

## IMPLEMENTATION OF IOT-BASED PRESENCE APPLICATIONS IN JUNIOR HIGH SCHOOLS TO SUPPORT IMPLEMENTATION SMART SCHOOLS

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**Abstract**—This research is conducted to address the observed inefficiency in the current attendance process at SMP As-Syahira Amka in Pekanbaru. The traditional method of manually calling each student for attendance not only consumes time but also results in prolonged manual record-keeping processes. Recognizing the need for a more efficient and structured system, this study aims to introduce an IoT-based attendance solution using RFID technology. By implementing this solution, the research aims to enhance the efficiency of the attendance process, reduce administrative burdens, and improve overall school management. Additionally, the study aims to contribute to the advancement of educational technology by applying the Research and Development (R&D) method to design, develop, implement, and evaluate the proposed IoT-based attendance system. Ultimately, the goal of this research is to provide a practical and effective solution that can be adopted by SMP As-Syahira Amka and potentially other educational institutions facing similar challenges in attendance management. By introducing an IoT-based attendance system, it is hoped that there will be an improvement in efficiency, accuracy, and security in the attendance process, as well as a positive contribution to creating a more modern and structured learning environment. Moreover, this research may provide new insights into the utilization of technology in education in Indonesia and encourage the adoption of innovative solutions to enhance overall educational quality.

**Keywords:** IoT, RFID, Smart School, Usability Testing

**Intisari**—Penelitian ini dilakukan untuk mengatasi ketidak efisienan yang teramati dalam proses absensi saat ini di SMP As-Syahira Amka di Pekanbaru. Metode tradisional yang melibatkan pemanggilan manual setiap siswa untuk absen tidak hanya memakan waktu, tetapi juga mengakibatkan proses pencatatan manual yang panjang. Menyadari perlunya sistem yang lebih efisien dan terstruktur, penelitian ini bertujuan untuk memperkenalkan solusi absensi berbasis IoT menggunakan teknologi RFID. Dengan menerapkan solusi ini, penelitian ini bertujuan untuk meningkatkan efisiensi proses absensi, mengurangi beban administratif, dan meningkatkan manajemen sekolah secara keseluruhan. Selain itu, penelitian ini bertujuan untuk berkontribusi pada kemajuan teknologi pendidikan dengan menerapkan metode Penelitian dan Pengembangan (R&D) untuk merancang, mengembangkan, menerapkan, dan mengevaluasi sistem absensi berbasis IoT yang diusulkan. Pada akhirnya, tujuan dari penelitian ini adalah untuk memberikan solusi yang

*praktis dan efektif yang dapat diadopsi oleh SMP As-Syahira Amka dan mungkin juga institusi pendidikan lainnya yang menghadapi tantangan serupa dalam manajemen absensi. Dengan memperkenalkan sistem absensi berbasis IoT, diharapkan akan terjadi peningkatan efisiensi, akurasi, dan keamanan dalam proses absensi, serta memberikan kontribusi positif dalam menciptakan lingkungan pembelajaran yang lebih modern dan terstruktur. Selain itu, penelitian ini juga dapat memberikan pandangan baru dalam pemanfaatan teknologi dalam pendidikan di Indonesia, serta mendorong adopsi solusi inovatif untuk meningkatkan kualitas pendidikan secara keseluruhan.*

**Kata Kunci,** *IoT, RFID, Smart School, Usability Testing*

## INTRODUCTION

Smart School is a school management information system to facilitate the process of school data processing [1]. School management includes the management of student's attendance in school or commonly known as attendance. Currently, attendance in some schools still uses manual methods by calling students names one by one and then record it in books. Manual attendance still has shortcomings, including the attendance violations such as students coming to school but skip class. There is a possibility of errors or obstacles in making a reference recapitulation due to the loss of paper or attendance list [2], waste of paper, and requires a long time in processing attendance data. Junior High School of SMP As-Syahira Amka located on Jl. Budi Daya, Tampan District, Pekanbaru City still uses manual methods to record the attendance of school students. It has not yet applied IoT technology for the development of *Smart School*.

