DESIGN AND DEVELOPMENT OF AUTOMOTIVE SAFETY AND AUTOMOTIVE SECURITY SYSTEM: ATRAINER MODEL

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ABSTRACT: *This research focuses on the design and development of automotive safety and security system (ASSeS). This is an instructional material to enhance the learning of automotive students on how to install and troubleshoot safety and security systems in vehicles. The trainer model consists of four main system: a power window system, a dash camera system, a car alarm system and a central locking system. The research study utilized a descriptive developmental research method. The Input-Process-Output (IPO) mode provided the general structure and guide for the direction of the study. The development of the ASSeS includes design and features, materials and components used. The study presented the design and development process of the trainer model, including planning and designing, purchasing of materials, fabrication, assembling, testing, and fine tuning. This device is safe and reliable for the use of automotive students. The trainer model also helps the learners to upgrade their knowledge and skills to adopt the modern technology of the vehicle.*

Keywords: Automotive Technology, Trainer Model, Safety, Security System, Industrial Technology, ASSeS

1. INTRODUCTION

The automotive industry continually evolves, incorporating advanced technologies and systems within vehicles to meet the growing demands of the market and regulatory standards. The academic success of future automotive professionals is contingent upon their ability to understand, maintain, and troubleshoot such systems, making it a vital area of study. Along with the rapidly changing designs, it is more difficult for student learners to interpret the application of theories taught in the school. There are still theories in the field of automotive that many students find difficult to conceptualize in the real world of modern automobile technology despite the efforts of the highly capable instructional mock-ups or trainers to enhance better understanding and principles presented [1].

The trainer is intended to cater to the needs for classroom instructions for the beginner and essential for the instructor to facilitate learning situation. This was deemed necessary by the researcher for the practical portion of teaching about the central locking and lighting systems for cars [2]. A study conducted by Naelga & Chavez [3] suggests that the technique of teaching and learning styles affects the kind of instructional materials used to boost student learning. Nowadays, the Philippines still struggles to buy a trainer model in the local market since the country still purchase a modern instructional device from another country, and it is quite expensive [4]. Academic and other technical training institutions offering automotive technology are mandated
to provide technical and technology graduates in automotive who will then be supplied to the demanding industries [5]. The related studies help the researchers to gather some information to propose the study for developing and innovating the instructional trainer. The study is different from the related studies cited in terms of its coverage. The design includes the automotive lighting,
car alarm with central locking system. This research, Design and Development of Automotive Safety and Automotive Security System (ASSeSS) aims to address the need for a comprehensive and practical training model for automotive students and to assess the impact of such a model on their academic performance.

This study will benefit the students and faculty to enhance their teaching performance, and for the students, so they can easily understand the topic. These initiatives will help the students to gain confidence and improve their knowledge and skills so that they will cope with the latest vehicle technology.

1.2 RELATED STUDIES

Naelga & Chavez [3] constructed an automotive lighting system trainer. The study revealed that the automotive lighting system trainer is very highly acceptable with respect to function, structure and convenience. It is highly acceptable to aesthetics and cost effectiveness. The circuit wiring constructions of the trainer are already arranged and installed (power source to the load, headlight circuit, park light circuit, tail light circuit, dome light circuit, stop light circuit, signal light circuit, and hazard light circuit) for wire orderliness.

As per the research study conducted by Feranndez, teaching automotive technology may be challenging if there is a severe lack of books and other instructional materials that can help learners acquire and develop the necessary abilities. Students nowadays struggle with communication skills, which is crucial to the educational process. The same feelings would be felt by many professors and instructors, which leads to a great deal of dissatisfaction when it comes to the learning goals. But, in order to become successful, the teacher or instructor must make the required innovations in response to the demand of providing the student with high-quality training. To become proficient in teaching both basic and complex subjects, one should learn to create his own teaching materials [6].

