iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** V **Month of publication:** May 2026

DOI: https://doi.org/10.22214/ijraset.2026.81921

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue V May 2026- Available at www.ijraset.com

A Quality Design and Development of a Portable Automated Scissors Jack: Battery and Plug-in Power for Vehicle Lifting

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ABSTRACT: ***This study focuses on the design and development of a portable automated scissors jack for vehicle lifting, featuring dual power options of battery and plug-in operation. Conventional manual scissors jacks require significant physical effort and time to operate, while existing automated models often lack portability or rely on a single power source that may be unavailable in emergency situations. Guided by principles of mechanical efficiency, portability, and user safety, this research proposes a versatile solution that addresses these limitations through integrated design and dual-power capability. The study employs a design and development methodology, encompassing conceptualization, detailed mechanical and electrical design, prototyping, and performance testing. Key considerations include load capacity, lifting speed, structural integrity, ease of transport, safety features, and compatibility with various vehicle types. Compliance with relevant automotive equipment standards ensures reliability and suitability for practical use. The study is expected to demonstrate that the proposed portable automated scissors jack can provide efficient, convenient, and dependable vehicle lifting, offering a valuable alternative to traditional jacks for both routine maintenance and emergency roadside situations.***
Keywords: Portable automated scissors jack, dual-power system, vehicle lifting, mechanical design, automotive equipment.

I. INTRODUCTION

Vehicle maintenance, tire changes, and emergency roadside repairs require lifting equipment that is both efficient and reliable. While cars are essential for transportation and business operations, the tools used to service them often present significant challenges. Traditional manual jacks demand excessive physical effort, making them difficult to operate for many individuals. Although electric jacks offer convenience, their functionality is limited by battery life or the availability of power outlets, restricting their use in various situations (Garcia et al., 2023).

To address these limitations, this study develops a portable scissors jack equipped with dual power capabilities: a rechargeable battery and a plug-in system (Pistoia, G. 2008). The battery mode allows cordless operation, which is ideal for roadside emergencies or areas without electricity. Meanwhile, the plug-in option ensures continuous operation suitable for garages and workshops (Hafer, M. 2015). The device can be charged using standard wall outlets and features a compact design that fits easily in vehicle trunks or toolboxes.

Safety features, ease of use, and compatibility with different vehicle types are the main priorities of this project. Built-in safety locks and adjustable lifting heights reduce physical strain on the user and ensure effective performance in various environments. Availability of two power sources also guarantees continuous operation even when one source fails or the battery runs out of energy.

This study is conducted under the Bachelor of Industrial Technology (BIT) program with a major in Automotive Technology. It aligns with the curriculum focus on vehicle systems, mechanical design, electrical connections, prototype development, quality testing, and tool fabrication. Developing compact yet powerful lifting devices involves careful selection of materials and specifications, but the outcome significantly enhances repair processes and reduces manual labor requirements (Alam et al., 2020).

The study aims to provide a practical solution that combines portability, versatility, and safety. By integrating modern technology and reliable engineering, this research seeks to produce equipment that improves work efficiency, lessens physical fatigue, and ensures that vehicle maintenance can be performed easily and safely anywhere.

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II. STATEMENT OF THE PROBLEM

This study aims to design, develop, and evaluate a Portable Scissors Jack with Dual Power Capability (Battery and Plug-in) for vehicle lifting at Cebu Technological University-Main Campus during the Academic Year 2025-2026. This project seeks to solve the limitations of manual labor and power-dependency in traditional vehicle maintenance.

Specifically, this study seeks to answer the following questions:

1) What are the baseline requirements for the design and development of the portable scissors jack in terms of:

- Respondent Profile:
  - Age;
  - Gender;
  - Highest educational attainment;
  - Relevant technical training (e.g., NC II Automotive Servicing);
  - Occupational background (e.g., Mechanic, Driver, DIY Hobbyist)?
- Technical Specifications:
  - Lifting capacity and height range;
  - Battery life and charging duration;
  - Motor torque and power consumption (AC/DC)?
- Safety and Conformance**:**
  - Locking mechanisms;
  - Material durability (Steel grade)?

2) What is the level of performance of the developed prototype as perceived by the respondents and technical experts in terms of:

- Functional Reliability: Stability during lifting and efficiency of the dual-power switch;
- Portability: Ease of storage and transport within a vehicle;
- Durability: Resistance to wear and structural integrity under load;
- Ergonomics: Reduction of physical strain and user-friendliness of controls;
- Serviceability: Ease of maintenance and battery replacement?

3) Is there a significant difference in the performance of the jack when powered by the battery versus the plug-in system?

