Journal of Biodiversity and Environmental Sciences (JBES)
ISSN: 2220-6663 (Print) 2222-3045 (Online)
Vol. 26, No. 6, p. 25-29, 2024
http://www.innspub.net

INNSPUB

RESEARCH PAPER OPEN ACCESS

Evaluation of components layout of three-wheeled electric vehicles

Audy R. Quebral*

Cagayan State University, Aparri Campus, Maura, Aparri, Cagayan, Philippines

Article published on June 07, 2024

Key words: Electric vehicles, E-trike, Accessibility, Serviceability, Operability

Abstract

The Philippines promotes the development and use of local three-wheeled electric vehicles, also known as electric tricycles or e-trikes, to reduce pollution and dependence on fossil fuels. Thus, this study evaluates the component layouts of electric tricycles, specifically those being studied at the Electromobility Research and Development Center, to aid local manufacturers in improving e-trike designs. The objective of this research is to identify the strengths and weaknesses of different electrical layout designs in terms of accessibility, serviceability, operability, safety, and security This research employs an observational approach validated by a survey to assess the layouts of the different e-trike models. Evaluation of different electrical layout designs of e-trikes presented that Model 1 emerges as a well-balanced option with high accessibility, satisfaction, serviceability, balanced safety, and security measures. Model 2 offers streamlined maintenance and strong operability, while Model 3, while presenting certain strengths, requires serviceability and safety features improvements. Model 1 emerges as having the most favorable overall layout among the three e-trike models, with a side-facing seat configuration, and a majority of the components located in front. The evaluation has given insights into the operation and servicing of the e-trikes and an improved locally fabricated e-trike addressing the issues and problems as presented can be developed.

***Corresponding Author:** Audy R. Quebral ✉ audyrq@yahoo.com

Introduction

Electric vehicles (EVs) are gaining popularity due to their fuel efficiency, environmental friendliness, and smooth driving experience. Unlike regular internal combustion engine automobiles, EVs operate differently in terms of mechanism, operating principle, usage, and maintenance procedures (Upadhyay *et al.*, 2021). EVs utilize stored electricity in the battery to power the motor and provide the driving force, which sets them apart from internal combustion cars that rely on burning fossil fuels for power generation. As a result, EVs do not require an engine or gearbox, which are crucial components in internal combustion vehicles. Instead, EVs rely on electric power components such as the electric motor, battery, charger, and electric power control unit, which work together to convert energy from the battery into kinetic force that propels the vehicle forward (Berjoza and Jurgena, 2017).

Electric three-wheeled vehicles, particularly classified under category L5, are gaining popularity in the Philippines, as indicated by administrative order no. 2021-039 issued by the Land Transportation Office. Electric tricycles, or e-trikes, are three-wheeled vehicles that consider the comfort of a vehicle and the pleasure of riding a motorcycle. Such vehicles are popular with the advantages of easy maneuvering, can traverse into narrow streets, and less parking space in congested cities. Electric tricycles are typically designed to be used on paved surfaces and are often used for transportation or recreation. E-trikes are also designed with cargo-carrying capabilities, with a large basket or cargo bed at the back that can be used to carry groceries or other items. Others are designed with seats for passengers, making them a popular choice for commercial or tour applications. Overall, electric tricycles offer a convenient and eco-friendly alternative to traditional vehicles and can be an excellent choice for those who want to reduce their carbon footprint and enjoy a stable and comfortable ride.

E-trikes can have different component layouts depending on the manufacturer and model. Some important electrical components that are in the e-trike are the motor, battery, and controller. Many studies have proven that in a vehicle, a balance of performance and cost must be reached, hence, the architectural layout chosen is crucial. Studies by Larminie and Lowry distinguished different architectural layouts of electric vehicles regarding different types (Larminie and Lowry, 2003). The same goes for the study of Upadhyay *et al.*, 2021, Katic *et al.*, 2014, and Mazumder *et al.* (2012). These studies analyzed the performance of the vehicle as to stability and mass distribution by changing the component layouts.