Auto lighting system is one area in automotive technology that can be considered very complicated but very essential. It is very essential in the sense that without it accidents can occur. This is following guidelines of the Land Transportation office stating that before a vehicle can registered, it must have complete and functional basic lighting system, Future automotive technicians therefore must acquire with mastery the basic knowledge about electricity, which will be very useful in the troubleshooting errors in auto electrical system of the latest automobile particularly in auto lighting system. [6]

The study Mendoza et al., [7] asserts that a lack of equipment, devices, and instructional materials has an impact on the standard of technology education. Lack of tools, equipment, and other facilities necessary for the teaching-learning process is an issue that many schools, colleges, and universities that offer technology courses deal with. As a result, it is challenging for both teachers and students to acquire the necessary mindset and abilities. The researcher, confronted with this issue, devised the concept of building an integrated electrical wiring installation panel trainer to expedite the assimilation of information and abilities among electrical students. Based on the themes covered in electrical courses at colleges and universities and the levels of competency from the Electrical Installation and Maintenance NC 2 Training Regulation of Technical Education and Skills Development Authority, the panel trainer will demonstrate practical exercises for the development of abilities. The panel trainer will be able to provide possibilities for the learners to get training in motor control, alarm and signal wiring systems, and electrical installation and maintenance.

Dashboard-mounted cameras, sometimes known as "Dash Cams," are digital video recorders (DVRs) that may be attached using a suction cup on the dashboard or windscreen to continually record what is seen through the windshield's glass [8]. These kind of video recordings have improved the safety of law enforcement personnel operating in rural places since they were first used in Texas in the 1980s. Dash Cams became more affordable and available to other drivers, which led to a sharp rise in the number of cars equipped with Dash Cams [9]. A second camera is included into certain contemporary devices known as "Dual Dash Cams," which are used to film the back and/or inside of the vehicle. Additionally, more advanced dash cams enable the recording of additional specific data, such as GPS data files and measurements of the vehicle's speed, steering angle, acceleration, and deceleration (g-force) [10]. This could facilitate the reconstruction of crash events [11]. Dash Cams, however, may elicit unfavorable opinions owing to privacy issues; as a result, they are either outlawed or only permitted under certain circumstances in many nations.

Among these areas may be the usage of dashcams in cars and the release of dashcam footage. The tapes' release sparks debate and raises issues related to privacy protection. In the EU, several general privacy protection standards and guidelines are followed. Data protection reform in the EU has been drafted and is now under discussion. When evaluating how these standards and guidelines should be applied to scenarios involving dashcams and the public release of footage captured with these devices on social media or other open platforms (like YouTube), concerns about whether or not people's right to privacy is always protected and what constitutes a private person's boundaries surface. In reality, dashcam-collected material is often made public after an incident or infraction. Nonetheless, this technique raises a number of problems. In several nations, dashcams are growing in popularity. The investigation of traffic accidents is often challenging and not always impartial (due to witness testimony and deceptive specialists). Video recording helps to observe these incidents objectively. Drivers who install dashcams in their vehicles may be eligible for insurance premium cuts in Europe. Videos that have been recorded assist insurance firms in resolving damage compensation disputes more quickly. However, dashcams, like CCTV, may also be used for illicit financial gain if a motorist who has broken the law is asked to pay to keep the footage from being seen by the authorities [12]. However, aside from all potential threats—personal privacy being the most significant of them, according to [13], dashcams may also be used to further beneficial objectives and defend the rights of private citizens. Following Michael Brown's tragic murder in the United States, police officers have begun to wear body cameras [14]. These cameras are worn on police uniforms and enable officers to record everything that goes on around them. The USA-prepared unique Body-Worn Camera Program [15] explains rationally when, how, and why body-worn cameras should be employed for video recording. Dashcams were first used in US police vehicles.

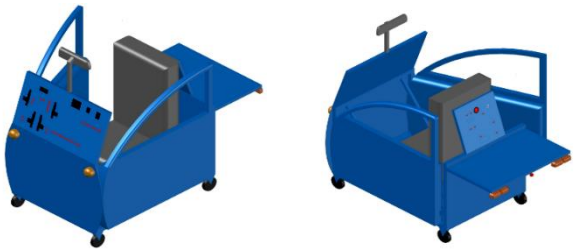
2. MATERIALS AND METHODS

The study employed a developmental research design method wherein this design defines as a systematic study of design development and evaluation process with the aim of establishing an empirical basis for the creation of instructional and non- instructional products and tools. It is also an interactive, cyclic process of development and research in which theoretical ideas of the designer feed the development of products. The ASSeS was designed for a purpose of instructional materials that the learners could perform simulations such as; a power window system, a dash camera system, a car alarm system and a central locking system that can help the users to upgrade their knowledge and skills. The Input-Process-Output (IPO) Model was provided the general structure and guide for the direction of the study.

