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Design and Creation of a Foldable Electric Vehicle for Urban Transportation

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ABSTRACT :

This project introduces an affordable and portable electric bicycle (EV bike) designed to serve as a sustainable mode of transport for urban and semi-urban areas. With an approximate cost of ₹38,000, the EV bike is built with a tough frame, PMDC motor, lithium-ion battery, throttle control, basic suspension, and an easy charging unit. Its lightweight and foldable structure make it ideal for short commutes and everyday use, offering a practical solution to rising fuel expenses, heavy traffic, and environmental challenges. Key stages of development include design planning, component selection, prototype building, and performance testing. The compact, foldable design enhances its mobility and storage convenience. The project also considers optional features like solar charging and modular upgrades while emphasizing energy efficiency, reduced weight, and safety for the rider. This EV bike is intended to boost last-mile connectivity for students, office workers, and small vendors while decreasing dependence on fossil fuels and minimizing carbon emissions. It highlights how creative engineering can promote greener urban transportation.

Keywords: Lightweight design, Lower fuel usage, Decreased emissions, Rider safety.

INTRODUCTION

The rising cost of fuel, heavy traffic congestion, and growing environmental issues have increased the need for affordable, compact, and sustainable modes of transportation. Electric vehicles (EVs) are emerging as a promising substitute for conventional internal combustion engine vehicles due to their zero-emission nature and minimal operating expenses. However, challenges like high upfront cost and inadequate parking space in densely populated cities restrict their widespread use. To overcome these limitations, the idea of a low-cost, foldable electric vehicle has been introduced.

Owing to its lightweight structure, energy-efficient operation, and foldable design, this vehicle is ideal for crowded urban spaces. It offers the convenience of being stored in compact areas like office corners, small garages, or even balconies. Its design prioritizes user comfort, affordability, and ecological sustainability, making it an excellent choice for short-distance city travel. The use of simple mechanical systems, effective electric drives, and locally available materials further minimizes production costs.

By encouraging the use of renewable energy and lowering carbon footprint, this vehicle supports a greener urban environment. With the continuous growth of cities and industrial regions, such foldable EVs offer a smart response to today's mobility challenges. They deliver a portable, cost-efficient, and eco-friendly means of personal transportation. This concept aims to harmonize sustainability, performance, and user convenience for the future of urban mobility systems.

LIERATURE REVIEW

Zern, Sagert, and Ruther conducted a study on ultralight foldable electric vehicles designed for safe use on pedestrian walkways. Their work emphasized the importance of lightweight vehicle design and compact operation to support sustainable mobility in urban public spaces. [1]A research project by Solanki et al.

documented the step-by-step development of a foldable electric vehicle, including its conceptualization, component analysis, and prototype creation. The project highlighted affordability and mechanical simplicity, making it suitable for academic and urban transportation needs.[2]

Dinesh Kumar and Ajay Raaj developed a foldable electric bicycle and tested its performance in terms of speed, range, and structure. Their findings revealed that lightweight frames combined with BLDC motors enhanced portability and energy efficiency, making the EV suitable for short-distance commuting. [3]

A technical resource explored the prototype of a foldable EV with long-range capability. The study focused on the optimization of electrical power systems and aerodynamics to extend travel range without compromising portability. [4]

Patel et al. conducted a review on foldable two-wheel electric vehicles comparing various frame materials. Their analysis found that aluminium provides better portability due to lower weight, while steel offers strength and cost advantages. The study also emphasized the importance of material selection in commercial-scale manufacturing. [5]

A conceptual study proposed a small, efficient, and long-range foldable EV to address mobility gaps in micromobility systems. The research emphasized the use of high-density batteries and innovative folding joints to improve compactness, function, and rider safety. [6]Mundel et al. introduced a foldable e-bike model designed for smart-city transportation.

Their work focused on user safety, environmental benefits, and the opportunity to integrate IoT-enabled monitoring systems for improved functionality. [7]

Kwon and Eu developed a portable folding electric scooter and presented a prototype model based on modular architecture. Their analysis highlighted ease of construction and low-cost manufacturing strategies that support large-scale production for urban users. [8]Dorugade et al. analysed the structure and performance of a foldable e-bicycle through computational modelling techniques. Their results showed that careful hinge placement and structural rigidity play crucial roles in enhancing stability during operation. [9]

Thanamalar and Eric John designed and fabricated a foldable electric three-wheeler aimed at improving mobility in confined urban environments. Their model demonstrated improved stability and functionality while maintaining a portable design. [10]