Several e-trikes available in the market are not locally made. In 2012, the Philippine government launched the Electric Vehicle Project, which aims to promote the use of electric vehicles, including e-trikes, to reduce air pollution and dependence on fossil fuels. The project has resulted in the establishment of local e-trike manufacturers, but it also increased the importation of foreign-made e-trikes that comply with the country's regulations. This study has been conducted to evaluate the component layout of existing e-trikes presently being studied at the Electromobility Research and Development Center of Cagayan State University. Furthermore, this paper aims to provide significant insights into operating and servicing e-trikes. This will also serve as a reference for researchers and designers.

Materials and methods

The e-trike models chosen for evaluation are the existing e-trikes in Region II Cagayan Valley, specifically, at Cagayan State University where the Electromobility Research and Development Center is established. The e-trike models are categorized as symmetrical three-wheeled vehicles [3]. Table 1 provides the technical specifications of the different e-trike models.

For accessibility and serviceability, a 5-point Likert scale ([1] Very Difficult [2] Difficult [3] Fair [4] Easy [5] Very Easy) is utilized. On the other hand, for safety security, and operability, a yes or no question is used.

The e-trike models are evaluated on the following factors: accessibility, serviceability, operability, and safety and security. This is done through an evaluation validated by a survey question given to the technical persons of the research center who had experience in driving, troubleshooting, and maintenance of the e-trikes. A thorough process of visual inspection and examination of the e-trikes is carried out.

The study followed proper safety guidelines for handling electrical and electronic components during evaluation. It employed a combination of qualitative and quantitative approaches to analyze the layout of e-trike components. Accessibility for maintenance, repairs, and placement of electrical components such as the battery, motor controller, wiring harnesses, and connectors was evaluated through visual inspections, describing their physical characteristics and placement. The safety and security of compartments or access panels housing these components were assessed. The wire harness condition and wiring techniques were examined for signs of wear, damage, and loose connections, and assessed for safety. Cable routing, labeling, and the number of wiring errors were evaluated. Observations and descriptions were used to assess ease of servicing and component replacement, considering factors such as part availability and accessibility for each e-trike.

Through user observations and feedback, overall experience in operating the e-trike is assessed. Insights on ease of maneuverability, placement of controls, and usefulness of informative displays will be gathered.

Results and discussion

The result of the survey gave perceptions on the accessibility, serviceability, operability, safety, and security of different component layouts of e-trike models, as shown in Fig. 1.

The overall mean accessibility of 3.34 for Model 1 suggests a relatively high level of accessibility across the board, making it a favorable choice among the three models. Model 2 follows closely with a mean of 3.04 positions it as a reliable option, though not without specific challenges. Model 3 lags slightly behind with a mean of 3.20 with specific strengths and areas for improvement within the accessibility context.

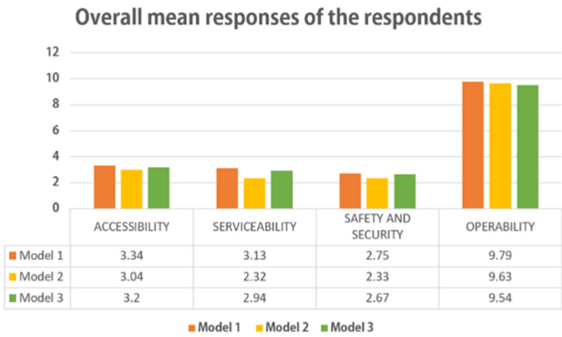

Fig. 1. Overall mean responses of the respondents

In the mean values for serviceability, the slightly higher overall mean value of 3.13 of Model 1 may be attributed to mixed results across different components. Model 2's overall mean value of 2.32 is lower than Model 1, suggesting that while Model 1 may have specific strengths, Model 2 maintains a commendable balance across a range of components. While Model 3's overall mean value is slightly lower than Model 1's, it reflects a balanced accessibility profile and suggests that Model 3 is well-optimized for both user experience and maintenance convenience.

