Charging Forward: Investigating Consumer Attitudes andPerceptions on Electric Vehicles

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Abstract

The adoption of electric vehicles (EVs) is a crucial step towards achieving sustainable transportation. However, the success of EVs is heavily dependent on the consumers' perception and acceptance of this technology. This paper presents a systematic review of research articles published on the topic of consumer perception of electric vehicles. The review includes articles published between 2015 and 2021 and encompasses a wide range of perspectives, including consumer attitudes, preferences, and barriers to adoption. The findings suggest that consumers have positive perceptions of EVs in terms of environmental benefits, but also express concerns regarding the range, charging infrastructure, and higher purchase cost. Additionally, several studies have found that socio-demographic factors, such as income, age, and education, play a significant role in shaping consumer perceptions of EVs. This paper provides valuable insights into the current state of research on consumer perception of EVs and highlights areas for future research. The results of this review can be useful for policymakers, manufacturers, and other stakeholders in developing effective strategies to promote the adoption of EVs.

1. INTRODUCTION

The global transition towards sustainable mobility systems has spurred the development and adoption of electric vehicles (EVs) as a promising alternative to fossil fuel-powered vehicles. While EVs offer numerous environmental and economic benefits, such as reduced emissions and lower operating costs, their widespread adoption has been hindered by a range of barriers, including consumer perceptions and attitudes towards EVs. Understanding consumer perceptions and attitudes is essential to address these barriers and facilitate a successful transition to a sustainable mobility system. This research paper titled "Charging Forward: Investigating Consumer Attitudes and Perceptions of Electric Vehicles" seeks to provide a comprehensive analysis of consumer perceptions and attitudes towards EVs, based on a review of published research papers on the topic. The study identifies key drivers of consumer behaviour towards EVs, including range anxiety, charging infrastructure, and perceived vehicle performance, and explores the role of social and cultural factors in shaping consumer attitudes. The research also offers recommendations for

stakeholders in the EV industry to overcome barriers to adoption and accelerate the transition to a sustainable mobility system. By providing insights into consumer perceptions and attitudes towards EVs, this research paper aims to contribute to a better understanding of the factors that influence EV adoption, and to inform strategies to promote sustainable mobility systems.

2. FACTORS INFLUENCING EV ACCEPTANCE

The emergence of electric vehicles (EVs) in India due to contemporary environmental concerns. The Indian market's skilled and semi-skilled technological base, large customer base, and relatively cheaper production and labour cost has attracted global EV manufacturers and component suppliers such as Bosch, AVL, and Cummins. However, there is a need to study factors that influence the consumer acceptance of these vehicles to understand the commercial success and purchase intention of EVs in India. The text identifies various factors that influence car buyers' purchase decision, including individual perceptions on dimensions such as environmental issues, cost, trust, technology advancement, infrastructure, and society acceptance.

The study concludes that environmental concerns and consumer trust in technology are antecedent factors for perception about EV purchase. However, factors that hinder EV

adoption include cost, infrastructure, and social acceptance. Therefore, the government must play a leading role in promoting EV sales by creating environmental policies, infrastructure, and subsidized costs or lower bank interest rates. The text also notes that research on the consumer acceptance of hybrid and full EVs in India is limited, despite the potential of EVs to reduce carbon emissions from transport.

The review of literature highlights the innovation diffusion theory, which explains the adoption of new technology based on usefulness (performance expectancy), ease of use (effort expectancy), social influence, and facilitating conditions. These parameters play acrucial role in the adoption of EVs.

Several studies have been conducted to understand the perception and adoption of electric vehicles (EVs) in India. The study is based on a literature review of research on EV adoption in other countries and aims to explore the driving parameters that would lead to a change in EV adoption in India. The study used an internet-based survey questionnaire with 233 respondents who were owners of fuel cars and had an intention to purchase an EV. The survey questionnaire focused on identifying the various aspects of the research such as demographics, purchase decision parameters, and technology adoption. The results of the study showed that the main factors that affect the purchase decision of EVs in India are environmental concern, cost, comfort, trust and technology, social acceptance, and infrastructure availability. The study is relevant for modern India as it enables us to understand the factors that would lead to the adoption of EVs in India.

Further based on the results of a study on the factors influencing the adoption of electric vehicles in India, it

came to the finding that people are aware of the environmental benefits of electric vehicles and have faith in technology, but they are hesitant to adopt them due to the rapid pace of technological change and the lack of necessary infrastructure. Social acceptance also plays a significant role in the adoption of electric vehicles. The study ranked the factors influencing the adoption of electric vehicles in order of importance: environment concern, technology, cost of vehicle, trust, comfort, infrastructure, and social acceptance. The study suggests that manufacturers and the Indian government should invest more in creating infrastructure and building consumer trust in electric vehicles to increase their adoption and reduce respiratory problems.

