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Factors Affecting Customer Decision Making for Electric Vehicles in India Using Machine Learning

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These days, everyone is worried about the weather changing because of global warming. India now ranks among the world's top 10 polluters due to its steadily rising rate of greenhouse gas emissions. One of the major causes of the greenhouse effect is air pollution. Ten percent of India's air pollution is caused by vehicles. In an effort to lessen the country's air pollution, the government of India is promoting the use of electric cars. However, how people feel, think, and comprehend electric vehicles (EVs) will determine how well they do. The goal of this case study was to get a sense of how electric car buyers in India feel. The primary goal of this study was to utilize Deep Learning techniques, such as the Doc2Vec Algorithm, Recurrent Neural Networks (RNNs), and Convolutional Neural Networks (CNNs), to extract opinions that would be useful for marketers, manufacturers, and prospective buyers. We choose to use a big data platform to examine EV sentiment since that's how social media data is naturally structured. The better text mining capabilities of Deep Learning based approaches made them the favored choice over more conventional machine learning algorithms like Support Vector Machine, Logistic regression, Decision trees, etc.

Keywords: Electric Vehicles (EV),Recurrent Neural Network (RNN), Convolutional Neural Network (CNN),Deep Learning.

1. Introduction

The adoption of electric vehicles (EVs) in India is gaining momentum as the country seeks sustainable and eco-friendly transportation solutions. However, customer decision-making for electric vehicles is influenced by various factors that need to be understood for effective market strategies [1][2].

Machine learning (ML) can play a crucial role in analyzing and predicting these factors, aiding

businesses in tailoring their offerings to meet customer preferences [3].Due to its bright future, the ideas of electric vehicles (EVs) are attracting enormous attention from all stakeholders. In order to manage potential long-term pollution requirements, electric vehicles are gaining popularity (ACEA, 2017). In March 2011, the International Geneva Motor Show showcased the future of environmentally friendly transportation at an automotive event to support this cause.[4][5] At the event, there was a "Green Vision" area that showcased over a dozen different environmentally conscious vehicle companies. Presenters at the event showcased the electric vehicle idea and its potential impact on the automotive industry in the future. More than a century has passed since the notion of an environmentally friendly car first emerged . A new consumer market is ready to be filled with these items as a result of the growing demand for environmentally conscious transportation options. Electric vehicles are definitely the way of the future when it comes to eco-friendly transportation due to their huge advantages in terms of energy usage and emissions[6]. Concerns about climate change and global warming are driving the ever-increasing interest in electric vehicles[7].

When compared to cars powered by internal combustion engines (ICEs), electric vehicles have significantly different technological specifications. This research primarily focused on battery electric vehicles (BEVs), however it did not exclude zero-emission vehicles (ZEVs) or pure electric vehicles (PEVs) from the electric vehicle category. The majority of India's new cars are EVs, or battery electric vehicles[8][9]. Electric vehicles are made up of many components, including a controller, an electric motor, and a battery to store energy. Most of the time, you can charge the batteries by plugging them into an electrical outlet. You have two options for where to put the battery charging unit: onboard or at the charging station. The controller usually regulates the forward and reverse power delivered to the motor.[10] A two-quadrant controller is the common name for this kind of controller. Regenerative braking and frictionless braking are commonly preferred methods of energy recovery. Both forward and reverse regenerative braking are also under the controller's purview. A four-quadrant controller describes this method. These days, permanent magnetic materials derived from rare earth elements (neodymium and samarium) are used to build electric motors that are very efficient and dependable[11]. There are a few ways to compare the efficiency of various electric vehicle engines: megajoules per kilometer, carbon dioxide equivalent emissions per kilometer traveled, or the proportion of energy converted to motion[12][13].

