



Design and Construction of an RFID and IoT-Based Attendance System to Improve the Efficiency of Employee Attendance Management at the Indonesian Polytechnic of Piksi Ganesha

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Abstract

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Attendance systems that still rely on manual input require more processing time due to the absence of an automatic identification mechanism, resulting in less efficient attendance recording. This study aims to design and develop an employee attendance system based on Radio Frequency Identification (RFID) and the Internet of Things (IoT) integrated with a web-based application. The research employed the Research and Development (R&D) method using the ADDIE development model. The system was developed using an ESP32 microcontroller, an RFID RC522 Reader, PHP, and MySQL, while IoT technology was utilized to transmit attendance data to the server via the internet. The test results indicate that all system functions operated successfully, including RFID card identification, data transmission, database storage, and attendance information display on the website. Furthermore, the developed system improved attendance processing efficiency by reducing the attendance time from 15–20 seconds to 2–5 seconds. Therefore, the proposed RFID and IoT-based attendance system can serve as an effective and efficient alternative for managing employee attendance.

Keywords: Employee Attendance, RFID, Internet of Things (IoT), ESP32, Web-Based System

Abstrak

Sistem presensi yang masih menggunakan proses input manual memerlukan waktu lebih lama karena belum memiliki media identifikasi otomatis, sehingga proses pencatatan kehadiran menjadi kurang efisien. Penelitian ini bertujuan merancang dan membangun sistem presensi karyawan berbasis Radio Frequency Identification (RFID) dan Internet of Things (IoT) yang terintegrasi dengan sistem berbasis web. Metode penelitian yang digunakan adalah Research and Development (R&D) dengan model pengembangan ADDIE. Sistem dibangun menggunakan ESP32, RFID Reader RC522, PHP, dan MySQL, sedangkan teknologi IoT digunakan untuk mengirimkan data presensi ke server melalui jaringan internet. Hasil pengujian menunjukkan seluruh fungsi sistem berjalan dengan baik, mulai dari pembacaan kartu RFID, pengiriman data, penyimpanan database, hingga penampilan data pada website. Sistem yang dikembangkan juga mampu meningkatkan efisiensi waktu presensi dari 15–20 detik menjadi 2–5 detik. Dengan demikian, sistem dapat digunakan sebagai alternatif dalam mendukung pengelolaan kehadiran karyawan secara lebih efektif dan efisien.

Kata-kata kunci: Presensi Karyawan, RFID, Internet of Things (IoT), ESP32, Sistem Berbasis Web



1. Introduction

The development of information technology has encouraged various agencies to utilize digital systems to support operational activities, including employee attendance management. The application of digital technology can increase the efficiency of work processes, accelerate data processing, and facilitate the delivery of information accurately and in real time [1]. One form of application of this technology is in the attendance system, which plays a crucial role as a source of information regarding employee attendance and discipline [2]. Properly recorded attendance data can be used as a basis for administrative processes, performance evaluations, and decision-making related to human resource management. Therefore, an attendance system is needed that can record data quickly, accurately, and easily managed.

Attendance systems that still use manual input processes have several limitations, such as relatively long recording times and the lack of automatic identification media [3]. This condition makes the attendance process less efficient and has the potential to increase errors and misuse in attendance recording. Furthermore, the identification process that is still carried out manually complicates the process of verifying user identity, so the opportunity for recording errors and misuse of attendance can still occur. Therefore, a system is needed that can automatically identify users while managing attendance data more quickly, accurately, and in an integrated manner [4].

One solution that can be implemented is to utilize Radio Frequency Identification (RFID) technology as an automatic identification medium and the Internet of Things (IoT) as a data communication medium [5]. Through RFID technology, the user identification process can be carried out quickly using RFID cards, while IoT allows attendance data to be sent directly to the server so that attendance information can be managed through a web-based system in real-time [11].

Several previous studies have utilized RFID and IoT technology to develop attendance systems [6]. The results show that the application of these two technologies can increase the speed of the identification process and simplify attendance data management [13]. However, some studies still focus on the attendance recording process without analyzing the increase in efficiency of the attendance process time compared to previously used systems. Furthermore, not

all systems implement real-time integration between RFID devices, microcontrollers, and web-based applications [12].

Based on these problems, this study aims to design and build an employee attendance system based on Radio Frequency Identification (RFID) and the Internet of Things (IoT) integrated with a web-based system using ESP32 as the main microcontroller [7] [15]. The developed system is expected to be able to carry out the identification process automatically, send attendance data to the server via the internet network, and increase the efficiency of the attendance recording process [8] [14]. Based on the test results, the developed system is able to reduce the attendance process time from around 15–20 seconds to 2–5 seconds, so it can be an alternative in supporting employee attendance management more effectively and efficiently.

