



Teacher and Student Attendance System at Noor Faqih Usman Foundation Based on RFID Integrated with Raspberry Pi

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ABSTRACT

In educational institutions, tracking attendance is crucial for ensuring effective administration and student engagement. This abstract presents the development of a Teacher and Student Attendance System at the Noor Faqih Usman Foundation, leveraging Radio Frequency Identification (RFID) technology integrated with Raspberry Pi. The proposed system aims to automate the attendance recording process, streamline administrative tasks, and enhance the overall efficiency of attendance management. This can create gaps in the development of data manipulation, data frameworks, and rigid systems. The purpose of this study was to create an RFID-Based Teacher and Student Attendance System integrated with Raspberry Pi. This study was conducted using a quantitative method of study and development study. This RFID-based attendance technology will later replace the role of paper to record the attendance of teachers and students using cards / keychains to make it easier to report attendance, data can be stored in digital form such as excel, can be accessed via wireless smartphones, interested parties can monitor through the website, and the educational institution will be touched by at least technology. The results showed that the system was able to control the attendance process and succeeded well.

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1. INTRODUCTION

Alongside the fourth industrial revolution, the education system in Indonesia must inevitably adapt to this continuously evolving digital era. It is not only the education system that needs to adapt, but also teachers and students must utilize existing technology to the best of their abilities in order to facilitate their tasks. One of the tasks that many teachers still perform traditionally is attendance, which is mandatory before starting a lesson at school.

The attendance system used in the Indonesian education world, especially in schools located far from urban areas, still relies heavily on paper sheets. This paper-based attendance system has many shortcomings [1]. One of the issues with this system is the excessive use of paper, which indirectly impacts the environment and may contribute to global warming since paper is made from trees [2]. Additionally, excessive paper usage can lead to a pile-up of documents, making it difficult to find specific files when needed. Furthermore, a paper-based system is prone to data redundancy, resulting in more paper usage and excessive costs to purchase paper [1]. This system is also highly vulnerable to data manipulation by unauthorized individuals [3]. Additionally, data storage in a paper-based system is susceptible to loss and damage.

In the midst of current technological advancements, there are already many ways to store data without relying on paper. A paperless document management system that exists today can simplify the documentation process itself, including the attendance system that is still paper-based. With a paperless system, student attendance data can be better organized, improved, cost-effective, and indirectly reduce paper usage, which may have a positive impact on the environment.

One way to digitize the attendance system is by utilizing Radio Frequency Identification (RFID) sensor technology. RFID is a technique used to identify objects using radio waves. RFID involves two devices in its process: a tag and a reader. The usage of RFID is straightforward—users simply attach the tag to the reader, and the reader will identify the tag. Each tag has a unique ID number, ensuring that no tags have the same ID as others. RFID technology is suitable for fast and automated operational activities.

With RFID technology, the attendance system becomes much easier and faster. Each student and teacher will have a tag with a unique ID representing their identity. Students and teachers can independently record their attendance by attaching their respective tags to the readers located outside the classroom or in designated areas [4][5]. The inputted data from the tags will be processed and stored in a database, ensuring more accurate and well-organized data compared to manual attendance, which is prone to human errors [4]. With RFID technology, teachers no longer need to call out each student's name for attendance, and relevant staff can easily monitor teacher attendance.

The RFID-based attendance system will have many positive effects, benefiting both teachers and students in schools [6]. Firstly, since all data will be digitally stored in a database, it reduces the foundation's expenses for purchasing paper and/or books solely used for student attendance records. Additionally, attendance can be taken much faster as it is done by the students themselves, and indirectly, the RFID-based attendance system introduces the extent of current technological advancements to underage students [7]. Since the data is stored in a database, data storage becomes more structured, and data security is significantly improved compared to manual attendance records on paper [8][9].

2. METHODS

This research was conducted through direct observation at Noor Faqih Usman Foundation using a quantitative survey method. The research involved data collection at the relevant institution and interviews with the Chairman of the Foundation. The data obtained from the observation and interview at Noor Faqih Usman Foundation are as follows:

1. Redundancy or overlapping of attendance data has occurred.
2. The foundation's head cannot control which teachers enter.
3. Attendance data needs to be stored in a digital format such as Excel.
4. Teachers or staff at the institution do not have laptops or computers.
5. There are three busy session schedules: early childhood education in the morning, tutoring in the afternoon, and children's religious study in the evening.

After the data was collected, the research proceeded to the next stage, which is the development phase. This research focuses on the goal of developing, expanding, and further exploring the attendance system based on a theory within the discipline of technology. The flowchart of this research method is shown in **Figure 1**.