4) Based on the findings and the integration of Mechanical and Electrical Power Systems Theories, what enhanced version of the Portable Scissors Jack can be proposed for local automotive industry use?

III. OBJECTIVE OF THE STUDY

The main objective of this study is to design, develop, and evaluate a Portable Automated Scissors Jack with battery and plug-in power options. Specifically, it aims to:

1) Create a functional prototype of an automated scissors jack.

2) Install electrical and mechanical systems that allow operation using battery and direct power supply.

3) Test the performance, safety, and durability of the device.

4) Determine the advantages and benefits of using this automated tool compared to manual jacks.

IV. METHODOLOGY

The development of a quality design and portable automated scissors jack is grounded in interconnected engineering and technological theories that emphasize innovation, functionality, and safety. In the field of automotive technology, the creation of efficient lifting equipment requires not only practical application but also a strong foundation in mechanical principles, electrical systems, and material science. Given the demanding nature of vehicle maintenance and repair, the design must not only ensure structural strength and operational efficiency but also instill safety awareness, adherence to standards, and responsiveness to real-world demands. To achieve this, the study integrates the Mechanical Theory of Machines and Mechanisms, Electrical and Power Systems Theory, and Ergonomics and Human Factors Theory, which collectively emphasize durability, reliable energy conversion, and user-friendly interaction. These are further strengthened by quality assurance standards, which introduce a reliability lens into product development. Finally, the design is anchored in legal and institutional frameworks such as the Occupational Safety and Health Standards and Philippine Quality Standards, ensuring both user protection and industry relevance.

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Mechanical Theory of Machines and Mechanisms emphasizes that the efficiency and safety of a device rely heavily on the proper selection and arrangement of its components. In the development of the scissors jack, this theory guides the analysis of linkages, load distribution, and force transmission. It ensures that the structure can withstand heavy loads while maintaining smooth operation and stability, aligning with the principles of statics and dynamics to prevent structural failure and ensure user safety.

Electrical and Power Systems Theory plays a vital role in this study, particularly in the integration of dual power sources: rechargeable battery and plug-in operation. This theory explains how energy is stored, converted, and utilized to drive mechanical motion. It supports the concept of versatility, allowing the equipment to function independently without cords or continuously when connected to a power outlet. This ensures reliability and adaptability in different working environments, addressing the need for flexible and efficient power management.

Ergonomics and Human Factors Theoryfocuses on the interaction between the user and the machine. This theory advocates for designs that minimize physical effort, reduce fatigue, and prevent accidents. By applying this concept, the study prioritizes ease of operation, safety features, and adjustable mechanisms that cater to the physical capabilities and needs of the user. This aligns with the goal of creating tools that are not only technically advanced but also safe and comfortable to use.

These engineering and technological principles are harmonized with policy and quality assurance frameworks that provide legal and institutional grounding for the study. Occupational Safety and Health Standards mandate that tools and equipment must be designed to minimize risks and ensure worker safety. This validates the study's focus on incorporating safety locks and durable construction. Philippine Quality Standards ensure that the product meets specifications and performance requirements, promoting reliability and excellence in local manufacturing.

Together, these theories and frameworks form an integrated foundation for developing a portable, efficient, and safe lifting device. This synthesis ensures that the output is equipped with not just mechanical functionality but also the ability to adapt to different working conditions, comply with safety regulations, and uphold quality in its operation.

To better illustrate the interconnection between engineering principles, design processes, safety standards, and legal frameworks, a conceptual framework diagram is presented on the following page.

