Implementation of the FP Growth Algoritm with RFID on the Monitoring System for Building User in a Smart-Building Environtment

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ABSTRACT

Internet of Things (IoT) technology is developing rapidly and widely applied to assist all human needs. Radio Frequency Identification (RFID) is a very popular IoT device. One application is to limit employee access in the office. In this study, RFID devices are used to limit room access rights, after the building user performs an RFID scan, the data will be stored in the database. The stored data is then used to find patterns of employee activity using the FP-Growth algorithm. The FP-Growth algorithm runs by tracing the tree from bottom to top and getting frequent itemsets obtained from the FP Tree based on the stored data. This study indicates that the time required for the RFID device to scan to determine whether the user has access or not is 2000ms. The hardware communication time with the information system using the API is 262ms then proceeding from the software to the database is 239ms. In the implementation of the FP-Growth algorithm, the time required for the FP-Growth algorithm to process 100 activity data divided into 10 days is 324 ms. From the 100 activity data, it can be concluded that if the employee enters the server room, server room, guest room, and guest room, the probability of the employee entering the multimedia room is 1 (100%). Furthermore, if the employee enters the multimedia room, multimedia room, server room, employee room, and the guest room then the probability of the employee entering the data room is 0.1 (10%).

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1 Introduction

Technology is an applied science or a whole means that aims to create objects or goods needed for the convenience of human life (Raja et al., 2018). One of the most popular technologies is the Internet. Nowadays, the life of modern society cannot be separated from internet connectivity. To provide for these needs, the concept of IoT was created. The creation of IoT also provides fresh air for the development of the internet which has been suspended for 4 decades since was invented the internet (Khan et al., 2020). IoT is a collection of smart devices or sensors that are connected to the internet network (Smys, 2020). IoT provides the concept that everything that can be automated will be automated. In addition, IoT is not only about control, but intelligence (Mohamed, 2019).

IoT turns a device into a smart device by providing capabilities for object-to-object communication, sensing, locomotion, and computing (Alansari et al., 2018). These smart devices are connected using wired or wireless network technology to communicate with each other or exchange data or information (Silverio-Fernández et al., 2018). By implementing IoT, daily life control becomes smarter, safer, and easier to do (Dian et al., 2020). In the last few decades, research, and development on IoT have targeted the concept of smart solutions building. The focus of the research is on the security, lighting, energy consumption, and disaster management sectors such as fires (Xu et al.,

2018). The most common use of the IoT concept in smart offices is the employee attendance system. Automatic recording can minimize attendance fraud and help the management of attendance to get better and faster data recap (Aji et al., 2020). The system is usually implemented using the help of a radio frequency smart device identification (RFID) that can be combined with an ID card employee.

This RFID technology utilizes radio signals to communicate with each other. In recent years, the development of RFID technology has been surprising mainly because of its low cost and also the potential that allows it to be developed and applied to IoT (Mattern & Floerkemeier, 2010). In addition to a very wide communication range, this RFID technology can uniquely monitor each connected device in real-time (Bayani et al., 2018). Monitoring systems used to describe of a phenomenon with the aim of conducting analysis concerning risk prevention (Carri et al., 2021). RFID works by sending or receiving data via radio frequency signals from a reader device (RFID reader) to a device already attached by an RFID tag (Erguler & Computing, 2015). This technology works very well indoors (Zhu et al., 2012).

This research focuses on the implementation and development of the use of RFID devices in a smart building environment. To develop a website-based building system that can analyze, monitor, and limit room access rights. In this system, the data received from the RFID device when the employee or building user taps the ID card will be stored in the database storage. Furthermore, the data can be monitored and analyzed so that it can produce any employees who are late, absent, and the last location of employees in the building. In addition, with the help of FP-Growth algorithm, the data can be analyzed and produced to know how the activity pattern of each employee, so that it can assist in all forms of decisions that will be given to an employee.

