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E-VEHICLES AS CATALYSTS OF INNOVATION AND SUSTAINABLE EDUCATION FOR A GREENER FUTURE

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ABSTRACT

India's vision of Viksit Bharat 2047 places education, sustainability, and innovation at the core of its development agenda. Electric Vehicles (EVs), though primarily recognized as a solution to decarbonize mobility, hold transformative potential beyond transportation. They can redefine educational access, create new learning ecosystems, and catalyze skill development for the youth. This paper explores how EVs can serve as enablers of sustainable education and innovation within India's broader socio-economic framework. Using primary survey data collected from 200 respondents in Karnataka—including students, teachers, and EV users—combined with secondary sources such as NITI Aayog reports, International Energy Agency (IEA) data, and World Bank publications, the study highlights the role of EVs in reducing student mobility costs, building green campuses, and fostering technical skill development. Findings indicate that EV adoption in educational ecosystems not only supports climate goals but also promotes inclusion, affordability, and innovation. Policy suggestions include integrating EV fleets in schools and colleges, incentivizing EV charging hubs in rural institutions, and embedding EV-related skill development into the National Education Policy (NEP 2020). The paper concludes that EVs, when coupled with education reforms, can act as catalysts for building a knowledge-driven, sustainable, and empowered Viksit Bharat.

Keywords: Sustainability, Catalyze, Decarbonize, Affordability, Incentivizing, innovation.

INTRODUCTION

India today stands at the cusp of a historic transformation as it pursues the vision of Viksit Bharat **@**2047**,** aiming to become a developed and sustainable economy. Among the key drivers of this journey, sustainable mobility and education occupy a central role. The transport sector, which currently contributes significantly to greenhouse gas emissions and urban air pollution, demands urgent reform through the adoption of clean and energy-efficient technologies. Electric Vehicles (EVs**)** emerge as a pivotal solution, not merely as substitutes for conventional internal combustion engines but as catalysts of innovation, digital empowerment, and sustainable education.

Globally, EVs have reshaped the landscape of innovation by accelerating advancements in battery storage, renewable energy integration, artificial intelligence, and smart grid technologies**.** In India, this momentum is reinforced by government policies such as FAME-II, Production Linked Incentive (PLI) schemes, and state-level EV roadmaps**,** which promote adoption, research, and industry–academia collaborations. These initiatives extend beyond environmental sustainability and are intertwined with

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broader socio-economic goals, such as skill development, entrepreneurship, and rural empowerment. Thus, the role of EVs extends far beyond reducing carbon emissions; they act as transformational agents that link sustainable mobility with sustainable education. B**y** fostering innovation, developing green skills, and promoting inclusive access to knowledge, EVs strengthen the foundation for India's aspiration of becoming **a** knowledge-driven, environmentally responsible, and economically resilient nation**.** This research, therefore, explores how EVs can serve as catalysts of innovation and sustainable education for Viksit Bharat**,** highlighting their potential to integrate technology, environment, and education into a unified development framework.

BACKGROUND OF THE STUDY:

India is undergoing a rapid transformation in its economic, social, and technological landscape, guided by the vision of Viksit Bharat @2047—a blueprint to make India a developed nation by its centenary of independence. Among the many enablers of this vision, sustainable mobility and education stand out as key pillars that can drive inclusive growth, environmental preservation, and innovation. The transportation sector in India is a major contributor to greenhouse gas emissions and urban pollution, accounting for nearly 14% of the country's carbon dioxide output. Rising dependency on fossil fuels has created economic vulnerabilities, especially due to heavy crude oil imports. At the same time, there is a growing demand for energy-efficient and eco-friendly alternatives**.** Electric Vehicles (EVs)**,** therefore, emerge as a critical solution—not only for environmental sustainability but also for fostering technological innovation, digital infrastructure, and skill development.