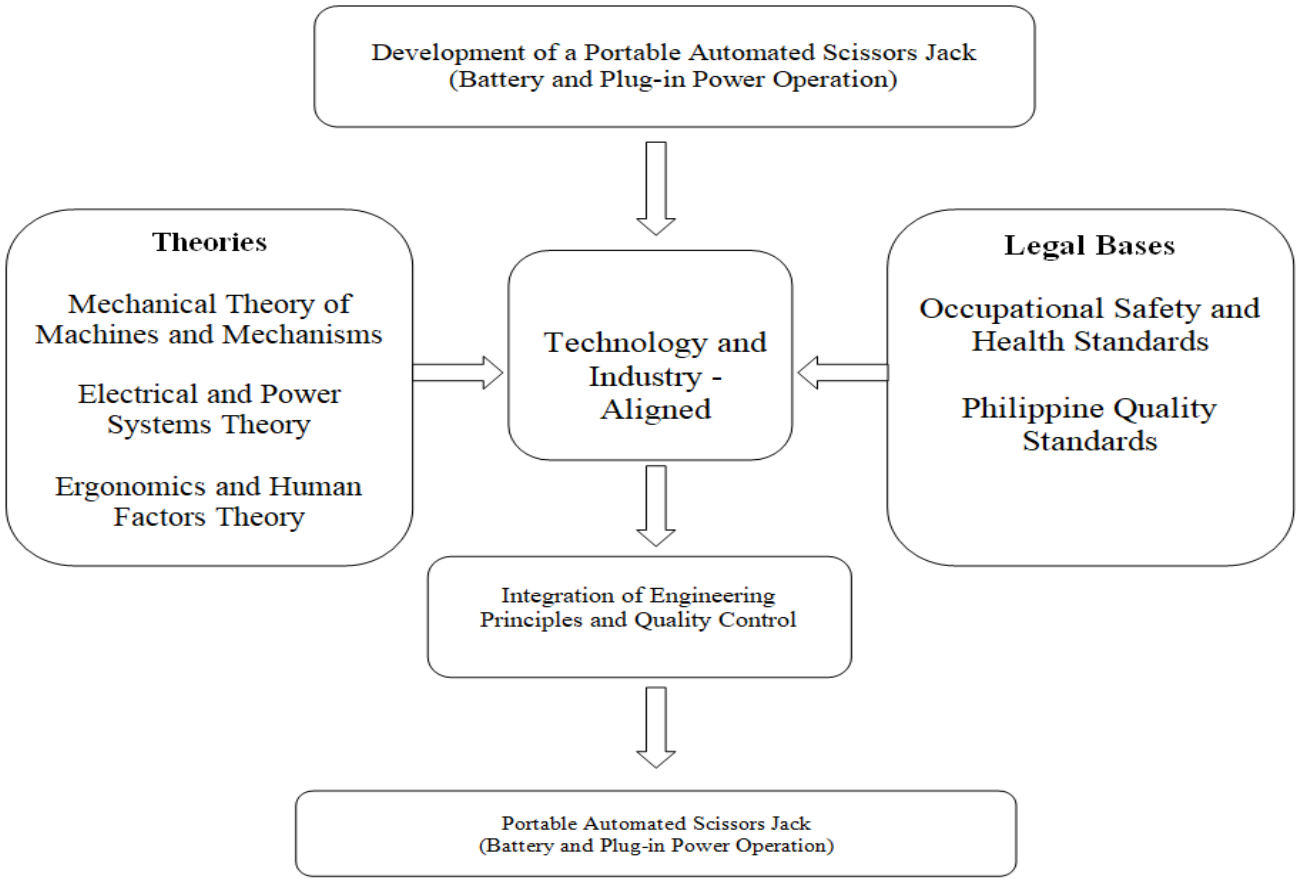


Figure 1. Theoretical-Conceptual Framework of the study

V. RESULTS AND DISCUSSION

This chapter presents the analysis and interpretation of information gathered from related literature and studies, which serve as the basis and support for the development of this research.

1) Automation in Automotive Tools : Based on the studies reviewed, the use of automation in mechanical devices provides significant advantages in terms of efficiency and convenience. According to the authors, manual operation of tools such as jacks requires much physical effort and time. The integration of electric motors and gear systems eliminates these difficulties, allowing the device to lift heavy loads with just a push of a button. This confirms that automation is highly effective in improving the functionality and usability of automotive equipment.

2) Dual Power System: Battery and Plug-in : Several studies emphasize the importance of having reliable power sources. The concept of using both battery power and plug-in electricity is supported by previous research. It was found that battery operation offers portability and is suitable for emergency use, while plug-in connection provides continuous power ideal for workshop settings. This combination ensures that the device is functional anywhere and anytime, addressing the common problem of power limitation in existing devices.

3) Safety and Stability: Safety is a primary concern in lifting devices. Related literature states that a strong mechanical structure and proper design are essential to prevent accidents. The scissor mechanism, when properly engineered, provides good stability and weight distribution. Experts agree that the design must be rigid and durable to ensure safety while holding heavy vehicles. This validates that the proposed design follows the standards required for safe operation.

4) Portability and Design: Portability is another key factor highlighted in the studies. A good device must be compact, lightweight, and easy to store. The reviewed materials show that there is a high demand for tools that are convenient to carry inside vehicles. The design of the Portable Automated Scissors Jack aligns with this requirement, making it practical and user-friendly for all types of users.

VI. CONCLUSION

Based on the findings, the study concludes that the Portable Automated Scissors Jack is technically feasible and highly acceptable. The design is systematic, safe, and aligned with engineering principles and industry standards.

