

STRATEGIES FOR ENHANCING CUSTOMER AWARENESS ON ELECTRIC CARS ADOPTION IN INDIA

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Abstract— India is promoting the widespread adoption of electric vehicles (EVs) that is essential for transitioning towards sustainable transportation systems and mitigating environmental impact. The acceptance and implementation of EVs, however, are heavily influenced by consumer perception and awareness. This study aims to explore key factors that influence consumer intentions to adopt electric vehicles, focusing on the Indian context. The larger objective of developing a greener and more sustainable national transport system is furthered by the research conducted in this area. By implementing the strategies derived from this study, stakeholders can enhance customer awareness, address adoption barriers, and encourage the widespread use of electric vehicles throughout India. The identified factors encompassing EV adoption in India include economic constraints, vehicle performance concerns, insufficient charging infrastructure, environmental conservation considerations, societal influence, and social awareness of EVs. By gaining a deep understanding of these factors, it becomes feasible to develop impactful strategies aimed at boosting consumer awareness and facilitating the widespread adoption of electric vehicles in the country. Furthermore, this paper examines the existing research on EV adoption, identifying gaps and limitations.

Keywords— *Consumer adoption, Sustainable transportation systems, Consumer awareness, Adoption barriers, Environmental impact, Electric vehicles (EVs)*

I. INTRODUCTION

The scope of this paper's objective is to examine a variety of aspects of EVs, including their sustainability, developments in technology, and the methods used for EV battery swapping, reuse, and recycling. Thus, by looking into these crucial areas, we hope to acquire a thorough grasp of the EV market today and offer insightful information on their function in the transportation industry. The

research report will additionally include case studies and examples of success from multiple sectors and nations. In order to help policymakers, businesses, and other stakeholders boost both the adoption and sustainability of the EVs, we aim to discover essential lessons and recommendations. In order to assess the full potential of EVs in reducing climate change and promoting sustainable mobility, it is essential to comprehend these complexities. By embracing the possibilities offered by EVs, we may open the door to a civilization that is more robust, low-carbon, and sustainable.

*In this study, I examine the procedures involved in battery replacement, battery deterioration, and the rightful disposal and recycling of EV batteries.

*To ensure the sustainable management of EV batteries, I intend to look at developments in battery recycling technology and the possibilities of a circular economy approach.

*I had also looked at developments in battery recycling technology and the future possibilities of a zero-waste approach.

The purpose of choosing this topic for my research paper is motivated by a deep passion for vehicles and an endless ambition to learn more about all facets of this industry. This study intends to bring together this enthusiasm with an academic investigation on consumer adoption trends for EVs and their sustainable features. By examining the sustainable attributes of EVs and understanding the factors that influence customer adoption, we aim to contribute to the knowledge base of the automobile

industry while catering to the interests of fellow enthusiasts.

II. LITERATURE REVIEW

Numerous global studies have been conducted to investigate the factors influencing consumer adoption of electric vehicles (EVs). These studies have explored various attributes such as the cost of EVs, driving range per charge, charging time, battery cost, and incentives offered.

Authors have examined the variable attributes of driving range, technology, charging time, charging station infrastructure, and financial incentives in relation to EV adoption. For instance, research by Bahamonde-Birke and Hanappi (2016), Helveston et al. (2015), and others have focused on driving range as a key factor affecting EV adoption. They have found that limited driving range, known as range anxiety, is a significant barrier to widespread adoption.

In terms of charging time, studies by Axsen, Bailey, and Castro (2015), Moon, Park, Jeong, and Lee (2018), and others have investigated its influence on consumer adoption.

The availability of charging stations has also been explored as an infrastructure attribute impacting EV adoption. Researchers such as Valeri and Danielis (2015), Bockarjova and Steg (2014), and others have highlighted the positive influence of accessible and adequate charging infrastructure on consumer adoption.

Financial incentives, including policies such as tax reductions or rebates, have been extensively studied as well. Chorus, Koetse, and Hoen (2013), Wang, Li, and Zhao (2017), and others have investigated

the impact of financial incentives on EV adoption, finding strong evidence supporting certain policies. In addition to these factors, studies have identified other barriers to EV adoption, such as the higher initial price of EVs, non-availability of EVs, lack of knowledge, and unqualified car dealerships. This article concentrates explicitly on electric cars as a subset of EVs, given India's relatively limited adoption and absence of EV experience.