2. Method

This research uses the Research and Development (R&D) method with the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) development model [9]. This model was chosen because it has systematic stages in the product development process, starting from needs analysis to evaluation of the developed system. The research stages using the ADDIE model are shown in Figure 1.

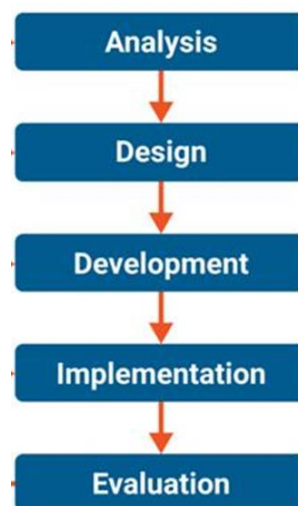


Figure 1. Flowchart of Research Stages Using the ADDIE Model

Integration: In the Analysis phase, system requirements are identified through observation and literature review on RFID technology, the Internet of Things (IoT), and web-based attendance systems.

The Design phase includes the creation of a system block diagram, flowchart, hardware circuit, database, and website interface. Next, in the Development phase, hardware assembly is

performed using an ESP32, RFID reader, step-down module, LEDs, and other supporting components, as well as software development using the Arduino IDE, PHP, and MySQL.

The Implementation stage is carried out by integrating hardware and software so that the system can be used as an employee attendance medium [10]. After the system is successfully implemented, the Evaluation stage is carried out by testing all system functions, including RFID card reading, sending data to the server, storing data to the database, and displaying attendance data on the website. In addition, attendance processing time is tested by comparing the developed system with the previously used system.

3. Results and Discussion

3.1 Research Results

This research successfully developed an employee attendance system based on Radio Frequency Identification (RFID) and the Internet of Things (IoT) integrated with a web-based system. The system consists of hardware using an ESP32 as the main microcontroller, an RC522 RFID reader for reading RFID cards, LEDs and buzzers as indicators, and a step-down module for reducing the voltage. All components are assembled into a single device, enabling it to be used as an employee attendance system. Meanwhile, the software was developed using PHP and MySQL to manage employee data and attendance data, as well as display attendance information via the website.

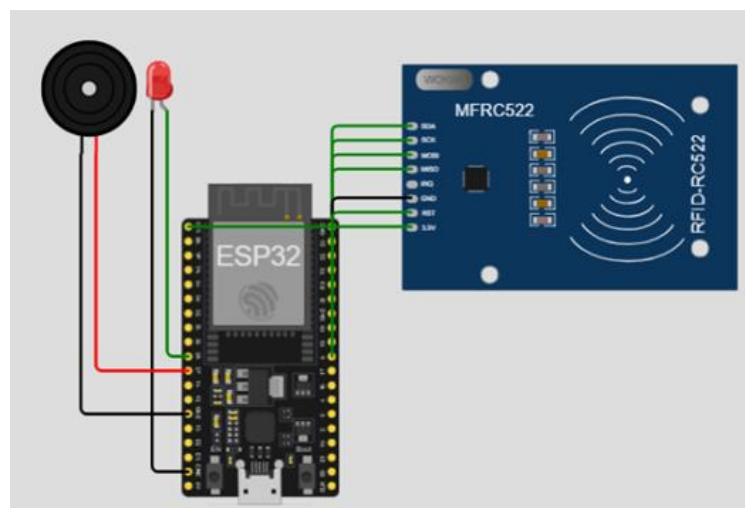


Figure 2. System Circuit

The system's hardware circuitry is designed to connect all components so they can work as a whole. The ESP32 acts as the control center, receiving data from the RC522 RFID Reader via SPI communication, then processing and sending the data to the server via the internet.

Additionally, an LED and buzzer are used to indicate the success or failure of the presence process, while a step-down module is used to adjust the system's voltage requirements.



Figure 3. Implementation of the Attendance System

The system works by reading the UID (Unique Identifier) on an RFID card via an RFID reader as part of the user identification process. The data from the reading is then sent to the ESP32 for processing according to the selected attendance type—either clock-in or clock-out. Next, the ESP32 sends the attendance data to the server via the internet using the Internet of Things (IoT) concept. The data received by the server is stored in a MySQL database and displayed on the website in real time, allowing administrators to monitor employee attendance information directly. Additionally, the system provides feedback via an LED and a buzzer to indicate whether the attendance process was successful or failed. The overall system workflow is shown in **Figure 4**.