3. CUSTOMER PERCEIVED VALUE

Another important aspect being discussed is of electric vehicles (EVs) in addressing environmental concerns, and the challenges that EVs face in terms of battery technology and customer acceptance. The authors propose a multi-scale model for measuring customer perceived value (CPV) of EVs and use the decision-making trial and evaluation laboratory (DEMATEL) method to analyse the interdependent relationships among the different scales. They also use a modified version of the house of quality (HoQ) to conduct a technical feasibility analysis for improving each scale. The article concludes with proposed market segmentation strategies for EV manufacturers based on the findings of the study. Overall, the study aims to assist EV manufacturers in developing products that effectively meet consumers' needs.

Further the study aims to develop a multi-scale model for Customer Perceived Value (CPV) of electric vehicles (EVs) and then apply the model's output to technical improvement analysis and marketing strategies for the EV industry in China. The literature review conducted in this study focuses on three themes: previous studies on CPV, the utilization of the DEMATEL method, and the HoQ. The first theme concentrates on the extensive research interest that CPV has received in the present century and its critical role in creating value for customers. The excerpt also outlines how various authors have defined perceived value and the different approaches used to measure CPV. The multidimensional construct of CPV leads to further discussions on how to choose the different scales for its measurement, and this issue has varied a lot among previous research. The excerpt provides examples of how CPV has been embraced as a strategic imperative by luxury retailers in the luxury goods market and coffee outlet industry. The study is unique because it takes both the 'product' side and the 'customer' side into consideration when constructing the multi-scale model, unlike previous research that mainly focused on the product side.

Also, an important factor is regarding the selection of ten Critical Product/Service Variables (CPV) for the study of the factors that influence consumers' adoption of electric vehicles (EVs). The ten CPV scales were chosen based on interviews and literature reviews and are grouped into three categories: product side,

interactions, and customer side. The product side scales include brand, infrastructure, preferential policy, purchase price, cost of use, horsepower, and safety. The interactions scales include enjoyment and service. The customer

side scale is customer characteristics. The text provides detailed explanations for each of the ten scales, including sub-scales where relevant. These CPV scales will be used to understand the factors that affect consumer perception of the influencing power of each scale in their decision to adopt EVs.

The study discusses the concept of Customer Perceived Value (CPV) in the context of Electric Vehicles (EVs) and how it can help manufacturers understand the main factors contributing to CPV and how to design future EVs that can yield higher CPV. The authors explain that CPV is the total value a customer can perceive and that it is heavily dependent on customer satisfaction. They also highlight the importance of market segmentation in understanding the unique needs and expectations of different groups of customers.

The authors then provide a detailed explanation of the House of Quality (HoQ) method used in their study to quantify the relationship between customer needs and technical requirements for EVs. They explain how the HoQ can be used to determine the relative importance of different customer needs and technical requirements and to assess the competitive advantage of EVs over traditional Internal Combustion Engine (ICE) cars.

The study concludes with a discussion on market segmentation, highlighting the importance of tailoring EVs to the actual driving missions of specific customers. By focusing on specific driving missions of customers, a company can match the requirements for a vehicle's battery capacity to a customer's needs or expectations, and thus design different types of EVs for different groups of customers. The authors also provide examples of how different demographic groups have different needs and expectations for EVs, and how this information can be used to shape a company's brand and advertising messages for different products.

4. THE RANGE ANXIETY

Range anxiety is a common concern among potential electric vehicle (EV) buyers, which refers to the fear that an EV will run out of battery power before reaching its destination or finding a suitable charging station. This anxiety can be a significant barrier for consumers considering an EV purchase, as it raises concerns about the vehicle's reliability and practicality compared to traditional internal combustion engine (ICE) vehicles.

A study by the Department of Energy's Lawrence Berkeley National Laboratory (LBNL) has found that the perception of range anxiety surrounding electric vehicles (EVs) may not match up with reality. The researchers found that most daily travel needs of drivers can be met by

EVs, even when batteries have lost up to 20% of their original energy storage capacity. At 50% capacity, EVs can still meet the needs of 80% of US drivers, and at 30% capacity, they can still meet the needs of 55% of drivers. The study analysed over 150,000 driving routes and itineraries and found that only a small fraction of drivers will no longer be able to meet their daily driving needs after losing 20% of their battery's energy storage capabilities.