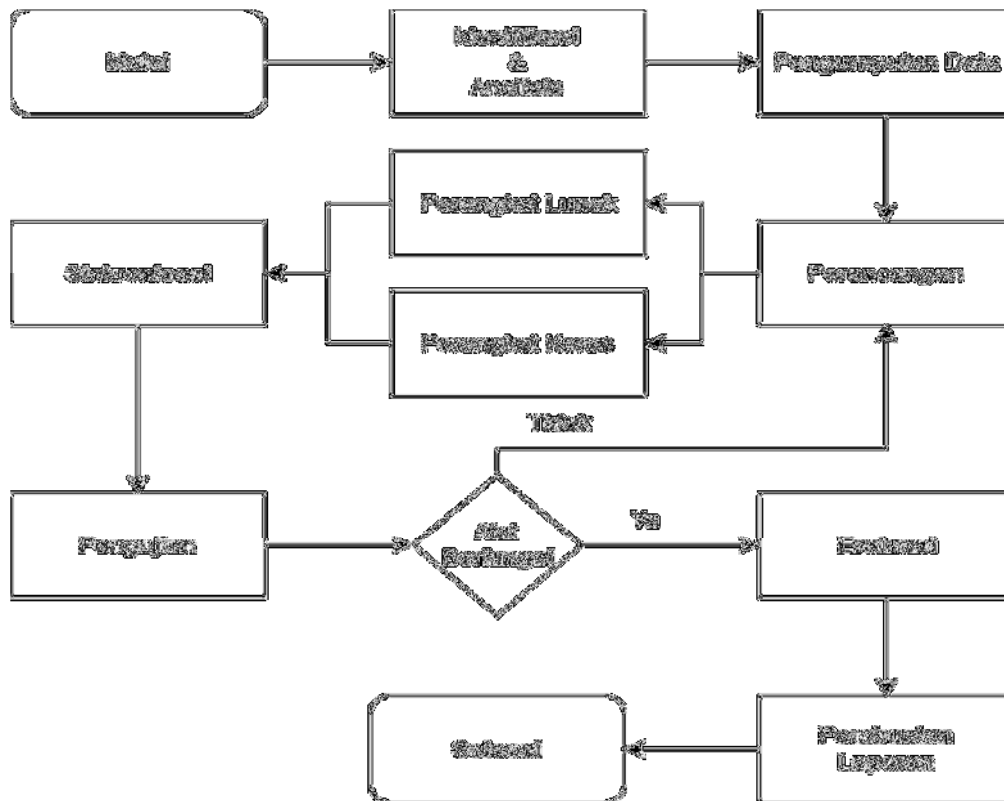


Figure 1. Research Method Flowchart.

In the design of the teacher and student attendance system at Noor Faqih Usman Foundation, this institution utilizes a hardware system consisting of Arduino Uno microcontroller, NodeMCU ESP8266 microcontroller [10], Raspberry Pi 2, RFID Module, LCD I2C, Access Point, Mini Buzzer Alarm, and two LEDs (green and red). The architectural diagram illustrating the hardware components in this system is shown in **Figure 2**.

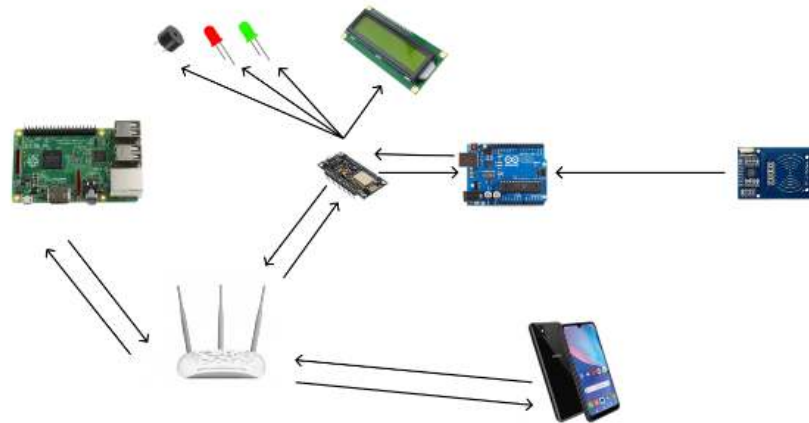


Figure 2. System Architecture Diagram.

This system consists of several components, each with its own function, and there are relationships between these components. The relationships between the components can be depicted through a system block diagram, with each component represented by a block. The block diagram of the teacher and student attendance system can be illustrated as shown in **Figure 3**.