2 Method

In this study, RFID is used for monitoring building users in an IoT-based application. This application was developed based on a website information system. In addition to having the features of building user access rights and presence, this system also applies an algorithm FP-Growth to determine the pattern of activity of the building's users in the hope that it can be a benchmark for decision support for the building's users. Researchers conducted this research using the Agile application development method development methods with extreme models programming (XP). Extreme stages of programming are shown in Figure 1.

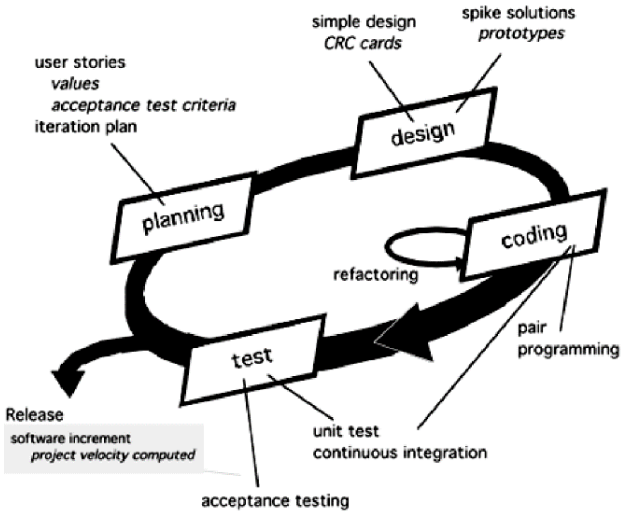

Figure 1. Extreme Stage Programming (Carolina & Supriyatna, 2019)

2.1 Planning

The planning stage focuses on selecting requirements that match the constraints of the client and the team. At this stage, the features are designed to be developed within the agreed timeframe. User requirements are described by using the user stories. User stories are described based on the results of the interview with the client, as shown in Table 1.

Table 1. User Stories

User	System Requirements
Admin	• Manage room data • Manage employee data • Registering an employee account • Manage employee attendance reports • Monitoring employee activities
Employee	• Access the room using an RFID tag • Do attendance

2.2 Design

The design stage is a process to design database system, application design, and monitoring tool design based on a user story that has been made at the planning stage.

2.2.1 Database Design

At this stage, the database design is represented by relations between tables with one and another. The objects of each table are connected to manage the operations of a database. Figure 2 shows the relationship between tables in the monitoring application.

