DESIGN OF A HONDA SUPRA X MOTORCYCLE ELECTRICAL SYSTEM TRAINER TO STRENGTHEN THE COMPETENCE OF MECHANICAL ENGINEERING STUDENTS AT THE UNIVERSITY OF MUHAMMADIYAH WEST SUMATRA

[*1]Bagus Muhadist Hasibuan,[2]Jana Hafiza,[3]Desmarita Leni

[1,2,3]Mechanical Engineering, Faculty of Engineering
Universitas Muhammadiyah Sumatera Barat, Indonesia

Author's email:
[1]adamcaturisrahasibuan@gmail.com; [2]janahafizaumbs@gmail.com; [3]desmaritaleni@gmail.com

**Corresponding author:adamcaturisrahasibuan@gmail.com*

Abstract. *The electrical system on a motorcycle plays a crucial role in supporting ignition, lighting, charging, and electric starter functions. A thorough understanding of this system is essential for Mechanical Engineering students to improve their motor vehicle analysis and maintenance skills. This study aims to design an educational trainer for the Honda Supra X motorcycle electrical system as an interactive learning medium in the laboratory. This trainer is developed with an ergonomic and modular panel design, displaying the main components of the electrical system such as the CDI, ignition coil, spark plug, lighting, starter motor, and horn. The panel is designed with an integrated open wiring diagram, allowing students to directly trace the electric current path from the power source to each component. Additional features in the form of LED indicators and a digital voltmeter allow for real-time monitoring of system conditions. The design results show that this trainer is effective as a practical medium to help students understand the distribution of electrical energy and the relationship between components in a motorcycle electrical system.*

Keywords: *Electrical system trainer, Honda Supra X, learning media, modular design, wiring diagram.*

1. INTRODUCTION

The electrical system is a crucial subsystem in a motorcycle, directly affecting the operational functions of the ignition, lighting, charging, and electric starter systems. In the context of mechanical engineering, mastery of the configuration and operating principles of electrical systems is not only necessary for understanding the interactions of electromechanical components, but also serves as the basis for diagnostics, maintenance, and engineering of land transportation systems (Kurniawan et al., 2019).

Students of the Mechanical Engineering study program are expected to have the capability to integrate basic electrical and electronic concepts with their systematic application in motor vehicle electrical systems, to support the analysis, design, and solution of complex technical problems.(Rifdarmon, 2018)However, the reality on the ground shows that most learning processes are still conceptual, with minimal practical facilities that allow for structured, hands-on exploration of electrical systems. Most conventional learning media, such as the use of standard motorcycle units, do not provide systematic visualization of electrical flows, making it difficult for students to identify functional relationships between components (Yusup et al., 2022) This results in low levels of understanding and a weak ability to apply theory in real-world technical contexts.

Various studies have shown that integrating interactive media and technical visualization-based training systems can improve the efficiency of knowledge transfer and students' skills in understanding complex systems. Putra emphasized that the use of electrical systems trainers significantly increased learning motivation and learning outcomes (Putra et al., 2019). Media that presents electrical system configurations in interactive visual form allows students to explore the causal and sequential relationships of current flow, while simultaneously understanding the working principles of components in a comprehensive and contextual manner (Eliza et al., 2024).

The selection of the Honda Supra X motorcycle as the object in the trainer design is based on its electrical system structure which is representative of the configuration of two-wheeled vehicles commonly used in the Indonesian automotive industry. In addition to the availability of technical data and ease of maintenance, this model has also become a reference in various vehicle electrical system design studies because of the completeness of its components which allow for full functional simulation (Sukirno, 2018).

This research aims to design and develop an interactive visual-based motorcycle electrical system educational trainer that is compatible with the needs of teaching Mechanical Engineering. This trainer is expected to be an effective medium in bridging theoretical understanding with practical skills, improving students' abilities in electrical system analysis, and strengthening the experiential approach in systems-based engineering learning.