METHODOLOGY

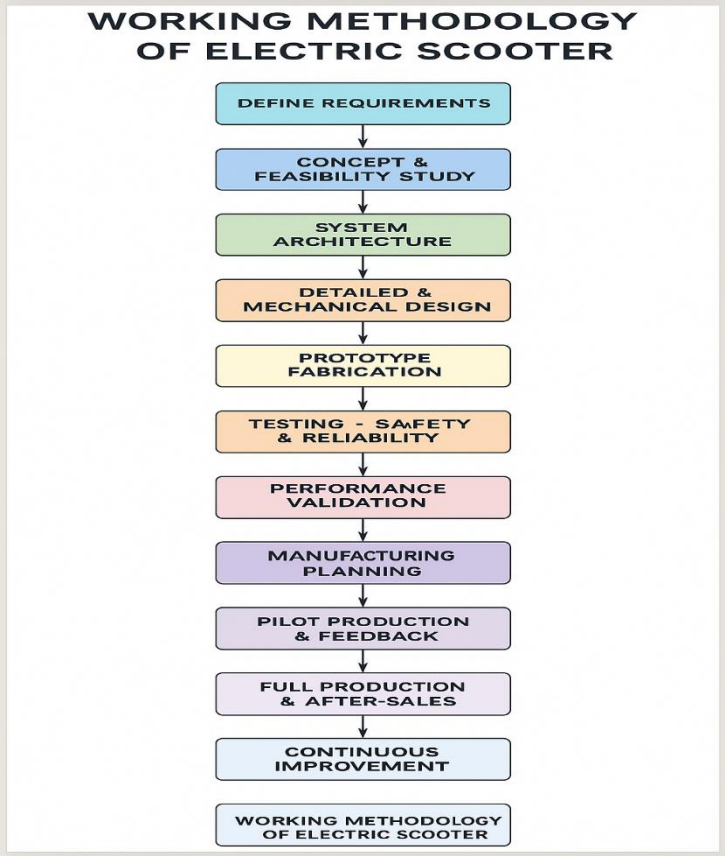

Fig 1: Working of an EV

1. Define Requirements

The first stage involves identifying the purpose of the electric vehicle, target users, load capacity, required speed, travel range, budget, and safety standards. This helps determine technical and functional specifications before design begins.

2. Concept & Feasibility Study

A basic concept model is developed, including motor type, battery capacity, frame size, and foldable mechanism. Feasibility is analysed based on cost, performance, material availability, market need, and environmental impact.

3. System Architecture

The complete system layout is prepared, showing how the battery, motor, controller, throttle, charger, frame, and safety components work together. Electrical and mechanical subsystems are integrated into a single structure.

4. Detailed & Mechanical Design

CAD modelling and engineering drawings are created. Component dimensions, weight distribution, suspension, braking, wiring, and folding joints are designed. Material selection (steel/aluminium/carbon fibre) is finalized for strength and light weight.

5. Prototype Fabrication

A working sample of the electric vehicle is built using selected components — motor, battery, frame, wheels, throttle, controller, etc. The prototype is assembled, wired, and prepared for testing.

6. Testing –Safety & Reliability

The prototype is tested for braking efficiency, motor performance, battery charging/discharging, weight handling, speed stability, and vibration resistance. Safety systems like cut-off switches and fuses are verified.

7. Performance Validation

The EV is tested under real conditions to check mileage, top speed, charging time, acceleration, and user comfort. Data is recorded and compared with the initial design requirements.

8. Manufacturing Planning

Once the design is validated, production planning begins including cost estimation, component sourcing, fabrication methods, assembly process, and quality control standards.

9. Pilot Production & Feedback

A small batch of vehicles is manufactured and used by selected users. Their feedback helps identify improvements in comfort, design, durability, and user interface.

10. Full Production & After-Sales

Large-scale production begins. Vehicles are distributed to the market along with warranty, servicing, spare parts supply, and customer support.

11. Continuous Improvement

User feedback, new technology, and market trends are analysed to upgrade future models example: higher range batteries, IoT tracking, regenerative braking, solar charging, etc.

CONCLUSION

The project titled **"**Development of a Compact and Portable EV for Urban Mobility" successfully tackles modern urban travel issues by merging low cost, environmental benefits, and innovative engineering. The foldable electric bicycle offers an efficient and green alternative for short-distance transport, especially in situations where fuel prices, traffic jams, and pollution are rising. With an estimated cost of ₹38,000, the vehicle is equipped with a hub motor, lithium-ion battery, throttle control, and a lightweight frame, ensuring a smooth and user-friendly riding experience. Its foldable structure significantly increases convenience for students, employees, and daily city commuters. Testing and trials confirmed that the model delivers satisfactory speed, stability, and range for urban use. While the prototype already fulfils its primary goals, further upgrades such as regenerative braking, smart IoT connectivity, and larger battery capacity can improve performance in future versions. The project also demonstrates how low-cost, locally developed electric vehicles can expand sustainable transport options, align with the "Make in India" mission, and support cleaner urban environments. The combination of the hub motor and battery system ensures minimal maintenance, simple operation, and effective energy utilization. By lowering carbon emissions and promoting clean transportation, the design encourages the shift toward renewable-powered mobility. CAD design, simulations, and prototype testing were carried out to validate the vehicle's durability, efficiency, and safety. Future models may also incorporate solar charging to increase energy independence and sustainability.

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