Several factors contribute to range anxiety in EVs:

- **Limited driving range**: Early electric vehicles were often criticized for their limited driving range compared to ICE vehicles. As battery technology has improved, newer EV models have substantially increased their ranges, with some models now offering over 300 miles on a single charge. Despite these advancements, the perception of inadequate range still lingers among some consumers.
- **Insufficient charging infrastructure**: A lack of available charging stations can exacerbate range anxiety, especially in rural or remote areas with sparse charging networks. Consumers may worry about the ability to find a charging station when needed, leading to concerns about being stranded with a depleted battery.
- **Longer charging times**: Charging an electric vehicle typically takes longer than refueling an ICE vehicle, which can contribute to range anxiety. Although fast- charging stations are becoming more prevalent, they are not yet as widespread as traditional gas stations, and charging times might still be a concern for potential EVowners.
- **Battery degradation**: Over time, EV batteries can experience degradation, resulting in reduced capacity and decreased range. This can heighten range anxiety, as drivers may worry about how the vehicle's range will be affected in the long term.

To address range anxiety, the automotive industry has taken several steps:

- **Improved battery technology**: Innovations in battery technology have led to increased energy density, allowing for longer driving ranges in modern EVs. This progress has helped alleviate range anxiety for many consumers.
- **Enhanced charging infrastructure**: Governments and private companies are investing in expanding charging networks, making it more convenient for EV owners

  to recharge their vehicles. As the charging infrastructure becomes more widespread, range anxiety is expected to diminish.

- **Faster charging solutions**: The development of fast-charging stations has significantly reduced the time it takes to recharge an EV, making the charging process more convenient and less time-consuming for drivers.

- **Accurate range estimations**: Many EV manufacturers have implemented advanced range estimation systems into their vehicles, providing drivers with more accurate and real-time information on the remaining battery range. This can help drivers plan their trips and charging stops more effectively, reducing range anxiety.

Therefore range anxiety has been a notable concern for consumers considering electric vehicles. However, advancements in battery technology, charging infrastructure, and vehicle features are continuously addressing this issue, making EV ownership increasingly practical and appealing. As the EV market continues to grow and evolve, range anxiety is expected to become less of a barrier for potential buyers.

5. CHARGING INFRASTRUCTURE

Governments and private companies are investing in expanding charging networks, making it more convenient for EV owners to recharge their vehicles. As the charging infrastructure becomes more widespread, range anxiety is expected to diminish.

Customer perception of charging infrastructure for electric vehicles (EVs) plays a significant role in the adoption of EVs. Charging infrastructure refers to the availability, accessibility, and convenience of charging stations for EV owners.
Consumers' perceptions of charging infrastructure can be influenced by severalfactors:

- **Availability**: The number of charging stations in a given area directly impacts consumers' perception of EV charging infrastructure. In areas with a high density of charging stations, consumers are more likely to feel confident about the ease of charging their EVs. Conversely, a lack of charging stations in an area can contributeto range anxiety and negatively affect consumers' perceptions.

- **Accessibility**: Consumers also consider the ease of finding and accessing charging stations. Well-signed, easily located charging stations with user-friendly interfaces

contribute to a positive perception of the charging infrastructure. In contrast, hard-to- find or poorly maintained charging stations can lead to frustration and a negative perception of the EV charging experience.

- **Charging speed and compatibility**: The speed at which an EV can be charged is another important factor shaping customer perception. Fast-charging stations that significantly reduce charging times are more likely to be viewed positively by consumers. Additionally, compatibility across various EV models and charging connectors is essential, as it ensures that drivers can charge their vehicles at any available station without worrying about finding a compatible charging point.

- **Cost**: The cost of charging an EV can also influence customer perception. Some charging stations offer free charging, while others may require payment. Consumers tend to appreciate transparent pricing structures and reasonable charging rates. High costs or confusing pricing models can lead to negative perceptions of the charging infrastructure.

- **Additional amenities**: The availability of amenities at or near charging stations can enhance the charging experience and improve customer perception. For example, charging stations located near shopping centers, restaurants, or rest areas allow customers to use their time effectively while waiting for their vehicle to charge. In contrast, charging stations in remote locations with limited amenities can lead to a lesssatisfying experience.

  To improve customer perception of EV charging infrastructure, governments, businesses, and the automotive industry can focus on increasing the number of charging stations, developing fast-charging technology, ensuring compatibility, offering transparent pricing models, and providing convenient amenities at charging locations. As the charging infrastructure continues to improve, it will help alleviate range anxiety, promote a positive perception of EVs, and ultimately encourage moreconsumers to consider EV ownership.