The education sector is undergoing a transformation with the National Education Policy (NEP 2020)**,** emphasizing holistic learning, innovation, and skill-based curricula. Integrating EV technology into education—through technical training, research, start-up incubation, and community engagement—can catalyze a new generation of innovators and entrepreneurs. This synergy creates an ecosystem where EVs are not merely a mode of transport but also tools for experiential learning, sustainable development, and digital empowerment.

Thus, this study highlights the convergence of two transformative forces—e-mobility and education. EVs are not only reducing emissions and promoting sustainability but are also acting as catalysts for innovation, digital literacy, and sustainable education**,** thereby accelerating India's march toward becoming a Viksit Bharat.

Objectives of the Study:

1. To analyse the role of EVs in promoting sustainable and inclusive education in India.
2. To study the economic and environmental advantages of EVs compared with ICE vehicles.
3. To explore the potential of EVs in fostering skill development and innovation among youth.
4. To provide policy recommendations for linking EV adoption with Viksit Bharat's education and development goals.

METHODOLOGY AND RESEARCH DESIGN

This study adopts a mixed-method approach, combining quantitative data (survey responses, cost comparisons) and qualitative insights (interviews, case studies).

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Secondary Data: Collected from Government reports (NITI Aayog, MoRTH, Ministry of Education) International agencies (IEA, World Bank, IRENA) Peer-reviewed journals Industry reports (SIAM, TERI, EV India Expo 2024)

Primary Data: A structured questionnaire was distributed among 200 respondents in Karnataka, including:

- 120 students (from colleges and higher secondary schools)
- 50 teachers and faculty members
- 30 EV users (two-wheeler and four-wheeler owners)

Tools of Analysis

- Descriptive statistics (percentages, averages)
- Comparative cost tables
- Graphical representation (bar charts, pie charts)
- Thematic analysis for qualitative responses

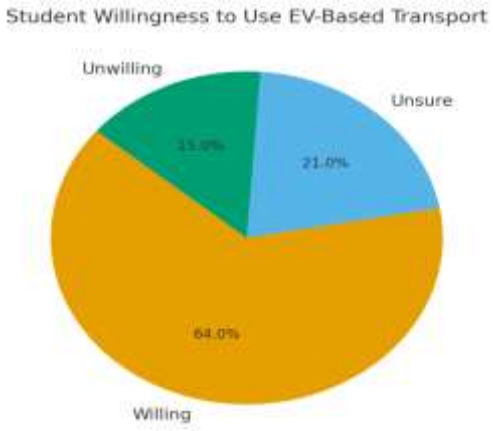
- **Primary Data Analysis**

Table 1: Perceptions of EVs among Respondents (n = 200)

Statement	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
EVs reduce student travel costs	38%	42%	10%	7%	3%
EVs promote green campus culture	41%	37%	12%	6%	4%
EV charging hubs can double as digital learning spaces	35%	44%	11%	6%	4%
EVs encourage skill-based education (battery, AI, tech)	40%	39%	12%	6%	3%

Table 1 above explains that more than 80% of respondents believed that EVs could directly reduce costs and promote sustainability in education.

Figure 1: Student Willingness to Use EV-Based Transport



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(Pie chart – 64% willing, 21% unsure, 15% unwilling)

