi,2010; Mazlan & Ahmad,2025)

1.2 Problem Statement

The continued use of manual attendance recording methods in higher education settings may present certain significant challenges that may have some impact on:

- **Errors in marking or transcription of attendance:** This can be addressed in which where in the classroom room setting the students are required to sign the attendance by either ticking in the box or signature. In certain circumstances the students may make some mistakes which can compromise the data accuracy. (Renaldo et al., 2014)
- **Possibility of false attendance:** This is a critical and academic integrity issue. Students can easily mark attendance for absent friends, which can often be referred to 'buddy punching". This practice can severely have some negative impact which would question the reliability of the attendance records in failing to provide an accurate measure of classroom participation. (Hussin et al., 2022).

- **Wasted class time for signing and roll calls:** Either signing or verbal roll calls especially in large classrooms setting can take 15 to 20 minutes of time. Over time it can lead to a substantial loss of time that can be equivalent to valuable time of lecture. (Haekal, 2024).
- **Difficulty in maintaining and analyzing attendance record:** Physical registration of attendance can be tedious to store, retrieve, and audit. This process may also be on the time-consuming aspect however it can also lead to some transcription errors. (Mazlan & Ahmed, 2025).

1.3 Objectives and Scope of Study

1.3.1 Objectives

The objective of this project is as follows:

- **System design and development:** To design and develop a portable RFID-based attendance system using a ESP32 microcontroller as the core processing unit.
- **Real-time data automation:** To automate the attendance data logging process, ensuring record are added into a Google Sheets (cloud-based) database in real-time.
- **Interface outlook:** To create a system that would display the feedback when tapping the RFID card when logging in the attendance on a small OLED 0.96-inch screen.
- **System evaluation:** To conduct a thorough evaluation of the final system reliability, accuracy and ease of use within a classroom-level implementation scenario.

1.3.2 Scope of Study

The project is focused on the following technical and functional components:

- **Identification method:** The system will use RFID cards as the identification tokens for the students
- **Core Hardware:** the ESP32 microcontroller is used to handle all key operations that reads the data from the RFID module, processing the student IDs in the managing the OLED display as well with the cloud synchronization
- **Data storage:** the attendance records are stored in a Google Sheets spreadsheets which would leverage the accessibility and cloud-based architecture for data management.
- **User Interaction and Confirmation:** the confirmation once scanned can be provide through 2 scenarios which would be visual feedback on the OLED display and a audible confirmation using a buzzer and/or LED indicator.

Limitations

The operation capability of this system is also subject to some limitations:

- **Connectivity Dependency:** a stable connection is mandatory for the device you successfully perform the real-time data synchronization with Google Sheets.
- **Identification Scope:** the system will only be able to recognize and process attendance for registered RFID cards. All student IDs must be pre-mapped to their corresponding RFID tag in the database for the system to function correctly

2.0 Chapter 2: Literature Review and Theory

This chapter reviews the existing automated attendance system to identify some of the gaps in current technology and justify the proposed solution.

2.1 Portability vs. Real-Time Connectivity

An early iteration of RFID attendance systems prioritized portability but sacrificed real-time data access. **Haekal (2014)** developed a portable RFID attendance system using ATmega 2560 microcontroller. While the device was successful in being fully portable and independent of a network connection, it relied on SD card storage. This meant that the data transfer required physical connectivity to the device to a PC, delaying the availability of attendance.

- **Gap Analysis:** The lack of real-time reporting limits the immediate utility of the data for the lecturers who would want to check the attendance during the class itself.
- **Proposed solution:** Using the ESP32 which has a built-in Wi-Fi capability, allowing for the portability.

2.2 Complexity of Cloud Integration

Mazlan & Ahmad (2025) introduced 'I-Attend", a comprehensive web-based tracking system for secondary schools utilizing Firebase. The system offered an excellent user experience and centralized management, the reliance on a Single Page Application (SPA) and Firebase introduces significant complexity in development and maintenance.

- **Gap Analysis:** It is a complex full-stack web application which can be an overkill for individual lecturers to take their attendance.
- **Proposed solution:** The project is simplified by using the backend architecture of Google Sheets as the database. This would leverage the platform for the lecturer and users that are already familiar with the software interface.

2.3 Security Measure vs. Efficiency

A common problem or critique of RFID is the “buddy punching” phenomenon. Azmi (2010) addressed this by combining RFID with thumbprint identification. Similarly, Hussin et al. (2022) proposed a double identification system using High-Frequency RFID and motion sensors to verify presence.

