

# RFID-Based Smart Attendance Management System : A Review Analysis

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**Abstract:** Conventional attendance systems implemented in organizations as well as in educational institutions are often cumbersome and error-prone. This paper proposes an efficient automated attendance system using an RFID system and the Wi-Fi-enabled ESP32 module along with the Google Sheets API for cloud storage of data. The proposed system combines the concept of Radio Frequency Identification with the Wi-Fi-enabled module and Google Sheets.

Every user is issued an RFID that is scanned and verified by the ESP32 module. Once scanned, the data related to the user's attendance, which can be user ID and time, is sent real-time to the Google Sheet via Wi-Fi. This increases the efficiency and scalability of the system. The system is more accurate and eliminates manual labor.

The advantages that the cloud-based system provides include cost-effectivity, easy deployment, real-time monitoring, and enhanced security of the data. The paper deals with the system design, implementation aspects including hardware and software parts, and the application of IoT-based automation in attendance management. The experimental results prove the effectiveness of the system developed..

**Keywords:** RFID, Automated Attendance System, Internet of Things (IoT), Cloud Computing, Smart Education, Attendance Management.

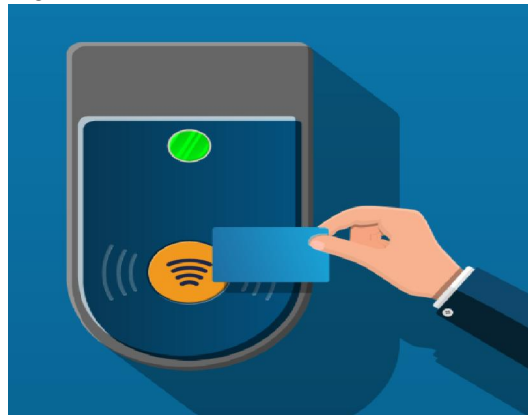


FIGURE 1: RFID Smart Attendance System[31]

## I. INTRODUCTION

Attendance management in schools, organizations, and events is very important using conventional systems such as manual registers and biometric systems; it's inefficient and full of errors. IoT technology has advanced, and with this, automated attendance systems are very reliable and effective. This paper discusses an attendance management system based on RFID, using the ESP32 microcontroller integrated with the cloud through Google Sheets. RFID technology is ideal for attendance recording because it is fast, accurate, and contactless. Each user has an RFID tag, which will then be scanned by the RFID reader. Data from the RFID reader are processed via the ESP32 microcontroller and



transmitted in real-time to a google sheet using the onboard Wi-Fi of the ESP32. This will skip the use of local databases or manual entry of recorded attendance. It offers real-time updates, remote access, improved data security, and efficient record management. In return, this proposed system improves reliability, scalability, and accuracy by reducing human involvement, hence making it practical for modern attendance management.

Many researcher works have been conducted to automate attendance management systems using different technology approaches. An attendance management system based on RFID technology developed in [1] was intended to minimize human errors and maximize efficiency. But this system was dependent on local data storage, which restricted real-time accessibility and scalability. Biometric attendance systems, such as fingerprint recognition attendance systems, offer enhanced security. But their implementation is associated with high costs, complexity, and sensor/ fingerprint mismatch errors. An attendance management system based on IoT technology, combining both RFID and cloud technology. The system supported online accessibility and real-time data update capabilities, requiring perpetual internet connectivity and was not simple to install. Another cloud-based attendance monitoring system based on RFID technology enhanced automation, with little concern for economical installation and simplicity in scalability. The proposed attendance system, with its ESP32 microcontroller and Wi-Fi capabilities, along with Google Sheets, offers a more economical, scalable, and real-time cloud-based attendance system with fewer installation complexities.

## **II . COMPONENTS OF THE SYSTEM**

The RFID-based attendance system comprises both software and hardware components that work in conjunction to ensure that attendance is automated.

### **1. Hardware Components:**

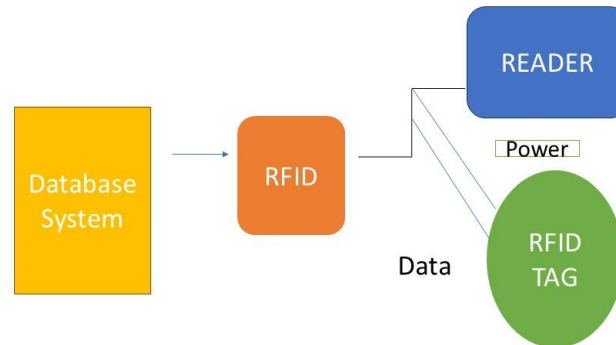
- 1.ESP32 Microcontroller – This is a Wi-Fi microcontroller capable of interpreting the RFID data and then sending it over the internet to Google Sheets.
2. RFID Reader Module (RC522/RDM6300) - This module is responsible for detecting the RFID tag whenever it is scanned and transmitting the information obtained from it over to the ESP32 microcontroller for
3. RFID Tags/Cards - These are identity tags given to individuals, storing their unique ID for authentication purposes.
4. OLED Display (optional)- Displays real-time messages, like 'AttendanceMarked' or 'Invalid Card.'
- 5.Buzzer (Optional) - The component gives an audio signal when the RFID card is scanned successfully or fails.
- 6.Power Supply (5V/3.3V) – It is used for powering the ESP32
- 7.Connecting Wires – For making connections to ESP32, the RFID module, and other peripherals.