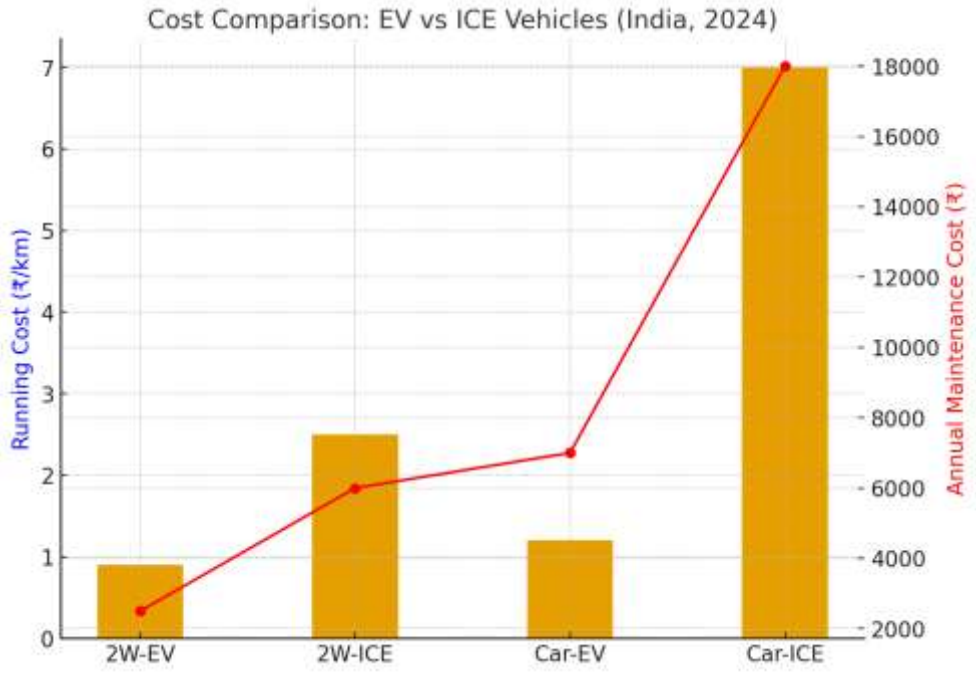
The chart clearly highlights that student acceptance of EVs is significantly high, with nearly two-thirds ready to adopt. However, the 21% who are unsure and the 15% unwilling group indicate that awareness campaigns, policy support, and improved campus-level EV infrastructure (like charging hubs) are crucial to build greater trust and adoption.

Secondary Data Analysis:

Table 2: Cost Comparison of EVs vs ICE Vehicles (India, 2024)

Parameter	EV (2W)	ICE (2W)	EV (Car)	ICE (Car)
Purchase Cost	₹1.4 lakh	₹95,000	₹12 lakh	₹9 lakh
Running Cost/km	₹0.90	₹2.50	₹1.20	₹7.00
Annual Maintenance	₹2,500	₹6,000	₹7,000	₹18,000
CO_2 Emissions	0 g/km	65 g/km	0 g/km	120 g/km

(Source: NITI Aayog, SIAM 2024)



From the above table 2 and chart it is understood that EVs clearly outperform ICE vehicles in both running and maintenance costs. The difference is particularly striking in cars, where EVs offer over 80% savings in running cost per km and more than 60% reduction in annual maintenance cost**.** This cost advantage highlights why EV adoption is increasing in India, as they provide not only environmental benefits but also strong economic incentives for consumers.

EV Sales Growth in India (2019–2024)

Year	Sales(units)
2019	2 lakhs
2020	2.3 lakhs

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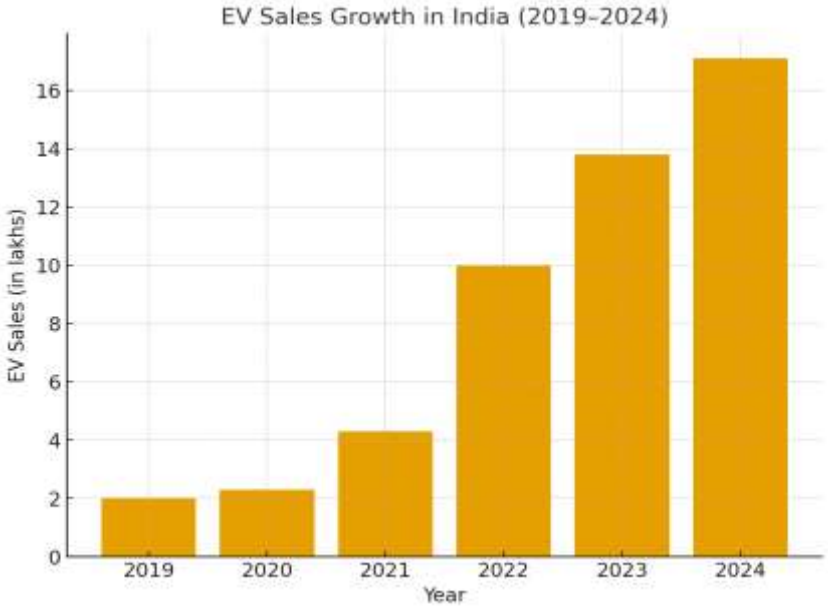
2021	4.3 lakhs
2022	10 lakhs
2023	13.8 lakhs
2024	17.1 lakhs