2.1 DESIGN AND FEATURES

Design refers to the overall aesthetic and visual qualities of a product, system, or object. Good design is often seen as both functional and aesthetically pleasing, and it should be tailored to the needs of the users or audience. A product's features are often created to satisfy the demands of certain customers or audiences, and they may also be customized for particular use cases or situations. Together, design and features play an important role in the development and success of products and systems. A well-designed product with useful features can help to enhance user experience, increase efficiency, and drive learner’s satisfaction. The design also includes the provision of testing the components individually, and it can be used as a demonstration and as a simulation trainer. The researchers considered this a necessity in the hands-on part of explaining about the automotive electrical system, and car alarm with central locking system. Although this is just a basic theory but without a concrete illustration of how the system constructed, tested, and operated, the students will not have the thorough understanding about it. This is the reason why the study is proposed.

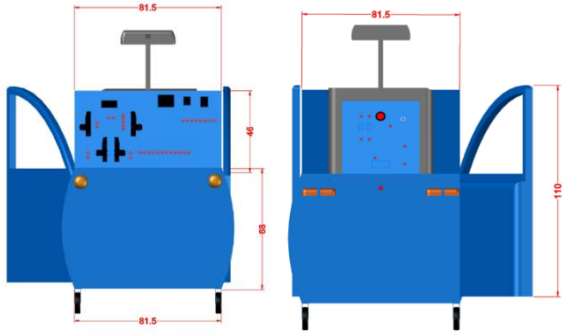
Figures 1-3 below show the design and the different view of the device, it also displays the different components of the developed safety and security system as instructional materials.



(a) (b)

Figure 1. Front and rear isometric view

Figures 1 above show the front and rear view isometric view of the device. This view displays the detailed part of the trainer model.



(a) (b)

Figure-2. Front and rear view

Figures 2 above show the front and rear view of the device. In front view (a) it has a width of 81.5 cm, a board size of 46 cm, and a body size of 68 cm, while the rear view (b) shows that the height of the door measure 110 cm and has a width of 81.5 cm.

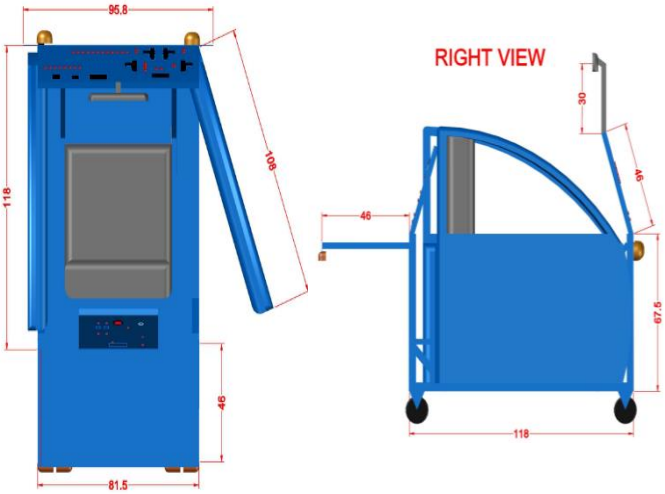


Figure-3. Top and side view

Figure 3 shows the top and following parts; cart wheel, reverse sensors, tail lights, rear camera, steering wheel, binding post, left side camera, left side mirror, global positioning system (GPS), right side mirror, right side camera, multimedia monitor, and parking assist module.

2.2 MATERIALS AND COMPONENTS USED

Developing a product requires a combination of materials and components, each of which plays a crucial role in the product's design, function, and performance. Materials refer to the substances or compounds that make up the physical structure of a product. Components, on the other hand, are the individual parts that make up the product's mechanical, electrical, or electronic system. The selection of materials and components can significantly affect the quality, reliability, and cost of the final product. Table 1 shows the materials and their operational function used in making the trainer model.

Table 1: Materials and their operational function

Materials/Supplies	**Functions** **The material/supply was used for**
Camera	Use to see the surroundings of the trainer model/vehicle.
Battery	Use to supply power to all electrical components of the trainer model.
Push start ignition switch	Use to as the main switch of the entire system.
PVC Poly wood	Use for the artistic design of the trainer model.
Wiring harness	Electrical path throughout the circuit
Binding post	Use as the hole for attaching and detaching electrical wires in the circuit.
Electrical tape	Use to insulate electrical wires after splicing.
Cart wheel	Use as wheels of trainer model so it can be carried easily when needed from one place to another moving.
Angle bar	Use as the frame of the trainer model.
Welding rod	Use for assembling the body and connecting metal to make trainer model
Cutting disc	Use for cutting metals
Ply-board	Use electrical circuit board frame and for tool compartment casing
paint with paint brush	Use for painting trainer model and to metal frame.

