DESIGN AND CONSTRUCTION OF SUPRA X MOTORCYCLE ELECTRICAL SYSTEM TRAINER BASED ON INTERACTIVE VISUALS TO STRENGTHEN THE COMPETENCY OF MECHANICAL ENGINEERING STUDENTS OF MUHAMMADIYAH UNIVERSITY OF WEST SUMATRA

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Abstract. *The development of vehicle technology demands the availability of technical aids that can represent the motorcycle electrical system in a real and functional manner. This study aims to design and build an interactive visual-based electrical system trainer on a 2005 Honda Supra X motorcycle. The method used is an experimental approach, which includes the stages of identifying needs, visual design using CAD software (SolidWorks), making a frame using hollow iron (SHS) material, installing electrical components, and testing system performance. The main components used include CDI, ignition coil, spool, regulator, battery, switch, and lighting. The assembly process is carried out by paying attention to ergonomics, safety, and ease of access in testing and measurement. Testing is carried out using a digital multimeter at important points in the circuit to ensure component function and voltage stability. The results show that the entire system can function normally according to vehicle electrical standards, with consistent voltage output and appropriate component working response. This trainer successfully represents the Supra X Motor's electrical system in its entirety, so it can be used for technical simulations and direct electrical circuit testing. With the success of this design, the trainer is considered suitable for use as a test and simulation device for the electrical system of two-wheeled vehicles.*

Keywords: *Electrical System; Motorcycle; Supra X; Trainer.*

1. INTRODUCTION

Motorcycle electrical systems are a core competency that must be mastered by Mechanical Engineering students, especially in the automotive field. This competency encompasses a comprehensive understanding of how electrical systems operate, diagnose, and maintain them, including ignition and lighting systems. According to (Hartono, 2019) , understanding electrical systems is crucial because it directly impacts vehicle performance and safety. Therefore, the learning process should not rely solely on theory but should also be complemented by hands-on practice through learning media that approximates real-world conditions.

Based on observations at the Mechanical Engineering Laboratory of the University of Muhammadiyah West Sumatra, it was found that the available learning facilities are still conventional, such as the use of static electrical diagrams and used vehicle units that are not always in optimal condition. This makes the learning process less effective because students cannot directly see how the electric current works or how the system responds to certain conditions. However, as explained by (Setiawan et al., 2020), hands-on learning methods have a significant impact on improving the understanding and skills of engineering students.

The main problem that arises is the lack of interactive educational media that can present electrical system simulations visually, dynamically, and structured (Chadry et al., 2023). Students often have difficulty understanding the relationship between important components in an electrical system, such as batteries, CDIs (Capacitor Discharge

Ignition), coils, lights, and switches, due to the lack of supporting visualizations (Setiawan et al., 2020). According to (Kurniawan & Pratama, 2021), the use of interactive visual media in engineering learning can increase learning motivation and material absorption because it involves more aspects in the learning process.

As a solution to this problem, it is necessary to develop an interactive visual-based trainer specifically designed to mimic a motorcycle's electrical system (Hendra, et al, 2023). The 2005 Supra X motorcycle was chosen as the main object in the development of this trainer because this model has a representative, simple, and widely used electrical system in the field. Thus, students can learn on a system that is relevant to the world of work. Trainer This course will present a realistic electrical system circuit, supported by visual simulations depicting the flow of electric current under operational conditions. This aligns with the opinion (Ramadhan, Yusron, & Maulana, 2022) that interactive learning media that integrates visual approaches and hands-on practice can strengthen students' technical memory and understanding.

This research aims to design and develop an interactive visual motorcycle electrical system trainer that meets the learning needs of Mechanical Engineering students. This trainer is expected to be an effective learning tool in connecting theoretical concepts with practical skills, improving students' ability to analyze electrical systems, and strengthening the hands-on, experiential learning approach.

2. LITERATURE REVIEW

2.1 Design and Construction Concept

Design and construction is a structured process that includes identifying needs, developing a technical design, creating the design, and evaluating the product. In engineering education, this approach is used to produce practical tools that can mimic the functionality of real systems. (Suparman, 2017) states that tool design must consider user comfort (ergonomics), operational efficiency, and alignment with curriculum objectives. Therefore, the electrical system trainer needs to be designed in such a way that it not only resembles the actual vehicle system, but can also clarify the electrical working path through a structured approach.

2.2 Electrical System Trainer Components and Circuits

Motorcycle electrical trainers generally cover a series of key systems, such as ignition and lighting. These components are mounted on a metal frame structure, arranged systematically for easy identification and learning. (Yulianto, 2020) stated that the use of genuine vehicle components is highly recommended for students to gain an authentic learning experience and improve their ability to detect and analyze electrical system failures.