IoT (*Internet of Think*) is a network of physical objects or "things" embedded with electronic devices, software, sensors, and network connectivity, which allows those objects to collect and exchange data [3]. Data collection and exchange on IoT can also be controlled and can take place at close and long distances through network connections. This creates a direct *integration* between the physical world and computer-based systems so that it can increase efficiency and accuracy [4]. This is certainly also useful in the world of education because it can provide convenience to the educational process in schools, which can realize a systemized school or better known as Smart School. The Smart School implemented will be connected to IoT by implementing a card system which will later be applied to sensors as Presence.

The utilization of IoT in Smart Schools encompasses various objectives, ranging from controlling electronic devices within the school premises to streamlining information processing and dissemination [5]. One specific application is the enhancement of the student attendance system.

By integrating IoT technology into the attendance process, schools can efficiently monitor students' attendance, providing real-time attendance information to parents or guardians [6]. This study implements IoT through cards connected to Arduino using sensors. When students tap their cards on the sensor device, their attendance is automatically detected. The Pekanbaru city government in Pekanbaru Perwako (mayor regulation) Number 56 of 2019 stated the determination of the Master plan in realizing Pekanbaru *Smart City Madani* consists of five pillars, one of which is *Smart People* which has five indicators including *Smart Competence*. This can be built through the realization of *Smart School*. The smart school implemented by the Pekanbaru city government is currently Smart Madani and KIA (Child Identity Card) which are useful for education, government, health, transportation, and licensing services [7].

In the previous study, *Smart school* itself had criteria including learning activities, learning evaluations, *student progress reports*, and attendance control that could be done digitally [8]. In another study, the criteria for the success of *Smart schools* is that teachers are easy to integrate technology [9]. From the two studies, it can be said that the embodiment carried out by the Pekanbaru City Government is still not worthy of being called a *Smart school*. Therefore, this research is expected to help meet the criteria of *Smart School* in Pekanbaru by conducting IoT application. The application of IoT will be carried out by using RFID which will later be connected to several applications.

Using Radio Frequency Identification (RFID) cards presents several advantages compared to other student attendance methods. Among these, the RFID card ensures high efficiency and accuracy in recording attendance. Its automatic usage allows seamless integration with the school's management system, while its security and versatility make it a convenient and cost-effective long-term solution. Additionally, the RFID card is non-intrusive and can be expanded for other purposes such as library access and cafeteria purchases. It's easy integration with various systems and user-friendly nature



makes RFID technology a superior choice for achieving efficiency and accuracy in student attendance tracking.

In previous research, *Smart School* was developed in the form of an application for the needs of teachers in the new normal era [10]. Then, in another study *Smart School* was developed into a learning evaluation media in the form of Online based on E-Learning [11]. Then in the next research *Smart School* was developed as a teaching material for *Smart School*-based mathematics in PKL (Field Work Practice) activities [12]. In this study, *Smart School* was developed again with the creation of IoT-based attendance system technology in the form of RFID (Radio Frequency Identification). RFID is the process of identifying a person or object using radio transmission frequency [13].

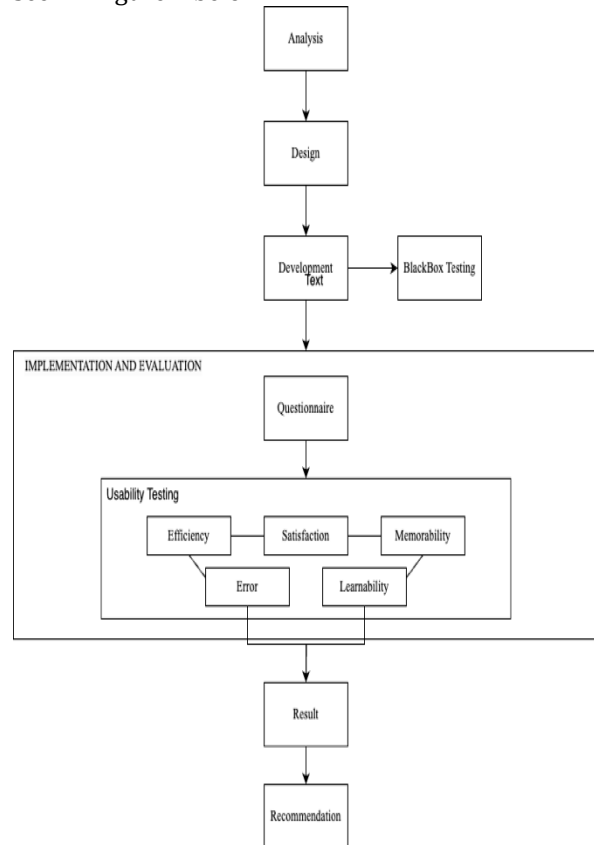
The attendance system was made by using research and development methods, namely methods that aim to produce or develop certain products. In this research, the *Usability* testing was also used which consists of five aspects, namely aspects of *Efficiency*, *Satisfaction*, *Memorability*, *Errors*, and *Learnability* to determine the success in terms of usability in the system made for its users [14]. Usability testing is the process of evaluating to what extent a product or system can be used easily and effectively by users. The goal of usability testing is to identify any issues that users may encounter when using the product or system, as well as to determine areas where improvements are needed to enhance the quality of the user experience [15].