6. LACK OF AWARENESS

The great automotive giant Ford has launched an all-electric SUV in 2020 as part of its electrified models line-up. A recent Ford-commissioned survey revealed that 73% of people aspire to own an electric vehicle one day, with 45% of respondents stating

that not stopping for fuel is a key benefit of owning an electric vehicle. However, 40% of respondents claimed to have little or no knowledge of electric vehicles. To help educate consumers, Ford has created an All-Electric website that allows users to input their daily driving routines and see how far they could travel between charges, using the new model's expected range of 600 km (370 miles). The survey also found that lack of charging stations (49%), short battery life (43%), and a need to charge frequently (38%) are the main concerns about owning an electric vehicle. Darren Palmer, Ford's Team Edison global product development director, said that there is a perception gap among customers, and Ford aims to offer a range of electrified

vehicles and bust commonly held myths to help consumers make the switch to electric.

Lack of awareness about electric vehicles (EVs) can significantly impact consumer perception and hinder the adoption of EVs. There are several aspects of EV technology that consumers may be uninformed about, and this lack of knowledge can lead to misconceptions, scepticism, and reluctance to embrace EVs. Many consumers may not be aware of the long-term cost savings associated with EVs, such as lower fuel and maintenance expenses. Additionally, they might not know about the various incentives, tax credits, and rebates offered by governments to encourage EV adoption. Increased awareness of these financial benefits can make EVs more attractive to potential buyers.

Misconceptions about EV performance, such as the belief that EVs have limited speed or acceleration capabilities, can hinder adoption. Educating consumers about the impressive performance of many modern EVs, as well as the advanced technology and features they offer, can help dispel these myths and improve consumer perception. A key selling point for EVs is their lower environmental impact compared to ICE vehicles. However, some consumers may not be aware of the full extent of the environmental benefits, such as reduced greenhouse gas emissions, improved air quality, and decreased reliance on fossil fuels. Raising awareness about these benefits can help shape a more positive perception of EVs. Therefore, lack of awareness about various aspects of EVs can significantly impact consumer perception and hinder the adoption of this sustainable transportation option. By addressing these knowledge gaps through education, marketing campaigns, and public initiatives, stakeholders can help reshape consumer perception and pave the way for widespread EV adoption.

7. FUTURE OUTLOOK

Consumer perception of electric vehicles is undeniably evolving, with more people recognizing the benefits of making the switch. As technology advances and charging infrastructure expands, electric vehicles are poised to become an increasingly dominant force in the automotive market. The future outlook for electric vehicles (EVs) appears to be quite promising, with a number of factors contributing to their growing market share and increasing adoption around the world.

As battery technology continues to improve, we can expect to see EVs with longer driving ranges, faster charging times, and more efficient energy consumption.

Furthermore, innovations in power electronics, electric motors, and lightweight materials will enhance the overall performance and efficiency of EVs. The cost of EV batteries has been dropping significantly over the past decade, and this trend is expected to continue. As battery prices fall, the overall cost of EVs will become more competitive with internal combustion engine (ICE) vehicles, making them a more attractive option for

consumers. Many countries are implementing policies and regulations to encourage the adoption of EVs. These include incentives like tax credits, rebates, and exemptions, as well as stricter emission standards for ICE vehicles. Some countries have even announced plans to phase out the sale of new ICE vehicles within the next few decades, which will further boost the demand for EVs.

As more consumers become aware of the benefits of EVs, such as lower operating costs, reduced environmental impact, and advanced technology features, the demand for EVs is expected to keep rising. The transition to renewable energy sources like solar and wind power can be accelerated by the widespread adoption of EVs. Smart charging and vehicle-to-grid (V2G) technologies can help balance the electricity grid, allowing EVs to serve as energy storage devices when not in use. The development of self-driving cars is expected to have a significant impact on the future of transportation. Many experts believe that autonomous vehicles and EVs will converge, as electric powertrains are well-suited for self-driving technology due to their simplicity, reliability, and instant torque.

8. CONCLUSION

Thus analysing the whole scenario, the future of electric vehicles (EVs) is on a promising trajectory, fuelled by technological advancements, decreasing costs, and supportive policies. As the world increasingly embraces sustainable transportation solutions, EVs are set to play a pivotal role in revolutionizing the automotive industry and mitigating the environmental impact of traditional internal combustion engines. With improvements in battery technology, charging infrastructure, and integration with renewable energy sources, EVs are poised to become an integral part of our daily lives, offering a cleaner, greener, and more efficient mode of transportation. As the adoption of EVs continues to accelerate, we can expect a more sustainable, eco- friendly, and technologically advanced future for the global automotive landscape.

Overall, regarding the consumer perceptions of EVs continue to improve as awareness of their advantages—such as cost savings, performance, and environmental benefits— grows. The ongoing development of charging infrastructure and the proliferation of electric vehicle options across various price points and vehicle types will further solidify their position as a viable and attractive choice for consumers. With the momentum behind electric vehicles only gaining speed, the future of transportation is looking greener and more sustainable than ever before.

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