2. LITERATURE REVIEW

2.1 Motorcycle Electrical System

The motorcycle electrical system is a circuit that functions to generate, store and distribute electrical energy to support various operational needs of the vehicle (Mulyadi et al., 2019a) Structurally, this system consists of five main subsystems: the ignition system, the lighting system, the charging system, the starter system, and the signal or indicator system. Each of these subsystems is interconnected and works together to ensure efficient, safe, and reliable motorcycle performance (Panggalo et al., 2018).

2.2 Charging System

In the charging system, the alternator (coil) converts mechanical energy from the engine's rotation into alternating current (AC). This current is then rectified and stabilized by the regulator/rectifier before being stored in the battery. (Firdaus, 2018) With this mechanism, electrical energy can be available and used to power various other systems, including ignition and lighting systems, while ensuring that electrical power remains stable and can be reused as needed (Bismaka et al., 2021).

2.3 Ignition System

The ignition system plays a vital role in initiating the combustion process of the fuel-air mixture in the engine. One technology used is CDI (Capacitor Discharge Ignition), which allows for more efficient control of the timing and energy of the spark plug compared to conventional ignition systems. This technology can produce a spark with the right power and timing, thus ensuring a more optimal combustion process and reliable engine performance (Alex et al., 2022).

2.4 Lighting and Signaling Systems

In addition to the ignition and charging systems, the lighting and signaling systems also play a crucial role in driving safety and comfort. Headlights, turn signals, brake lights, and indicator lights are designed to provide visibility for the driver and provide visual communication to other road users, especially in low light conditions or in poor weather. These systems are regulated and controlled by relays and switches to ensure efficient use of electrical power and protection from the risk of short circuits or overload (Mulyadi et al., 2019b).

2.5 Starter System

The starter system is used to rotate the crankshaft to start the motorcycle engine. There are two main mechanisms in this system: an electric starter and a manual starter (kick starter). The electric starter uses power from the battery to turn the starter motor, while the kick starter serves as a backup or alternative when the electric system cannot be used. This design allows the motorcycle to be started under a variety of conditions and operational requirements (Akhmadi & Suprihadi, 2020).

2.6 The Importance of Interactive Visual Learning Media

As technology advances, the need to understand motorcycle electrical systems is also increasing. One effective method for bridging the gap between theoretical and practical learning is through the use of visual and interactive media. The use of LED lights, indicator panels, and diagrams can provide a more realistic picture of how the system works, enabling students to understand the working patterns and flow of the electrical system more easily and comprehensively (Kader et al., 2021).

2.7 Motorcycle Electrical Education Trainer

The motorcycle electrical education trainer was developed as a simulation medium for electrical system operation to support a more interactive and realistic learning process. This trainer allows students to directly study the operation of various electrical subsystems, from ignition, charging, lighting, starter, to signaling systems. It can be used to simulate faults and diagnose system operation (Chadry et al., 2023) With this method, students can better master motorcycle electrical systems and be prepared to meet the job needs of the automotive industry. (Hendra et al., 2023).

3. RESEARCH METHODS

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

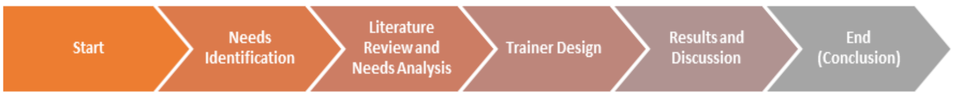

Figure 1. Flow chart

The stages of research implementation in the flow chart above consist of the following systematic steps:

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 & Needs Analysis

At this stage, literature was collected and reviewed from various scientific references related to motorcycle electrical systems and learning media development methods. A needs analysis was conducted to ensure that the developed trainer design complies with curriculum standards and can be used as a medium to support the achievement of learning competencies.

3. Trainer Design

The Honda Supra X motorcycle's electrical system trainer was designed using SolidWorks software. This software was used to create a precise 3D model of the trainer frame, including panel layout and electrical component positions.

The frame is designed using hollow structural sections (HSS) 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. Results and Discussion

This stage will present the results of the design of the Honda Supra X motorcycle electrical system trainer, in the form of a 3D design using SolidWorks, frame dimensions, and component arrangement on the panel. The discussion includes an analysis of the frame structure, component positions, and ease of use in learning.

