DESIGN AND CONSTRUCTION OF INTERACTIVE MEDIA PRECISION APPROACH PATH INDICATOR AS A LEARNING SUPPORT AT MAKASSAR AVIATION POLYTECHNIC

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Abstract — This study aims to design and develop an application-based interactive media as a learning tool for the Precision Approach Path Indicator (PAPI) system at Makassar Aviation Polytechnic. The background to this development is the limited direct practice facilities at the airport, so alternative media are needed that allow students to understand the working principles of PAPI independently. The method used is research and development (R&D) based on the Sugiyono model, with the stages of designing, developing, and testing the media. This media is designed using Visual Studio Code with HTML, CSS, and JavaScript programming languages and runs on local hosting to be used without an internet connection. Testing was conducted through a questionnaire to students of the Airport Technology study program to measure functionality, usability, and portability. The test results showed that the developed interactive media received positive responses from more than 88% of respondents in each aspect, indicating that this media is suitable for use as a learning support in the campus environment.

Keywords — Interactive Media, Precision Approach Path Indicator (PAPI), Learning, Airport Technology, R&D

I. INTRODUCTION

Indonesia has numerous airports across various regions, from major cities to remote areas. The rapid growth of the aviation industry has driven the development of international and pioneering airports throughout the country. Air transportation is now essential for developing countries and is increasingly important in the modern era. As the global population increases, so does the demand for transportation. The vast distances between cities, countries, and continents make transportation an unavoidable necessity, particularly air transportation. One of the main reasons people choose air transportation is its efficiency, particularly in significantly shorter travel times compared to other modes. To support this need, adequate infrastructure is necessary to ensure smooth flight operations. The runway is crucial in flight operations, particularly in layout, comfort, and lighting systems.

Runway lighting, or the Airfield Lighting System (ALS), plays a vital role in flight safety, particularly during takeoff and landing. This visual landing aid system enables aircraft to navigate the runway safely and efficiently. Special lights in this system provide visual cues for pilots, particularly in adverse weather conditions or at night. Therefore, the intensity and configuration of the lights must meet strict safety standards to maintain optimal performance under various flight conditions. Runway lighting installations cover a large area, so the potential for disruption due to fluctuations in light intensity is relatively high. Lighting instability can impact flight operations, particularly at night. Airway lights' Power imbalances can cause uneven distribution, requiring in-depth analysis to ensure stable lighting. Various types of lights are used on runways, such as taxiway lights, runway lights, and Precision Approach Path Indicators (PAPI). Hence, an optimal maintenance system ensures lighting quality meets aviation safety standards.

In education, learning is an interaction between students and teachers that aims to transfer knowledge through the teaching and learning process. Makassar Aviation Polytechnic (Poltekbang Makassar) is a higher education institution under the Ministry of Transportation of the Republic of Indonesia that focuses on vocational and academic education in the field of aviation engineering and safety. Poltekbang Makassar offers several Diploma III study programs, including Airport Technology (TBU), Air Navigation Technology (TNU), Aircraft Maintenance Technology (TPPU), and Air Traffic Management..

Interactive and applicable learning media are needed to support a better understanding of aviation so that students can more effectively understand the concept and implementation of the PAPI system. PAPI (Precision Approach Path Indicator) is a visual flight aid that helps pilots land by following the correct landing angle (on slope) as recommended to the landing point (touchdown zone)..

The interactive learning media designed by the author will later be used as a learning medium for visual aids, namely PAPI lamps. The author developed interactive learning media for PAPI lamps found at airports to provide practical equipment that functions similarly to those found at airports. With this interactive learning media, students can understand the working principles of PAPI lamps directly without relying on airport visits. In addition, students can carry out repeated practice, thereby improving their skills and understanding more deeply..

The system will be run using local hosting to ensure this learning tool can be used effectively. This allows the interactive tool to function without an internet connection, allowing for more stable use in the classroom or laboratory. Students can access the PAPI lamp simulation anytime and practice independently without relying on an external network. Furthermore, using local hosting also makes the system easier to run on various devices available on campus without requiring an online server.

II. THEORETICAL STUDY

Airports are hubs for aviation activity, equipped with runways, terminals, hangars, and other supporting facilities. One crucial element in airport operations is the runway lighting system, which plays a crucial role in maintaining safety, especially at night or during low visibility.

According to Regulation of the Minister of Transportation of the Republic of Indonesia No. 9 of 2022 concerning technical provisions for national air navigation, runway lighting, or the Airfield Lighting System (ALS), a key issue must be understood. Failure to comply with national aviation safety standards during takeoff and landing can pose a significant security risk. Therefore, the lighting intensity on the runway must be maintained. The runway installation is very long and extensive, and the potential for disruption is also high. If the lighting intensity is unstable, this will disrupt flight operations, especially at night. (Panjaitan & Sahputra, 2020).