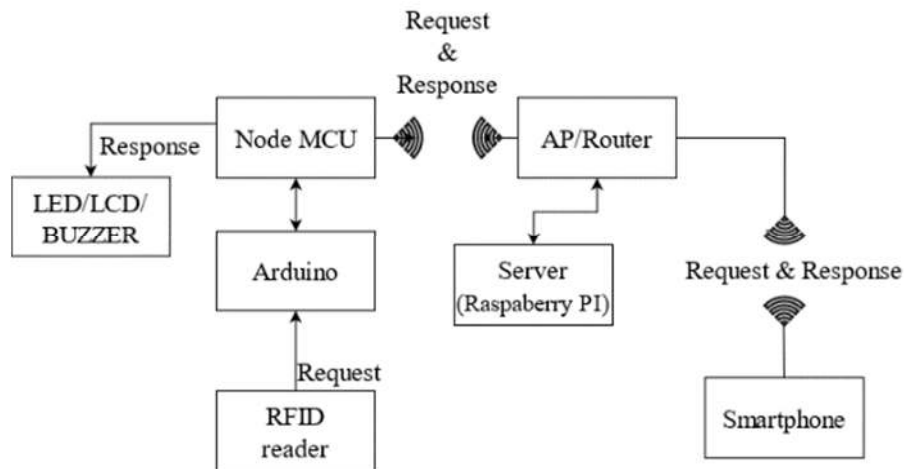


Figure 3. System Block Diagram.

The block diagram shown in **Figure 3**. represents the basic overview of the system design. A detailed explanation of the above Block Diagram is as follows:

2.1 LED/LCD/BUZZER

LED, LCD, and buzzer are devices that display and provide notifications to indicate interactions between the system and users.

2.2 RFID Reader

The RFID reader is responsible for reading information from RFID cards. This information will be used to fill in parameters or queries when making requests to the server. The RFID reader module plays a crucial role when users interact with the system.

2.3 Arduino Microcontroller

Arduino is used to receive data read by the RFID reader module. The received string data will be processed or assembled to make requests through NodeMCU.

2.4 NodeMCU Microcontroller

NodeMCU is used to identify or retrieve data from Arduino for processing. NodeMCU is also used to transfer GET requests to the server, and because it has a WiFi module, it can be used for GET requests to the Raspberry Pi server.

2.5 AP/Router

Since the built system is a local system, which means the attendance system is not connected to the internet, an AP/Router is used as a provider of local network access. Data can be forwarded from NodeMCU to the Raspberry Pi server.

2.6 Server (Raspberry Pi)

In this attendance system, Raspberry Pi is used as the server [11], which serves as the database storage used by users [12]. Requests sent from the NodeMCU microcontroller or smartphone will be received by the server. After the server receives the request, the response will be sent back to the requester. This response contains the requested components or information.

2.7 Smartphone

Users need a device to communicate with the system, and one of the devices is a smartphone. This device is used to make requests to the server, allowing users to interact with the system. The smartphone functions as a platform to view user data and attendance data through the browser. Since the system runs on a local network, the smartphone needs to be connected to the same network to use all the features of the attendance system web app.

The system flow diagram in **Figure 4.** shows how the interaction is performed with the system, starting from the card being read by the RFID reader, entering the predefined process request of the Arduino microcontroller. After processing, the request will be forwarded through NodeMCU to the predefined process request of the Raspberry Pi. The request received will generate a response, which will be sent back as an answer from the server. The response will be sent back through NodeMCU and processed to display the obtained answer from the server through the buzzer, LCD, and LED.

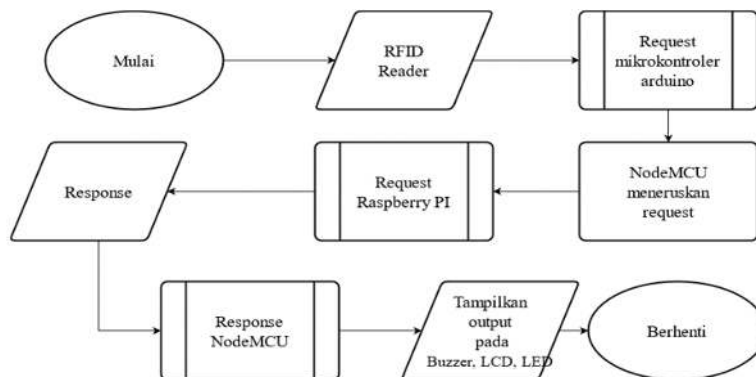


Figure 4. Flowchart of attendance system.

