

## **Airport Runway Defect Detection Device: A Project-Based Learning Media**

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**Abstract:** In the Aviation industry, runways play a significant role in flight safety. Damage to the runway can cause aircraft accidents that can harm several parties. The use of labor in inspection activities tends to frequent human error. Therefore, the author makes a neural network technology tool to detect runway damage at the airport. This research aims to design a runway defect detection device used as a project-based learning media for Transportation Cadets, especially Palembang Aviation Polytechnic Cadets, so they can absorb learning material quickly and find a new learning atmosphere. This research uses the research and development method by analyzing the needs qualitatively. The results of this study indicate that the design scenario and how this tool works can help in learning, especially project-based learning. Hence, the design of this tool can be utilized as a reference in the development and use of the tool.

**Keywords:** Airports, Defect Detection Device, Human Error, Project Based Learning, Runway

### **A. Introduction**

The airport runway plays a vital role in flight safety in the aviation sector. Damage to the airport runway can cause aircraft accidents and enormous losses for various parties, especially the airline, airport, and airplane passengers (Dwi, 2017). Therefore, ensuring that the airport runway is always in good condition and safe to use is essential. The problem of transportation infrastructure in Indonesia in the land, sea, and air modes still needs to be addressed to minimize the level of accidents by users of transportation services (Budiarto, 2017). Reviewing this, it is very necessary to survey the state of transportation infrastructure facilities so that they can be used as much as possible. However, the survey process is still done manually and must utilize the latest technology to identify road damage (Arum Sari, 2018). Therefore, the research study conducted by (Agung Wira, 2023) provides the latest innovation to classify road damage data with image patterns using convolutional neural networks. In this case, the output can be supervised by identifying road damage with maximum accuracy like the tests (Yoga Triardhana, 2020).

In addition to the mode of transportation, markings are a very important benchmark to provide traffic instructions or guide road users when using this mode of transportation. However, the research proposed by (Putra, 2023) revealed that there are still many users who are negligent with road markings, so accident cases are unavoidable. Therefore, a road marking detection system is necessary for classification using machine learning (Chen et al., 2015). Reviewing some of the problems above, we offer a solution to overcome these problems by building a defect detection device on the airport runway based on automation and sensors. This tool uses a sensor system to detect damage and send signals to the automation system to process data and display damage information (Ranyal, 2022). According to (Prakoso, 2020), this system can detect damage quickly and accurately, thus ensuring that the airport runway is always in good condition and safe to use.

Utilizing computerized technology that utilizes artificial neural network learning media with a supervised learning type will lead to the success of learning outcomes (Khairudin, 2012). Most of the dataset of images of surface cracks can be collected collectively and quickly so that the tool can read the fatal point of damage to the available roads (Mellyssa et al., 2022). Thus, all cadets quickly understand the learning that is done in class. Then, Anwar et al. (2022) successfully evaluated the accuracy of predicting learning outcomes with artificial neural networks. The device's performance for feature extraction methods and picture data processing is still being worked on. As a result, there is a certain lag between the development of analytical algorithms and data collecting. While conventional automated methods have been created, their complexity and lack of accuracy make them difficult to employ. Moreover, the majority of conventional techniques are predicated on several presumptions, including those on data distribution and boundary conditions. Even though most of these algorithms are theoretically effective, these limitations severely restrict their practical application. According to Utomo (2021), while most pavement management departments employ manual surveys, some automatically computed pavement condition assessment systems continue to use specific image processing methods. In recent years, advances in machine learning (ML) technology have given researchers new insights into how to create sophisticated crack detection techniques. Previous machine learning (ML) contributions were made by professionals who created crack detection techniques primarily through artificial neural networks, support vector machines, 14, 15, 16, and other ML techniques. However, these techniques only evaluate a portion of the fracture components because of limited computer power and inefficient structures, which produces less accurate results.

Maudi (2016) and Dewi (2021) suggest that project-based learning allows lecturers to manage classes by going directly to the field to raise problems that commonly occur so that the cadet learning process becomes more interesting. The learning process with this system will certainly be applied to cadets within the Ministry of Transportation, especially the Airport Engineering Technology Study Program. The learning outcomes of this course are Pavement Construction, Operation and Maintenance of Airport Engineering Facilities, and Maintenance Engineering. In the Maintenance Engineering course, cadets must be able to practice and classify the

types of damage, maintenance, and maintenance of land-side and air-side facilities. Then, the operation and maintenance of the airport engineering Facilities course requires all cadets to know some regulations and how to inspect airport facilities that need more intensive maintenance. After that, the Pavement Construction Engineering course requires all cadets to know the principles of pavement, investigation, and evaluation by considering the maintenance and evaluation of pavement structures at airports, especially runways. Based on this needs analysis, a project-based learning media is needed as a neural network-based runway defect detection device. The use of this tool is to motivate cadets to conduct experiments when they work on assignments. With a project-based learning approach using tools, cadets can practice simultaneously with the trial and error method, so learning outcomes can be achieved more effectively if not using tools.