The testing process involves inviting several users to try out the product or system. During the testing process, users are given specific tasks to complete, and observers record the users' interactions with the product or system. Once the testing is complete, observers analyze the results of the testing and identify any issues that were found [16]. After conducting the analysis process, the result of this research is the IoT-based attendance system tool technology in the form of RFID utilizing Arduino. To ensure the Smart School system functions effectively in this school, the study conducted two rounds of testing. The black box testing performed successfully for the Smart School system. Subsequently, usability testing was conducted, and all variables were well-received by users. Thus, the system is deemed suitable for implementation in this school.

## MATERIALS AND METHODS

Methodology is a technique that is structured to solve a problem. This research used the R & D (*Research and Development*) method. R&D is a

research method used to produce a product and test the effectiveness of that product [17]. The development model used was the ADDIE (Analysis, Design, Development, Implementation and Evaluation) model. In this study, it also used the Usability testing which consists of aspects of Efficiency, Satisfaction, Memorability, Errors, Learnability [18]. The flow of the method can be seen in figure 1 below:



Source: (Research Results, 2024)

Figure 1. Research Methods

The following is an explanation of figure 1.

### A. Analysis

The research and development method started from analysis to see existing problems and solve them. In the data analysis stage, there were several ways that the author used for this study. These methods are as follows:

### Data Collection Techniques

#### Observation

Researchers made observations directly at As-Syahira Amka Junior High School in Pekanbaru.

#### Interviews

This data collection technique was carried out by interviewing the school parties directly, namely the teacher of SMP As-Syahira Amka Pekanbaru

regarding the attendance system implemented in the school.

**Literature Studies**

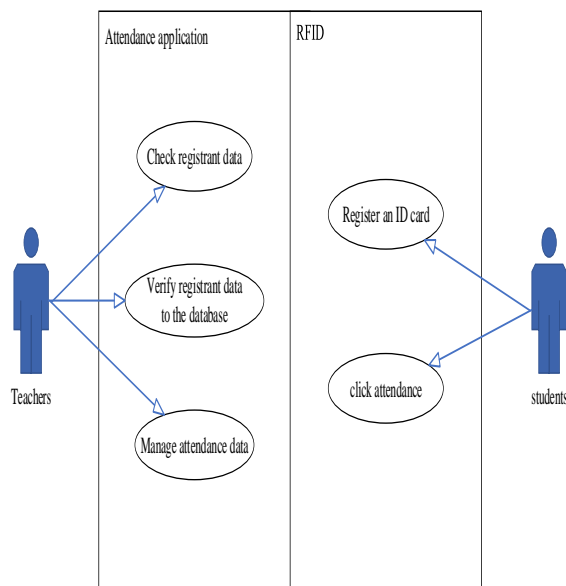
The next data collection technique was to conduct a literature study and development by reading and also analyzing some related literature that supports this research. The literature study conducted also aimed to obtain some information about the study of several studies and the originality of the research

**B. Design**

At the design stage, the researcher designed the initial product related to the attendance system to be built. The product design was made based on the needs model which can be seen from the use case diagram and the following activity diagram:

**Use case Diagram.**

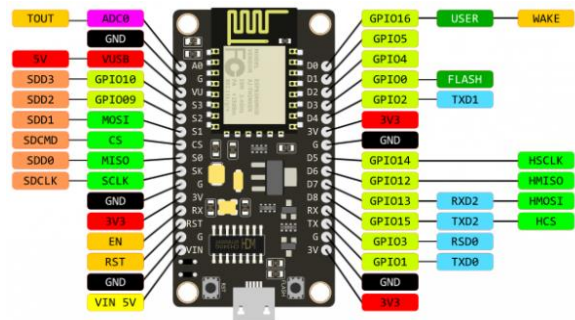
IoT-based attendance system using RFID



Source: (Research Results, 2024)  
 Figure 2. Use Case Diagram System

The use case diagram in Figure 2 explains that the built attendance system can be used by school teachers and students. School teachers were actors who can check the data of students who registered their ID cards for the first time, verified registration data into the database and also managed the attendance data in the database. Meanwhile, student actors can register ID cards, and make attendance on RFID. To build the IoT system, this research utilizes the NodeMCU ESP8266. The NodeMCU ESP8266 is a microcontroller employed to control both hardware and software, known for

its resilience and stability in device control [19]. The NodeMCU ESP8266 is particularly suitable for IoT-based projects (Internet of Things) [20]. In this study, the utilized NodeMCU is the version 3 with a 4MB flash memory, operating at a frequency of 2.4 - 22.5 GHz, a voltage of 3.3 volts, 13 digital input/output, and 1 SPI (Serial Peripheral Interface) interface.



Source: (Research Results, 2024)  
 Figure 3. GPIO NodeMCU ESP 8266 [21]

**Design User Interface**

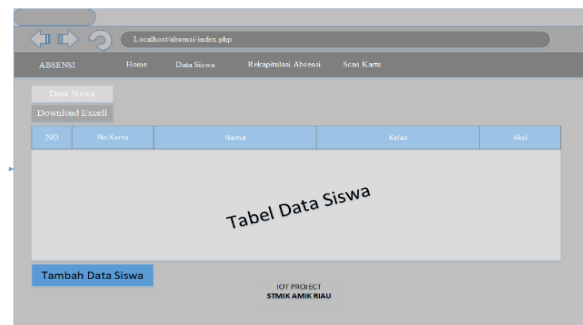
The following is the display design for the home menu, where this page is the page that first appeared when the application was first run.



Source: (Research Results, 2024)  
 Figure 3. Home Menu Display Design

**Student Data Menu View**

In the design display design, the student data menu is a display design that will be used to collect the registered student data.

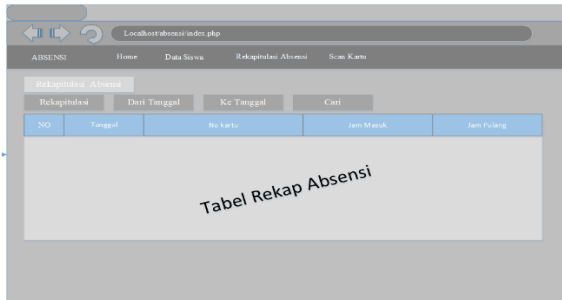


Source: (Research Results, 2024)  
 Figure 4. Student Data Menu Display Design



### Attendance Recapitulation View

Display of the attendance recapitulation menu presents the data of the attendance results that had been carried out by students. In this attendance recapitulation menu, there is also a feature of filtering the attendance data that you want to display.



Source: (Research Results, 2024)

Figure 5. Design of the Attendance Recapitulation Menu Display

### Card Scan Menu Display

On the display of the card scan menu or RFID *key chain tag*, it displays a choice of attendance mode (entry mode or return mode) and displays a message when successfully conducting attendance.



Source: (Research Results, 2024)

Figure 6. Card Scan Menu Display Design

### C. Development

At this stage, the researchers made a system from the results designed previously into a product to be achieved, namely an IoT-based attendance system using RFID.

### D. Blackbox Testing

Once the attendance system is successfully developed, the next step is to conduct black-box testing. This testing is essential to assess the system's performance and ensure its smooth operation. If any issues or errors are identified during testing, immediate corrections will be applied to prevent errors during implementation.

### E. Implementation and Evaluation

Furthermore, in the implementation stage of the absence system at SMP As-Syahira Amka

Pekanbaru, the RFID attendance system was tested by using a black box test and applied to the As-Syahira Amka Junior High School class VIII and class IX. Then, the distribution of questionnaires to students was carried out. After that, the processing of questionnaire result data performed by testing validity, reliability, and usability testing.