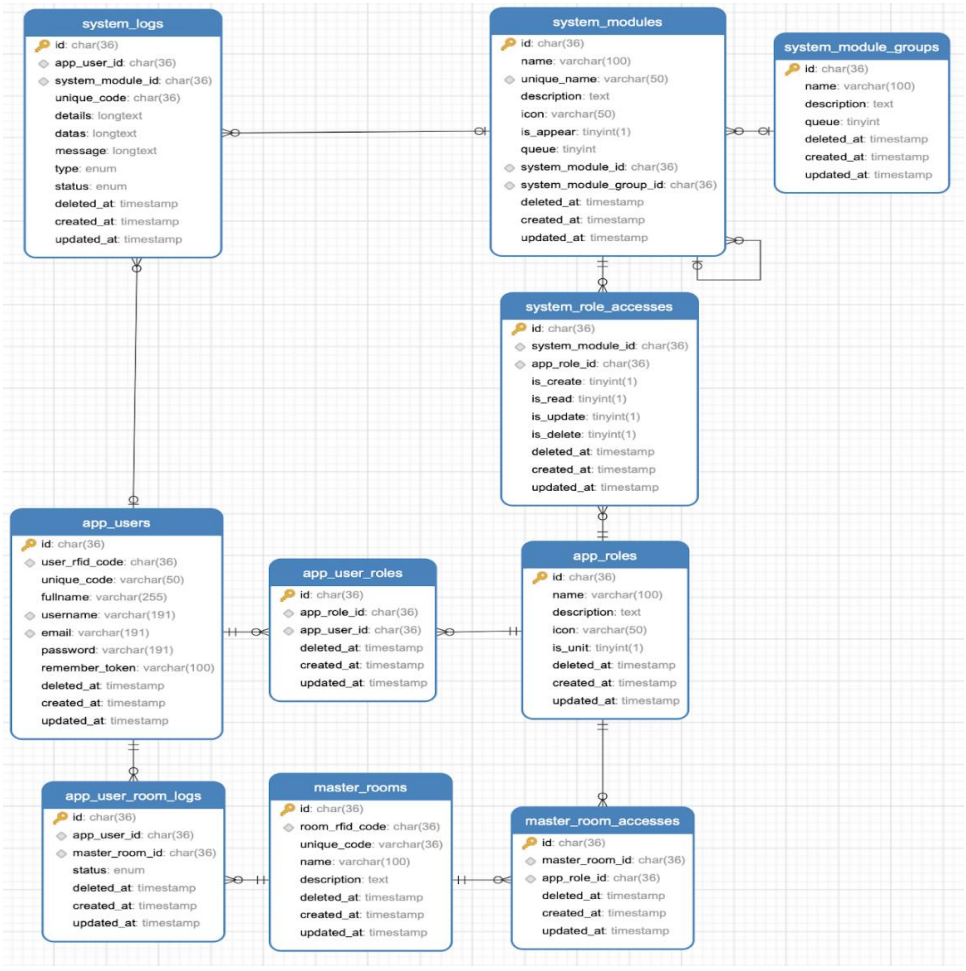

Figure 2. Entity Relationship Database

2.2.2 Application Design

The application developed in this research is called SIM Building. Several pages can be accessed by the user, starting from the login page shown in Figure 3.

