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Design and Development of an IoT-Based Escalator Control System Using WhatsApp as a Learning Medium at Makassar Aviation Polytechnic

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Abstract

The limited practical laboratory facilities at Makassar Aviation Polytechnic, especially for the Airport Equipment course, force students to make direct visits to the airport to study equipment such as escalators. This condition not only hampers the effectiveness of learning but also adds to the cost and time burden. This research aims to design and test an Internet of Things (IoT)-based escalator control system integrated with WhatsApp application as an interactive learning media. The system is controlled through WhatsApp message commands using ESP32, which is connected to the SSR module, LCD, buzzer, and AC motor. The tool development was carried out using the Research and Development (R&D) method and tested using a black box testing approach. The test results show that all system components work optimally, and a survey involving 29 respondents showed an average effectiveness rate of 97.8%. The system proved to be easy to understand, responsive, and suitable for learning needs. Thus, this tool not only accelerates students' understanding of IoT-based automatic control systems, but also becomes an efficient solution to overcome the limitations of practicum facilities in the campus environment. This system also opens up the potential of utilizing popular communication platforms as a means of controlling engineering devices in the world of vocational education.

Key Words: IoT, Escalator, WhatsApp, ESP32, Learning Media, Aviation Polytechnic.

INTRODUCTION

According to Law of the Republic of Indonesia Number 1 of 2009, Aviation is a unified system consisting of the use of airspace, aircraft, airports, air transportation, flight navigation, safety and security, the environment, as well as supporting facilities and other public facilities. Meanwhile, Airspace is the area of air sovereignty above Indonesia's land and waters.

The need for air mode transportation using aircraft to transport passengers, cargo, and posts increases every year. To support the service and comfort of air transportation service users, it requires mastery related to airport service support equipment. In order to plan infrastructure, design and maintenance of airport equipment in accordance with the needs and development of the times, competent Human Resources in the field of Air Transportation are needed.

Transportation Human Resources Development is an important element in carrying out the duties and functions of the Ministry of Transportation. Therefore, BPSDMP (Transportation Human Resources Development Agency) which is a unit under the Ministry of Transportation of the Republic of Indonesia is tasked with developing human resources in the field of transportation by forming an implementing unit in the form of a transportation high school to support its duties and functions, one of which is Makassar Aviation Polytechnic. The duties and functions of BPSDMP are contained in the Regulation of the Minister of Transportation Number PM 189 of 2015.

Makassar aviation polytechnic is a Technical Implementation Unit (UPT) under the auspices of the Transportation Human Resources Development Center (BPSDM) which has the main task of carrying out diploma education and aviation training in order to produce competent Transportation Human Resources in the world of air transportation, namely skilled personnel who are ready to use because they apply special / vocational education programs to obtain special skills that are operational / practical in nature with certain skill specifications. Makassar Polytechnic offers several Diploma III study programs, namely Airport Technology (TBU), Air Navigation Technology (TNU), Aircraft Maintenance Technology (TPPU), and Air Traffic Management. (Wartoyo, 2023).

The Airport Technology Study Program is a study program that focuses on vocational education in Airport Engineering which is a combination of three study programs namely Airport Mechanical, Airport Electrical and Airport Foundation Building. To support learning with a variety of courses, an effective learning method is needed according to the ability of students in the Official School. Generally, the School applies practice-based vocational learning. Indeed, theory is very helpful for practice. And the existence of theory also actually comes from practice, but the human brain will understand something faster through direct practice with related devices. According to Edgar Dale, it is 90% easier for humans to understand something by simulating and doing real things compared to just reading and listening.

There are several courses in the TBU study program, one of which is Ground Support Equipment and Airport Equipment. Students graduating from the TBU Study Program must have a Traction Equipment Certificate of Competence. Traction equipment consists of elevators, escalators, travelators, conveyors, and Garbarata. Traction equipment as an operational support tool for aviation facility services that has a function to provide comfort and smoothness for service users in the operations building (Zulina et al., 2023). While one of the equipment that supports comfort in airports, especially airport train stations, is an escalator.

According to (Gunardi & Muhya, 2015) Escalators or walking stairs are one of the vertical transportation in the form of a conveyor to transport people consisting of separate stairs that can move up and down following a path in the form of a rail or chain driven by a motor.

Based on PM Ketenagakerjaan RI No.6 of 2017 concerning Occupational Safety and Health of Elevators and Escalators. Escalator is a transportation aircraft to move people and / or goods, following a rail track driven by an electric motor. The parts of the Escalator consist of a base curve, steps / pallets, take-off plane, protective wall, bottom protection, handrail / handrail and glide path / void.

As a vocational college, Makassar Aviation Polytechnic also teaches Escalator equipment both in theory in the classroom and practically in the field, namely at Sultan Hasanuddin Airport Makassar, especially in the Airport Technology Study Program in the Airport Equipment course.

So that when carrying out practical activities students take part in visitation at Sultan Hasanuddin Airport Makassar where the Campus must facilitate transportation for students to travel from campus to Sultan Hasanuddin Airport Makassar. With that, the campus incurs costs for transportation and drains student energy in carrying out practical visitation at Sultan Hasanuddin Airport Makassar. The rapid development of technology makes students often late to get information and learn directly so that more visits are needed to meet student learning competencies.

According to the Regulation of the Minister of Education and Culture Number 3 of 2020 Article 34 concerning National Higher Education Standards. The standard of learning facilities referred to is educational equipment as learning support on the Makassar Aviation Polytechnic campus.