- **Gap Analysis:** multi factored system helps to reduce fraud however it introduces high level implementation cost and hardware complexity and may take more time to scan each student into a classroom.
- **Proposed Solutions:** the project acknowledges the trade-off of security compared to biometrics and double identification, the visual feedback on the OLED screen by showing the student’s name to the lecturer acts as a deterrent to monitor the attendance without slowing down the entry process.

2.4 System Reliability

Renaldo et al. (2021) noted in their study a significant reliability issue in university attendance systems noting that time recording accuracy dropped to 80% due to hardware malfunctions and poor internet connections. The study revealed that the data was often lost or delayed during the transmission process leading into the records being incomplete.

- **Gap Analysis:** The system relied too heavily on a good internet connection. When the network would delay, the system will lose the record, and student had no way track if the attendance was tracked or lost.
- **Proposed Solutions:** the ESP32’s dual core processing to implement robust error handling. This includes and automatic reconnection protocol in the code to handle Wi-Fi drops so that it does not stop the system from crashing, and with the addition of a buzzer would provide a audio feedback so the lecture and students have a physical confirmation of the log-in.

2.5 Integrated Health Feature vs. Processing Latency

In response to the Covid-19 pandemic, Hasman & Ahmad (2022) project proposed a RFID attendance system integrated with an MLX90614 temperature sensor. The system enforced a sequential protocol where the student must first scan their body temperature and only if it's below 37°C would unlock the RFID reader to record the attendance.

- **Gap Analysis:** as much the temperature check added a layer of health and safety, the sequential nature of the process significantly increases the time required per student. The reliance of SD card and a separate Real-Time Clock (RTC) that would increase hardware complexity compared to a network-connected device that retrieves time automatically from the internet.
- **Proposed Solution:** As this project target the post-pandemic "new normal," the priority is maximizing student attendance log-in as utilizing the ESP32's Network Time Protocol (NTP) capabilities, this eliminates the need for an external RTC module and allows for rapid scanning.

3.0 Chapter 3: Methodology

This project follows the **Software Development Life Cycle (SDLC)** methodology. This structure approach ensures that the development proceeds systematically from initial planning to the final development with also allowing for iterative testing and refinement. Following Figure 3.1 shows the basic flow of the SDLC methodology.