As mentioned earlier, the Arduino microcontroller is the component where the predefined process request takes place. This process involves data processing, where the information obtained from the card read by the RFID reader is assembled with the Arduino microcontroller to make a request. The execution of this sequence is then passed on by the NodeMCU. The flowchart illustrating this process can be seen in **Figure 5**.

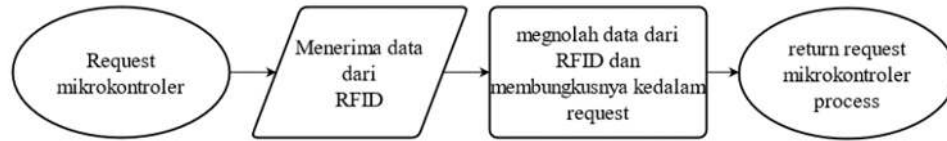


Figure 5. Flowchart of predefined process request microcontroller.

After the data from Arduino is forwarded to NodeMCU, NodeMCU will then make a request to Raspberry Pi. The data from NodeMCU's request will be processed in the predefined process on Raspberry Pi to obtain a response. The response will be sent back as a reply, containing the information requested. If the requested information is found, the response will indicate success along with the answer. However, if the requested information is not found, the response will still be given but will contain information that the request cannot be processed. The flowchart illustrating this process can be seen in **Figure 6**.



Figure 6. Flowchart of predefined process Raspberry PI.

After obtaining the response from the request by the predefined process response microcontroller, the NodeMCU microcontroller will process the response further in order to display it. The process response of the microcontroller can be illustrated in **Figure 7**.

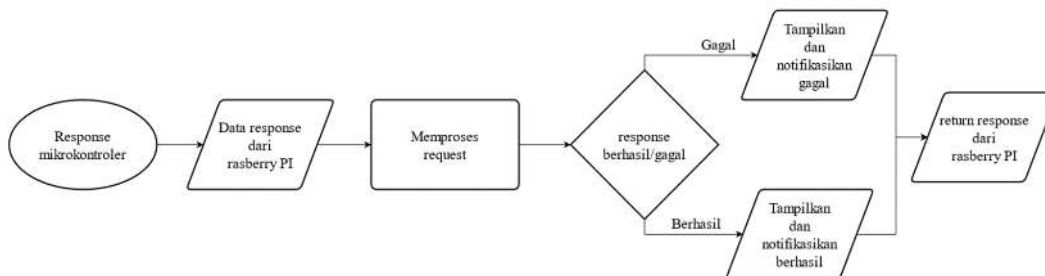


Figure 7. Flowchart of predefined process response microcontroller.

If the sent response is successful, the successful display and notification will be returned. However, if the received response fails (the requested data is not available), the failed display and notification will be returned.

Since this system is web-based, users can access their attendance history through the browser on their smartphones. In order to access the attendance history, the smartphone's browser needs to send a request to the server. The process from the smartphone to the server to retrieve attendance data from the server can be illustrated with a flowchart in **Figure 8**.

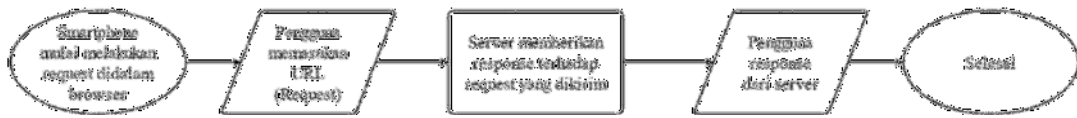


Figure 8. Flowchart diagram *smartphone to server*.

Smartphones and devices can communicate directly if the smartphone makes a request through the browser on the smartphone. Therefore, the requests made through the browser can be received directly by the server, and the server can also send responses directly.

The wiring diagram for the hardware components of the teacher and student attendance system can be illustrated in **Figure 9**.