III. RESEARCH METHODOLOGY

*Research methodology: to explore and analyze the strategies for enhancing customer awareness on electric car adoption in India.

*A qualitative research approach: to gain in-depth insights and understanding of consumer perceptions and preferences.

*Quantitative survey: To complement the qualitative findings, among a larger sample of potential electric vehicle consumers.

*Statistical analysis techniques: To examine the survey data and identify significant patterns and correlations.

Evolving Through Time – A Historical Journey of Electric Vehicles

Similar to combustion engine vehicles, electric cars were not created by a single person.

<i>Inventor</i>	<i>Contribution</i>
Robert Anderson	Invented the first functional electric vehicle in 1837, using non-rechargeable batteries.

Anyos Jedlik	Developed an early electric motor in 1828, contributing to the propulsion systems of EVs.
Thomas Davenport	Built a locomotive in 1834 that operated on a circular electric track, showcasing electric power.
Thomas Parker	Invented one of the first practical electric cars in 1884, utilizing rechargeable batteries.
Thomas Edison	Conducted research on battery development, contributing to improvements in electric vehicle technology.

The work of early innovators established the basis for the cutting-edge electric vehicles we see today, and their contributions contribute to the continued search for environmentally friendly modes of transportation.

The Revival of Electric Vehicles: A Sustainable Shift in the 20th Century

Increased concern about the adverse environmental impacts of conventional automobiles fueled by fossil fuels were a major factor in this move. There was an upsurge in investigating alternate forms of transportation as people grew more conscious of the harmful emissions and pollution produced by traditional cars, with EVs appearing as a possible answer.

There are several factors that contribute to their rising growth:

- First, their absence of exhaust emissions addresses environmental concerns and advances a greener future.
- Second, technological advancements, such as enhanced batteries and fast-charging facilities have helped make EVs more convenient, practical and desirable.
- Thirdly, government assistance and incentives, combined with long-term cost reductions, have increased interest among customers.

IV. COMPARISON ICE v/s EV – A COMPREHENSIVE STUDY

The comparison table below highlights the key differences between Internal Combustion Engine (ICE) vehicles and Electric Vehicles (EVs) in various aspects.

<i>Aspect</i>	<i>IC Engines</i>	<i>Electric Vehicles</i>
<i>Emissions</i>	Produce greenhouse gases and pollutants	Produce zero tailpipe emission
<i>Energy efficiency</i>	Lower energy conversion efficiency	Higher energy conversion efficiency

Performance	Varies depending on engine type	Instant torque, quick acceleration
Operating costs	Higher fuel maintenance costs	Lower fuel maintenance costs
Environmental impacts	Contribute to air pollution	Potentially lower environmental impact
Range	Lower Range	Limited range, improving with battery technology
Charging/Refuelling	Quick refueling time	Longer charging time, expanding infrastructure
Vehicle weight	Lighter Weight	Heavier weight due to battery
Driving Experience	Traditional Feel, engine noise, familiar experience	Instant torque, quiet operation, unique driving experience
Government incentives	Few Incentives targeted specifically at ICE vehicles	Incentives available to promote EV adoption

Market Perception	Established Market Presence	Symbol of technological advancement, growing trend
Fueling/Charging Infrastructure	Well-established refueling infrastructure	Developing charging infrastructure, concentrated in urban areas

Customer-Centric Technological Advancements in EV Charging Infrastructure

- Fast charging reduces wait times and enables quick recharging.
- Seamless authentication and payment systems simplify the charging process.
- Expanded charging infrastructure coverage ensures accessibility in urban areas, highways, and popular destinations.
- Intelligent load management optimizes power distribution and reduces wait times at busy charging stations.
- Real-time monitoring and support enhance the reliability and efficiency of charging infrastructure.

How Technological Advancements in EVs Benefit Customers?

EV technology upgrades have successfully met consumer expectations by addressing concerns related to range anxiety, charging infrastructure, performance, cost-effectiveness, and environmental

impact. Advancements in battery technology, faster charging, improved performance, and innovative features have made EVs more practical, enjoyable to drive.