2. Electric vehicles in India

To combat traffic congestion and ensure the country's energy independence, the Electric Vehicle Industry (EVI) of India launched the "National Electric Mobility Mission Plan (NEMMP) 2020" in 2013. In doing so, it hoped to encourage the development of indigenous manufacturing capacities for eco-friendly automobiles. The Indian government has set a goal of transitioning to electric cars in large numbers by 2030 in response to the Paris Agreement. The Reva Electric Car Company of India and Ola, an Indian app-based transportation network company, are collaborating to develop electric vehicles that are both more efficient and more dependable. But, in an effort to achieve a pollution-free environment, the government has begun incentivizing the purchase of electric cars in an effort to speed up their acceptance and production. Incentives for electric vehicles in India range from 1,388 to 1,39,000 rupees (PTI,

2015) for automobiles and scooters and motorbikes. In an effort to expand charging infrastructure throughout the nation, the government has been issuing bids over the last few years (PTI, 2015). The Electric Vehicle and Energy Storage Policy, which aims to encourage greener energy, was enacted in 2017 by the Indian state of Karnataka.

Bloomberg Business (2018) states that India's 7.3% GDP growth in the last five years has established it as one of the most powerful economies in Asia. On the other hand, Indians would want to avoid wasting money on unnecessary gasoline and oil. A transition to fully electric cars by 2030 is part of the government's strategy to save expenditure on petroleum products. The government of India has begun programs to encourage the purchase of electric cars by offering them with no down payment. Apart from the financial incentives, the Indian government has also committed to covering as much as 60% of the R&D expenses for creating domestic, affordable electric car technology. In order to reach its goal of fully electrified cars by 2030, India may rely on this program. Reducing reliance on fossil fuels and oil imports is the rationale behind this endeavor. The government of India has just put out a call for proposals to establish 10,000 EV assembly plants around the country. The country's energy-efficient vehicle industry is also being pushed forward by organizations like POWERGRID, Rural Electrification Corporation, Energy Efficiency Services Limited (EESL), and Power Finance Corporation. Tata Motors, Mahindra & Mahindra, Renault, Hyundai, Nissan, Maruti Suzuki, and the country's sixth-largest carmaker are among those who have shown interest in forming partnerships with the government to promote environmentally friendly transportation.

3. Consumer Perspectives' Towards Electric Vehicle

Major automakers are exploring more eco-friendly car options in response to climate change and global warming. Various electric vehicle models have been introduced to the market by many automakers, including Mahindra, Nissan, Tesla, and Chevrolet. A plethora of new, specialist electric vehicle (EV) manufacturers have recently joined the market.

The widespread availability of oil and people's mentalities, however, have dampened sales of these vehicles when contrasted with sales of traditional cars. As concerns about global warming, carbon dioxide emissions, and the rising cost of gasoline have grown since the turn of the century, some nations and car manufacturers have begun to prioritize electric vehicles and hybrid electric vehicles. The most potential future transportation system answer may be the broad adoption and distribution of electric cars (EVs). However, compared to other vehicles (conventional ones), EV mass distribution is more challenging due to several infrastructural limits and technical disparities.

The general public's attitude toward and propensity to adopt electric cars are crucial factors in their marketing. In order to boost commercial distributions, it is necessary to look at people's personal and societal difficulties in addition to improving the technical limits of EVs, such as battery capacity and weight. Numerous studies have projected the market for carbon-free, clean, energy-efficient PHEVs and surveyed public opinion on electric cars (EVs) and plug-in hybrids (PHEVs) in recent years. The elements that influence people's acceptance or rejection of electric vehicles have been extensively investigated and recognized by academics.

However, consumers won't buy electric vehicles (EVs) unless they learn about and embrace the technology that make them superior to traditional cars powered by internal combustion engines. Electric vehicles' underlying technology are a game-changer in the transportation industry. People are more likely to embrace this invention if it follows the rules laid forth by the theory of innovation dissemination. Thus, a baseline and proxy measure for future car purchases may be an exposure measure. Mark Singer (2017) contrasted the reactions of respondents to the new technology with those to the status quo, which consists of conventional automobiles powered by internal combustion engines. Consumers' views on the practicality of EVs and their feelings towards EVs' technical aspects were identified as the most influential elements in the adoption rate. How buyers evaluate the practical and technological features of electric vehicles has been the subject of several studies. In the technological sphere, a well-known adoption hurdle of EVs is their short range. The range of an electric vehicle is a serious issue as it falls short of what consumers want, according to a survey of 369 Danish drivers who tried out EVs for a test drive. Legislation at the federal level is another critical component for EV adoption. But consumer behavior experts are worried about how consumers will feel and what they will anticipate from these regulations.