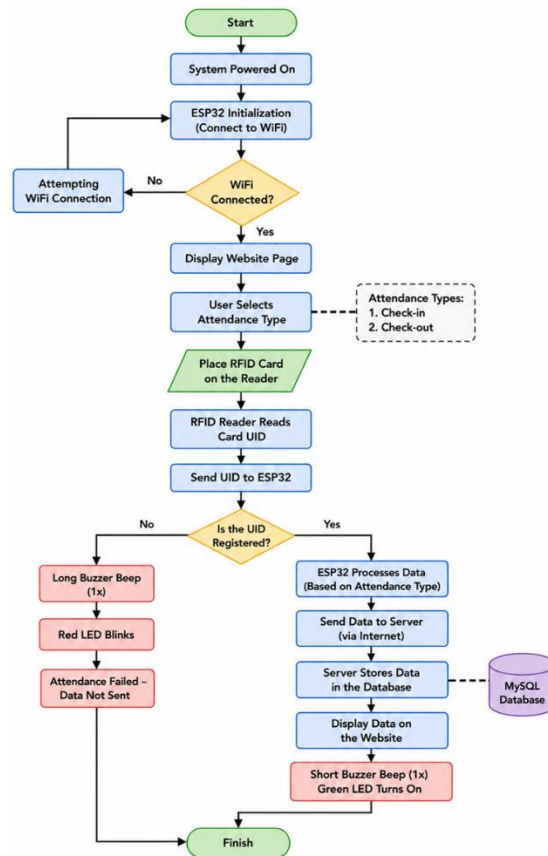


Figure 4. System Flowchart

Testing was conducted on all the system's main functions, including RFID card reading, data transmission to the server, data storage in the database, and attendance data display on the website. Based on the test results, all system functions performed as expected. The system test results are presented in Table 1.

Table 1. System Test Results

No.	Test Item	Result	Status
1	System Login	Successful	Valid
2	Add Employee Data	Successful	Valid
3	Edit Employee Data	Successful	Valid
4	Delete Employee Data	Successful	Valid
5	Check-in Attendance Using RFID Card	Successful	Valid
6	Check-out Attendance Using RFID Card	Successful	Valid
7	Display Attendance Data	Successful	Valid
8	Send Data from ESP32 to Server	Successful	Valid

In addition to functional testing, attendance processing time was also tested by comparing the developed system with a previously used system. The test results showed that the RFID and

IoT-based system significantly accelerated the attendance process. The time test results are presented in **Table 2**.

Table 2. Comparison of Attendance Times

No.	User	Current System	Developed System
			With Click
1	Mrs. Asni	17 seconds	9 seconds
2	Mr. Amri	15 seconds	4 seconds
3	Mr. Wahyu	10 seconds	3 seconds
4	Mr. Rouf	10 seconds	1 second

3.2 Discussion

Based on the research results, a Radio Frequency Identification (RFID) and Internet of Things (IoT)-based employee attendance system was successfully designed and built by integrating hardware and software into a single system. The hardware used consists of an ESP32 as the main microcontroller, an RC522 RFID reader for reading RFID cards, LEDs and buzzers as indicators, and a step-down module for reducing the voltage. Meanwhile, the software was developed using PHP and MySQL as a web-based system to manage employee data, attendance data, and attendance reports. The integration between the RFID reader, ESP32, server, database, and website allows for automated attendance processing and real-time display of attendance data.

The implementation of RFID technology in this system functions as an automatic identification medium that replaces the manual recording process. Each RFID card has a different UID (Unique Identifier) so it can be used as a unique identity for each employee. When the card is attached to the RFID Reader, the UID will be read and processed by the ESP32, then sent to the server via the internet network to be verified against the data stored in the database. If the UID has been registered, the system automatically records attendance data according to the selected attendance type. Conversely, if the UID is not found in the database, the attendance process will not be carried out, thereby reducing user identification errors.

Based on the test results, all system functions performed as designed. The RFID reader successfully read the RFID card, the ESP32 successfully transmitted data to the server via the internet, and attendance data was successfully stored in the database and displayed on the

website. These results demonstrate that the integration between hardware and software has worked well, supporting an automated and centralized attendance recording process.

Furthermore, the test results indicate that the developed system can improve the efficiency of the attendance process compared to the previous system. The time required for a single attendance process has been reduced from approximately 15–20 seconds to approximately 2–5 seconds. This increased efficiency is achieved because the identification process is carried out automatically using the RFID card, and attendance data is sent directly to the server without requiring manual input. Thus, the developed system can support faster, more effective, and more efficient employee attendance management.

4. Conclusion

Based on the design, implementation, and testing results, it can be concluded that the RFID and Internet of Things (IoT)-based employee attendance system integrated with a web-based system was successfully designed and built in accordance with the research objectives. The implementation of RFID technology as an automatic identification medium is capable of recognizing users by reading the UID on the RFID card. The data is then processed by the ESP32 and sent to the server via the internet, allowing for automatic attendance recording without requiring manual data input. Based on the test results, the system was able to perform all functions as expected and increased the efficiency of the attendance process from approximately 15–20 seconds in the previous system to approximately 2–5 seconds. Thus, the developed system can support faster, more effective, efficient, and integrated employee attendance management.

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