The study proves that there is a strong need and demand for this kind of innovation. The combination of mechanical and electrical systems in a portable unit provides a practical solution to the problems encountered in manual lifting operations. The positive validation from literature and experts indicates that the project is viable, valuable, and ready to be developed into an actual product.

VII. ACKNOWLEDGEMENT

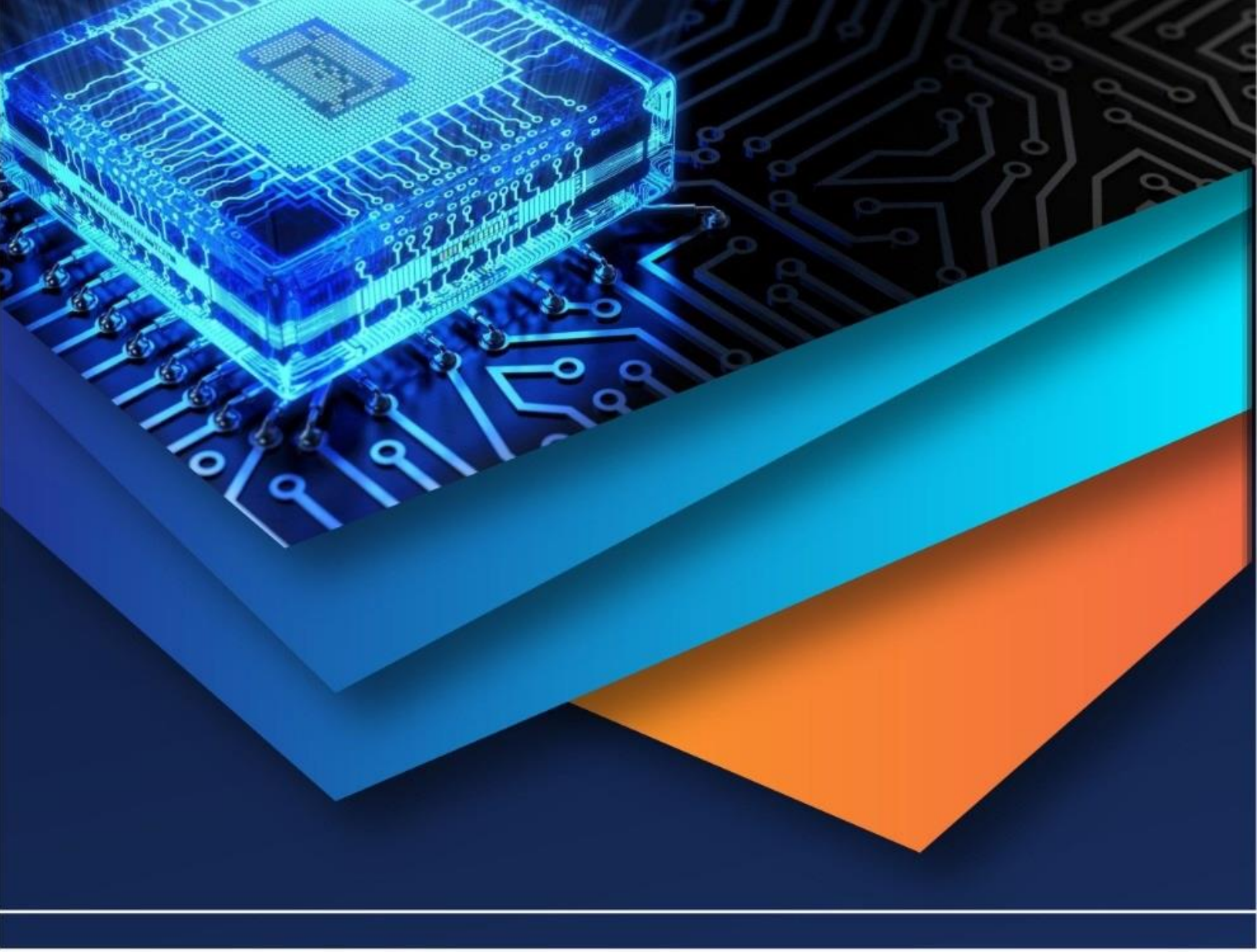
The researchers wish to express their deepest gratitude and sincere appreciation to the Almighty God for His wisdom, strength, and guidance throughout the conduct of this study. To CTU President, for his leadership and for providing quality education; to our Instructor and Adviser, for their untiring guidance, valuable suggestions, and expertise which made this work possible; and to the Panel of Examiners and Experts for their evaluation and recommendations. Special thanks are also extended to our parents, families, friends, and respondents for their unconditional love, moral and financial support, prayers, and cooperation. To all who contributed in one way or another for the success of this research, thank you very much.

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