### F. Questionnaire

Questionnaire is a data collection technique that is done by giving questions or statements to respondents in writing by giving answer choices. In this study, the questionnaire was used to determine the level of usefulness of the RFID-based attendance system. To build the questionnaire, the reference used is the usability test method which has 5 variables, namely Efficiency, Satisfaction, Memorability, Errors, and Learnability [22][23][24][25], [26].

This questionnaire employs a Likert scale, including options such as strongly disagree, disagree, agree, and strongly agree. Following the creation of the questionnaire based on usability testing, the subsequent step involves distributing the questionnaire. The distribution for this research utilizes Google Forms, and to ensure accurate responses, respondents are guided throughout the questionnaire filling process.

### G. Recommendations

This recommendation is one of the benefits of this study which was obtained based on the results of data processing. The purpose of the recommendation was to determine the level of use of the RFID-based attendance system in helping to facilitate the student attendance process.

## RESULTS AND DISCUSSION

### A. Implementation Environment

The implementation environment is things related to the application or implementation of a thing. The implementation environment in building an RFID presence was divided into two parts, namely software and hardware. The followings are the software and hardware specifications used:

#### Software Specifications

The specifications of the software used to build this attendance system are as follows:

1. Windows 10 64-bit operating system
2. Arduino IDE 2.0.0 version
3. PHP 8.1.6 version, and
4. Xampp 3.3.0

This research employs a Database Management System (DBMS) utilizing the Object-

Oriented Model (OOM), commonly referred to as OOM. OOM is an approach to designing and managing databases that utilizes the concepts and principles of the object-oriented programming paradigm. In this model, data is stored in the form of objects, which can have attributes (data) and methods (functions or operations). The advantages of OOM include Reusability, Modularity, Maintainability, Flexibility, More Accurate Modeling, and Security.

**B. Hardware Specifications**

The minimum hardware specifications required at the time of making the RFID attendance device are as follows:

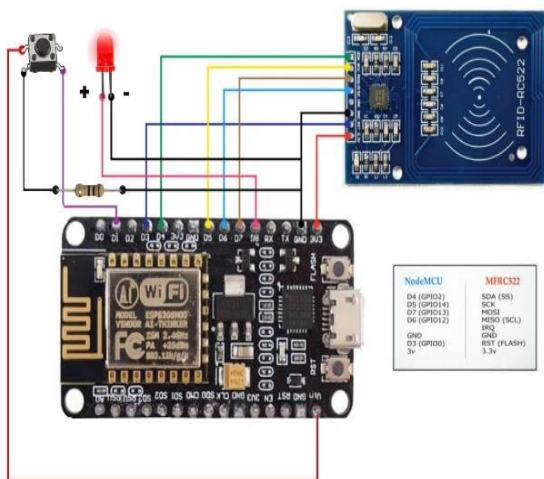
1. Nodemcu ESP8266 as Microcontroller and RFID attendance control center
2. RC522 RFID Sensor
3. Red LED light as indicator *Scanning RFID Key Chain* tag and indicator when push button pressed
4. Jumper cable as a connector
5. *Solderless* 830-point Breadboard
6. Push button as a button to replace the attendance mode

**C. Development**

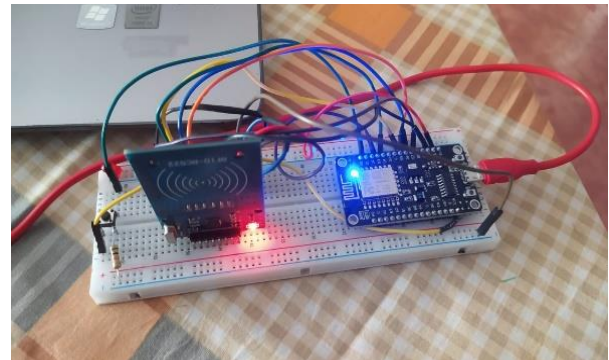
From the RFID attendance design that had been made, it resulted in an RFID attendance design which is divided into two parts, namely the design of the RFID attendance tool series, and the RFID website application design.