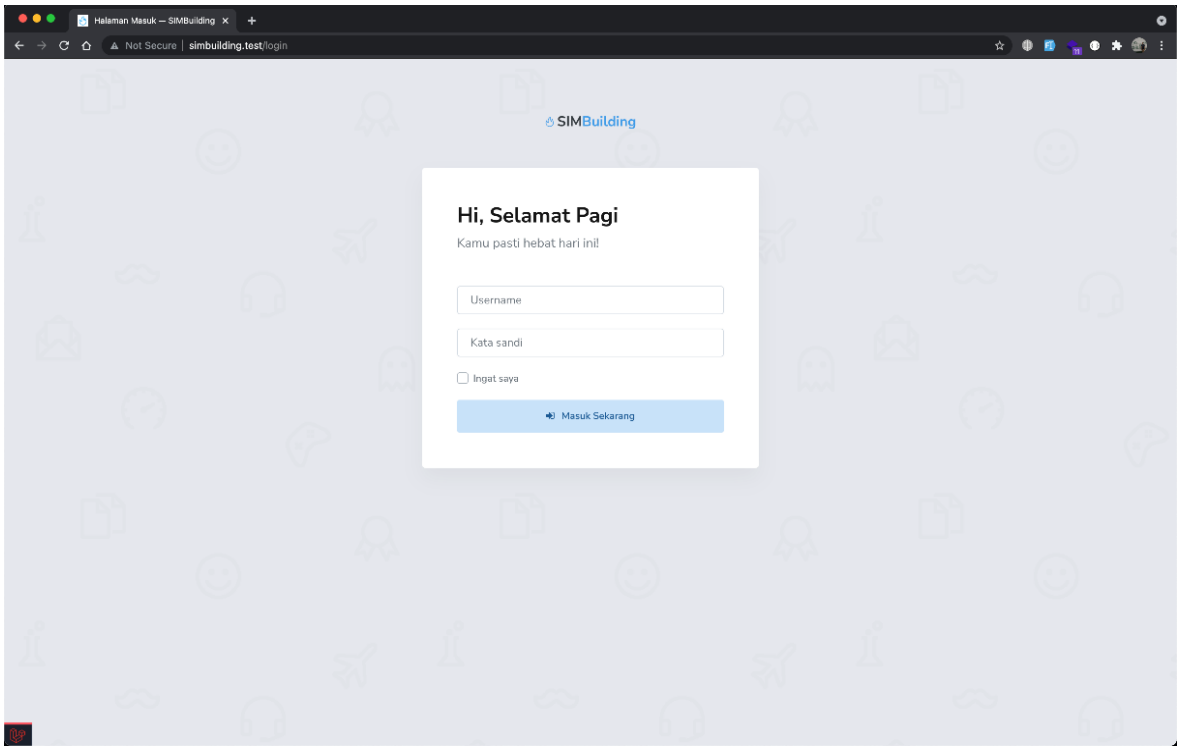

Figure 3. Login Menu

The user who entered the username and password correctly will be redirected to the main SIM Building page as shown in Figure 4.

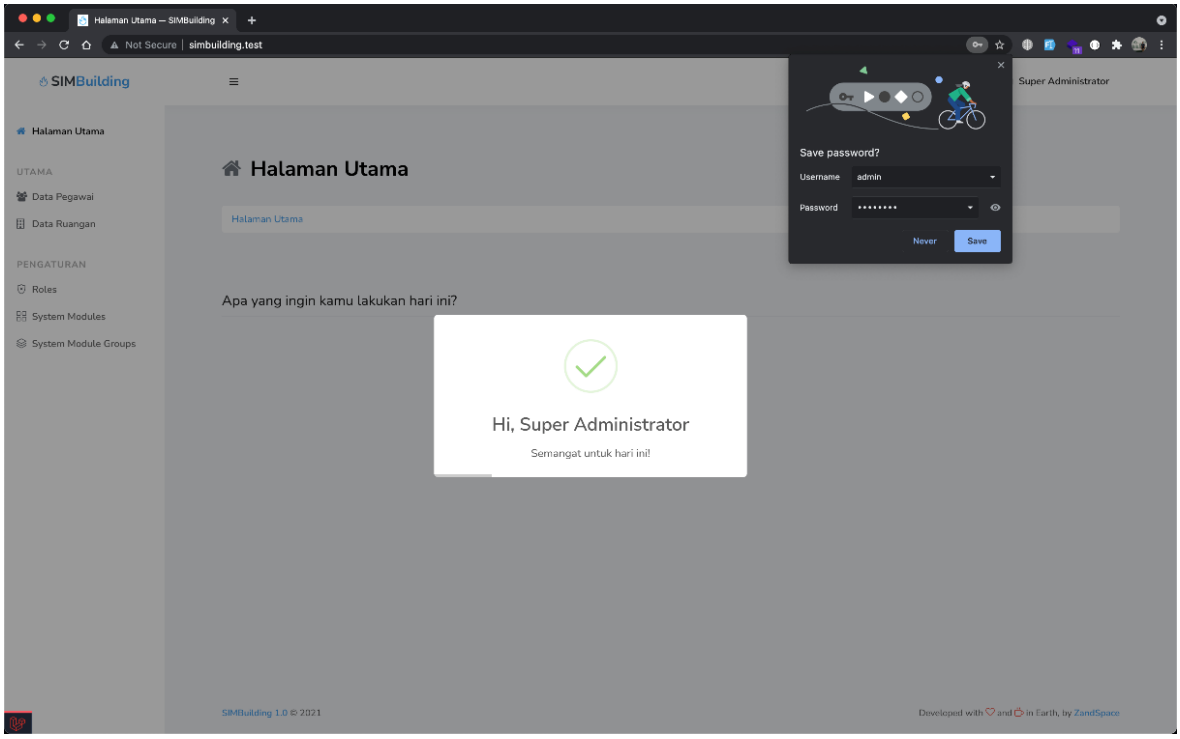

Figure 4. Main Page

The application displays employee data according to the data stored in the database. Users can manage employee data, starting from inputting new data, updating data, and deleting existing data. The employee data menu is shown in Figure 5.