### **2. Software Components:**

1. Arduino IDE – to write the code to the ESP32 microcontroller.
- 2.Google Sheets API - This is used for communication with the Google Sheets API for ESP32 to enable cloud storage of attendance records.
- 3.Google Apps Script - This helps in automating the data entry task in Google Sheets.
- 4.Wi-Fi Network – For connecting the ESP32 to the internet to upload attendance records to Google Sheets.

All these parts combine to make a cost-effective and efficient scaled RFID-based attendance system for real-time cloud integration for attendance management.





**FIGURE 2: Components of the RFID Smart Attendance System**

### III. HARDWARE DESCRIPTIONS

#### ESP32 Microcontroller

**Function:** Serves as the system's central processing unit, managing RFID data, establishing Wi-Fi connections, and sending attendance data to Google Sheets.

#### RFID Reader Module (RC522 or RDM6300)

**Function:** Reads RFID tags/cards and sends their unique ID (UID) to ESP32 for processing.

#### RFID Tags/Cards

**Function:** Stores a unique identification number assigned to each individual for authentication.

#### OLED Display (Optional)

**Function:** Displays real-time messages, such as "Attendance Marked" or "Invalid Card".

#### Buzzer (Optional)

**Function:** Provides an audio alert when an RFID tag is scanned successfully or unsuccessfully.

#### Power Supply (5V/3.3V)

**Function:** Provides power to the ESP32 and RFID reader module.

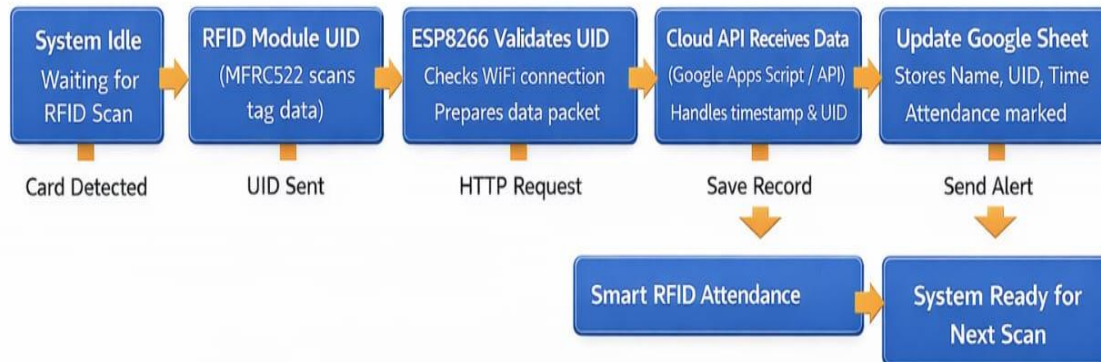
#### Connecting Wires and Breadboard

**Function:** Establishes electrical connections between components.

### IV. METHODOLOGY

This is an RFID-based attendance system, basically based on the ESP32 microcontroller interfaced with an RC522 or RDM6300 RFID reader via SPI for contactless UID detection within a 5 cm range. Programmed via Arduino IDE, the ESP32 connects to Wi-Fi and uses HTTP Client libraries to post validated attendance data (comprising UID, date, and timestamp) to a Google Sheet through a publicly accessible Google Apps Script web app. At any tag scan, the system verifies the UID against the registered list. Valid entries trigger real-time appends in the cloud to be remotely accessed from any device, while invalid ones display "Invalid Card" on optional OLED screens and sound buzzers for feedback. Such a buildup with Google Sheets allows analytics like filtering by user or date, creating reports, and sending auto notifications to Absentees via Apps Script. Deployed in Kolkata's educational settings, this IoT solution ensures sub-second responses and costs less than ₹ 2000 while being reasonably reliable despite power issues, hence replacing error-prone manual tracking with scalable efficient automation.





**Smart RFID Attendance System – Flow Diagram**

**FIGURE 3: Smart RFID Attendance System – Flow Diagram**

### V. LITERATURE SURVEY

The "IoT Connectivity" Peak (2019–2020)

The transition from offline to online systems was crucial during this time.

Technological Shift: In order to enable built-in Wi-Fi capabilities, researchers switched from using the Arduino Uno, which required a wired PC connection, to the NodeMCU (ESP8266).

Data Evolution: Administrators can now view attendance records in real time from any location thanks to the shift in storage from local Excel/SQL files to cloud databases like Google Sheets and Firebase.

Result: The main objectives were cost-cutting and worldwide accessibility, which made smart attendance practical for large-scale campus.

The "Hybridization & Security" Phase (2021–2022)

The "proxy attendance" (buddy punching) loophole, in which students swiped cards for absent friends, was fixed during this time.