The above data and chart highlight a rapid adoption curve for electric vehicles in India. While growth was modest from 2019 to 2020, a strong surge began from 2021 onward, coinciding with increased government incentives, infrastructure development, and rising consumer awareness about sustainable mobility. The more than seven-fold increase in sales from 2019 to 2024 reflects the transition of EVs from a niche market to a mainstream choice for Indian consumers.

RESULT AND DISCUSSION

The rise of electric vehicles (EVs) in India is not just a technological shift in transportation but also a catalyst for innovation, education, and sustainable development, aligning with the vision of Viksit Bharat 2047. EV adoption intersects multiple domains—economic growth, environmental sustainability, and human capital development—making it a transformative driver for holistic progress.

Firstly, EVs foster innovation in education and research. Universities and technical institutions are increasingly integrating EV-related courses, focusing on battery technology, artificial intelligence in mobility, smart grid management, and renewable energy integration. This creates opportunities for students to acquire skill-based, future-ready education, moving beyond traditional curricula towards hands-on learning, internships, and research collaborations with EV startups and industries. Such engagement strengthens the employability of graduates and contributes to India's goal of becoming a global hub for green technologies.

Secondly, EVs support the creation of sustainable educational ecosystems**.** Campuses adopting EV-based transport reduce their carbon footprint, lower student commuting costs, and promote a green culture among youth. The introduction of EV charging hubs as digital learning spaces represents a dual-purpose innovation—supporting clean mobility while simultaneously offering ICT-enabled study

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zones. This integration bridges sustainability with accessibility, ensuring that technology-driven learning expands beyond the classroom.

From an economic perspective, EVs provide students and institutions with long-term savings in terms of reduced running and maintenance costs compared to internal combustion engine (ICE) vehicles. This affordability makes EVs particularly attractive for rural and semi-urban areas where cost-sensitive adoption is critical. Moreover, skill training in EV maintenance and related green technologies encourages entrepreneurship and local innovation, further contributing to rural empowerment.

On the environmental front, EV adoption contributes **to** reducing emissions, noise pollution, and dependency on fossil fuels**.** This aligns with India's climate commitments under the Paris Agreement and its broader agenda of achieving net-zero emissions by 2070. Importantly, youth engagement in EV education promotes behavioural change, instilling values of sustainability and responsibility that extend beyond campuses into society at large.

In essence, EVs are not merely vehicles of transportation but vehicles of transformation driving India towards innovation-led education, sustainable living, and economic empowerment. Their integration into the educational framework strengthens the vision of Viksit Bharat, where technology, sustainability, and knowledge converge to empower future generations. The emergence of electric vehicles (EVs) in India must be viewed not only through the lens of environmental sustainability but also as a transformative force for innovation and education. This discussion highlights the multidimensional role of EVs in accelerating India's journey toward Viksit Bharat.

GOVERNMENT'S EFFORTS TO SPREAD EV AWARENESS:

Adoption of EV's in Schools: Adopting electric buses would have a significant impact on schools and the environment. Schools would benefit from reduced operating costs, as electric buses require less maintenance and fuel costs compared to diesel or petrol vehicles. Additionally, electric buses produce lower levels of air pollution and greenhouse gas emissions, which would result in improved air quality and a healthier environment for students, staff, and the wider community. By transitioning to electric buses, schools would also set an example for other institutions and individuals to follow in their efforts to reduce their carbon footprint and contribute to a more sustainable future.