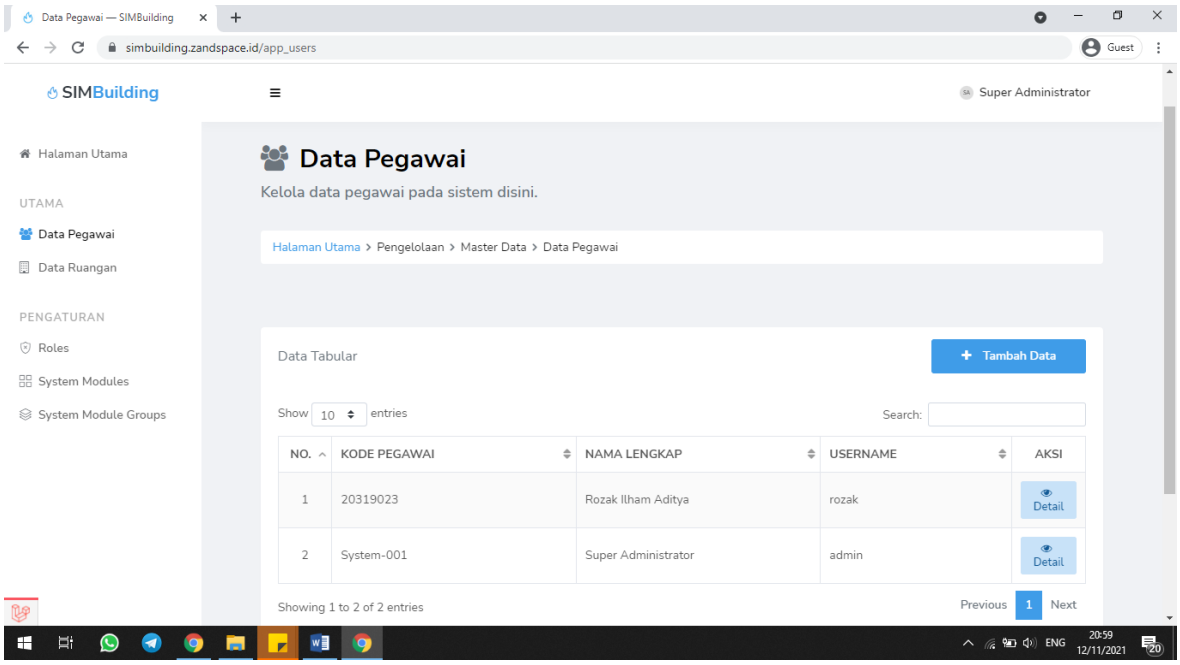

Figure 5. Employee Data Page

Users can view detailed employee data as shown in Figure 6. The RFID code data is used as a unique code for the card RFID is owned by the user, so this RFID code is also stored on the RFID card.

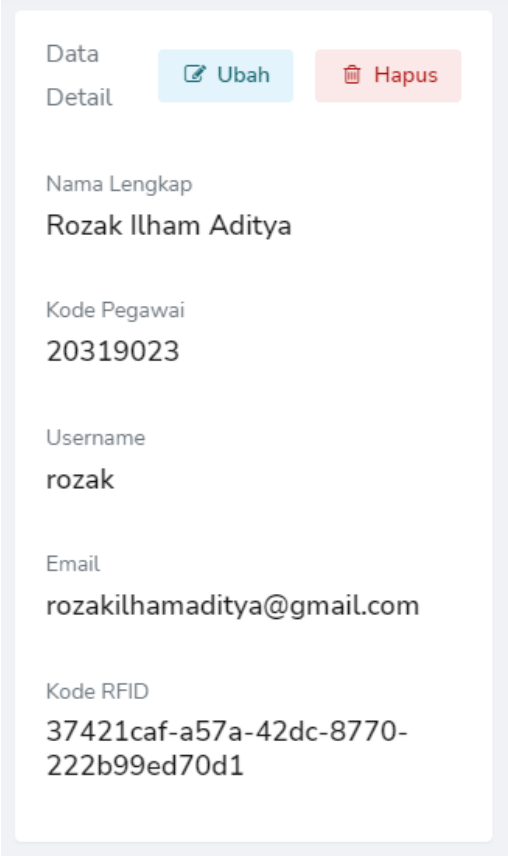

Figure 6. Details of Employee Data

User room access history is presented in the form of data as shown in Figure 7. Data of the user room access history represents the name of the room that is accessed, the status of the access whether in or out, and the time of the access.