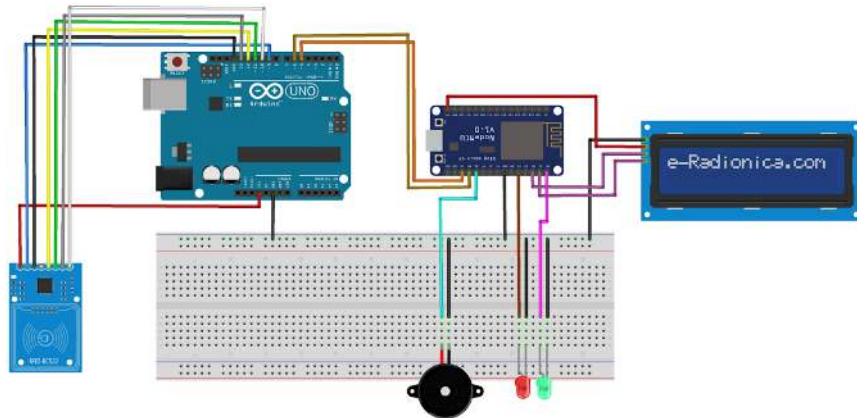


Figure 9. Hardware *Wiring Diagram*.

The conceptual design of the Entity Relationship Diagram (ERD) for the software of the teacher and student attendance system can be illustrated in **Figure 10**.

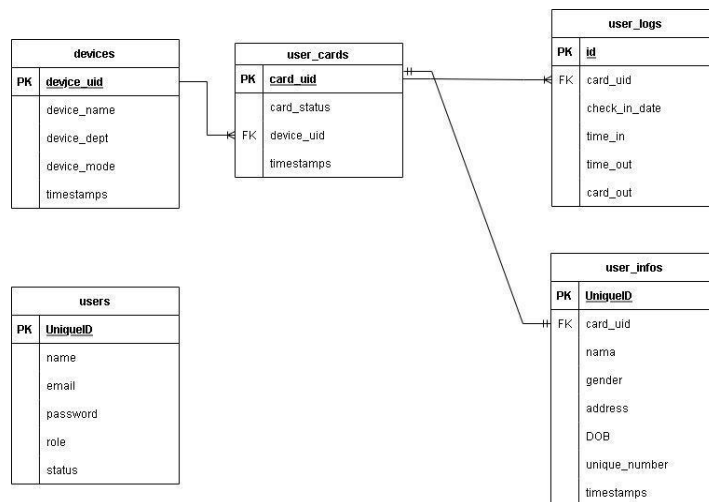


Figure 10. Entity Relationship Diagram (ERD).

The last one is the conceptual design of the RFID card/keychain and the junction box as the casing for the hardware of the teacher and student attendance system at Noor Faqih Usman Foundation. These designs can be illustrated in **Figure 11.** and **Figure 12.**



Figure 11. card/keychain design.



Figure 12. junction box design as casing.

3. RESULTS AND DISCUSSION

For the implementation, this system is divided into several menus. Each menu has different functional features and actors, which will affect the process. The use case actors in this system include:

1. User, with read-only access, can only view attendance history.
2. Staf, with access rights, can view attendance history and user card data.
3. Actor Admin, with the highest access rights, can view attendance history, user card data, and WebApp user data. They can add user cards and WebApp accounts, modify user card information and WebApp credentials, delete user cards and WebApp users, as well as create, modify, and delete RFID devices for attendance purposes.

In **Figure 13.**, it shows the interface of the login page of the WebApp. This login page is used by various actors to access the main page of the attendance system. There is a feature to create an account in **Figure 14.**, specifically designed for new users who will have their account creation requests accepted or rejected by the admin actor [13][14].



Figure 13. Login Page WebApp.



Figure 14. Creating Account Page WebApp.

Table 1. Login Page Description

Object	Usage	Description
Login Authentication Account	Enter the registered email and password credentials, then press "Login".	Usage rights for a valid account
Account Creation	Press "Create Account!", then fill in the account information and credentials. After that, wait for the request to be accepted and the actor's role to be assigned by the admin.	Creating a new WebApp Account

If logged in as an admin, the main menu of the web application specifically designed for admins will appear. It can be seen in Figure 15.

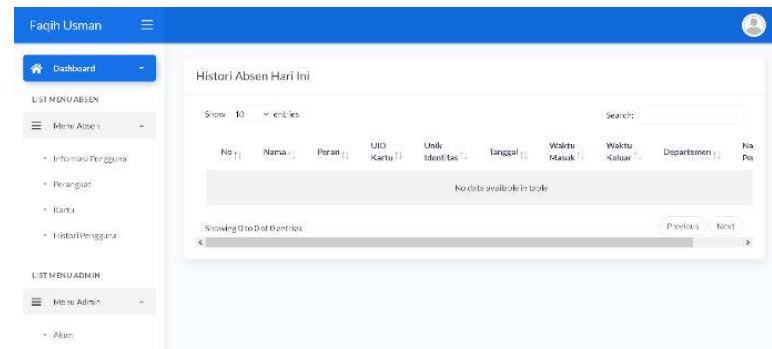


Figure 15. Main Page WebApp Admin.