Technological Shift: Multi-Factor Authentication (MFA) became the focus of research. In order to verify identity, systems started requiring both an RFID tag and a biometric input (such as a fingerprint or PIN).

Key Innovation: Integration of GSM Modules (SIM800L/900) became standard for automated SMS alerts to parents, ensuring an extra layer of institutional accountability.

Result: Integrity was the main objective. Researchers changed their focus from merely "collecting data" to "verifying data," making sure that the individual listed as "Present" was actually present.

Mobile & AI Evolution (2023–2025)

"Making the system work" has given way to "making the data useful."

2023–2024: Accessibility & Integration

Technological Shift: By concentrating on cross-platform accessibility, researchers went from basic web logs to specialised iOS and Android apps.

Key Innovation: RFID systems could communicate directly with the University Management Systems (UMS) that were already in place thanks to the use of REST APIs and Webhooks, which made the hardware a "plug-and-play" addition to the school's digital infrastructure.

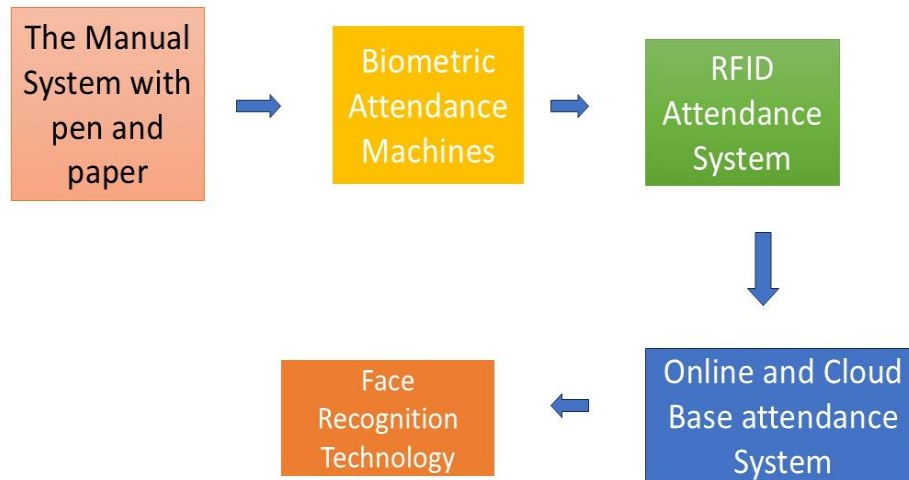
Result: Well-designed, real-time mobile dashboards that enhance the user experience for parents and teachers.

2025: The Frontier of AI and Analytics



Integration of Edge AI represents a technological shift. These days, research uses chips like the ESP32-CAM to perform real-time "RFID + Face Verification," guaranteeing 100% fraud-proof attendance at a very low cost. Predictive analytics is a key innovation. These days, attendance data is used to train machine learning (ML) models to find patterns, such as identifying students who are likely to fail or drop out due to persistent absences. Result: From a basic recorder, the system has developed into an Early Warning System that offers useful information for educational intervention.

### The evolution of attendance machines



**FIGURE 4: The evolution of attendance machines**

### VI. CONCLUSION

To monitor attendee presence at offices, schools, organizations, and other events, a platform that offers a real-time and effective solution for automatic attendee presence recording is the "RFID Attendance System with ESP32 and Google Sheets." The system combines various technologies like RFID and cloud and is a result of IoT advancements. However, the system has several drawbacks, such as hardware constraints, security issues, and reliance on Wi-Fi. Despite such challenges, the system presents several advantages, such as being cost-effective, scalable, and capable of offering real-time data updates. Future enhancements for the system could be biometric authentication, storing data even when offline, and fraud detection by artificial intelligence.

In conclusion, this RFID attendance system is intelligent, scalable, and efficient to manage attendance in today's world. To improve attendance management, innovations such as blockchain security features, mobile attendance tracking, and prediction analysis can be introduced in this system.

### VII. ACKNOWLEDGEMENT

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### VIII. DISCUSSIONS

From the reviewed literature, time efficiency and minimized manual errors are pointed out as major advantages of automated attendance system. As a result, administrative work is minimized by at least 90% against manual or paper-based systems. Nevertheless, various research papers, such as those by Shrivastava et al. (2023) and Mazlan et al.



(2025), emphasize that proxy attendance problems are still prevalent. Even though RFID technologies are quite effective in automating attendance, missing out on the biological verification aspect increases abuse. Consequently, there have been recent advancements in multimodal attendance.

From a technical perspective, the advancement from Arduino-based local storage systems to ESP32-based cloud-integrated systems is a great improvement in scalability and real-time access capabilities. According to a report given by Meghana et al. (2020), the utilization of IoT communication protocols like MQTT and HTTP POST protocol provides real-time monitoring capabilities through the usage of Firebase services. However, the effectiveness of the system is largely dependent on the performance of the connectivity networks. Furthermore, metal interference can impact the range of the RFID system by as much as 40%.

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