## B. Methods

This study implements the Research and Development (R&D) methodology, which aims to produce goods and evaluate their efficacy (Sugiyono, 2008). An approach to creating tools by modifying the ADDIE framework is through research and development of the prototype model. The five phases of the ADDIE model are as follows: analysis, design, development or production, delivery or implementation, and evaluation. The stages of this research can be seen in Figure 1. This research focuses on a series of processes to develop a new product to answer community problems. In this study, up to the analysis and design stages.

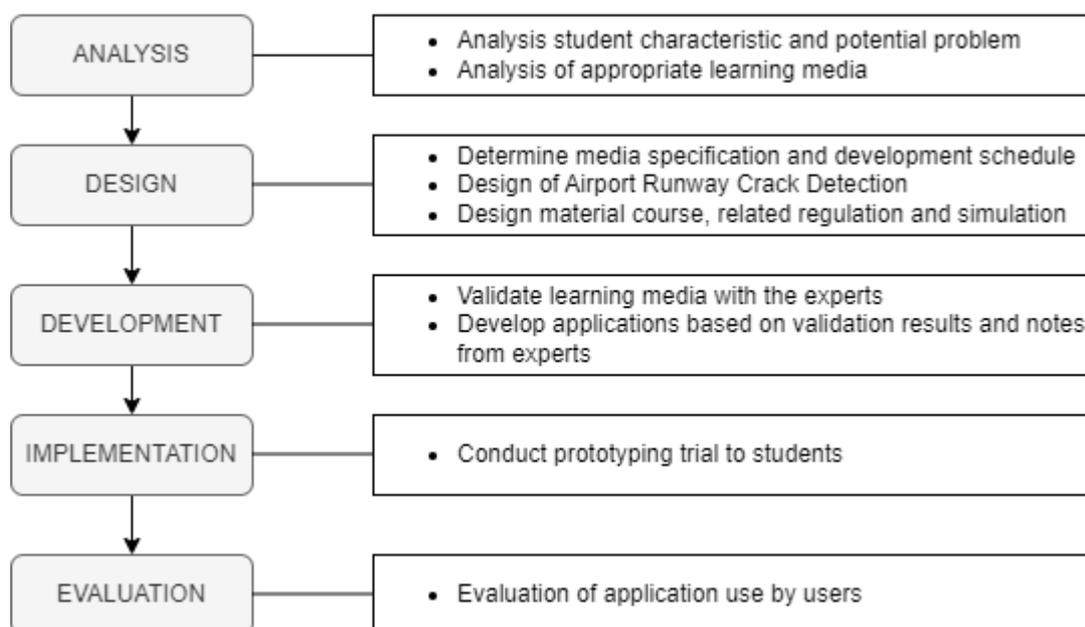


Figure 1. ADDIE Model

This research begins with observations and interviews with Sultan Mahmud Badarudin II airport practitioners as sources in the industrial world. This research also

interviewed cadets as end users in this learning. From the observations and interviews, a runway defect detection device design was obtained as a project-based learning media.