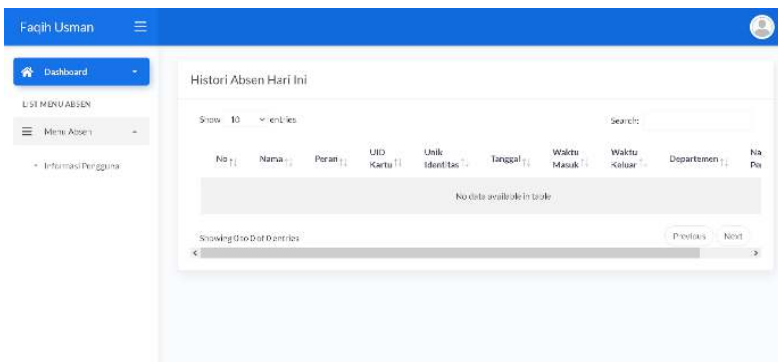


Figure 16. Main Page WebApp Staff.

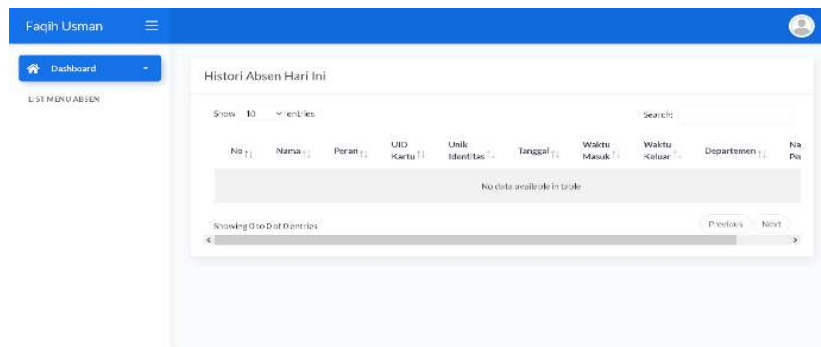


Figure 17. Main Page WebApp User.

On the homepage of the WebApp, can be seen in **Figure 16.** and **Figure 17.**, regardless of the user's access level (admin, staff, or user), a table displaying the attendance history for the current day (Dashboard) will be shown [3][8]. The main functions of the navbar are primarily for navigation to other features. To access other WebApp features, there is a dropdown menu titled "Menu Absen" (Attendance Menu) and a specific dropdown menu for admin actors titled "Menu Admin" can be seen in **Figure 18.** and **Figure 19.** Within the "Menu Absen", several sub-dropdowns will appear to access different system features, such as "Informasi Pengguna" (User Information), "Perangkat" (Devices), "Kartu" (Cards), and "Histori Pengguna" (User History) can be seen in **Figure 20.** Meanwhile, within the "Menu Admin", there is one sub-dropdown to access the "Akun" (Account) feature in **Figure 21.** The description of these menu shown in those figure can be seen in **Table 2., Table 3., Table 4., Table 5.** However, the usage of these features is restricted based on the user's role for security reasons [9][17][18].

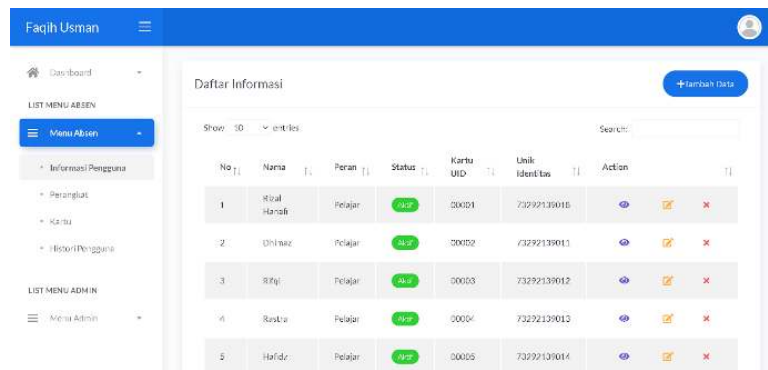


Figure 18. Information Page User on Admin.

Table 2. Description of User information page for Admin.