Learning is a process where learners and teachers interact with each other which results in the transfer of knowledge material from teachers to learners through teaching and learning activities. Especially for users of courses that can be maintained along with regulatory issues that can provide changes to the broader field of network technology and still continue to evolve, mutate, impact, but not always benefit the interests of society or the public in front of private and commercial forces and lack of application of theory to practicum (Rafika et al., 2020).

From the above background, it is found that the Makassar Aviation Polytechnic Airport Technology Study Program does not have complete laboratory facilities so that it must carry out visitation to Sultan Hasanuddin Airport Makassar to fulfill practical learning. One example is in the course of Airport Equipment, especially the Escalator Tool. Students must conduct visitation to the Mechanical Unit of Sultan Hasanuddin Airport Makassar to support practical learning. This is less efficient because the campus incurs costs for transportation and drains student energy in carrying out practical visitation at Sultan Hasanuddin Airport Makassar.

The lack of learning media for practicum is still one of the reasons for the obstruction of material delivered by lecturers to be understood by students, encouraging the importance of developing interactive learning media that suits the needs of Makassar Polytechnic students in the airport equipment course in the TBU study program. The learning process in the course has no trainer as a practicum media so that the material provided by the lecturer is only limited to theory without providing practical understanding.

One of the main challenges in the use of escalators within the campus environment is the reliance on manual operation without the support of a remote control system. This leads to inefficiencies, particularly in terms of energy consumption, as the escalator operates continuously without regard to actual usage. Furthermore, from an educational perspective, the application of Internet of Things (IoT) technology in escalator control systems as a learning medium has not yet been implemented at the Makassar Aviation Polytechnic. Therefore, this research aims to design and develop an IoT-based escalator control system that can be operated via WhatsApp. This solution not only addresses the issue of operational efficiency but also enhances the learning experience by providing students with direct exposure to applicable and modern control system technologies, reducing the need for off-campus visits.

Research on IoT-based escalator control systems has been conducted, but integration with WhatsApp as a control application and design implementation as a learning medium are still rare. Most of the previous research focuses more on the use of specialized applications or other IoT platforms. Thus, this research is unique in terms of the approach used, namely utilizing WhatsApp as a control medium that is more easily accessed and understood by users, especially students and educators at Makassar Aviation Polytechnic.

This research is expected to provide benefits in both academic and practical aspects. Academically, the designed system can be a learning medium for students in understanding the concept of IoT and its application in the real world. Practically, this system can increase energy efficiency by controlling the escalator only when needed, and provide convenience for managers in monitoring and controlling escalator operations remotely. In addition, the results of this research can also be a reference for the development of similar technologies in various airport and other public facilities.

Based on previous research, an automatic escalator was made, using an Arduino Pro Micro microcontroller with bottom and top sensors, the ultrasonic sensor functions as a distance detector between the acrylic and the escalator itself, the escalator will automatically follow as designed. By adjusting the motor speed from the microcontroller, the escalator will run properly. An automatic escalator simulation based on Arduino Pro Micro microcontroller has been made (Gunardi & Muhya, 2015). With that research still needs to be refined with remote control via WhatsApp as an application that is easily found by users.

Therefore, a learning media is needed that can support the learning process of students at Makassar Aviation Polytechnic without having to rely entirely on visitation activities to Makassar Sultan Hasanuddin Airport. Based on these problems, the author focuses this final project research on designing and building an Internet of Things (IoT) based escalator control system that can be operated via the WhatsApp application as an alternative learning media. The title of this final project is "Designing an IoT-Based Escalator Control System Through WhatsApp as a Learning Media at Makassar Aviation Polytechnic".

METHOD

A. Research Design

The research design is a framework that is used as a guide in carrying out the research process systematically. This design includes the initial stages of preparation, design, manufacture, to testing and reporting the results of the research conducted.

This research uses the Research and Development (R&D) method, which is a research method that aims to produce a certain product or tool and test the effectiveness and feasibility of the product or tool. In the context of this research, the product developed is an Internet of Things (IoT)-based escalator control system that can be accessed through the WhatsApp application as a learning medium. The stages of this research design can be described through the following diagram:

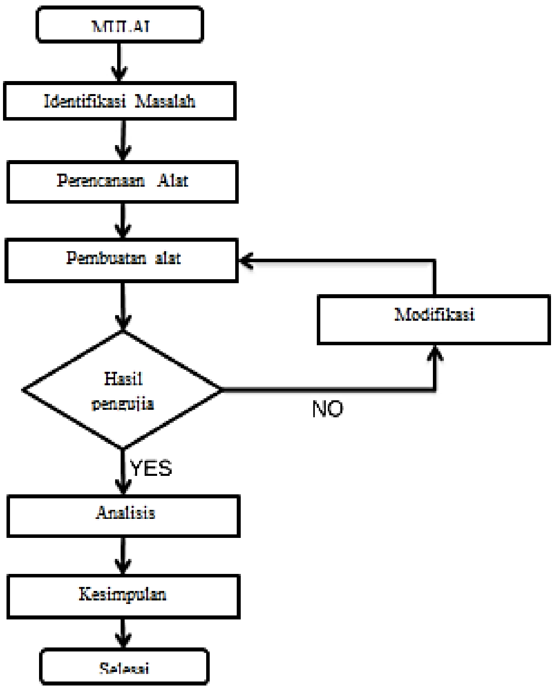

Figure 1. Research Flow Diagram
Source: Author's Processed Data

1. Problem Identification: At this stage, the process of identifying the problems that occur in the Makassar Aviation Polytechnic environment is carried out. The main problem found is the absence of relevant learning media in the use of technology-based escalator control systems, as well as inefficient use of energy due to manual control systems.
2. Tool Planning: After the problems are identified, the next step is to design a tool that can be a solution to these problems. At this stage, the system design, hardware and software components to be used, and technical specifications of the tool are determined.
3. Tool Manufacturing: This stage includes the process of assembling all hardware components according to the planned design. In addition, microcontroller programming and system integration are also carried out so that the tool can function as intended.
4. Tool Testing: The tool that has been made is then tested to find out whether it functions as expected. If the test shows results that are not yet appropriate, then improvements or modifications are made to the tool, then tested again until it reaches optimal results.
5. Data Analysis: Data obtained from the results of tool testing are analyzed to evaluate the performance of the tool, the level of effectiveness, and the achievement of the objectives of the designed tool.
6. Conclusion: Based on the results of the analysis, conclusions are drawn regarding the effectiveness of the tool that has been designed and made. At this stage it is also concluded whether the tool can be a solution to the problems that have been identified at the beginning of the research.

B. Tool Design

This tool design will involve several electronic devices. From this design, it will be connected to the Fotek-40 DA SSR Module to control the on / off of the escalator which is connected to Esp 32 to send notifications or receive messages / commands from Whatsapp.

1. Tool Design

In designing and making tools, a block diagram is needed which functions to explain and organize the flow of the system as a whole.

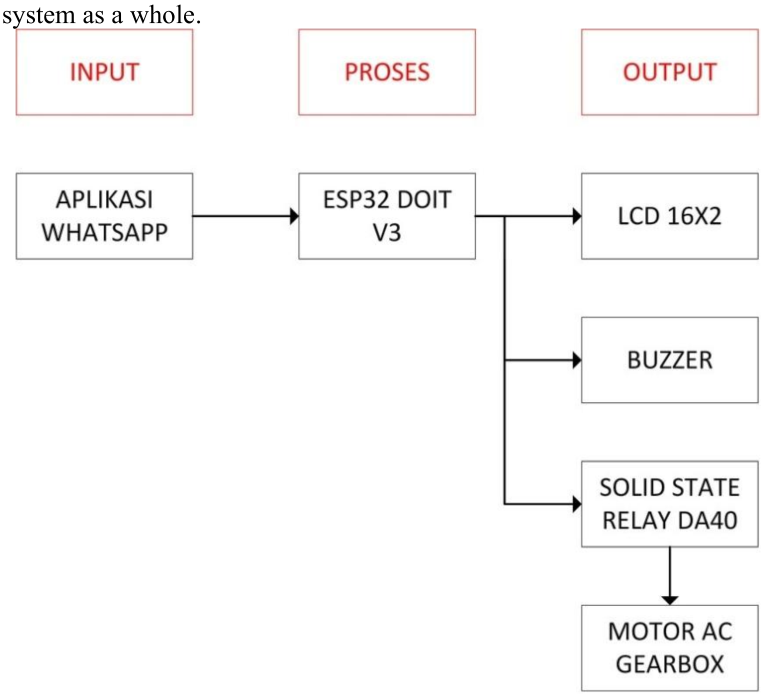

Figure 2. Block Diagram of Tool Design
Source: Author's Processed Data

a. The WhatsApp application is used as a communication medium between the user and the control system.
b. ESP32 DOIT V3 is a microcontroller with Wi-Fi connectivity used as the main processing unit.
c. LCD 16x2 functions to display status or messages from ESP32, such as Status: ON, Status: OFF, or other notifications according to WhatsApp input.
d. Buzzer functions as an alarm or sound indicator when the system is active.
e. SSR DA40 module functions to control the electric current to the AC Gearbox Motor to drain or cut off the power to the AC Motor.
f. AC Gearbox Motor as the driving motor of the Escalator, the motor will be on or off depending on the command sent from WhatsApp via ESP32 and relay.

2. How the Tool Works

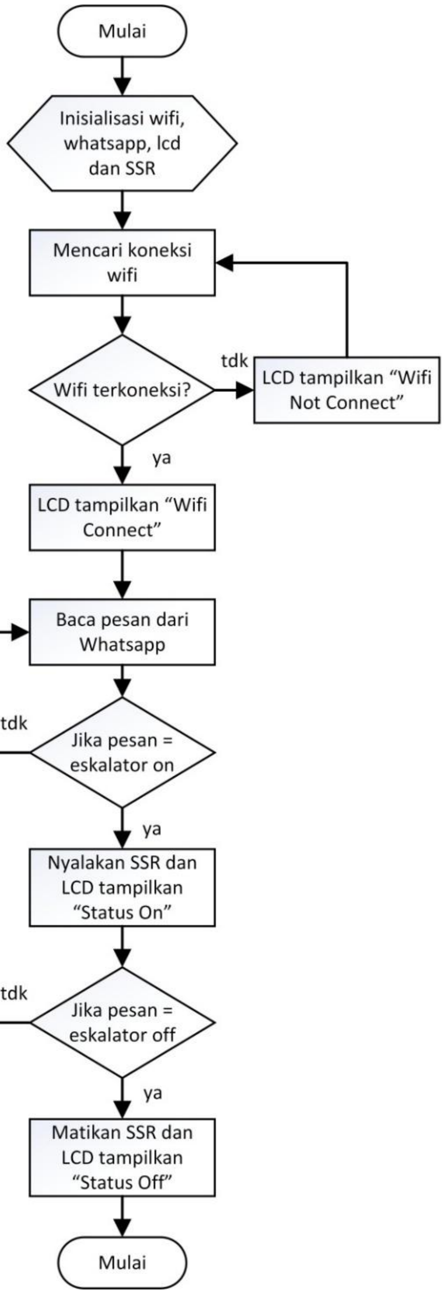

Figure 3. How the Tool Works
Source: Author's Processed Data

3. Tool Components
   In the design and development of this control system, several hardware and software components were utilized, including the following:
   a. Hardware Components
      1) ESP32: The ESP32 serves as the main microcontroller unit (MCU) and acts as the central control system for the entire device.