However, customers may become reluctant and hesitant due to the frequent policy changes, which in turn affects uptake. However, some EV adopters in the US, UK, and India bring up the issue of national independence from foreign oil as a motivation factor to adopt EVs, in addition to consumers being fascinated by financial incentives like tax rebates or government cash refunds on the purchase of EVs.

Many academics have found important obstacles to the widespread adoption of EVs, despite the trend and benefits of EVs. An important step in the adoption of EVs before they are even evaluated by customers is getting to know the market. Electric vehicle (EV) markets and prospects may be better understood by identifying and addressing the obstacles to EV adoption. One major obstacle to the widespread use of electric vehicles is the restricted range that comes with smaller batteries. Another obstacle to adoption is the charging time. The size of the electric vehicle's battery and the accessibility of charging infrastructure determine the time-to-charge. However, filling stations are widely available, and cars that run on gasoline or petroleum can be refueled quickly. The volume of their oil tanks is the only limitation. Some people have voiced concerns about the performance, size, appearance, safety, and recharge time of electric vehicles, in addition to the range and charging time. Some British buyers valued EVs for their acceleration, smoothness, and reduced noise, but others rated them poorly for their performance and safety. Another research indicated that consumers' attitudes and perceptions of electric vehicles might be positively impacted by getting some hands-on experience with them. Consequently, customers' views regarding EVs may be changed by giving them opportunity to have hands-on experience with EVs.

Furthermore, universities should choose entrepreneurial education programs with consideration, thinking about the attitude, language possibilities, and technological components. They should also strive for interdisciplinary synergies, either within or outside, via coordinated effort. The vast alumni network of HEIs may be used in several ways, including providing mentorship, gaining access to markets, and access to funding. Colleges and universities also have a responsibility to inform the public about the many aid programs they run and the policies that regulate them.

4. Machine Learning Based Model to Predict Who Will Buy

Based on the input factors, a predictive machine learning model was created to determine whether an Indian buyer would purchase an electric car or not. The logistic regression approach was used for forecasting in this research work, however there are several well-known machine learning classification models that may provide reasonable predictions. One benefit of logistic regression is that it does not need data standardization, data scaling, or the handling of missing data when generating models. One potential drawback of logistic regression models is the time it takes to teach analysts to utilize them, which might be a worry at times [37–39]. To get insight into customer behavior, surveys are often used. The researcher gathers data directly from the source via a primary survey, and then analyzes it to draw conclusions. A questionnaire was sent to the participants in order to gather information for the model. Results from the literature study and the examination of the tweets' content informed the selection of the factors. Consumers' demographics, socioeconomic status, environmental consciousness, and other pertinent factors are included into the model. The created predictive machine learning model can categorize Indian consumers as either "Buy" or "Won't Buy" when it comes to electric vehicles.

Several methods, including machine learning algorithms, have been used to investigate the factors impacting electric vehicle (EV) purchase decisions made by Indian customers. A number of important criteria have surfaced from the offered search results as influencing the decision of an Indian customer to "buy" or "won't buy" an electric vehicle.

- Age, gender, income, and level of environmental concerns
- Vehicle cost, running cost, vehicle performance, and driving range
- Mass behavior, indicating general trends within society
- Availability of charging stations and battery-related issues
- Government subsidies, although less significant according to one study
- Sociodemographic factors, such as educational background and employment status
- Attitudes and perceptions towards EVs, which play a critical role in consumer intentions

5. Conclusion

A data-driven viewpoint on electric car adoption has been added to the conversation by this research. A potent analytical tool, machine learning has revealed the complex web of consumer choices, enabling players to traverse the electric transportation future. The combination of machine learning with sustainable mobility will be crucial in creating a more environmentally friendly car industry as data sets and technologies keep expanding.

Conflicts of Interest

The authors declare that they have no competing interests.

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