The system's electrical current flow is also explained, as it flows from the power source to the ignition switch, then to the fuse, switch, and then to components such as relays, lights, or simulated motors. The current then returns to ground to close the circuit.

5. Conclusion

The conclusion stage contains a summary of the results of the design of the Supra X motorcycle electrical system educational trainer that has been carried out. At this stage, the achievements of the design process are explained, starting from needs analysis, material selection, to the creation of 3D models using SolidWorks software. In addition, the conclusion also contains an evaluation of the resulting design, whether it meets the ergonomic, functional criteria, and is suitable for use as a learning medium in automotive laboratories. This stage closes the entire design process by providing an overview of the success of the design according to the initial objectives.

4. RESULTS AND DISCUSSION

4.1 Final Trainer Design

The development of automotive technology demands learning media that can bridge theory and practice, especially in understanding the increasingly complex motorcycle electrical system. Mechanical Engineering students as prospective experts in the automotive field need to be facilitated with educational tools that are representative, interactive, and comply with laboratory safety standards. Based on these needs, an educational trainer for the Honda Supra X motorcycle electrical system was designed which aims to support the practical learning process in the automotive laboratory.

The design process begins with a needs analysis that considers student learning outcomes in the theory and practice of electrical systems. Next, the design process is carried out systematically using Computer-Aided Design (CAD) software, namely SolidWorks, to produce an accurate, ergonomic, and robust three-dimensional model. The design results include frame dimension specifications, material selection, and component layout on the main panel, which are described in detail in this section.

This trainer uses a frame structure made of Square Hollow Structural Section (SHS), which was chosen because it has good mechanical strength and portability that supports flexible placement in the laboratory space. The main dimensions of the trainer frame adjusted to ergonomic standards and practicum needs are presented in Table 1 as a reference in the design.

Table 1. Trainer Frame Dimensions

No	Structural Components	Dimensions (mm)
1	Total Frame Height	1845
2	Panel Width	950
3	Main Field of Work Height	1060
4	Horizontal Leg Length	570
5	Support Base Size	100 × 100

A two-dimensional visualization of the design is shown in Figure 2, which depicts the structural configuration of the complete frame with horizontal supports and a square base for stability. This design provides a clear view of the spatial relationships between the elements, simplifies the assembly process, and ensures stability during use.

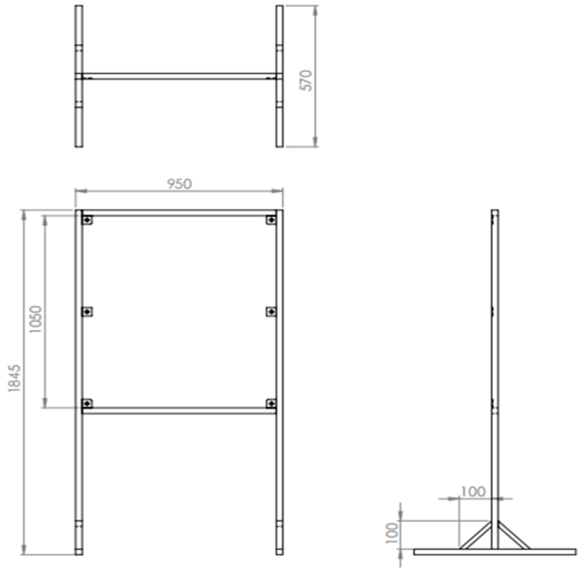

Figure 2. 2D design of the educational trainer frame for the Honda Supra X motorcycle electrical system

The main part of the trainer consists of a work panel made of thick plywood that provides a more detailed 3D visualization, showing the work panel with the arrangement of components of the Honda Supra X motorcycle electrical system. This panel is designed to display the ignition, lighting, charging, and starter system modules in an integrated manner. The arrangement of components on the panel allows students to easily identify the function and path of electric current through an open wiring diagram. The panel is also equipped with various supporting devices such as LED indicators, main control switches, safety sockets, and a digital voltmeter display that functions to monitor voltage in real-time.