For the insights into the operability of three distinct e-trike models, Model 1 stands out as the most operable option with an average frequency of positive responses at 9.79. Model 2 closely follows with an average of 9.63, demonstrating high operability in key aspects, though slightly trailing Model 1. Model 3, while presenting an average of 9.54, exhibits consistent operability but falls slightly behind Models 1 and 2 in specific areas.

In the frequency of positive responses regarding safety and security, Model 1 demonstrates a balanced but not exceptional performance in safety and security, as indicated by an average score of 2.75.

Model 2, with an average score of 2.33, falls within a moderate range of safety and security. While the model exhibits commendable features, addressing the identified areas for improvement could enhance its safety and security profile. Model 3, on the other hand, presents a balanced but moderately satisfactory performance with an average of 2.67. The score indicates a need for improvement in specific safety measures to enhance the overall security and reliability of Model 3. The evaluation of three e-trike models reveals distinct component layouts (Fig. 2), raising considerations in terms of accessibility, serviceability, operability, and safety and security.

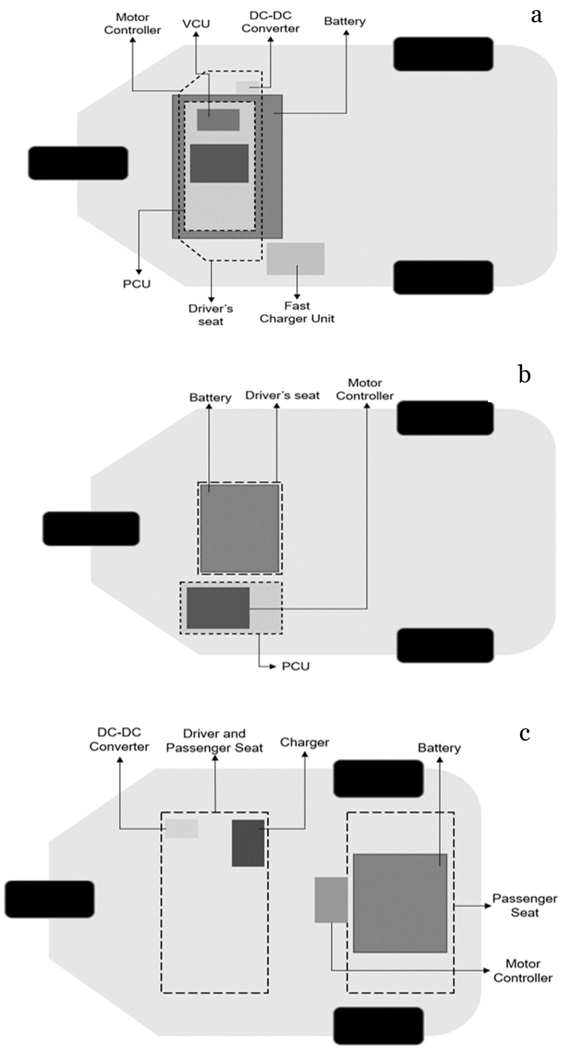

Fig. 1. Overall mean responses of the respondents

Model 1 and Model 2 share similarities in their side-facing seat configuration, with front-heavy components located under the driver's seat. This prioritizes accessibility but compromises security and raises concerns about water leakage. This is about Model 1's challenges in servicing the battery and limited part availability, introducing potential safety risks and inconveniences. Model 2 streamlines the process with readily available peripherals, enhancing the maintenance experience. Both e-trike models share a blind spot and emphasize stability but differ in handling ergonomic design. Model 2 excels but Model 1 suggests an improvement with its cumbersome handle. While all e-trike models align with industry practices, improvement in labeling could be enhanced for overall safety and maintenance efficiency. Model 3 takes a unique approach with a front-facing seat configuration, placing its crucial components at the rear of the vehicle. Its design places the battery and motor controller under the rear passenger seat, emphasizing the need for standardized practices in maintenance and troubleshooting. Model 3's lightweight construction aids in maneuverability but raises concerns about potential overturning, emphasizing the need for careful weight distribution, while Model 3 adopts an accessible online ordering approach, improving user-friendliness.