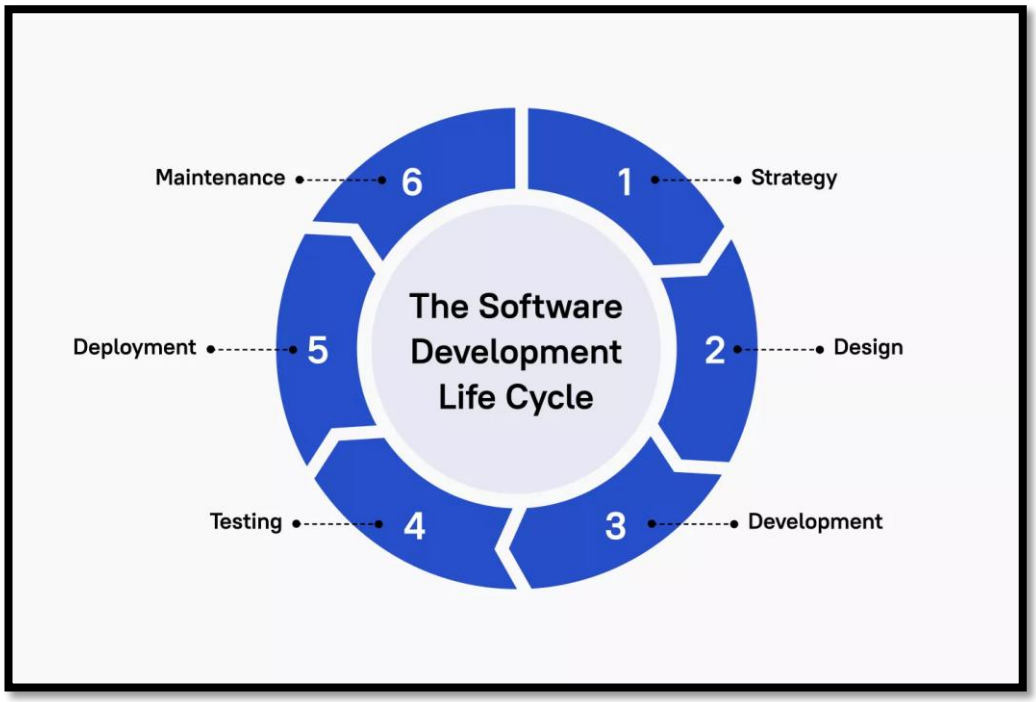


Figure 3.1 Software Development Life Cycle

3.1 Planning and Requirements Analysis

The initial phase of the project involves the inefficiencies of manual roll calls. Functional requirements are defined with the need for a scan-in system that requires no button presses from the student however but to use the student card to tap and scan-in for attendance. The device does not need a power bank nor a battery to operate however a power source that is just to plug-In the computer for the power to be turned on and proceed with the procedure.

3.2 System Architecture & Hardware Design

The system hardware will be built around the **ESP32 microcontroller.** Here is a breakdown of why the components are chosen for this project and process:

- **Why ESP32 microcontroller:** Compared to the Arduino Uno which is on the older components however the ESP32 feature a dual-core processing and more importantly an integrated Wi-Fi and Bluetooth. This would eliminate the need for an external Wi-Fi which can reduce the cost.

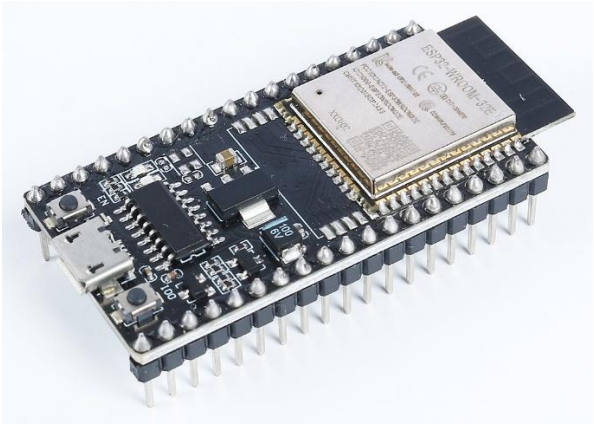


Figure 1 example of ESP32

- **RFID Reader (RC-522)**: This module operates at 13.56 MHz (High Frequency). It communicates with the ESP32 via the **Serial Peripheral Interface)** protocol which would be chosen for its high-speed data transfer capabilities which are essential for quick scanning.

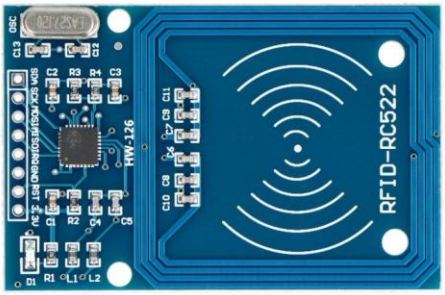


Figure 2 Example of RC522

- **User Interface:** The OLED display 0.96 inch connected via the 12C protocol (SCL/SDA) to minimize wiring. It provides a visual for the lecturers as a confirmation of the scan and show the number of scans taken. A buzzer will also be used to provide as feedback for example, 1 beep mean scan successful and 2 beeps if it's an error.