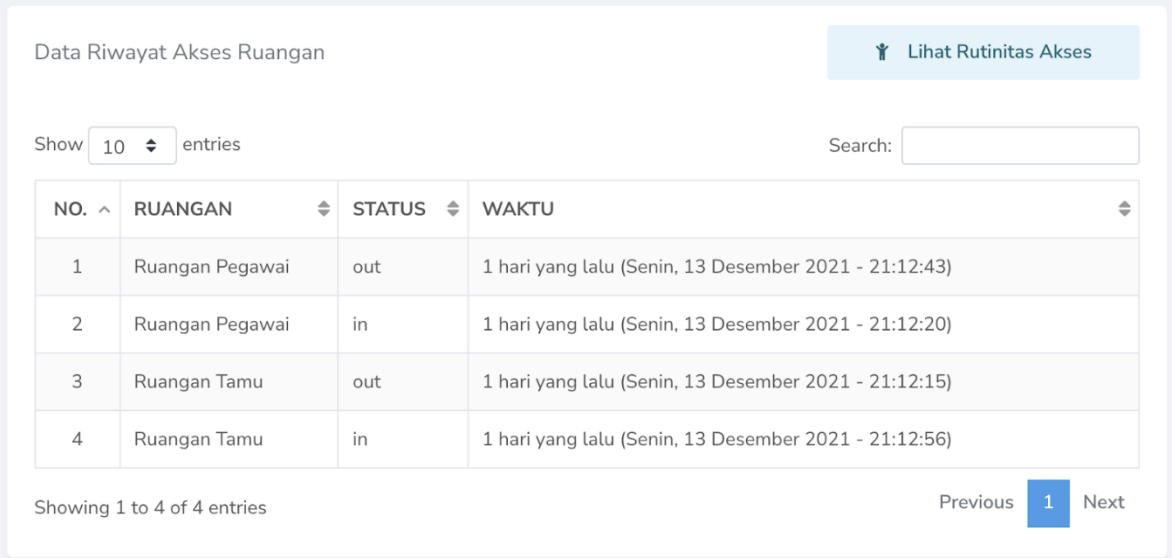

Figure 7. Room Access History Data

By using the algorithm FP-Growth, the application will automatically find out what the pattern of employee activity in a room is like in Figure 8. By using the algorithm FP-Growth, the application will automatically find out what the pattern of employee activity in a room.