Conclusion

This study has presented different component layouts of an e-trike. In the evaluation, Model 1 emerges as having the most favorable overall layout among the three e-trike models. Model 1 features a side-facing seat configuration, with most of its components located in front.

These insights can inform manufacturers, policymakers, and researchers in refining existing models and shaping future developments in the electric three-wheeled vehicle landscape. As the demand for sustainable transportation solutions continues to grow, addressing these nuanced aspects is paramount for ensuring the widespread acceptance and success of e-trikes in the evolving mobility ecosystem.

The scientific novelty of this study is the findings from the evaluation of commercialized three-wheeled electric vehicles in the Philippines.

The limitations of the study include its focus on a few selected e-trikes and limited scope of study to drivers and technicians. As such, future research should include more updated e-trike models and consider the perspectives of passengers. An e-trike addressing the issues and problems as presented can be developed.

Acknowledgements

We would like to acknowledge and express our sincere thanks to the Department of Science and Technology- Philippine Council for Industry, Energy and Emerging Technology Research and Development (DOST-PCIEERD) for providing financial support in carrying out this research and achieving the objectives

References

Administrative Order No. 2021-039. Consolidated Guidelines in the Classification, Registration, and Operation of All Types of Electric Motor Vehicles. Land Transportation Office (LTO), Department of Transportation, Quezon City, Philippines, 11 May 2021.

Berjoza D, Jurgena I. 2017. Effects of change in the weight of electric vehicles on their performance characteristics. Agronomy Research **15**, 952-963.

Duan Q, Feng C, Xia L. 2021. Discussion on the technology of high voltage cable for hybrid electric cable in Proceedings of the 7th International Symposium on Sensors, Mechatronics and Automation System (ISSMAS).

Katic V, Dumnic B, Corba Z, Milicevic D. 2014. Electrification of the vehicle propulsion system an overview. Facta Universitatis Series: Electronics and Energetics **27**, 299-316.

Larminie J, Lowry J. 2003. Electric Vehicle Technology Explained. 2nd Ed. John Wiley & Sons Ltd.

Mazumder H, Al Emran Hassan MM, Kapoor A. 2012. Performance analysis of EV for different mass distributions to ensure safe handling. Energy Procedia **14**, 949-954.

Mohammed AS, Salau AO, Sigweni B, Zungeru AM. 2023. Conversion and performance evaluation of petrol engine to electric powered three-wheeler vehicle with an onboard solar charging system. Energy Conversion and Management: X 20. https://doi.org/10.1016/j.ecmx.2023.100427

Suwapaet N, Uppasai P, Silaphai A, Boonma K, Kaewyoo A, Phimsak A, Nabchit Y, Wichata P, Charoenkhet C. 2019. Design and development of an electric tricycle prototype "E-Skylab" in the 11th International Conference on Science, Technology and Innovation for Sustainable Well-Being (STISWB XI).

Upadhyay A, Dalal M, Sanghvi V, Nair, S, Scurtu IC, Dragan C. 2021. Electric vehicles over contemporary combustión engines. In: Proceedings of the International Conference on Sustainable Future and Environmental Science.

Zain AT, Suranto DD, Karimah CN, Azhar FA, Tyagita DA. 2024. Analysis of lithium-Ion battery consumption for three-wheeled electric vehicle with variations in weight and speed. Engineering Proceedings **63**, 13. https://doi.org/10.3390/engproc2024063013