2.3 Ergonomic Design and Component Accessibility

In designing a trainer, it is important to pay attention to the comfort and safety aspects of the user, especially during practice. The position of the tool, the height of the frame, and the layout of the components must be designed to facilitate access and observation by students. (Wahyudi, 2019) emphasized that clear labeling and neat cable routing significantly contribute to speeding up system understanding. Furthermore, easy access to components simplifies testing, replacement, and fault analysis.

2.4 Trainer Eligibility Standards for Engineering Learning

An effective trainer must meet two key aspects: technical feasibility and support for the learning process. (Arifin et al., 2021) explain that, technically, the tool must be able to perform similarly to the original system. Therefore, a validation process that includes technical testing is required.

2.5 Utilization of Trainers in Mechanical Engineering Learning

The designed trainer is used as a practice medium to strengthen students' understanding of electrical systems in the laboratory. This tool functions as a link between the theory studied and practice in the field. Through the use of a trainer, students can perform electrical measurements, identify system failures, and directly understand the role of each component. This aligns with the experiential learning model, which is currently the primary approach in engineering education (Rahman et al., 2019) .

3. RESEARCH METHODS

This research was conducted at the Mechanical Engineering Laboratory, Faculty of Engineering, Muhammadiyah University of West Sumatra, with an implementation period from March to July 2025. The stages of this research can be seen in Figure 1.

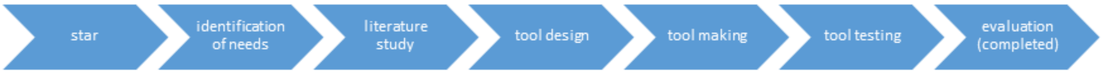

Figure 1. Flow Chart

1. Identify Needs

The initial stage of the research began with identifying needs related to the development of learning media for the Supra X motorcycle electrical system. This identification was carried out through initial observations and discussions with teaching staff and students to understand the obstacles and needs in the learning process.

2. Literature study

Literature review is the process of collecting and reviewing various scientific sources, such as journals, books, and research reports, relevant to motorcycle electrical trainers and learning media. This activity is conducted to obtain a strong theoretical foundation for trainer design, including component selection, circuit design, and appropriate learning approaches. The results of this study serve as a reference in ensuring that the trainer created is in accordance with the practical needs and standards of engineering learning.

3. Tool Design

The frame is designed using a Hollow Structural Section (HSS) profile arranged vertically and horizontally to form a vertical frame. The main dimensions include a total height of 1845 mm, a width of 950 mm, a panel height of 1060 mm, a supporting leg length of 570 mm, and a base footprint of 100 × 100 mm. This design ensures a sturdy, ergonomic structure suitable for practical learning needs in the automotive field.

4. Tool Making

At this stage, the trainer frame is first constructed using hollow steel. Welding is then performed to join the frame parts to ensure strength and stability. Afterward, electrical components, such as the ignition and lighting systems, are systematically installed on the trainer frame, ensuring safety and ease of observation and testing.

5. Tool Testing

This process is carried out to ensure that all components and systems are functioning properly according to their intended purpose. Thorough testing is performed to determine the performance of each component, such as the function of the lights and ignition system. During this process, a multimeter is used to measure voltage, current, and continuity in the electrical circuit to ensure that all connections and components are functioning optimally.

6. Evaluation

It is an important process to assess whether the trainer that has been designed is easy to use, easy to understand, and appropriate to the students' learning objectives.

4. RESULTS AND DISCUSSION

The development of automotive technology encourages the need to develop practical media that are able to connect theory and field applications, especially in understanding the increasingly complex motorcycle electrical system. Mechanical Engineering students need practical facilities that are representative, safe, and in accordance with learning standards in the laboratory. To answer this need, a Honda Supra X motorcycle electrical system trainer was designed as a practical learning aid that can represent the vehicle's electrical system in a real and functional manner in a laboratory environment

The creation of the Supra X motorcycle electrical trainer begins with designing the trainer using SolidWorks Computer Aided Design (CAD) software to produce an accurate, ergonomic, and robust three-dimensional model, as shown in Figure 2.

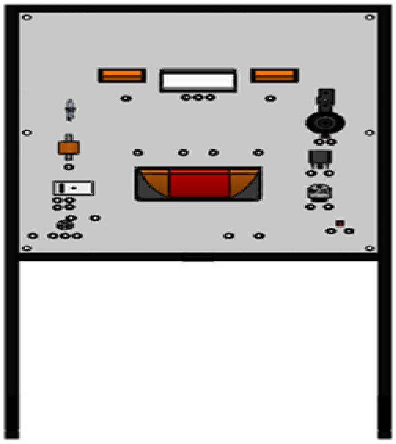

Figure 2. Supra X motorbike trainer design

The three-dimensional design of the Supra X motorcycle electrical system trainer designed for learning purposes in a mechanical engineering laboratory environment is arranged vertically with a gray work panel mounted on a metal frame . The trainer displays the main electrical system components of the Supra X motorcycle. After the system design and trainer layout are completed, the next stage is the tool manufacturing process. This stage begins with the procurement of all electrical components that will be used, such as CDI, spool, ignition coil, regulator, 12V battery, main switch, lights, and cables with sizes and colors that comply with the Honda Supra X motorcycle electrical system standards. In addition, materials for the trainer frame are also prepared, namely Hollow Structural Section (SHS) iron. measuring 25 x 25 mm with a thickness of 2 mm as shown in Figure 3. as the main material for physical construction.