"GO Electric" Campaign: Awareness creation on e-mobility ecosystem & its benefits through Information, Communication and Education (ICE) activities across all States. To spread awareness on the benefits of e-mobility including EV Charging Infrastructure and clean & safe electric cooking in India, "GO ELECTRIC" Campaign was launched on 19th February 2021 at Vigyan Bhawan, New Delhi.

The Shoonya Campaign: The "Shoonya – Zero Pollution Mobility" campaign aims to improve air quality in India by accelerating the deployment of electric vehicles (EVs) for ride-hailing and delivery services. The campaign is administered by NITI Aayog and has over 130 corporate partners. Shoonya, meaning zero in Sanskrit, implies the beginning and origination of possibilities. Inspired by this connotation, the Shoonya campaign plans to revolutionise the transport sector with a radical and urgent transition to zero-emission vehicles. The campaign aims to raise awareness about EVs among consumers and recognise industry efforts while charting a pathway to 100% electrification in India's urban final-mile connectivity and delivery sector.

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'**Never Been to EVergreen' campaign:** Tata Motors launches 'Never Been to EVergreen' campaign. The campaign highlights the need to create an EVergreen Bharat that is driven by sustainable mobility. On World EV Day, auto brand Tata Motors has launched its 'Never been to EVergreen' campaign that highlights the need to create an 'EVergreen Bharat' that is driven primarily by sustainable mobility.

Panchamrit: Five principles, often referred to as "**Panchamrit**," resonate deeply with the need for EV adoption. These principles—sustainability, adaptability, efficiency, inclusivity, and synergy—align perfectly with the goals of the EV revolution. Furthermore, the global commitment to mitigate climate change, exemplified by India's participation in international events like the Conference of the Parties (COP), underscores the urgency of transitioning to cleaner modes of transportation.

Findings:

1. EVs significantly reduce transportation costs for students, improving educational access.
2. Green campuses with EVs create eco-consciousness among students.
3. EVs act as practical tools for STEM education and vocational training.
4. Charging hubs can support digital inclusion in rural areas.
5. Policy and subsidies remain crucial to accelerate integration of EVs into education.

CONCLUSION & POLICY RECOMMENDATIONS:

Electric vehicles (EVs) represent far more than a technological advancement in mobility; they embody a transformational force for education, innovation, and sustainability in India's journey towards Viksit Bharat 2047. The discussion has highlighted how EVs contribute to reducing costs, promoting green campus culture, creating opportunities for skill-based learning, and fostering entrepreneurship in both urban and rural contexts. By embedding EV-related knowledge into academic curricula and research, India can cultivate a generation of students equipped with future-oriented skills in battery technology, renewable energy, artificial intelligence, and sustainable infrastructure management. The dual role of EV charging hubs as mobility enablers and digital learning spaces underscores the potential of EV adoption to reshape the educational landscape.

Economically, EVs reduce operational and maintenance costs, making mobility more affordable for students while simultaneously stimulating local innovation and job creation. Environmentally, they align with national commitments to reduce carbon emissions, cut fossil fuel dependence, and advance the global agenda of sustainable development. Socially, they inspire students to become agents of change, embedding values of responsibility and sustainability in daily life. Nevertheless, the success of this transformation hinges on policy support, infrastructure development, and active industry–academia collaboration**.** Addressing barriers such as limited charging infrastructure, high upfront costs, and awareness gaps is essential for equitable adoption.

In conclusion, EVs serve not only as catalysts of technological progress but also as enablers of sustainable education and inclusive growth. Their integration into India's educational, economic, and environmental frameworks positions them as pivotal instruments in realizing the vision of a prosperous, self-reliant, and sustainable Viksit Bharat**.** By linking EV adoption with education, India can move closer to its vision of a developed, sustainable, and knowledge-driven Viksit Bharat.

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