Table 2: Tools /equipment and their operational functions

Tools/Equipment	**Functions** **The tools/equipment was used for**
Welding machine	Use to weld the metal frame of the device.
Angle grinder	Use to refinish the metal surface of the frame.
Hand drill	Use to create a hole in the circuit board of the device.
Hack saw blade	Use for cutting metal and ply-board
Wrenches	Use for the tightening bolts and nuts.
Test bulb	Use for circuit testing and current supply load.
Screw	Use for tightening screws in the device.

2.3 FABRICAION

Fabrication process refers to the series of steps or procedures involved in developing the trainer model from raw materials or semi-finished materials. It typically involves various techniques such as cutting, shaping, forming, joining, and finishing, depending on the material and the desired end product. The pictures below show the process of fabrication on the development of automotive safety and security system of the vehicle.

Figure 4 shows the actual photos during the fabrication of the device. It involves a series of cutting, welding, and joining all the parts make a trainer model.

Figure 4. Actual photos during the fabrication

2.4 INSTALLATION

Installation is the process where all the system and components of the trainer model were installed in one frame. To install the Power Window System, carefully remove the door panels to access the interior components. Install the power window motor securely within the door cavity and connect it to the wiring harness. Attach the power window switches to the door panel and wire them to the harness. Connect the wiring to the vehicle's power supply and ground, and then test the system's functionality. Reattach the door panels, reconnect the battery, and perform a final test to ensure proper operation. For the Dash Camera System Mount the dash camera using the provided kit, and route the power cable to the power source. Connect the camera to the vehicle's power, either via the cigarette lighter or hardwiring kit, adjust camera settings, and verify proper recording. To install the Car Alarm System, mount the control module and shock sensors in the chosen locations within the trainer model. Wire them using the provided harness, ensuring correct connections. Install the siren or horn in a secure location. Reconnect the battery and test the alarm by arming, disarming, and triggering the sensors and finally adjust sensor sensitivity. For the Central Locking System, remove door panels and mount door lock actuators inside each door. Route the wiring harness to the central locking control module and connect according to instructions. Secure the control module, reattach door panels, and reconnect the battery. Test the system by using both the remote and interior switches to lock and unlock doors.

Figure 5 shows the actual photos during the installation of the different components of the device. This process covers the installation of the plugs, actuators, bulbs, electronic modules, wiring connections, and sirens. Further, to easily understand the system connection, schematic diagram of the safety and security system was designated.

(a) (b)

Figure 5. Actual photos during installation of the device

3. RESULTS AND DISCUSSION

In response to the high cost of purchasing instructional devices from foreign countries, the researchers behind this study have taken it upon themselves to design and develop a trainer model that caters specifically to the needs of automotive students in the Philippines. This model, known as the Automotive Safety and Security System, is an innovative and cost-effective solution that includes a range of features such as power window systems, dash cameras, central locking, and car alarm systems. By providing students with hands-on experience using this cutting-edge device, the hope is to better equip them for the challenges of the modern automotive industry. Not only does this help address the need for affordable instructional equipment in the Philippines, but it also has the potential to revolutionize the way students learn and engage with automotive technology.

The researchers' successful development of the Automotive Safety and Security System (ASSeS) represents an innovative and cost-effective trainer model designed specifically for automotive students in the Philippines. The meticulous development process involved the integration of cutting-edge designs and features, careful selection of materials and components, and detailed documentation of the entire process, resulting in a high-quality training tool.

To ensure the optimal design of the system, the researcher employed the AutoCAD software to create a detailed design model that accurately depicted the dimension and structure of the device. In addition to the design aspect, the study also focused on incorporating state-of-the-art features, such as a power window system, dash camera, central locking and car alarm system. The development process also involved carefully selecting the materials and components used in the production of ASSeS to ensure its durability and reliability. To further enhance the credibility and transparency of the research, the study also included detailed documentation of the entire development process. As such, this research provides a comprehensive and valuable resource for the development of advanced automotive safety and security systems.

Figure 6 shows the actual photos of the device that includes the isometric view, front and back view.

(a) (b)

(c) (d)

Figure 6. Actual Photo of the device

Figure 7 shows the schematic diagram of the power window system. It consists of battery, ignition switch, fuse, switch, and direct current (DC) motor.