The Precision Approach Path Indicator (PAPI) is a visual flight aid that helps pilots land by following the correct on-slope recommended to the landing point (touchdown zone). Because of its vital role, the instrument must always be ready, and its elevation angle must be precisely calibrated. (Wartoyo, 2023).

The Precision Approach Path Indicator (PAPI) is a visual landing tool that guides aircraft landing by providing the correct landing angle. For runways equipped with an Instrument Landing System (ILS), the PAPI landing angle must be the same as the landing angle provided by the ILS Glide Slope. To ensure the accuracy of the PAPI equipment angle, flight calibration is required every six months for PAPIs with ILS and every 24 months for PAPIs without ILS. (Surabaya & Clinometer, n.d.)

Learning media or interactive media can be used to convey messages (learning materials), so that it can stimulate students' attention, interest, and feelings in learning activities to achieve learning goals. According to (Muthoharoh & Sakti, 2021) Interactive learning media can motivate students to be more enthusiastic and improve student learning outcomes.

III. METHOD

The author used research and development (R&D) research to write this final assignment. According to Sugiono (2016:297), Research and Development (R&D) is a method used to produce a specific product and test its effectiveness.[6] The research stages included:

1. Instrument Design

This interactive media design aims to design and create interactive media that can be used as a learning support at the Makassar Aviation Polytechnic.

2. Population and Sample

This study's population was all students at the Makassar Aviation Polytechnic, and its sample in this study was students in the Airport Technology Study Program.

3. Design

Design of the Precision Approach Path Indicator interactive media as a learning support at the Makassar Aviation Polytechnic.

a. homepage

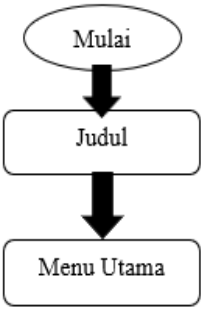

Figure 1 design home page

b. Main page

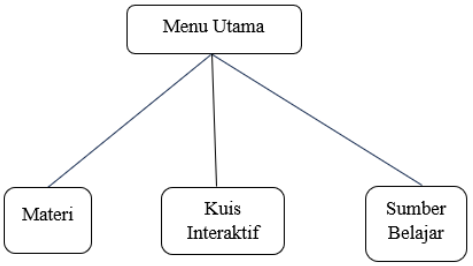

Figure 2 design main page

c. End page

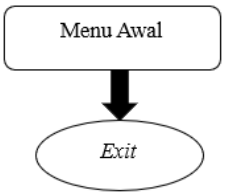

Figure 3 design ens pae

1. How Interactive Media Works

The Precision Approach Path Indicator interactive media, a learning aid at the Makassar Aviation Polytechnic, works as follows:

a. Home Page

Students log in to the interactive media and then view the title and main page of the interactive media.

b. Main Page

Students can view and select menus on the main page. These menus include learning materials, Precision Approach Path Indicator light simulations, and learning resources.

c. Closing Page

Students return to the main page menu and then press the exit button..

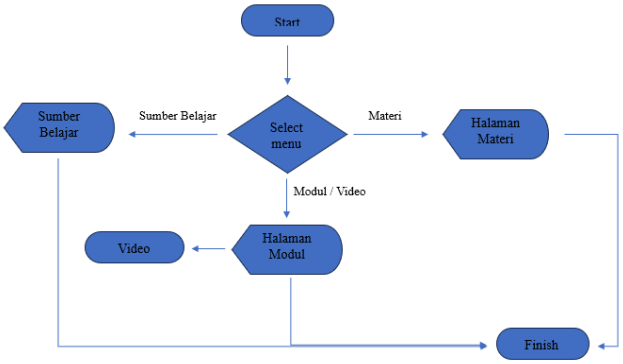

Figure 4 how aplication work

2. Data collection

To obtain accurate and relevant data in this study, the author used several data collection techniques, as follows:

a. Observation

Based on the researcher's initial observations, it was discovered that the learning process regarding the Precision Approach Path Indicator (PAPI) lighting system on campus was still theoretical. This was due to limited opportunities for students to conduct field trips to airports. This situation prompted the development of interactive media that could be used independently on campus as an alternative practical tool.