Table 1. Specification of ESP32

No	Specification
1	Processor
2	Input Voltage
3	PWM Channels
4	ADC
5	GPIO Pins
6	Flash Memory

Source: Author's Processed Data

2) SSR Module (Solid State Relay): The SSR module functions as an electronic switch to control the power supply to the escalator motor.

Table 2. Specification of SSR Fotek Module

No	Specification
1	Output Power
2	Input Power Supply
3	Control Signal Voltage

Source: Author's Processed Data

3) 12V Power Supply: This component supplies electrical power to the ESP32, buzzer, and LED components.

Table 3. Specification of Power Supply

No	Specification
1	Output Voltage
2	Input Voltage (AC)
3	Dimensions

Source: Author's Processed Data

4) LCD Display: This component displays the status of the escalator control system, such as ON/OFF indicators.

5) 220V AC Gearbox Motor: The motor serves as the primary actuator that drives the escalator movement.

Table 4. Specification of Motor

No	Specification
1	Speed
2	Voltage
3	Current

Source: Author's Processed Data

b. Software Components

1) Arduino IDE: This software is used to write, compile, and upload code to the ESP32 microcontroller.

2) WhatsApp: This application serves as a remote-control interface for the escalator system, integrated via the Twilio API bot to send and receive commands.

4. Tool Testing Technique

The testing technique used in this research is by means of direct testing which is used to test the functions of the software from the design. In this study using black box testing. Black box testing is a testing technique that focuses on the functional specifications of the software. Black box testing is a software testing method that tests the functionality of the application as opposed to the internal structure or work (Pradana Putra et al., 2020).

5. Data Analysis Techniques

From the problems described earlier, the authors will design a tool that functions remotely. As for the data and tests that have been obtained and have conducted testing tests, the following data analysis is obtained:

a. Looking for references related to the circuit and its materials.

b. Designing tools/mockups.

RESULTS AND DISCUSSION

A. Tool Design Process

1. Hardware Manufacturing Process

a. Hardware Installation

1) Design PCB wiring/layout according to wiring diagram needs.

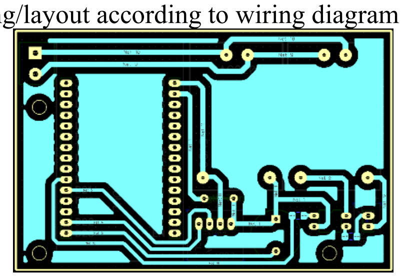

Figure 4. PCB design
Source: Author's Processed Data

2) Printing the design on 85gram kingstruk paper.
3) Transferring the printout on a plain PCB using heating technique.
4) Dissolving PCB by using Water, H2O2, and HCL in the ratio of 6:2:1
5) Punching the pcb board according to the pad on the design
6) Sticker Installation
7) Installation of Esp 32, Power Supply and buzzer components using soldering.
8) Installation on Escalator Mockup

b. Software Development Process

In this process, the Arduino IDE software is used for programming the coding of the tool design. The steps are as follows:

1) Download the Arduino IDE application on google.

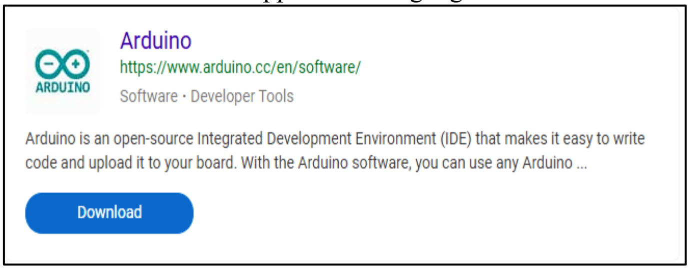

Figure 5. Download the Arduino Application
Source: Author's Processed Data

2) Open the Arduino IDE application to start coding the tool design and make the tool design code according to what is needed.

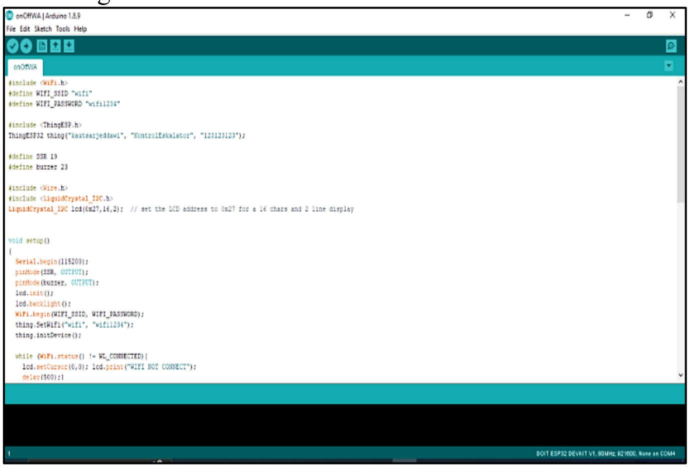

Figure 6. Escalator Control System Code
Source: Author's Processed Data

3) After the coding is complete, the next step is to check the coding by clicking verify on the Arduino software to find out if there are any errors in the coding.