**Series of RFID Attendance Tool**

The design of the RFID attendance system tool that was created is as follows



Source: (Research Results, 2024)  
Figure 7. Cable Line series on RFID Attendance System Tool



Source: (Research Results, 2024)  
Figure 8. Results of a Series of Pre-Designed Tool

**RFID Attendance Website Applications**

The development of the RFID attendance website that was designed can be seen in the following picture:

**Home menu view**

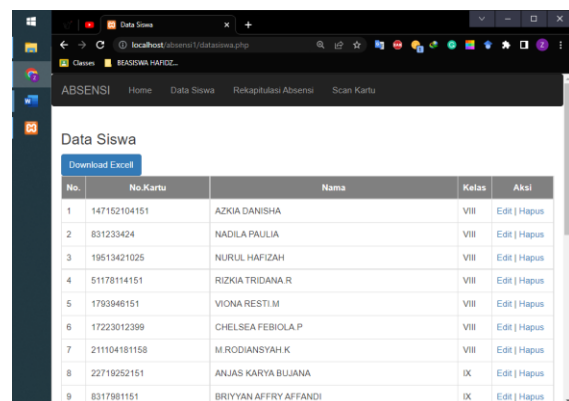
The display section of the home menu displays the text saying "Welcome to the RFID CARD-BASED STUDENT ATTENDANCE SYSTEM" on the user when the website is first opened by the user.



Source: (Research Results, 2024)  
Figure 9. Home menu display

**Student Data menu view**

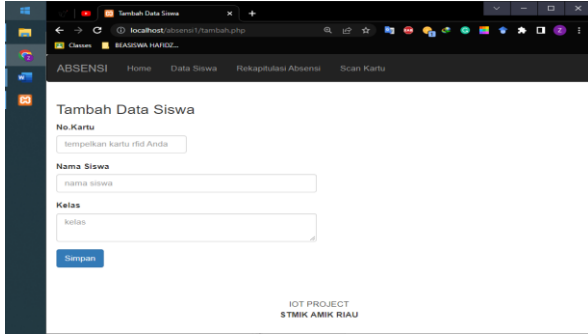
The display section of the student data menu shows the student data that had been registered on the input form menu.



Source: (Research Results, 2024)  
Figure 10. Student Data menu view

**View of Add Student Data Form**

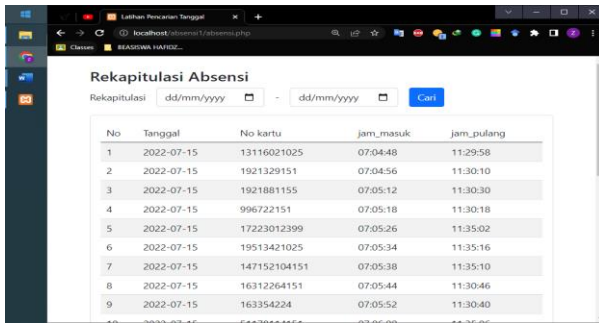
The display section of the add student data menu presents the student data *input forum* section.



Source: (Research Results, 2024)  
Figure 11. View of the Add Student Data Form Menu

**Attendance Recapitulation menu display**

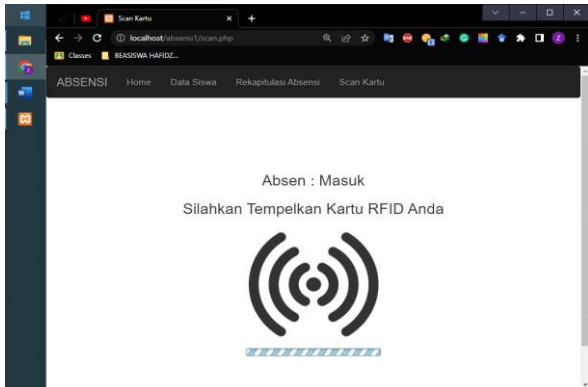
In the attendance recapitulation menu section, it is part of the website page that aims to display a recapitulation of student attendance data.



Source: (Research Results, 2024)  
Figure 12 Attendance Recapitulation menu view

**RFID Key Chain Tag Scan menu display**

On the display menu, the RFID *key chain* tag scan menu displays a section of the page that presents class and after school attendance action.