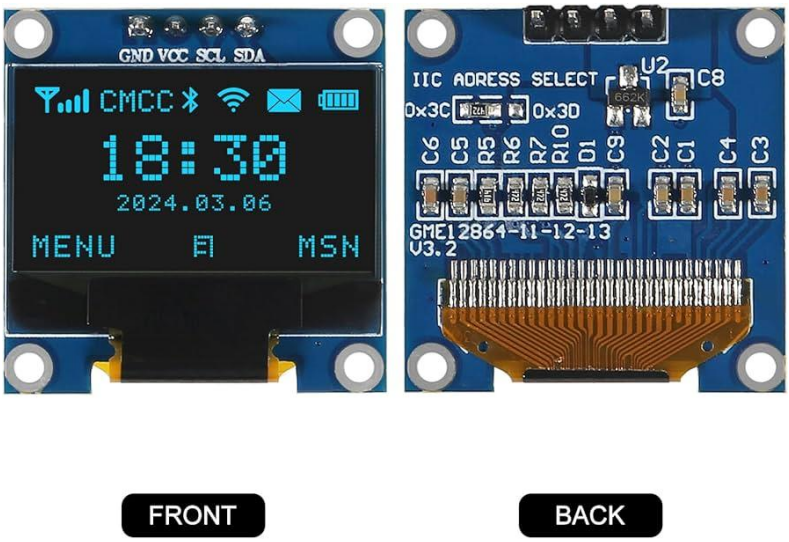


Figure 3 Example of 0.96-inch OLED display

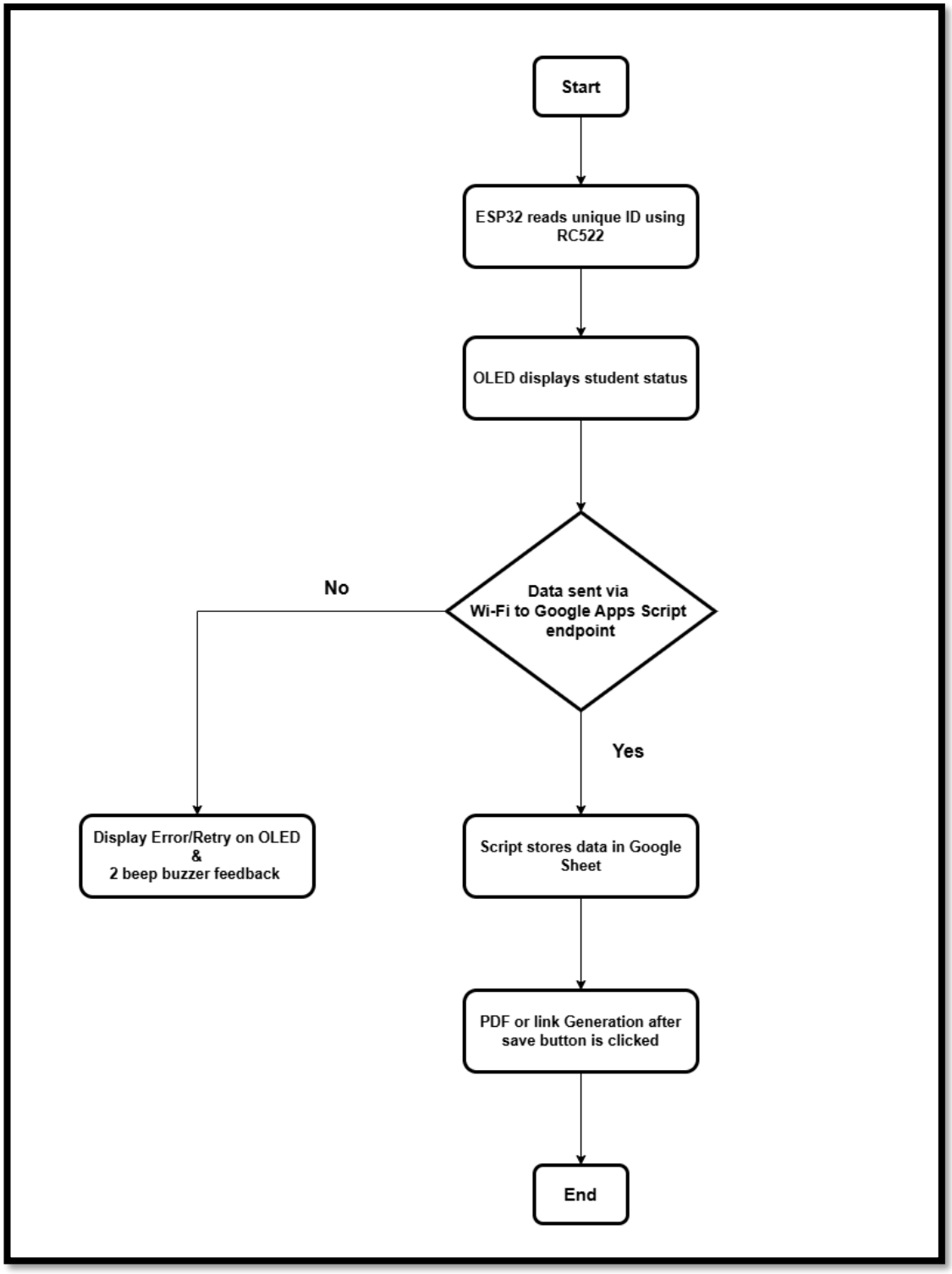


Figure 4 System Architecture Flow

3.3 Software Design & Data Flow

The software architecture follows a client-server model tailored for IOT:

- **Firmware (C++):** The code will be done in the Arduino IDE, and it will handle the initialization of the Serial Peripheral Interface (SPI), and it will manage the Wi-Fi connection as it will the Unique ID (UID) form the RFID tags.
- **API bridge (Google Sheets):** the ESP32 can not write directly to a Google Sheet file, a Google Apps Script is deployed as a Web App. This Script acts as an Application Programming Interface (API) endpoint.
- **Protocol:** When the card is scanned, the ESP32 sends a HTTPS POST request to the script URL. The payload will contain a JSON data to signify the Student ID and the name.
- **Database:** the Apps Script receives the POST request, parses the JSON, adds and timestamp and appends a new row to the sheet. The architecture ensures the heavy processing is done in the cloud.