Object	Usage	Description
Add user data	Press the "+Add Data" button, then fill in the data for the new user and click the save button.	Register and add a new user
Edit User Data	Click the pencil icon in the "action" column and the row of the selected user.	Modify the identity of the selected user
Delete User Data	Click the cross icon in the "action" column and the row of the selected user.	Delete the selected user

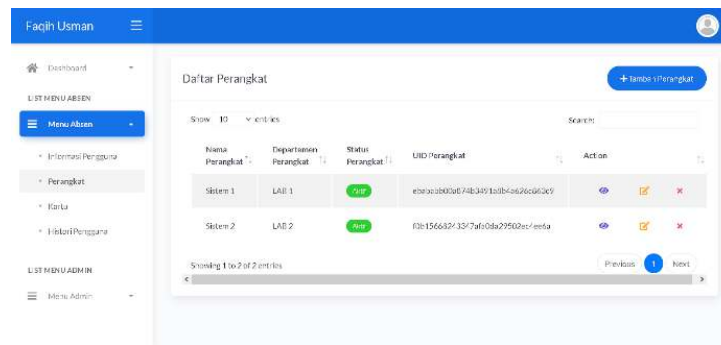


Figure 19. Page Device for Admin.

Table 3. Description of the Device Page for Actor

Object	Usage	Description
Add Device	Press the "+Add Device" button, then fill in the device name and department, and press the add button.	Register and add a new attendance device.
Edit Device	Click on the pencil icon in the "action" column and the selected device row to edit the device.	Modify the identity of the selected device.
Delete Device	Click on the cross icon in the "action" column and the selected device row to delete the device.	Delete the selected device.

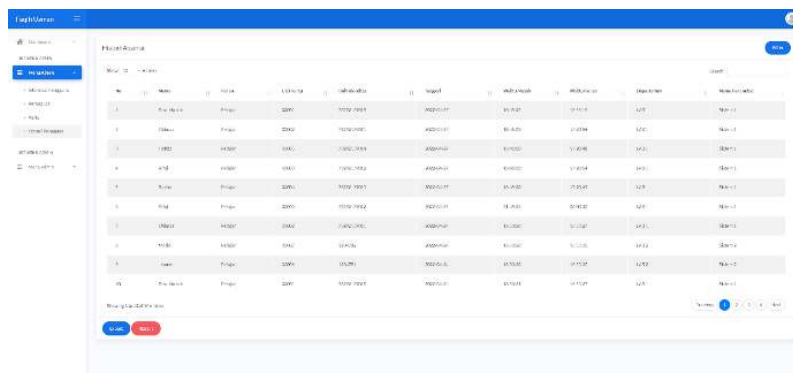


Figure 20. User History Page on Admin.

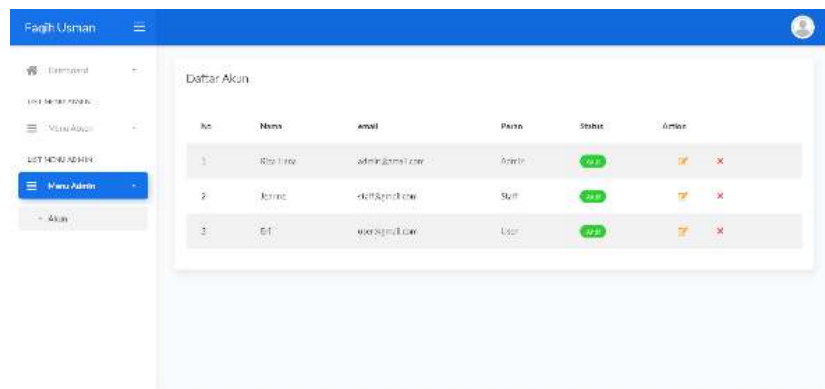


Figure 21. Account Page on Admin.

Table 4. Description of User *History Page* on Admin.

Object	Usage	Description
Filter	Press the "Filter" button above the "search" text field and specify the parameters to filter the data.	Filter the data based on the parameters input by the user.
Search	Click on the text field above the right side of the table and enter the name to be searched.	Search for a name based on what is entered in the "search" text field.
Export	<i>Click on the "Export" button next to the "RESET!" button and specify the parameters to limit the data to be exported.</i>	Export the data according to the parameters specified by the user in .xlsx format.
Reset	Click on the red button with the title "RESET!" next to the "export" button to reset the data.	Delete all history data.

Table 5. Description of Account Page on Admin.

Object	Usage	Description
Delete WebApp Account	Click on the cross icon in the "action" column and the row of the account name to be deleted.	Delete the selected account.
Edit WebApp Account	Click on the pencil icon in the "action" column and the row of the selected account name.	Modify the identity of the selected account.