Figure 7. Verify Coding
Source: Author's Processed Data

4) If there is an error, fix it immediately, but if it is correct, the next step is to upload the code to the Arduino Esp 32 board using a USB cable.

Figure 8. Upload Coding to ESP 32
Source: Author's Processed Data

5) Setelah koding ter*upload*, selanjutnya cabut kabel usb dan memasang board Arduino Esp 32 ke PCB.

2. Making a Survey of the Effectiveness of Tool Design
The process of making a survey of the effectiveness of designing an Iot-based Escalator Control System tool via Whatsapp as a learning medium at Makassar Aviation Polytechnic, is divided into several steps as follows:
a. Collecting Survey Data
The author has made a questionnaire instrument using Google Form, then the questionnaire is distributed to students via social media. From distributing the questionnaire, the author obtained 29 respondent data.
b. Processing data
The data obtained from the survey results are as follows:

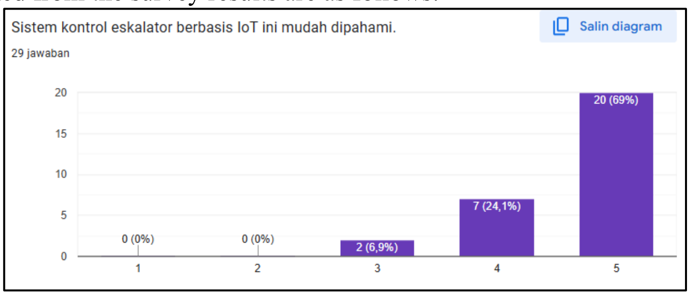

Figure 9. Data Results of Questionnaire Statement 1
(*Source: Google Form*)

In the first questionnaire statement, the data results from 29 respondents stated that 20 people strongly agree that the IoT-based escalator control system is easy to understand, 7 people agree that the IoT-based escalator control system is easy and 2 people are neutral about the IoT-based escalator control system is easy.

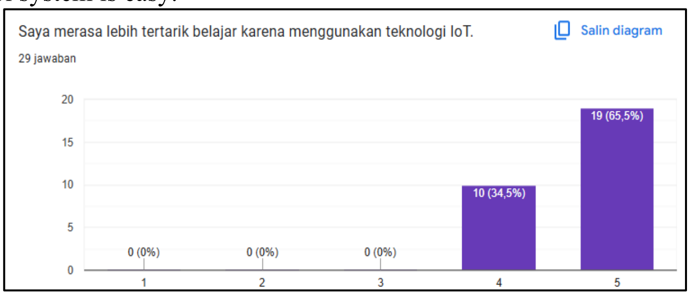

Figure 10. Data Results of Questionnaire Statement 2
(*Source: Google Form*)

In the second questionnaire statement, the data results from 29 respondents stated that 19 people strongly agreed with the interest in learning to use IoT technology such as this Escalator control system and 10 people agreed with being interested in learning to use IoT technology.

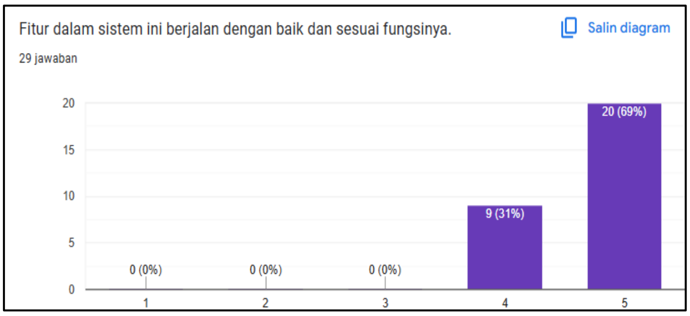

Figure 11. Data Results of Questionnaire Statement 3
(*Source: Google Form*)

In the third questionnaire statement, the data results from 29 respondents stated that 20 people strongly agree that the features in this system run well according to their functions and 9 people agree that the features in this system run well and according to their functions.

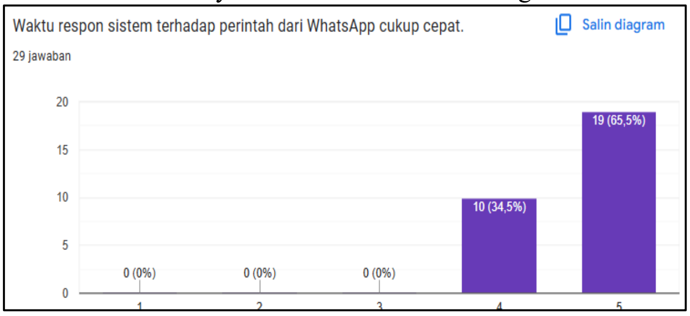

Figure 12. Data Results of Questionnaire Statement 4
(*Source: Google Form*)

In the fourth questionnaire statement, the data results from 29 respondents stated that 19 people strongly agreed that the system response time to commands from Whatsapp was fast enough and 10 people agreed that the system response time to commands from Whatsapp was fast enough..