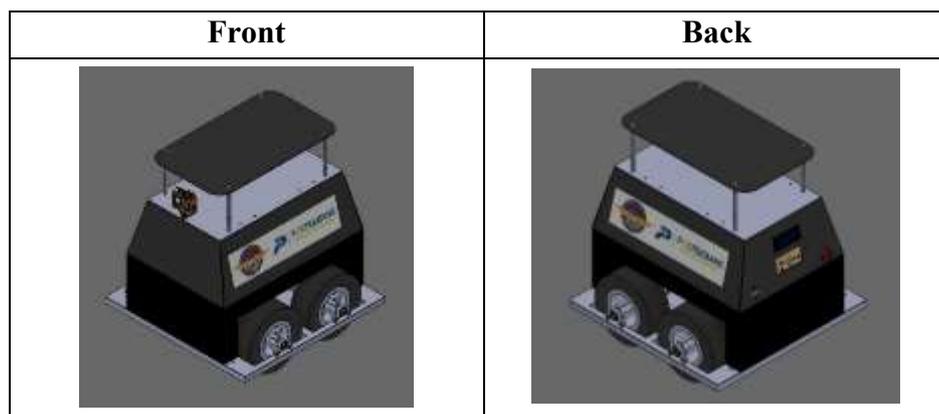
### **C. Results and Discussion**

Regarding the design of defect detection devices at airports, researchers conducted interviews with Angkasa Pura II about the maintenance mechanism for pavement construction, specifically at Sultan Mahmud Badaruddin II Airport. The standard operating procedures in maintenance management are listed in KP 94 of 2015 concerning types of damage and handling of small, medium, and large-scale damage at airports. To minimize damage, the airport conducts inspections twice daily, carried out in the morning and afternoon, to check for Foreign Object Debris (FOD) and cracks on the runway that can cause flight hazards (Akbar, 2021). Usually, the airport is only given 20 minutes to conduct routine inspections. The tools used in routine inspections are palm fiber brooms, stick brooms, shovels, and others because they are more directed at cleaning FOD. According to the source, from 2017 to 2023, no crack was found when inspections were carried out at Sultan Mahmud Badaruddin II Airport.

In addition to conducting daily inspections, Sultan Mahmud Badaruddin II Airport has work items routinely carried out to minimize the impact of aircraft accidents, including cleaning rubber deposits. Rubber deposits tend to be the reason for overlaying the runway because the rubber deposit value is still far below the limit despite maximum cleaning. Therefore, it is very necessary to cover the old layer. If the MU meter value is more than 0.42, it needs to be analyzed as a justification for follow-up to minimize troubleshot. After routine inspections, PT Angkasa Pura II recaps inspection reports from daily, monthly, and annual (Riandi, 2022). The report contains the type of damage and handling that occurred during the year, including FOD. To get the perfect category, there is a Pavement Condition Index Runway (PCI) report, which contains a percentage value as an indicator of its assessment. Currently, the condition of the Sultan Mahmud Badaruddin II runway is categorized as perfect because the runway PCI data categorizes 99% good with complete image details of each runway layer after the runway overlay is carried out. This reporting system is usually reported to the Airport Authority and the Directorate of Airports.

In addition to conducting interviews with Angkasa Pura II, researchers also conducted interviews with Palembang Aviation Polytechnic cadets, especially the Airport Engineering Technology study program, on the importance of neural network-based runway defect detection devices when developed as learning media in the subjects of pavement construction, maintenance engineering and operation and maintenance of airport engineering facilities. According to the resource person, learning pavement construction using innovative runway defect detection devices can make him understand technical and learning methods that are more interesting, innovative, and quick to understand. Meanwhile, cadets revealed that the application of neural network-based tools as a runway damage detector makes the implementation of technician work faster and does not need many hands to operate

it. Then, they argue that in learning activities with Project Based Learning, using a neural network-based runway defect detection device can increase the innovation and absorption of cadets when learning takes place. Based on the results of observations and interviews, it shows that neural network-based runway defect detection devices can minimize the work of airport technicians (Zhou et al., 2022). In addition, this tool can be developed as a learning media for cadets in lectures to increase understanding and a more innovative learning atmosphere (Utari, 2018). Therefore, researchers developed a neural network-based runway defect detection device with the image design in Figure 2.

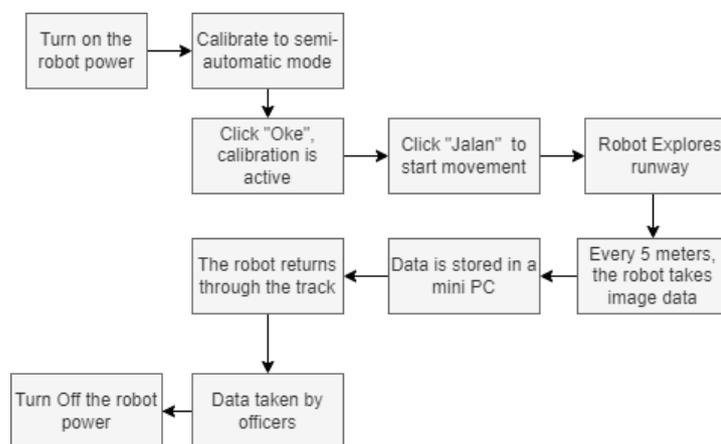


**Figure 2. Design of Airport Runway Defect Detection Device**

The design of this neural network-based defect detection device has the following workings:

1. Semi-Automatic

A semi-automatic way of working is a tool work process where most of the control system has been automated and still requires supervision from the user (Rumapea, 2020). The workflow of semi-automatic in project-based learning media is shown in Figure 3.