To assess the feasibility of the developed interactive media, the researcher conducted internal observations by directly testing the application. The data observed included feature completeness, user-friendliness of the interface, and the media's potential effectiveness in supporting the learning process.

b. Questionnaire

A questionnaire is a data collection method that asks respondents questions to provide information. The questionnaire evaluated the effectiveness, ease of use, and material quality of the Precision Approach Path Indicator interactive media.

IV. RESULT

A. Result and discussion

1. Result of research

This research developed an interactive media called the "Precision Approach Path Indicator Interactive Module." This interactive media development supports learning for Airport Technology students at the Makassar Aviation Polytechnic. This application can be accessed on a laptop, making it easier for students to conduct simulations directly without relying on airport visits. Furthermore, it allows students to engage in repeated practice, improving their skills and understanding more deeply..

2. Identify Potential and Problems

Based on observations conducted by researchers, it was found that learning about PAPI lamps on campus is still theoretical. Students lack practical experience due to limited opportunities for field trips to airports. This served as the basis for developing interactive media that can be used independently on campus..

3. Data collection

Data were collected through a literature review, including scientific journals related to the Precision Approach Path Indicator (PAPI) system, teaching materials used on campus, and references from ICAO Annex modules and FAA Advisory Circulars. Furthermore, technical specifications for components such as the ESP32, WS2812B, 20x4 LCD, and linear actuator used in the device simulation were collected.

4. product design

The product design consists of a desktop-based application that displays a visual simulation of the PAPI system, and is equipped with learning materials, learning resources, a video demonstrating the operation of a PAPI lamp mock-up, and an interactive quiz. The product design stage includes a learning media framework containing a flowchart for application development..

Figure 5 How the Application Works

5. Testing

In the product trial stage, a list of questions was created to check the application's function with students as data collection, which was then tested to find out students' opinions regarding the use of learning media..

a. Main display

The image below shows the initial display of the Precision Approach Path Indicator Interactive Module application. After opening the website, this display will appear, allowing users to access a selection of buttons for materials, learning resources, or quizzes..

Figure 6 Main Page View

b. Material Page Display

The image below shows a screenshot of the material page. The material page is the page accessed by the user. It's an application for viewing and selecting material to be studied..

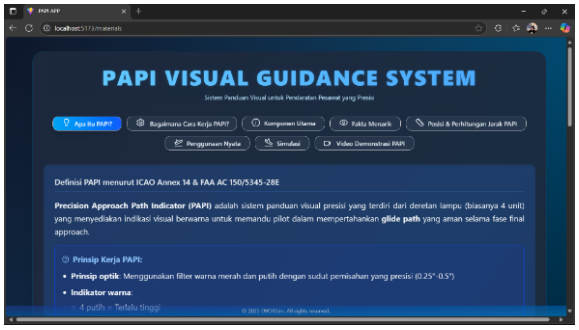

Figure 7 Material Page View

c. Simulation page display

The image below shows a simulation of the Precision Approach Path Indicator light. Users are presented with a virtual simulation screen to see the PAPI light colors..

- Simulation page display

Click the Simulation button on the learning materials page.

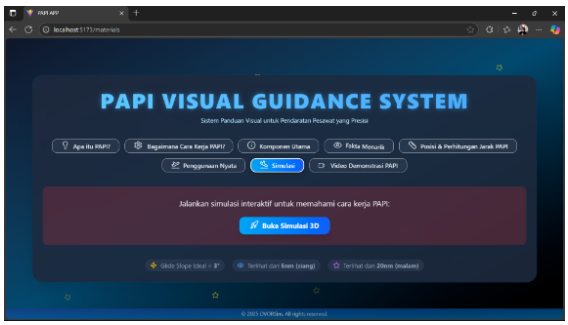

Figure 8 Simulation Button Display

Then, after clicking the "Open 3D Simulation" button, a 3D view of the PAPI lamps will appear, as shown in the image below. Next, click on one of the PAPI lamps..

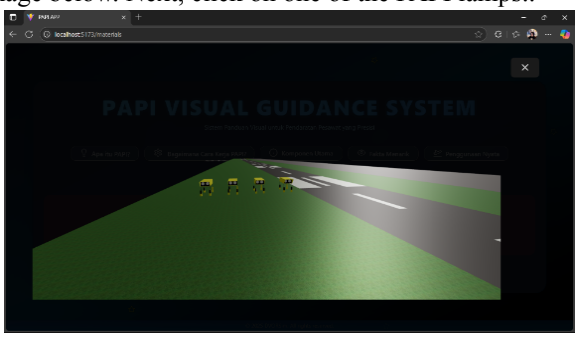

Figure 9 3D view of PAPI lamp

After clicking on one of the 3D PAPI light displays, the application user will see a simulated display of the aircraft and the color of the PAPI lights based on the aircraft's altitude..