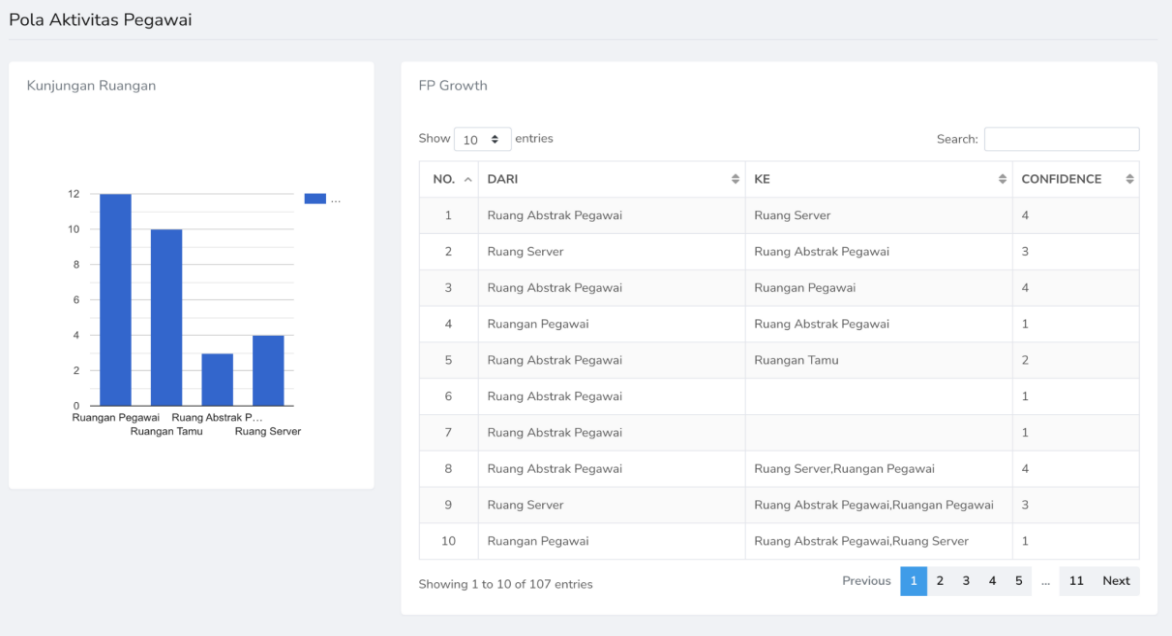

Figure 8. Activity Pattern

2.2.3 **Monitoring Tools Design**

The monitoring tool is made using several components such as ESP32, RFID reader, and RFID tag. ESP32 is used for the sensor control center to read and execute programs that have been written. The RFID reader is used to capture signals and read specific information from RFID tags. The RFID reader is installed near the entrance and exit as shown in Figure 9.

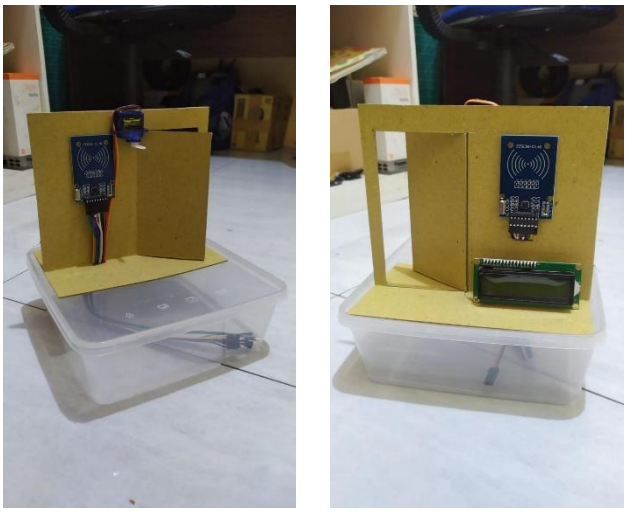

Figure 9. Monitoring Tool

2.3 Coding

For this stage is implementation of the model that has been made in the form of a user is carried out interface using a programming language. There are 2 programming languages used in this research, it's PHP for application system development and C ++ for tools. In addition, for database management using MySQL.

2.4 Testing

The next stage is testing of monitoring tools and applications is carried out. The test was carried out several times by testing the functionality of the designed tools and applications. The following results of tool testing can be seen in Table 2.

Table 2. Testing Tool

Testing Time	Test	Expected results	Test result	Conclusion
October 15, 2021	RFID scanner can read RFID card	The unique data on the RFID card can be read properly	RFID scanner can read RFID cards well uniquely	VALID
	Communicating from hardware to applications	Send and receive response from hardware to application with REST API	The data is sent from the hardware to the application and can receive data feedback from the application	VALID
October 19, 2021	Receive communications from the app and process them	Receive response well fit	Response data well received by hardware	VALID
October 23, 2021	The light is green when you have access and red when you don't have access	The light turns green automatically when the user has access and turns red automatically when the user does not have access	The lights turn on well according to the response rendered from the application API	VALID
	Open the door when have access	The door opens automatically when the user has access to the room	The door opens properly when response from the application API is to have access to the room	VALID

November 13, 2021	Displays communication results from hardware to application using LED monitor	The results of the communication are displayed by indicating whether the user has access rights to the room or not	Displays the results of communication well on the LED monitor device according to the response from application API	VALID
December 7, 2021	Automatically closes the door by tapping the RFID card again	The door can be closed again according to the RFID card used previously	The door can be closed properly again according to the expected results	VALID

2.5 Evaluation

The last stage is an overall evaluation carried out starting from the design, coding, and testing stages.The following list of evaluations is shown in Table 3.

