



Design and Fabrication of an Electric Trike for Sustainable Urban Mobility

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ABSTRACT

This paper presents the design, fabrication, and performance analysis of an Electric Trike (E-Trike) developed as a low-cost, eco-friendly transportation solution for urban environments. The E-Trike incorporates stability features, a tilting mechanism, and reused materials to enhance its sustainability profile. The paper details the specifications, design calculations, and test results, demonstrating the vehicle's performance in terms of stability, speed, range, and suitability for sustainable urban mobility.

Keywords: Electric trike, Urban transportation, Sustainable mobility, Tilting mechanism, Recycled chassis, Eco-friendly vehicle

1 Introduction

Electric vehicles (EVs) are becoming vital in efforts to reduce greenhouse gas emissions and reliance on fossil fuels. Within the EV category, electric trikes represent a practical alternative to both cars and motorcycles for short-distance urban commuting, especially in crowded city environments. This project introduces the design and fabrication of an Electric Trike (E-Trike) focused on enhancing rider stability, safety, and eco-friendliness while keeping the production cost low. The E-Trike employs a reused chassis and an electric propulsion system to align with sustainability goals and minimize its carbon footprint.

2 Literature Review

Electric trikes have been studied as stable and efficient options for urban transport, particularly due to their three-wheel configurations. Previous work on electric trikes with tilting mechanisms demonstrates improved rider balance, control, and safety over conventional two-wheel electric bikes. Studies on hybrid trikes also reveal that battery-electric configurations offer more sustainable alternatives to internal combustion engines (ICE) by eliminating emissions and reducing maintenance costs. This E-Trike project draws from these principles, prioritizing low-cost, high-stability design choices suited for urban environments.



3 Design Methodology and Specifications

The E-Trike was designed with specific attention to stability, shock absorption, and energy efficiency. The major components include a recycled chassis, hub motor, lead-acid battery, and a dual-suspension system.

3.1 Component Selection and Specifications

- Chassis: Recycled from a Kinetic Honda scooter to meet Sustainable Development Goal (SDG) 12 on responsible consumption and production. High-strength steel provides structural integrity.
- Motor: 48V, 500W brushless direct current (BLDC) hub motor.
- Battery: 48V, 28Ah lead-acid battery selected for availability, affordability, and compatibility with the motor's power needs.
- Controller: A 48V BLDC motor controller with overcurrent and low-voltage protections.
- Dual Suspension: The front dual suspension enhances shock absorption, stability, and rider comfort.
- Tilting Mechanism: Allows the front wheels to tilt independently, enhancing stability during turns and improving rider balance on uneven terrains.

3.2 Design Calculations

Design calculations were conducted for speed, motor power, battery capacity, and range, ensuring the E-Trike meets the required performance specifications.

4 Calculation Details

4.1 Motor and Speed Calculation

Data:

Motor RPM = 560, Voltage (V) = 48V

Power (P) = 500W, Wheel size = 10 inches

Tire rim ISO = 254 mm (Diameter), Tire width = 2.4 inches

Calculations:

1. Wheel Circumference

a. Radius of the wheel = $\frac{254}{2} = 127\text{mm} = 0.127\text{m}$

b. Circumference C:

$$C = 2\pi r \quad (1)$$

$$= 2 * 3.1416 * 0.127 = 0.798 \text{ m}$$

2. Wheel Speed

a. Revolutions per Hour (RPH): $560\text{rpm} * 60 = 33600\text{RPH}$



$$b. \text{ Speed (Km/h)} = C * RPH / 1000 = 0.798 * 33600/1000 = 26.82\text{Km/h}$$

3. Motor kV (RPM per Volt)

$$\begin{aligned} kV &= RPM/Voltage \\ &= 560/48 = 11.67\text{RPM/V} \end{aligned} \quad (2)$$

4.2 Battery Capacity and Range Calculation

Specifications

- Battery voltage $V_b = 48\text{V}$
- Motor Power $P_m = 500\text{ W}$
- Target Speed $V = 27\text{km/h}$

Calculations

1. Range Calculations:

- Battery Capacity, $C = 28\text{Ah}$
- Battery Range R:

$$\begin{aligned} R &= \frac{C * V * V_b}{P_m} \\ &= \frac{28 * 27 * 48}{500} = 72.58\text{Km/h} \end{aligned} \quad (3)$$

2. Required Battery Capacity (Ah)

$$\begin{aligned} C &= \frac{P_m * R}{V_b * V} \\ &= \frac{500 * 73}{48 * 27} = 28.164\text{ Ah} \end{aligned} \quad (4)$$

These calculations confirm that the 48V, 28Ah lead-acid battery provides adequate capacity to support the motor's power needs over the estimated range of 73 km per charge.

5 Fabrication and Testing

The fabrication process involved assembling the chassis, motor, suspension, and battery into a functional prototype. Welding was used to secure the frame and suspension components, while the motor and battery were installed with custom mounts for stability and ease of access. Wiring and controller setup were completed to ensure smooth power delivery to the motor.



Figure 1: *Fabricated Trike*

5.1 Testing Results

Testing was conducted to validate the trike's stability, handling, braking performance, and battery range. The vehicle was tested on various terrains to assess its adaptability and to measure battery consumption under different loads.

5.2 Key Findings

- Top Speed: Approximately 25 km/h
- Range: Consistently achieved ~70 km on a full charge
- Stability: The tilting mechanism significantly enhanced stability, allowing each front wheel to navigate obstacles independently.

6 Results and Discussion

The testing phase confirmed that the E-Trike performs as expected in terms of speed, stability, and battery life, making it a feasible solution for short-range urban commutes. The recycled chassis reduced material costs, and the tilting mechanism contributed to safer handling, especially on rough roads. However, the lead-acid battery, while affordable, added significant weight, suggesting potential for improvement with lighter battery options like lithium-ion cells.

7 Conclusion

The E-Trike prototype presents a viable and eco-friendly transportation solution for urban settings. Through its tilting mechanism, robust design, and reliance on electric power, the vehicle meets critical performance metrics while aligning with sustainability goals. Future



work will focus on reducing weight and exploring lithium-ion battery integration for longer-range capabilities and higher energy efficiency.

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