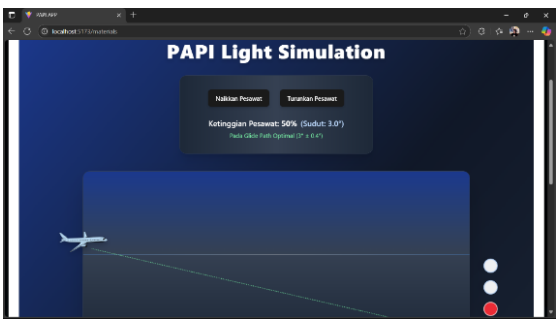

Figure 10 PAPI Lamp Simulation Display

d. PAPI Lamp Mock-up Video Simulation Display

The image below shows a video mock-up of the Precision Approach Path Indicator lamp. Users are presented with a visual display of the PAPI lamp mock-up's operation..

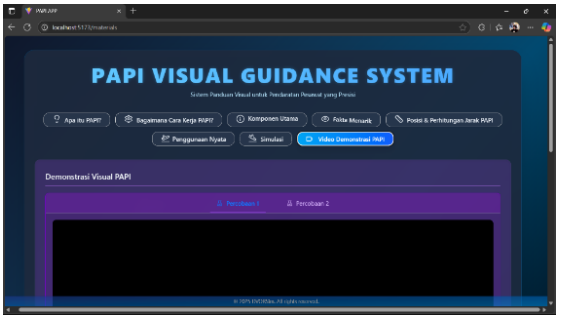

Figure 11 PAPI Lamp Mock-up Video Simulation Display

e. Learning Resource Display

The image below displays learning resources. In the Learning Resources menu, users are presented with two main categories: Learning Materials and Regulations & Standards. The Regulations & Standards category displays official international documents, such as ICAO (International Civil Aviation Organization) documents relevant to the Precision Approach Path Indicator (PAPI) topic, such as documents on Aerodromes..

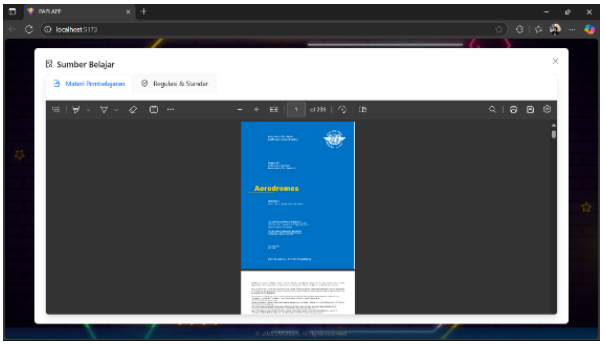

Figure 12 Learning Resources Display

f. Quiz display

The image below shows the quiz page. Users will answer several questions about their understanding of PAPI lamps and the steps to operate a PAPI lamp mock-up..

Figure 13 Quiz View

6. Discussion of Research Results

This interactive media received positive responses based on the results of trials with students of the Airport Technology Study Program at Makassar Aviation

Polytechnic. The functionality aspect was 91.2%, indicating that all features in the application function well and meet user needs. The usability aspect was 89.7%, indicating that the media is easy to understand, comfortable to use, and practical for students. Meanwhile, the portability aspect was 89.8%, indicating that the media can be operated smoothly on various devices and operating systems, and remains stable even when used repeatedly and without an internet connection..

V. CONCLUSION

Based on the research results, the following conclusions can be drawn:

The Precision Approach Path Indicator (PAPI) interactive media was successfully designed using the Sugiyono Research and Development (R&D) model. It encompasses problem identification, data collection, product design, and implementation using website-based technologies, including HTML, CSS, and JavaScript, with the assistance of Visual Studio Code. This media can be run offline via a local hosting system, eliminating the need for an internet connection.

The Precision Approach Path Indicator interactive media was deemed feasible and effective as a self-learning tool, particularly in enhancing students' understanding of the PAPI lighting system. Based on testing results with 68 respondents, this media achieved an effectiveness rate of 87.9%, which is categorized as very good on the Likert scale.

VI. SUGGESTION

Based on the conclusions reached, here are some suggestions for further development:

Given that this interactive media has proven effective in function, ease of use, and accessibility, further development of interactive content and features is highly recommended to ensure it continues to adapt to the needs and developments in digital educational technology.

This media's success in effectively conveying PAPI material can serve as a model or reference for developing similar media in other courses in Airport Technology, providing students with access to more diverse and engaging learning experiences.

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