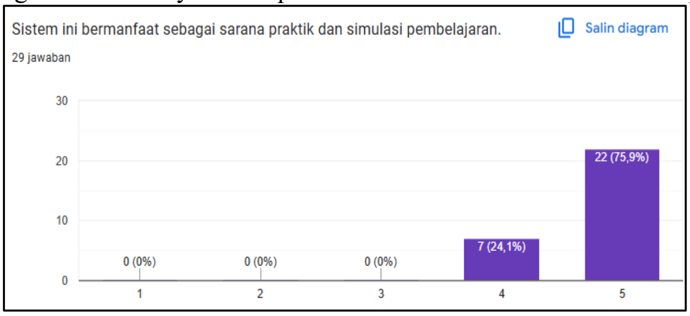

Figure 13. Data Results of Questionnaire Statement 5
(*Source: Google Form*)

In the fifth questionnaire statement, the data results from 29 respondents stated that 22 people strongly agreed that this system was useful as a means of learning practice and simulation and 7 people agreed that this system was useful as a means of learning practice and simulation.

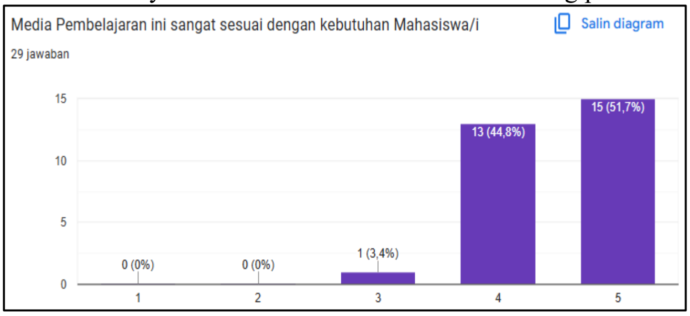

Figure 14. Data Results of Questionnaire Statement 6
(*Source: Google Form*)

In the sixth questionnaire statement, the data results from 29 respondents stated that 15 people strongly agreed that this learning media was very suitable for the needs of students, 13 people agreed that this learning media was very suitable for the needs of students and 1 person was neutral that this learning media was very suitable for the needs of students.

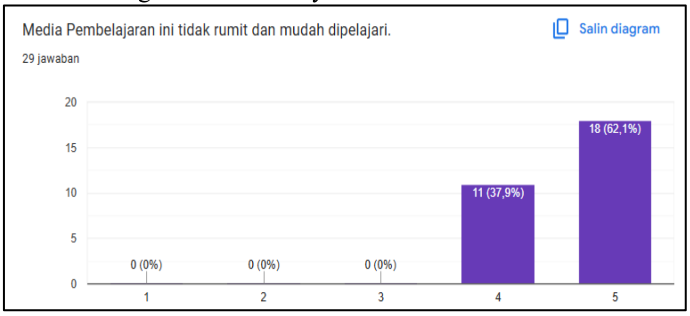

Figure 15. Data Results of Questionnaire Statement 7
(*Source: Google Form*)

In the seventh questionnaire statement, the data results from 29 respondents stated that 18 people strongly agree that this learning media is not complicated and easy to learn and 11 people agree that this learning media is not complicated and easy to learn.

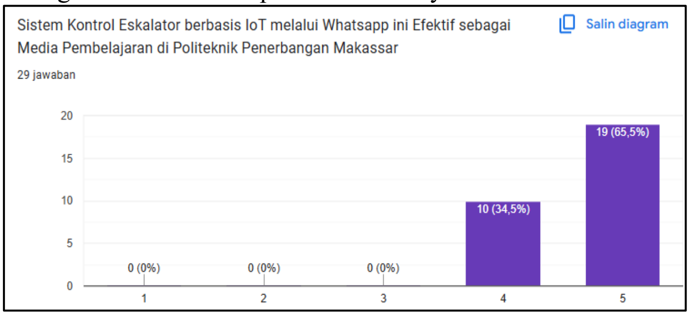

Figure 16. Data Results of Questionnaire Statement 8
(*Source: Google Form*)

In the eighth questionnaire statement, the data results from 29 respondents stated that 19 people strongly agreed that the IoT-based Escalator control system via whatsapp is effective as a learning medium at Makassar Aviation Polytechnic and 10 people agreed that the IoT-based Escalator control system via whatsapp is effective as a learning medium at Makassar Aviation Polytechnic.

c. Perhitungan Efektivitas

1) The control system is easy to understand.

$$\text{Percentage} = (27/29) \times 100 = 93\%$$

2) The system response time to whatsapp commands is fast enough.

$$\text{Percentage} = (29/29) \times 100 = 100\%$$

3) This learning media is very suitable for the needs of students.

$$\text{Percentage} = (28/29) \times 100 = 96\%$$

4) This learning media is easy to understand and not complicated.

$$\text{Percentage} = (29/29) \times 100 = 100\%$$

5) This IoT-based escalator control system via Whatsapp is effective as a learning media at Makassar Aviation Polytechnic.

$$\text{Percentage} = (29/29) \times 100 = 100\%$$

B. Discussion of Research Results

In this sub chapter, the author will discuss how the IoT-based Escalator control system tool design works via Whatsapp as a learning media at Makassar Aviation Polytechnic where this tool can be an effective innovation in helping students understand how IoT-based escalators work in campus learning. Therefore, it is necessary to test each component used to ensure that the components work properly. Testing the entire tool is useful for knowing the success of the tool design.