Source: (Research Results, 2024)  
Figure 13. Menu Display of Scan RFID Key Chain Tags

**D. Implementation and Evaluation**

The Black Box test was carried out to find out whether the RFID-based attendance system built is already functioning as expected or not. The following is the result of the black box test that was carried out.

Table 1. Black Box Test

Testing	Expectation	Results	Description
Bring Key Chain tags closer to RFID Reader tags distance $\leq$ 3cm	Readable	Readable	Successful
Connecting ESP 8266 Nodemcu with Wi-Fi and IP	Connected	Connected	Successful
RFID reader can receive data from Key Chain Tags	Readable	Readable	Successful
Push button can change the attendance mode	Successful	Successful	Successful
The attendance mode appears in the website application and changes mode when the push button is pressed	Successful	Successful	Successful
The website application can display students' data	Successful	Successful	Successful
The website application can display the form of adding student data	Successful	Successful	Successful
The website application can display a recapitulation of the attendance	Successful	Successful	Successful

Source: (Research Results, 2024)

After testing the black box, the distribution of questionnaires to respondents was then performed for usability testing by using five aspects of the test, namely Efficiency, Satisfaction, Memorability, Errors, and Learnability which were given to teachers and students as respondents. Teachers were given tests on the Efficiency aspect to determine the efficient level of the attendance system created while students answered statements from other aspects, namely Satisfaction, Memorability, Errors, and Learnability.

The Efficiency category was to find out whether the RFID attendance system is efficient to use or not



whereas the Satisfaction category aimed to know whether the RFID attendance system is in accordance with the needs. Besides, the Memorability category was intended to see whether the use of RFID attendance system is easy to understand. Then, Errors category was set to see whether the RFID attendance system still has errors or obstacles when the system is run. The last is the Learnability category to find out whether the RFID attendance system generates new knowledge for students or not.

**Validity Test**

After obtaining the results of the answers from the respondents, a validity test was then conducted by using the SPSS application by analyzing each instrument item in the questionnaire. Validity test referred to the consistency and accuracy of scores on a questionnaire test used to measure its validity or invalidity. The

Each item of the questionnaire instrument was tested into the R-value formula with the provision of the criterion. If the R-value > the R-table, it can be said to be valid and otherwise if the test of R-value < the R-table, it is invalid. In this study, teacher respondents were eight while student respondents were twenty-one students, seven students from class VIII and fourteen students from class IX with a significant level or level becoming reference level for the lowest chance of error analysis of data results which was 5%.

The r-table value can be seen in table 2 in which teacher respondents totaling 8 respondents had an r-table value of 0.707 and an r-table value for student respondents totaling 21 respondents was 0.433. Then the r-table value was used for validity test which can be seen in the following table:

Table 2. Validity test results (teacher respondents)

Variable	Indicator	R Value	R Table	Status
X1: Efficiency	X1.1	0,718	0,707	Valid
	X1.2	0,821	0,707	Valid
	X1.3	0,923	0,707	Valid

Source: (Research Results, 2024)

Table 3. Validity Test Results (student respondents)

Variable	Indicator	R Value	R Table	Status
X2: Satisfaction	X2.1	0,528	0,433	Valid
	X2.2	0,645	0,433	Valid
X3: Memorability	X3.1	0,516	0,433	Valid
	X3.2	0,685	0,433	Valid
	X3.3	0,743	0,433	Valid
X4: Errors	X4.1	0,545	0,433	Valid
	X4.2	0,598	0,433	Valid
	X4.3	0,460	0,433	Valid

Variable	Indicator	R Value	R Table	Status
X5: Learnability	X5.1	0,450	0,433	Valid
	X5.2	0,584	0,433	Valid
	X5.3	0,498	0,433	Valid

Source: (Research Results, 2024)

From the table above, it can be seen that the validity test of the Efficiency category shows it has valid result. This means that the RFID attendance system can be said to be efficient to be applied to SMP As-Syahira Amka. In the Satisfaction category, the RFID attendance system can ease the attendance process, and the Memorability category result indicates that the use of RFID intelligence system is easy to understand and remember. Errors category is valid which suggests that the RFID attendance system has no problems when the system is run, and Learnability also has valid test results, which indicates that the RFID attendance system can increase students' knowledge about attendance technology, especially RFID-based attendance technology.