- Economies of Scale: Increased production volumes lead to cost reductions, making EVs more affordable.
- Battery Cost Reduction: Advancements in battery technology decrease the overall cost of EVs.
- Lower Operating Costs: EVs have lower fuel and maintenance costs compared to conventional vehicles.
- Government Incentives: Subsidies and incentives reduce the upfront cost of purchasing an EV.
- Total Cost of Ownership: EVs can have lower long-term costs when considering fuel and maintenance savings.
- Improved Manufacturing Efficiency: Streamlined production processes result in cost savings for customers.
- Long-Term Resale Value: Advanced EV technology can retain higher resale or trade-in values.
- Reduced Dependence on Fossil Fuels: Stable or decreasing electricity costs offer cost predictability.

Battery Reuse and Repurposing

In second-life applications, electric vehicle (EV) batteries that no longer meet the requirements for vehicular use are repurposed for less demanding tasks, such as energy storage.

Lease or battery swapping programs: Some manufacturers and service providers offer electric vehicle (EV) owners lease programmes or battery swapping services, enabling them to lease the battery or exchange their depleted one for a fully charged one at designated swapping stations.

The table below highlights notable brands and companies that have participated in electric vehicle battery swapping initiatives

<i>Company</i>	<i>Battery Swapping Initiative</i>	<i>Key Details</i>
HONDA	e: PROGRESS	Partnership with EV Mobility Service Co. (EVmo) to offer battery swapping services for the Honda e: PROGRESS model in Japan. Battery cartridges can be quickly exchanged at dedicated swapping stations.
NIO	Battery as a Service (BaaS)	NIO owners can subscribe to a battery pack plan and exchange discharged batteries for fully charged ones at

NIO's battery swapping stations, promoting convenience and reducing charging time.

GOGORO Gogoro Battery Swapping Gogoro has implemented an extensive network of battery swapping stations, enabling users to easily swap batteries for fully charged ones, contributing to the popularity and convenience of their scooters

BYD BYD Battery Swapping BYD has developed its own battery swapping system and has implemented it in select cities in China, allowing for quick and efficient battery exchanges for their electric vehicles.

Energy Storage System: Manufacturers reuse electric vehicle (EV) batteries by integrating them into larger energy storage systems, enabling the

storage and discharge of renewable energy. By repurposing these batteries, their useful life is extended beyond automobile applications, thereby enhancing their value in the energy sector

V. GLOBAL LEADERS IN EV & ITS BATTERY MANUFACTURING

The following table highlights key participants in the **electric four-wheeler (4-wheeler)** originating from different countries, have emerged as major contributors to the development and manufacturing of electric cars.

Rank	Company	Market Cap	Country
1	Tesla	Over \$600 billion	USA
2	Volkswagen	Approx \$130 billion	Germany
3	BMW	Approx \$55 billion	Germany
4	Hyundai	Approx \$50 billion	South Korea
5	Nissan	Approx \$40 billion	Japan
6	Audi	Part of Volkswagen Group	Germany
7	Chevrolet	Part of General Motors	USA
8	KIA	Part of Hyundai	South Korea
9	BYD	Approx \$60 billion	China

10	NIO	Approx billion	\$60	China
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The following table lists **electric two-wheeler (2-wheeler)** market participants located in various countries who have made substantial contributions to the development and production of electric motorcycles and scooters and have played a significant role in advancing the electric 2-wheeler industry.

Rank	Company	Country
1	NIU	China
2	Hero Electric	India
3	Ather Energy	India
4	Gogoro	Taiwan
5	Vespa	Italy
6	Energica	Italy
7	Zero Motorcycles	USA
8	Yamaha	Japan
9	Revolt Motors	India
10	Evoke Motorcycles	China

The following table highlights key players in the global **electric vehicle (EV) battery** industry that have emerged as leaders in manufacturing high-quality EV batteries, contributing to the rapid growth of the EV market.