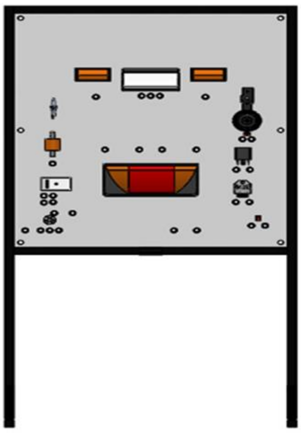

Figure 3. 3D design representation of the Honda Supra X motorcycle electrical system trainer

Figure 3 shows a three-dimensional representation of an electrical systems educational trainer designed for interactive learning in a mechanical engineering laboratory environment. The trainer is vertically arranged with gray work panels mounted on a black metal frame.

The trainer displays the main electrical system components of the Honda Supra X motorcycle, which are arranged in a modular and representative manner, as shown in table 2.

Table 2. Trainer components

No.	Component Name	Location on Panel	Main Function
1	Ignition Spool (Ignition Coil)	Top left	Converts low voltage to high voltage for the ignition system
2	CDI (Capacitor Discharge Ignition)	Top center	Adjust the ignition timing based on the signal from the coil
3	Ignition Switch	Top right	Connecting and disconnecting the main current from the battery to the electrical system
4	Starter Switch & Main Switch	Bottom left	Activate the starter system and manual electrical control
5	Battery Simulation (12V Battery)	Bottom panel (input terminal)	Provides the main voltage source for the entire system
6	Turn Signal Lights & Indicators	Top center	Demonstrates the function of the lighting system and visual indicators
7	Brake Light (red indicator)	Bottom center	Shows the condition when the brake is activated.
8	Horn	Center right	Produces sound as a vehicle audio signal
9	Test Terminal	Bottom left and bottom right	Connecting a multimeter for system current and voltage measurements
10	Current Path Indicator LED	Spread across the panels	Displays the flow of electric current when the system is activated (current visualization)

The panel is also designed to support open visualization of wiring diagrams, allowing students to trace the electrical current path directly from the power source to the final component more easily. Furthermore, this design facilitates safe operation through an ergonomic layout and the integration of safety features, allowing for effective use in a laboratory environment without risk to the device or the user. A schematic of the electrical current flow occurring in this trainer is presented in Figure 4 to provide a clearer picture of the energy distribution path and the relationships between system components.

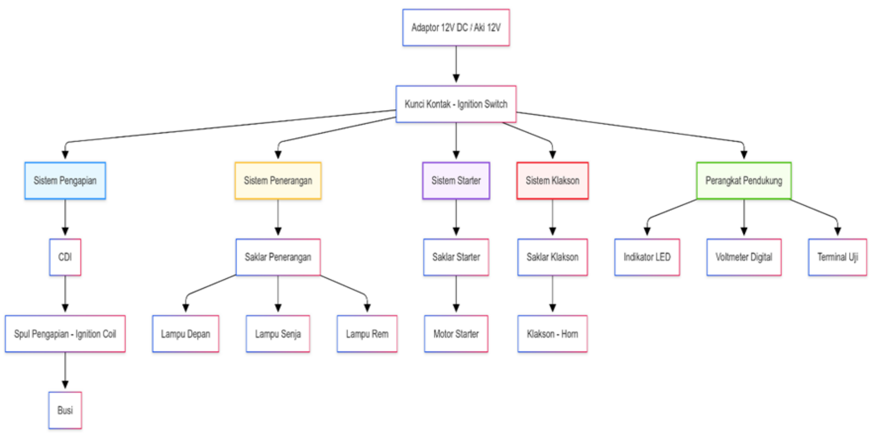

Figure 4. Supra X Electric Current Schematic

The electric current flow diagram presented in Figure 4 depicts the overall energy distribution in the Honda Supra X motorcycle electrical system education trainer. The electric current flow starts from the main power source, namely a 12V DC adapter or 12V battery, which functions as the main voltage provider for the entire system. The voltage is then directed to the ignition switch which acts as the main switch to control the current distribution to various subsystems on the work panel. From this point, the current branches into four main paths, each of which represents an important electrical system on the motorcycle, namely the ignition system, lighting system, starter system, and horn system, as well as one additional path to the supporting device.