Figure 3. Hollow Structural Section (SHS)

The initial process of making a trainer begins with cutting and welding hollow steel according to the dimensions and shape of the designed frame. The welding process is shown in Figure 4. This is done to connect the iron parts to form a sturdy, symmetrical and stable structure for long-term use.

Figure 4. Welding process

The welds are inspected to ensure joint strength and dimensional accuracy. After the welding process is complete, the frame is coated with anti-rust paint to prevent corrosion and provide a more polished and durable finish. Next, the Plywood Panel is installed in Figure 5. as a medium for placing electrical components.

Figure 5. Plywood Panel

Each component is installed according to the position specified in the design, considering the readability of the circuit path, accessibility for measurement, and ease of testing. Cables are organized using cable holders and labeled and color-coded to facilitate function identification during practice. Overall, the trainer creation process considers key aspects. physical structural strength through welding, regularity of component layout, and user safety during practice. After assembly is complete, the trainer in Figure 6. thoroughly tested using a digital multimeter to ensure all systems are functioning as they should.

Figure 6. Supra X motorcycle electrical trainer

Testing was performed at critical points such as the input and output current, battery voltage, regulator output, and switch and light operation. Measurements were made using a digital multimeter, as shown in Figure 7. namely an electrical measuring instrument that functions to measure electrical quantities such as voltage (volts), current (amperes), and resistance (ohms).

Figure 7. Multimeter

This multimeter is very important in electrical system analysis because it allows users to identify and detect faults in the circuit accurately. As can be seen from the results of measurements using a multimeter, the voltage reached 12 V. The test results indicate that the entire system is functioning normally and is close to the original vehicle specifications. The test data is summarized in Table 1.

Table 1. Results of electrical measurements of the Supra X motor trainer

No	Component name	Lamp power	Standard on the Supra x Motorcycle	Results
1	Headlights	25 w	12v	12v
2	Rear lights	18 w	12v	12v
3	Front left and right turn signals	5 w	12v	12v
4	Rear left and right turn signals	5 w	12v	12v
5	Horn	10 w	12v	12v

The test results show that the trainer successfully simulated the motorcycle's electrical system functionally and stably. Every system, from ignition and lighting, can work according to the Supra X motorcycle standards. Components used such as lights and horns can be tested and measured directly by students using measuring tools such as multimeters. The use of a multimeter in this process allows students to analyze the voltage, resistance, and continuity values of the circuit at key points. This trainer not only shows electrical functions visually, but also allows direct interaction in diagnosing damage, measuring system performance, and understanding the working logic between components, the presence of this trainer is able to increase student involvement in field practice. Compared to conventional methods that only rely on wiring diagrams or theory on the whiteboard, the trainer provides hands-on experience. Students can easily identify electric current paths, perform troubleshooting, and understand the cause-and-effect relationships of any electrical disturbances that occur. Overall, the design of the 2005 Honda Supra X motorcycle electrical trainer developed in this research has been successfully realized and demonstrated consistent work performance. This trainer is considered representative as a safe, functional, and suitable practical learning tool for mechanical engineering laboratories.

The findings in this study are also in line with Darmawan's (2014) research which designed an electrical system trainer for the Honda Supra X 125 PGM-FI. However, there are significant differences in development focus. Darmawan focuses more on the fuel injection system and the damage diagnosis feature through the MIL (Malfunction Indicator Lamp) indicator, which represents modern electrical technology in injection vehicles. In contrast, this study focuses more on the conventional carburetor-based electrical system such as that found in the Supra X Motorcycle (2005). The system displayed in this trainer includes the entire ignition and lighting circuit, and the body switch system. The main advantage of this study compared to previous studies lies in the balance between the simplicity of the conventional system (carburetor) with practicality and ease of operation by students. By displaying the entire electrical system in one real vehicle-based trainer, this tool is not only relevant to the needs of mechanical engineering learning, but also easily adapted for training novice technicians.

CONCLUSION

Based on the design and testing results, the Supra X motorcycle electrical trainer was successfully built and functions well. This trainer is able to realistically represent a motorcycle's electrical system, both in terms of ignition and lighting circuits. Measurement results using a multimeter showed a system voltage of 12 V, in accordance with standard motorcycle specifications. All components work normally and are integrated with each other, so this trainer is suitable for use. With this trainer, students can understand the workflow of the electrical system and carry out analysis and detection of disturbances more effectively.

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