Rank	Company	Market Cap	Country	Establishment
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1	Contemporary Amperex Technology Co. Ltd (CATL)	Over \$200 billion	China	2011
2	LG Chem	Approx \$65 billion	South Korea	1999
3	Samsung SDI	Approx \$45 billion	South Korea	1999
4	BYD Company Limited	Approx \$92 billion	China	2008
5	SK Innovation	Approx \$55 billion	South Korea	1991
6	Panasonic Corporation	Approx \$24 billion	Japan	1996
7	Envision AESC	-	China	2009
8	Northvolt	-	Sweden	2016
9	SVOLT Energy Technology	-	China	2018
10	Eve Energy	-	China	2001

VI. INDIA'S LEADING MANUFACTURER IN EV & ITS BATTERY TECHNOLOGY

Here is a table highlighting Indian electric vehicle (EV) manufacturers in the four-wheel segment and their manufacturing presence in India.

<i>Rank</i>	<i>India</i>	<i>EV</i>
	<i>Manufacturer</i>	
1	Tata Motors	
2	Mahindra Electric	
3	MG Motors India	
4	Reva Electric	
5	Strom Motors	
6	Gayam Motors Works	
7	JBM Auto	
8	Euler Motors	

Here is a table highlighting Indian electric vehicle (EV) manufacturers in the two-wheel segment and their manufacturing presence in India.

<i>Rank</i>	<i>tr</i>
1	Hero Electric
2	Bajaj Auto
3	TVS Motors
4	Ather Energy
5	Okinawa Autotech
6	Revolt Motors
7	Ampere Vehicles
8	Emflux Motors
8	Tork Motors
10	Yulu

In the following table, Indian electric vehicle (EV) battery manufacturers are listed. These Indian EV battery manufacturers play a vital role in promoting the development of the EV industry in India.

<i>Rank</i>	<i>EV</i>	<i>Battery</i>
	<i>Manufacturer</i>	
1	Exide Industries	
2	Amara Raja Batteries	
3	Tata Auto Comp Systems	
4	HBL Power Systems	
5	Cos light India	
6	Eveready Industries	
7	Green Fuel Energy Solutions	
8	Okiya Power Group	
9	Napino Auto & Electronics	
10	Base Batteries	

VII. COMPARISON OF RUNNING COSTS FOR DIFFERENT FUEL TYPES

The running expenses for different fuel types, including petrol, diesel, compressed natural gas (CNG), and electric vehicles (EVs), based on capacity, current prices, mileage, total distance, total cost, and running cost per km in India (May-2023) are compared in the table below:

Fuel	Capacity	Current Rate (in ₹)	Mileage	Total Distance (in km)	Total Cost (in ₹)	Running Cost per km (in ₹)
Petrol	40 L	105	10 km/L	400	4,200	10.50
Diesel	40 L	95	15 km/L	600	3,800	6.33
CNG	14 kg	79	18 km/kg	252	1,106	4.39
EV	40.5 kWh	18.56	400 km	400	751.68	1.88

People may use this comparison to evaluate the cost-effectiveness of various fuel alternatives based on their vehicle's fuel usage and total cost per km.

VIII. CUSTOMER ADOPTION OF ELECTRIC VEHICLES

Factors influencing customers to opt for electric vehicles

- 1) Environmental Awareness: The increasing popularity of electric vehicles (EVs) is largely due to customers' growing environmental concerns. Due to absence of exhaust emissions, electric vehicles (EVs) are a less polluting means of transportation. Many customers choose EVs to lower their carbon footprint and support environmental sustainability.
- 2) Enhanced Driving Experience: Electric vehicles (EVs) deliver lots of benefits that enhance the driving experience. The quick delivery of torque is a significant advantage, as it enables rapid acceleration. This instantaneous power delivery provides EVs with a responsive and exhilarating driving performance, making them a pleasure to operate.

3) Cost Benefits: Electricity is typically less expensive than gasoline or diesel fuel to charge an EV. Customers can benefit from cheaper power prices and perhaps have access to additional incentives for charging their EVs, which will further cut the cost of charging them.

4) Government Incentives: Government-funded programmes and incentives, such as tax exemption, reliefs and rebates, can dramatically lower EVs' initial costs.

5) Technological Advancements: EVs are viewed as a representation of innovation and advancement in technology. Modern EV features and smart technology like regenerative braking, cutting-edge infotainment systems, and connection options are attracting a lot of customers.