In the ignition system, electric current flows to the CDI (Capacitor Discharge Ignition). The CDI functions to store and release an electric charge to the ignition coil in a very short time to produce a high-voltage jump. This high voltage is then transmitted to the spark plug, which is responsible for producing a spark in the combustion chamber. This configuration realistically mimics the ignition process on a motorcycle, allowing students to understand the coordination function between the CDI, ignition coil, and spark plug in the combustion cycle.

For the lighting system, electric current flows through a lighting switch that allows manual control of the lighting components. From this switch, the current is then distributed to various lighting devices such as headlights, side lights, and brake lights. The placement of the lighting components on the trainer panel follows a layout representative of actual motorcycle conditions, allowing students to easily map the component positions on a real vehicle.

The starter system on the trainer receives electricity through the starter switch. When this switch is activated, current flows to the starter motor, which theoretically rotates the engine's crankshaft to initiate the combustion cycle. Although the trainer isn't connected to a physical engine, the operation of this subsystem provides students with a clear understanding of how an electric starter works on a motorcycle.

Meanwhile, in the horn system, electric current flows to the horn switch and then to the horn component. When the switch is pressed, the horn produces an audible signal identical to that of a real vehicle. This section provides students with an understanding of the working principles of simple audio circuits in a vehicle's electrical system.

In addition to the four main paths, electric current is also channeled to supporting devices. These devices consist of LED indicators, a digital voltmeter, and test terminals. LED indicators are installed at several points on the path to provide direct visualization of the current flow when the system is activated. The digital voltmeter monitors the system voltage in real time, allowing students to analyze power stability. Test terminals are provided so students can connect measuring instruments such as a multimeter to check voltage and current at specific points. The presence of these supporting devices enhances the trainer's educational value by providing opportunities for hands-on measurement practice.

Overall, the electrical circuit diagrams in this trainer not only facilitate understanding of power distribution flows but also integrate safety and ergonomics into the learning process. Students can visually and interactively trace the electrical current path, from the voltage source to each final component, creating a learning experience that closely approximates real-world conditions.

CONCLUSION

The design of the Honda Supra X motorcycle electrical system educational trainer has been successfully realized using a frame structure made of Square Hollow Structural Section (SHS) which has the characteristics of high mechanical strength, structural stability, and portability that supports use in a laboratory environment. The work panel is designed modularly to accommodate the main electrical system components, including the ignition system, lighting, starter, and horn, which are arranged to resemble the original vehicle configuration. The applied open wiring diagram design allows students to trace the electric current path directly, starting from the power source to the final components such as CDI, spark plugs, lighting lamps, starter motor, horn, and supporting devices in the form of LED indicators, digital voltmeters, and test terminals. The application of this systematic electric current distribution scheme makes a significant contribution to interactive and comprehensive learning, so that it can improve students' conceptual understanding and practical skills in analyzing the electrical system of two-wheeled vehicles effectively.

REFERENCES

Akhmadi, A. N., & Suprihadi, A. (2020). Manufacturing A Diesel Engine Starter Motor Cutting Trainer As A Learning Media For Machine Maintenance. *Asiimetrik. Journal: Scientific Journal of Engineering & Innovation, 2*(2), 71–76. https://doi.org/10.35814/asiimetrik.v2i2.1302

Alex, I., Rabeta, B., & Rosadi, I. (2022). Design of an Ignition System for the AERO–16 Micro Turbojet Engine. *Aerospace Student Journal, 1*(2), 35–40. https://doi.org/10.35894/jmd.v1i2.61

Bismaka, A. P., Riawan, D. C., & Anam, S. (2021). Power Flow Control Design for a Standalone Solar Power Plant Using a Water Pump Energy Storage Mechanism. *El Sains: Jurnal Elektro, 2*(2). https://doi.org/10.30996/elsains.v2i2.4771