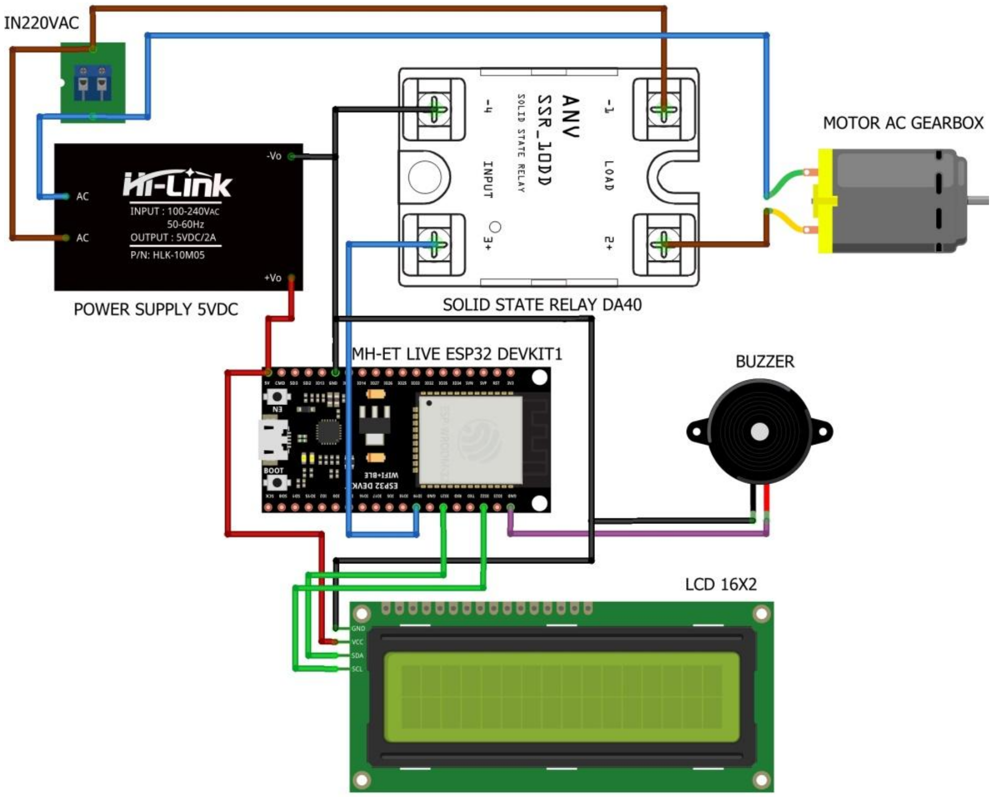

Figure 17. Wiring Diagram Design
Source: Author's Processed Data

1. Tool Working System
   This design works by turning on / off automatically when getting a command from Whatsapp, namely "escalator on" to turn on the escalator or "escalator off" to turn off the escalator sent to the Arduino Esp 32 which is connected to the SSR Module then turns on / off the motor from the Escalator. When Whatsapp sends a command to Esp 32, the buzzer will sound as an indicator that the command has been sent to the SSR Module so that when damage or problems occur it can be known quickly that the damage is in the Escalator motor.
2. Testing Results
   Before being used for learning media, the design must be ensured in good condition. Therefore, it is necessary to test the components that will be used to ensure that each component is working properly before testing as a whole. Testing the entire tool is useful for knowing how the performance and success rate of the designed tool.
   a. PLN Voltage Testing
      PLN voltage serves to provide 220 VAC voltage to the Gearbox Motor and to the SSR. Testing is done by measuring the phase of PLN and neutral from PLN. How to test:
      1) Prepare a digital avometer.
      2) Take measurements on the PLN Input voltage.
      3) Record the measurement results.

Figure 18. PLN Voltage Testing
Source: Author's Documentation

Table 5. PLN Voltage Testing Results

No	Incoming Voltage
1	231.4 V
2	235 V
3	233 V

Source: Author's Data

Based on the test results presented in Table 5, it can be concluded that the voltage supplied by the PLN (State Electricity Company) to the device's circuit falls within the expected range of 220–240 VAC, thereby meeting the required specifications for proper operation.

b. Power Supply Testing

Power supply functions as an AC to DC current converter to fulfill SSR input and other component inputs such as, LCD, Esp 32 and buzzer. How to test:

1) Prepare a digital avometer.
2) Take measurements on the output voltage of the Power Supply and SSR input.
3) Record the measurement results.

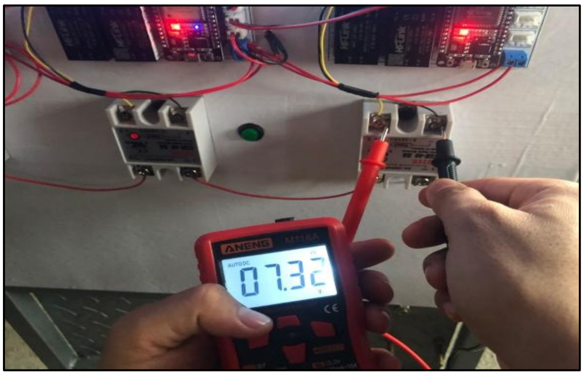

Figure 19. Power Supply Testing
Source: Author's Documentation

Based on the testing illustrated in Figure 4.16, the results obtained are summarized in the following table:

Table 6. Power Supply Testing Results

No	Output Voltage
1	7.32 VDC
2	7.34 VDC
3	7.40 VDC

Source: Author's Data

The test results indicate that the power supply output voltage consistently falls within the expected range, ensuring that the device receives a stable and reliable DC voltage for optimal performance.

c. LCD Testing

The LCD functions as a Wifi connect/not connect status indicator screen and escalator on/off status. How to test:

1) Prepare a digital Avometer.
2) Test the LCD input volt and LCD ground.
3) Record the measurement results.