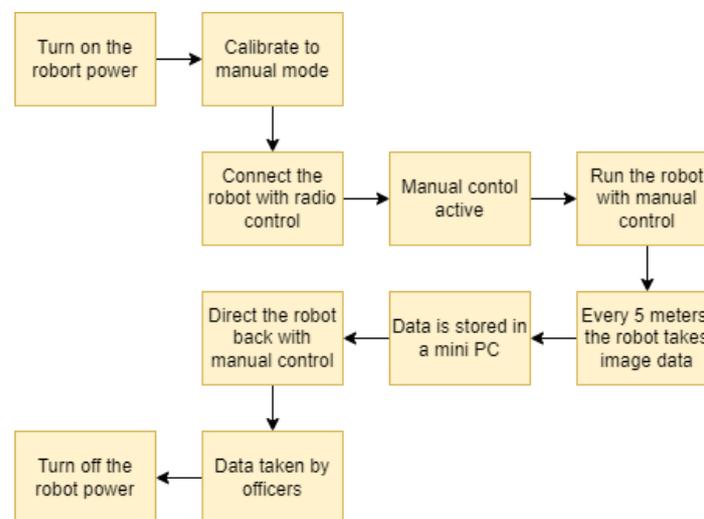


**Figure 3. Flow Chart of Semi-automatic in Project-based Learning**

The damage detector can be used as a project-based learning tool in the field by starting the engine first while calibrating the semi-automatic mode on the control board at the back of the robot. To activate the semi-automatic mode, select "OK". Then press "Go" to start the movement. Then, the robot will automatically go to the end of the runway by taking several image datasets every 5 meters and will be stored in the mini-PC. After completion and processing, the robot will automatically return to the starting place according to the route that has been traveled. Cadets can retrieve datasets on the mini-PC when the robot has arrived to explore the location, not forgetting the user to turn off the robot. Cadets can retrieve data and further research using a neural network for identification if there is a crack in the trajectory traveled by the robot.

## 2. Manual

A Manual is a tool work process that is fully controlled by humans without using an automation system (Mahrus Ali, 2022). The workflow of manual handled in project-based learning media is shown in Figure 4.



**Figure 4. Flow Chart of Manual in Project-based Learning**

To operate the device manually in the cadet learning process, the device must be turned on by pressing the robot power first. Then, select the robot calibration to manual mode with the control located on the back of the robot. The robot must be connected to the radio control to activate the manual mode. Then, cadets can control the robot as desired using a radio control system. During the exploration process, the robot will take dataset images every 5 meters in real-time, and when the exploration process is complete, the system will automatically save the data on the available mini-PC. Later, cadets can take some data to review on the mini-PC, and do not forget that when the data has been taken, the robot must be turned off.

The use of devices in practical activities and project-based learning can increase motivation in learning (Firmansyah, 2023) Through this tool can provide valuable practical experience in designing, building, and testing electronic or mechanical devices, while also teaching basic concepts in damage detection. This project-based learning scheme can be an opportunity to teach them about material procurement and maintenance management, especially in the courses on pavement construction, airport facility maintenance operations and management, and airport infrastructure maintenance techniques. Cadets can present their project results to the group or lecturer. Then, they reflect and evaluate the project (Sari, 2018). Cadets can consider what they have learned, what works, and what can be improved in this project. In research (Murniarti, 2017), project-based learning like this can provide in-depth and practical experience in understanding and handling damage, while also honing various skills such as problem-solving, design, and programming. In addition, this research can serve as a foundation for further research in engineering and science.

#### **D. Conclusion**

The design of a runway defect detection device using a neural network is the latest breakthrough in technology to classify damage types with image processing as crack detection during runway inspections. With this tool, airport technicians do not need to spend some budget to conduct inspections because robots do all the work accurately. Besides being used as a tool for runway damage detection, this tool is also suitable to be applied as a project-based learning media. This can be seen in the many successes of the Palembang Aviation Polytechnic cadets, especially the Airport Engineering Technology study program cadets, who easily understand Pavement Construction, Maintenance Engineering, and Airport Engineering Facility Operations and Maintenance learning materials. Cadets' understanding can be seen from personal interviews with several personalities, with an average showing an increase in new and fun learning styles, and cadets can successfully accept the delivery of material carried out by lecturers.

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