Chadry, R., Leni, D., Nofriadi, N., Sumiati, R., Budiman, D., & Mulyadi, M. (2023). Development Of A Starting System Trainer Tool For Practical Media For The Light Vehicle Department Of Smk Dhuafa Padang. *Jurnal Vokasi, 7*(3), 315. https://doi.org/10.30811/vokasi.v7i3.4186

Eliza, F., Faudi, Z., & Fadli, R. (2024). Design and Construction of a Microcontroller Trainer to Improve Student Learning Motivation. *JRST (Journal of Science and Technology Research), 8*(2), 137. https://doi.org/10.30595/jrst.v8i2.20231

Firdaus, F. (2018). Troubleshooting the Charging System on a Prototype Vehicle (PECAN AM). *Nozzle: Journal of Mechanical Engineering, 5*(1). https://doi.org/10.30591/nozzle.v5i1.801

Hendra, H., Nur, I., Leni, D., Roza, Y., & Mayana, H. C. (2023). Creation Of Motorcycle Electrical Simulation As An Interactive Learning Media For Automotive Engineering Vocational School Students At Smkn 1 Sumbar. *Jurnal Vokasi, 7*(3), 307. https://doi.org/10.30811/vokasi.v7i3.4187

Kader, M. M. M. A., Razali, Z. B., Mustafa, W. A., Saidi, S. A., Nagoor Gunny, A. A., Setumin, S., Osman, M. K., Idris, M., Akbar, M. F., Sarbini, M. A. A., & Mizam, N. S. S. (2021). Automotive Mechanical Vehicle Starters. *Journal of Physics: Conference Series, 2107*(1), 012021. https://doi.org/10.1088/1742-6596/2107/1/012021

Kurniawan, J. A., Rijanto, A., & Hakim, L. (2019). Troubleshooting Analysis of the Body Electrical System on the Honda Revo Absolute. *Majamecha, 1*(2), 128–135. https://doi.org/10.36815/majamecha.v1i2.543

Mulyadi, R., Artika, K. D., & Khalil, M. (2019a). Design Of Electrical Systems For Electronic Devices In Electric Cars. *Elements: Journal Of Mechanical Engineering, 6*(1), 07–12. https://doi.org/10.34128/je.v6i1.85

Mulyadi, R., Artika, K. D., & Khalil, M. (2019b). Design Of Electrical Systems For Electronic Devices In Electric Cars. *Elements: Journal Of Mechanical Engineering, 6*(1), 07–12. https://doi.org/10.34128/je.v6i1.85

Panggalo, I., Dillak, R. Y., & Da Silva, F. (2018). Design Of A Motorcycle Starter System Using A Microcontroller-Based Smartphone. *Jurnal Ilmiah Flash, 4*(1), 17. https://doi.org/10.32511/jiflash.v4i1.206

Putra, A. A. Pt. A., Dantes, K. R., & Nugraha, I. N. P. (2019). The Effect Of The Implementation Of The Electrical Trainer-Assisted Demonstration Learning Method On The Learning Outcomes Of Light Vehicle Electrical Maintenance Of Grade Xi Tkr Students At State Vocational High School 3 Singaraja. *Undiksha Journal of Mechanical Engineering Education, 5*(3). https://doi.org/10.23887/jjtm.v5i3.20252

Rifdarmon, R. (2018). Development of an Integrated Active Wiring Diagram Engine Trainer Simulator to Improve Learning Effectiveness in Automotive Electrical and Electronics Courses. *INVOTEK: Journal of Vocational and Technology Innovation, 18*(1), 31–38. https://doi.org/10.24036/invotek.v18i1.156

Sukirno, S. (2018). The Effect of Implementing a SCADA (Supervisory Control and Data Acquisition) Operation Trainer to Improve Student Motivation and Learning Outcomes in the Electrical Power Transmission System Course. *Jupiter (Journal Of Electrical Engineering Education), 3*(2), 45. https://doi.org/10.25273/jupiter.v3i2.3335

Yusup, Y. M., Sutedi, A., & Tresnawati, D. (2022). Design and Construction of Android-Based Automatic Motorcycle Component Learning Media. *Algorithm Journal, 18*(2), 594–602. https://doi.org/10.33364/algoritma/v.18-2.953