Customer Expectations: Key Considerations When Buying an EV

When buying an electric vehicle (EV), customers typically have several expectations:

Reliability and Longevity: Customers anticipate EVs to be reliable and durable, with performance and lifespan comparable to conventional internal combustion engine vehicles.

Total Cost of Ownership: When assessing EVs, consumers consider the total cost of ownership. They expect that EVs will provide savings in the longer term via reduced maintenance and fuel expenses than conventional vehicles.

Comfort and Interior Space: Customers expect EVs to provide comfortable seating, adequate interior

space, and equivalent amenities compared to traditional vehicles. They desire a cabin environment that is well-designed and pleasant for both the driver and passengers.

Styling and Design: Customers place greater importance on visual appeal and aesthetic design when selecting an EV. They anticipate that the interior and exterior designs of electric vehicles will reflect their personal interests and preferences.

User-Friendly Technology: Customers expect user-friendly and intuitive technology interfaces in EVs. They look for features such as touchscreen displays, smartphone integration, voice commands, and seamless connectivity to enhance their driving experience and make EV operation and navigation effortless.

Safety Features: Customers prioritize safety when considering an EV. They expect advanced safety features, including collision avoidance systems, adaptive cruise control, lane-keeping assist, and robust structural design to protect occupants in case of accidents.

Warranty and After-Sales Support: Customers value a comprehensive warranty package and reliable after-sales support when buying an EV. They expect manufacturers to provide warranties that cover major components, including the battery pack, and responsive customer service to address any issues or concerns that may arise during ownership.

Brand Reputation and Trust: Customers consider the reputation and reliability of EV manufacturers.

They look for established brands known for their quality, customer support, and commitment to EV technology. Trust in the brand and confidence in the reliability of the EV play a crucial role in customer decision-making.

Strategies for Enhancing Customer Awareness on EV Adoption

Education and Outreach: Conduct targeted educational campaigns to inform customers about the benefits and capabilities of EVs. This can include organizing workshops, webinars, and public awareness events to provide accurate information about EV technology, charging infrastructure, and incentives.

Government Incentives and Policies: These can include tax credits, rebates, grants, and exemptions from tolls or parking fees for EV owners. Such incentives can make EVs more financially attractive and encourage customers to consider them as a viable option.

Charging Infrastructure Expansion: Invest in the expansion of public and private charging infrastructure to alleviate range anxiety and provide convenient charging options for EV owners.

Collaboration with Stakeholders: Foster collaboration between automakers, utilities, local communities, and other stakeholders to create a cohesive ecosystem that supports EV adoption.

Demonstration Programs and Test Drives: Organize demonstration programs and offer test drives to allow customers to experience EVs first hand. This can help dispel any doubts or concerns they may

have and showcase the performance, features, and benefits of EVs.

UN Sustainable Development Goals

It aligns with the growing need for sustainable transportation solutions, such as electric vehicles (EVs), to reduce carbon emissions and promote a cleaner environment and focuses on ensuring access to affordable, reliable, and clean energy for all.

- 1) Promoting Accessible and Affordable Clean Energy for All: SDG 7 emphasizes the importance of making affordable and clean energy services accessible to everyone. In the case of electric cars, this involves addressing barriers such as high upfront costs and limited charging infrastructure to promote affordability and accessibility.
- 2) Promoting Renewable Energy Sources: SDG 7 targets increasing renewable energy's global share. Electric cars, compatible with renewable sources like solar and wind energy, offer environmental benefits. Promoting their synergy with renewables raises customer awareness and fosters adoption for a sustainable future.
- 3) Improving Energy Efficiency: SDG 7 targets doubling global energy efficiency improvements. Electric cars, with their superior energy efficiency, offer significant savings and environmental benefits. Highlighting their cost-effectiveness and energy-saving potential can drive customer awareness and adoption for sustainable transportation.

- 4) Investing in Charging Infrastructure: To support the adoption of electric cars, SDG 7 emphasizes the importance of expanding infrastructure and upgrading technology for providing clean and sustainable energy. This includes the development of a robust charging infrastructure network in India.
- 5) Raising Customer Awareness: Enhancing customer awareness is crucial for driving electric car adoption. SDG 7 calls for promoting international cooperation to facilitate access to clean energy research and technologies.