**Reliability Test**

The questionnaire instrument reliability test is a test used to determine whether the questionnaire used in a study is reliable or not [27]. A variable can be said to be reliable if it gives a Cronbach Alpha value > 0.60 [28]. In the results of the reliability test using the SPSS application, it can be seen in figure 14 that the Cronbach's Alpha value for teacher respondents is 0.758 > 0.60 and from the reliability test results of student respondents, the Cronbach's Alpha value is 0.728 > 0.60 which means that the research on RFID-based attendance systems can be said to be reliable.

**Reliability Statistics**

Cronbach's Alpha	N of Items
.758	3

Source: (Research Results, 2024)

Figure 14. Reliability Test Results (Teacher Respondents)

**Reliability Statistics**

Cronbach's Alpha	N of Items
.728	15

Source: (Research Results, 2024)

Figure 15. Reliability Test Results (Student Respondents)





### Usability Test

Usability testing was carried out to find out whether the RFID-based presence system has obtained results that suit the needs of the user or not. The following is the percentage results obtained from the questionnaires distributed.

Table 4. Average Value Variable (Teacher respondents)

Variable	Average Value
Efficiency	87,5%

Source: (Research Results, 2024)

In table 4, it can be seen that the average value obtained for the Efficiency aspect is 87.5%, which indicates that the RFID-based attendance system can be said to be very good.

Table 5. Variable Average Value (Student respondents)

Variable	Average Value
Satisfaction	84,52%
Memorability	84,13%
Errors	51,98%
Learnability	87,30%

Source: (Research Results, 2024)

In table 5, it can be seen that the average value for the Satisfaction aspect is 84.52% which means testing for the Satisfaction aspect gets excellent results and shows most respondents agreed that the RFID-based attendance system was easy to use. Then the Memorability aspect with a value of 84.13% obtains excellent results and suggests that most respondents agreed that the way the RFID-based attendance system works was easy to remember and learn. Furthermore, the Errors aspect with a value of 51.98% have a good result and indicates that most respondents agreed that the RFID-based attendance system did not have any difficulties or many obstacles on the system when the system was run. The last is learnability with a value of 87.30% which acquires excellent results and implies that most of the students agreed that students gained additional knowledge regarding RFID-based attendance systems.

### E. Recommendations

The test results in the five aspects of the category used as measurements in the RFID attendance system built for student attendance at the As-Syahira Amka Pekanbaru Junior High School shows that excellent values were obtained in the aspect of testing Efficiency from teacher respondents whereas the result of student respondents of class VIII and IX in Satisfaction, Memorability, and learnability testing was very good. Besides, the Errors testing aspect demonstrates a good result. These results were in accordance with the

provisions of the grades in each aspect of the test. Therefore, the author provides recommendations to the As-Syahira Amka Pekanbaru Junior High School to apply technology to the student attendance process such as RFID-based attendance system technology.

Furthermore, as the attendance process progresses over several semesters, it is necessary to conduct a reevaluation and add a notification feature connected to parents' smartphones. This is done to enable parents to continuously monitor their children's journey to school and participation in all subjects. Additionally, there is a need for the addition of other features such as student misconduct and achievements, allowing parents at home to provide feedback to students, thus minimizing school misconduct and enhancing student achievements.

### CONCLUSION

Based on the discussion of the stages of analysis, design, implementation, evaluation and testing stages, it is concluded that the RFID-based attendance system has valid data value result in the categories of *Efficiency*, *Memorability*, *Errors*, and *Learnability*, and *Satisfaction*. In reliability testing, the result is reliable. *Usability* aspect gets excellent value and so does the aspect of *Efficiency*, *Satisfaction*, *Memorability*, *Learnability*, and *Errors*. This shows that the RFID-based attendance system is appropriate to be applied or used in the As-Syahira Amka Junior High School Pekanbaru.

This study still has shortcomings, such as students being able to cheat by entrusting their cards to their friends. Therefore, there is a need to use alternative methods, one of which is facial recognition patterns. In addition, attendance using facial recognition patterns is highly beneficial. Facial patterns can be developed using various algorithms such as YOLO version 9. By implementing facial recognition attendance, students no longer need to carry cards that are prone to loss due to their small size. Furthermore, facial recognition attendance is secure against cheating methods such as students passing cards to each other.

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