3.4 Implementation

With the core hardware components successfully procured, the assembly of the components and integration phase. The process involves a process where:

- **Component testing:** components are to be connected and tested on the Arduino IDE to test each unit of the components to verify any defects before adding hard code.
- **Prototype:** components will be connected as a non-permanent setup for troubleshooting and adding code to test the stability of the process and fix any bugs or problems that may occur.
- **Final assembly & Enclosure fitting:** one the prototype is stable and confirmed to be sent and transferred to a measured and permanent enclosing to ensure the portability use of the process.

3.5 Gantt Chart

Activity / Week		1	2	3	4	5	6	7	8	9	10	11	12	13	14
		September				October				November				December	
1	Project Title Confirmation & Form 1A														
2	Preliminary Research (Literature Review)														
3	Identify Methodology & Tools														
4	Identify Equipment & Hardware														
5	System Design (Circuit & Database)														
6	Review Design with Supervisor														
8	Proposal Defence Preparation														
9	Proposal Defence Presentation														
12	Purchasing Equipment (Transition)														
10	Submission of Interim Draft														
11	Submission of Final Interim Report														

4.0 Chapter 4: Conclusion and Future Work

4.1 Conclusion

The proposed RFID-Powered Automated Attendance System project will address some of the administrative gaps in the educational institutions. Through the past projects that has been done and analysed, it is ranged from an offline portable unit to impressive biometric systems which proves the technological creations and innovation to bring new approach to the attendance system in educational institutions. As mentioned in the methodology to leverage the IoT architecture of ESP32 and Cloud API to ensure reliability by faster processing and record management.

4.2 Future Work – Final Year Project 2 (FYP2)

The steps that will be taken for the upcoming semester of Final Year Project 2 will focus on the hardware assembly and code implementation into the microcontroller and RFID module to test the functionality of the hardware. Details are as follows:

- **Acquiring components required for the project:** all components parts that are required to purchased has been purchased during the timeframe of Final Year Project 1 to help acquire during an early stage to assemble and to verify compatibility upon arrival.
- **Hardware assembly and integration:** to connect all components which are the ESP32, RFID RC522, 0.96-inch OLED display, buzzer, LEDs, and button switches. The assembly will be done on a breadboard for testing and when testing is confirmed to set the components on a preboard for stability.
- **Software development and coding:** the code will be written using the Arduino IDE for the ESP32 firmware. In the code will also have the implementation of Google App Script for the Google Sheets integration. Adding some section into the code for duplicate prevention, timestamp log-in and OLED display for feedback.
- **Optimization and final touches:** the possibility to encase the final look into a portable device through a 3d-printed casing.

References

1. Azmi, A. (2010). RFID + Thumbprint Identification for Attendance Tracking. *Universiti Teknologi PETRONAS.* https://utpedia.utp.edu.my/id/eprint/1117/
2. Haekal, M. (2014). Portable RFID Attendance Systems with SD Card data storage. *Universiti Teknologi PETRONAS.* https://utpedia.utp.edu.my/id/eprint/14244/
3. Renaldo, et al. (2014) Lecturer and Student Attendance System: Implementation and Analysis. https://www.researchgate.net/publication/356714840_Lecturer_and_Student_Attendance_System_with_RFID
4. Hasman, M.I. (2020). RFID Attendance System. Universiti Kuala Lumpur (UNIKL). https://bmi.unikl.edu.my/wp-content/uploads/2022/11/17_25_RFID-Attendance-System.pdf
5. Hussin, et al. (2022). Double Identification System using HF RFID + Motion Sensors. *UCSI University.* https://alife-robotics.co.jp/members2022/icarob/data/html/data/OS/OS20/OS20-5.pdf
6. Mazlan, S., & Ahmad, R. (2025). I-Attend: RFID Attendance + Web-Based Tracking for Secondary Schools. *Universiti Teknologi MARA(UiTM).* https://ir.uitm.edu.my/id/eprint/114308/1/114308.pdf