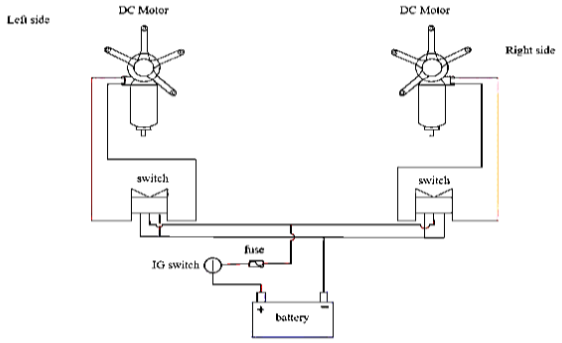


Figure 7. Schematic diagram of power window system

Figure 8 shows the diagram of dash camera system. The system consists of camera, wire that is directly connected to reverse light, video wire for display and monitor.

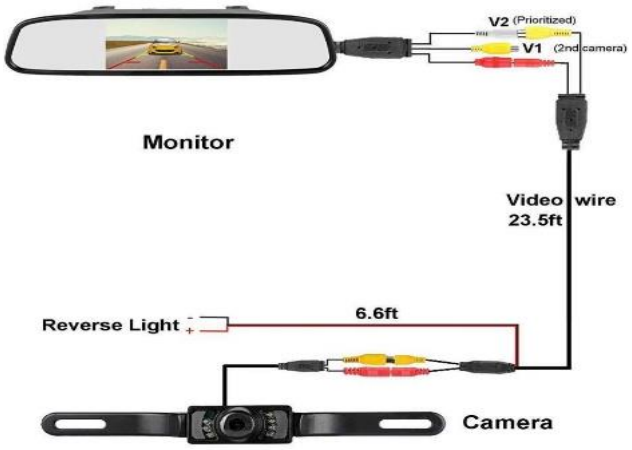


Figure 8. Diagram of dash camera system

Figure 9 shows the schematic diagram of central locking system. This system is responsible for securing the safety of the vehicle.

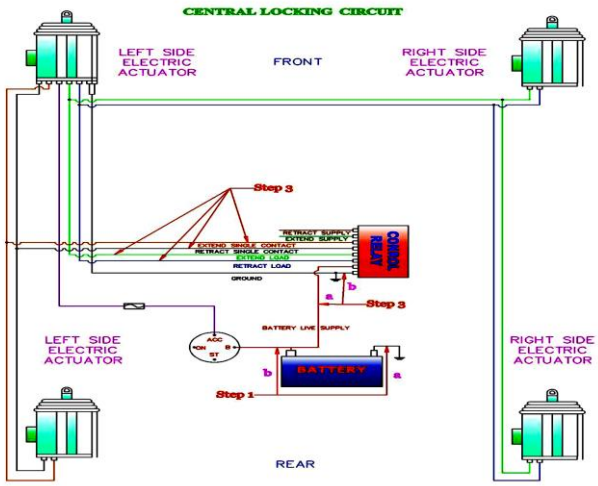


Figure 9. Schematic diagram of central locking system

Figure 10 shows the car alarm system of the vehicle. This system in alarming the vehicle's user if there are unusual activities in the car.

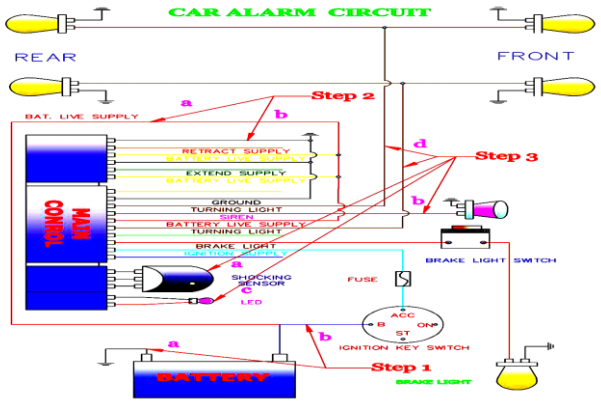


Figure 10. Schematic diagram of car alarm system

4. CONCLUSION

The design and development of a trainer model for Automotive Safety and Security System (ASSeS) represents an innovative and cost-effective trainer model designed specifically for automotive students in the Philippines. The ASSeS training tool is an effective resource for developing advanced automotive safety and security systems, potentially revolutionizing the way students learn and engage with automotive technology. It represents an important contribution to the field of automotive education and has the potential to shape the future of the industry by producing skilled and competent automotive professionals.

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