Table 3. Research Evaluation

No	Error	Evaluation
1	Users can still access pages that do not match the role	Added authorization function on source application code.
2	The room access data in the application does not match the data from the hardware.	Check REST API

3 Results and Discussion

SIM Building Application is built to design a smart environment building that utilizing RFID hardware. This application can be used to monitor employee access for available space in a building or office. Furthermore, by using the algorithm FP-Growth which is an algorithm data mining the application can provide information about the pattern of employee activity from the data stored in the application. This SIM Building application is built from 2 sides, it's the application or software side and the hardware side. In terms of application of software, SIM Building is built using the Laravel PHP framework while on hardware device using Arduino Uno, ESP32, and RFID. The hardware will communicate with the software through the REST API so that it can send and receive the required data. The data is sent using the FormData API method where the data is represented by a key/value so that the parameters or key data needed when the API is accessed are status, room_rfid_code, and user_rfid_code. Furthermore, the software will process the input from the API and will be returned to the hardware according to the previous input.

Tests that have been carried out on monitoring tools and applications working with good by sending data directly in real-time starting from RFID scan to door open. Table 4 shows the results of testing time during the process on the application and monitoring tools.

Table 4. Comparison of Time Test Results

Rubric	Time (ms)	time(s)
Communication with API (POSTMAN)	262	0.262
From API (POSTMAN) to Database	239	0.239
From RFID to Database	528	0.528
Whole Start from Scan to door open	2000	2

Then in the implementation of FP-growth algorithm, the time required for the FP-Growth algorithm to process 100 joint activity data in 10 days is 324 ms. Table 5 shows example results implementation from the FP-Growth algorithm

Table 5. Examples of Implementation Results FP-Growth Algorithm

If	So	Confidence
Server Room, Server Room, Guest Room, Visitor Room	Multimedia Room	1
Data Room, Multimedia Room, Server Room	Employee Room, Visitor Room	1
Data Room, Employee Room, Visitor Room	Multimedia Room, Server Room	0.98
Data Room, Multimedia Room, Server Room, Guest Room, Visitor Room	Employee Room	0.1

The table above is the activity data classified for one employee in the specified time span. Likelihood rate or confidence is a description of how much big a possibility an employee the according to a column if and then. For example, if an employee enter a server room, guest room, or visitor room so possibility employee the enter a multimedia room is 1 (100%). Next, if an employee enters a multimedia room, multimedia room, server room, employee room, or visitor room, the possibility of the employee entering the data room is 0.1 (10%).

4 Conclusion

RFID is implemented using Arduino Uno and ESP32 to transmit data from monitoring tool to API endpoints in applications developed using the Laravel framework. The data sent from the monitoring device is in the form of unique data that represents the room's unique code, unique RFID card code and access status whether out or in. The data received by the application will be processed to produce the output of access status, the name of the accessing user, the name of the room that is accessed, and the status of the authorization of the user. The data stored in the database will be analyzed using the FP-growth algorithm to determine employee activity patterns. The results of the implementation of the FP-growth algorithm using 100 activity data divided into 10 days requires 324 ms algorithm calculation time. The results of the algorithm show that if an employee enters a certain room, the employee will also enter a certain room with a different level of confidence. For example, if you enter the Room, Server Room, Guest Room, and Guest Room, then entering the Multimedia Room has a confidence level of 1 or 100%. With this monitoring application and tool, decision-making on employee performance becomes more objective.

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