IX. POLICIES AND INCENTIVES BY THE INDIAN GOVERNMENT TO PROMOTE ELECTRIC VEHICLES

State	Government Incentives and Policies for EVs
Maharashtra	Financial incentives: Subsidies of up to 25% on EV purchase price. Tax exemptions: Exemption from road tax and registration fees for EVs. Charging infrastructure: Incentives for setting up public charging stations and support for residential charging infrastructure.
Delhi	Subsidies: Financial incentives of up to INR 30,000 on EV purchase.

	<p>Registration fee exemptions: Exemption from registration fees for EVs.</p> <p>Charging rates: Special rates for EV charging at public stations.</p>		<p>Charging infrastructure: Incentives for setting up public charging stations and support for residential charging infrastructure.</p>
<p>Tamil Nadu</p>	<p>Financial incentives: Subsidies of up to 15% on EV purchase.</p> <p>Road tax exemption: Exemption from road tax for EVs.</p> <p>Charging infrastructure: Subsidies for setting up public charging stations and support for residential charging infrastructure.</p>	<p>X. MANAGERIAL IMPLICATIONS OF STUDY</p> <p>Increased Customer Awareness: The research on strategies for enhancing customer awareness on electric car adoption in India has a significant impact on increasing customer awareness. By identifying effective educational approaches and engagement strategies, the research promotes a better understanding of the benefits, features, and environmental impact of electric cars.</p> <p>Marketing and Communication Strategies: Organizations in the electric car industry can utilize the findings of this research to develop targeted marketing and communication strategies.</p> <p>Industry Collaboration: The research can foster collaboration among various stakeholders in the electric car industry. Manufacturers, policymakers, and environmental organizations can come together to implement the identified strategies and work towards a common goal of increasing customer awareness and adoption.</p> <p>Infrastructure Planning and Investment: The research emphasizes the importance of developing robust charging infrastructure networks. Organizations, in collaboration with policymakers, can invest in the expansion and improvement of charging infrastructure to address range anxiety and ensure convenience for electric car users.</p>	
<p>Gujarat</p>	<p>Financial incentives: Subsidies of up to INR 20,000 on EV purchase.</p> <p>Tax exemptions: Exemption from road tax for EVs.</p> <p>Charging infrastructure: Incentives for setting up public charging stations and support for residential charging infrastructure.</p>		
<p>Kerala</p>	<p>Financial incentives: Subsidies of up to 10% on EV purchase.</p> <p>Tax exemptions: Exemption from road tax and registration fees for EVs.</p>		

Monitoring and Evaluation: Organizations can establish effective mechanisms to collect and analyze data on customer perceptions, market trends, and sales performance. By doing so, they can make informed decisions and continuously improve their strategies to maximize their impact.

XI. SCOPE FOR FUTURE STUDY

The research paper on strategies for enhancing customer awareness on electric car adoption in India reveals several opportunities for future study. These include assessing the long-term effects of implemented strategies, conducting comparative analyses of different regions or cities, exploring the efficacy of targeted communication approaches, evaluating the impact of government policies and incentives, examining the effectiveness of education and training programs, and analyzing consumer behavior patterns.

XII. CONCLUSION

In conclusion, this research paper has explored various strategies for enhancing customer awareness and promoting the adoption of electric cars in India. The findings highlight the critical importance of raising awareness among potential customers to drive the transition to a more sustainable transportation system.

Automakers have a vital role to play in enhancing customer awareness. They can invest in marketing campaigns that highlight the benefits of electric cars and a greener footprint.

Education is key for enhancing customer awareness on electric car adoption in India. It provides

accurate information, dispels misconceptions, and highlights the benefits of electric vehicles. Research provides valuable insights into electric vehicle technology, performance, and market dynamics, informing targeted strategies. Battery development focuses on improving range, charging speed, and cost, addressing key customer concerns.

Government policies are instrumental in creating an enabling environment for electric vehicle adoption. Through financial incentives, charging infrastructure development, support for research and development, awareness campaigns, and regulatory measures, governments encourage customers to consider and embrace electric cars as a sustainable and practical mode of transportation.

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