In the software testing of the WebApp for the Teacher and Student Attendance System, black box testing with fuzzing technique and boundary value analysis technique were employed [15][16]. Black box testing involves providing a set of inputs to the program, while fuzzing is a technique for searching for bugs in software by injecting imperfect data, and boundary value analysis focuses on identifying errors from the external or internal boundaries of the software. The specific testing scenarios in this research are divided into two parts: front-end and back-end testing, and hardware client and server architecture testing [17][18]. The testing scenarios are as follows:

Table 6. Results and Testing of the Attendance System

Tested Objects	Actor Action Descriptions	Results
1. User History Page		
Tapping History Time In dan Time Out	The user attaches a card/keychain to the RFID, provided that the devices mode has been activated.	Success
Log Filter	An actor with admin access performs Log Filtering from a presence history. The filters can be based on date, user, time, and RFID device in the department room.	Success
Export Excel	<i>An actor with admin access performs an export of the existing presence history data from the WebApp to a digital format such as Excel.</i>	Success
Search	An actor with admin access performs a search of the existing presence history data on the WebApp.	Success
Reset	An actor with admin access performs a reset of the presence history data.	Success
2. Device Page		
List RFID Devices	An actor with admin access views the list of RFID devices distributed in the rooms per department within the institution or organization.	Success
Add Device	An actor with admin access adds an RFID device for a new room. They then input the device name along with its corresponding department.	Success
Delete Device	An actor with admin access deletes the desired RFID device.	Success
Edit Device	An actor with admin access modifies a device, including the device name, room department name, and RFID device mode status. The active mode status indicates that the device is in presence history mode, while the inactive mode status indicates that the device is in user card/keychain registration mode.	Success
3. Card Page		
Search	An actor with admin access performs a search for card/keychain user data on the WebApp.	Success
List Registered Users	of An actor with admin access views the list of registered card/keychain users, marked with an active status.	Success
List Unregistered Users	of An actor with admin access taps a card/keychain to the RFID device with the device mode set to passive, intending to register a user's card/keychain. Then, the admin actor can view the UID of the card user, which is still unregistered, marked with a passive status.	Success

4. User Information Page

Add User Data	After the actor with admin access taps a card/keychain to the RFID device with the device mode set to passive, intending to register a user's card/keychain, they then navigate to the User Information page. They click on the Add User Data button, select the desired Card UID, change the status to active, and input user information including name, unique number, date of birth, and address. Finally, they assign a role to the user (student or teacher) and click the save button.	Success
Edit User	An actor with admin access performs changes to a desired card/keychain user.	Success
Delete User	An actor with admin access performs changes to a desired card/keychain user.	Success

5. Account Page

List of Registered WebApp Accounts	An actor with admin access views the list of registered WebApp accounts marked with an active status.	Success
List of Unregistered WebApp Accounts	A user who wants to create a WebApp account first performs a sign-up process on the WebApp login page. Then, the admin actor can see the registered WebApp accounts marked with a passive status. If the admin approves the creation of the WebApp account, they will assign a role (admin, staff, user) and change the status to active.	Success
Edit Account	An actor with admin access performs changes to a desired WebApp account.	Success
Delete Account	An actor with admin access deletes a desired WebApp account.	Success

6. Login Page & Object Logout

Login as User, Staff, and Admin	Please enter your email and password credentials to log in. Once entered successfully, you will be directed to the main page.	Success
Creating Account WebApp	To create a WebApp account, please provide the desired credentials such as name, email, and password. Once done, please wait for the admin actor to approve the account creation.	Success
Logout	Select the Logout button on the navbar. Upon doing so, the actor with any access rights will be automatically logged out from the system and redirected to the initial login page.	Success

4. CONCLUSION

Based on the testing results, the system is functioning well. The RFID reader module in the system successfully reads data from tags, cards, and E-KTP (Electronic Identity Card) at a distance of approximately 2-4 cm between the card and the RFID reader. The obtained data consists of unique codes that are different for each card. After a successful card tap, each unique code is automatically stored in the database, representing the identity of each card,

including the number, name, date, and time of entry, as well as the date and time of exit for both teachers and students who attend classes. By implementing this attendance system for teachers and students, the effectiveness of teaching and learning activities at Yayasan Noor Faqih Usman will be maximized. In the beginning of the class, teachers no longer need to manually take attendance by calling out each student's name, thus allowing more time for actual learning in the classroom without interruption.

However, it is important to note that the system is not created to be perfect. There is a need for further in-depth research and development in managing the attendance system by utilizing the latest technologies to ensure the effective and efficient management of student and teacher attendance. For example, utilizing biometric face recognition as an input method for student and teacher attendance.

5. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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