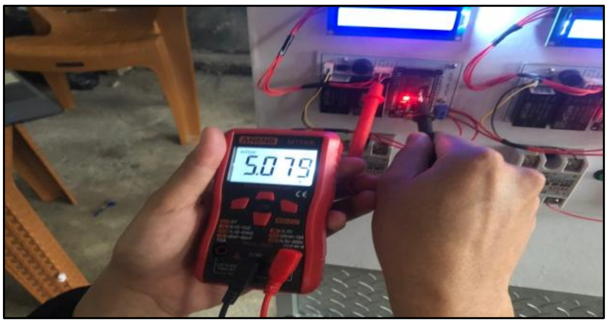

Figure 20. LCD Input Testing
Source: Author's Documentation

Based on the testing conducted, the following results were obtained:

Table 7. Input Voltage Testing Results for LCD

No	Input Voltage
1	5.07 VDC
2	5.00 VDC
3	5.10 VDC

Source: Author's Data

The results indicate that the LCD operates properly with an input voltage of approximately 5 VDC. The display is able to function as intended and successfully shows the text uploaded via the Arduino IDE, confirming that the voltage supplied meets the operational requirements of the LCD module.

d. Esp 32 Testing

Esp 32 functions to process the coding program and send output to SSR, buzzer and LCD. Esp 32 has a pin function as input / output data that will be processed in the design of this tool. How to test:

1) Prepare a digital Avometer.
2) Test the Volt input Esp 32 and gnd Esp 32.
3) Record the measurement results.

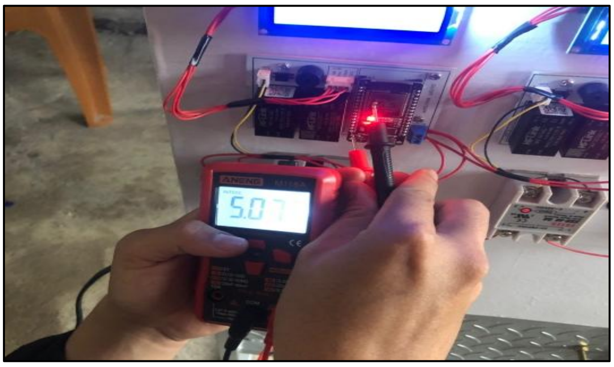

Figure 21. Testing Esp 32
Source: Author's Documentation

e. Testing the SSR Module

The SSR module functions as a breaker or connector of Voltage on the Gearbox Motor. How to test:

1) Prepare a digital Avometer.
2) Test the Volt on the AC phase output of the SSR and neutral on the Power cable.
3) Record the measurement results.

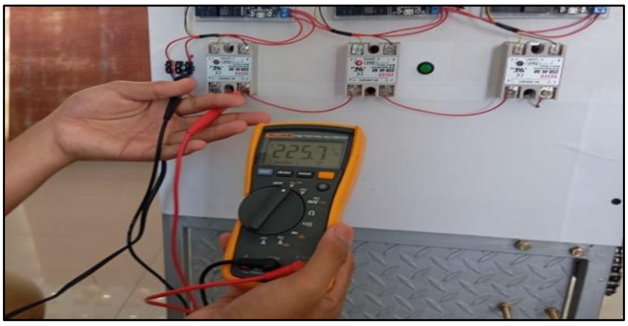

Figure 22. SSR Testing
Source: Author's Documentation

Based on the testing conducted, the following results were obtained:

Table 8. SSR Output Voltage Testing Results

No	Output Voltage
1	225 VAC
2	228 VAC
3	226 VAC

Source: Processed Data by the Author

From the results above, it can be concluded that the SSR (Solid State Relay) module is functioning properly, successfully delivering an output voltage within the range of 220–230 VAC to power the gearbox motor.

3. Discussion of Survey Results
   Based on the survey development process and the results obtained, the following data were recorded:
   a. 93% of respondents stated that the IoT-based escalator control system via WhatsApp is easy to understand.
   b. 100% of respondents agreed that the system's response time to WhatsApp commands is fast.
   c. 96% of respondents indicated that the learning media meets the needs of students.
   d. 100% of respondents stated that the learning media is user-friendly and not complicated.
   e. 100% of respondents believed that the IoT-based escalator control system via WhatsApp is effective as a learning medium at Politeknik Penerbangan Makassar.

   Based on the above data, the average satisfaction percentage is 97.8%. Therefore, it can be concluded that the IoT-based escalator control system via WhatsApp is effective as an educational tool at Politeknik Penerbangan Makassar.

4. Advantages and Limitations of the System
   a. Advantages
      This control system operates remotely via WhatsApp, where user commands are sent to the Twilio bot. Upon receiving the commands, the bot forwards them to the ESP32 microcontroller, which then triggers the output through the SSR module.
   b. Limitations
      The system is restricted to a single registered WhatsApp number. To allow access from multiple users, each number must be pre-registered in the source code. Furthermore, the WhatsApp control feature is limited to simple On/Off commands for the escalator.

CONCLUSIONS

Based on the results of the discussion and analysis that has been carried out, the author concludes that an Internet of Things (IoT)-based escalator control system controlled through the WhatsApp application has been successfully designed and built using ESP32 components, SSR modules, buzzers, power supplies, and LCDs. This system is designed as an interactive learning media at Makassar Aviation Polytechnic, which is intended to support the teaching and learning process between students and lecturers, especially in the field of automation technology and IoT. In addition, based on the results of data processing from questionnaires distributed to respondents, an average satisfaction percentage of 97.8% was obtained. This shows that the IoT-based escalator control system via WhatsApp is considered effective and feasible to use as a learning medium at Makassar Aviation Polytechnic.

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