

Electric Vehicle Adoption Trends and Consumer Sentiment Analysis

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1 Introduction

The market of electric vehicles is rapidly growing because nowadays the world needs clean energy sources. Governments around the world are increasingly imposing emissions controls while consumers are slowly developing a conscience for the environment, hence, the fast-evolving popularity of EVs from luxury items to regular commodities. Some of the current market leaders include China, the United States, and several European countries, and most analysts believe that EVs could be the market leaders in the next ten years. This rise is being driven by technological advancement, cost reduction, and increased availability of charging stations. However, while the numbers are soaring high, analyzing the rationales for consumers' choices and making further forecasts is much more profound in terms of data analysis and consumer behavior analysis.

The sales data are very essential in monitoring the uptake of the EVs. Some of the most widely adopted models include Bass Diffusion Model, Generalized Bass Model (GBM), and the Uncertain Bass Model that help to predict the rate of adoption of EVs. These models use historical sales data and apply it to growth by giving considerations to factors such as market trends, government policies and innovation cycles. For instance, there has been research work comparing the effect of EV diffusion on electricity de-

mand in South Korea and China and are used in the analysis of the rate of adoptions and the market (Park and Shin, 2024; Ning et al., 2024) [5], [4].

There is another important factor of EVs apart from the sales data and it is the consumer attitude towards them. Through reviews, tweets, blogs and other feedbacks, it is possible to understand how the consumers feel about EVs: whether they are happy to embrace them or are concerned about the costs and inconvenience of recharging. By employing SA methods, it is possible to examine these opinions as to get a glimpse of what influences the consumers. In order to enhance the accuracy of forecasting the sales of EVs and to present the complete view of the sentiments regarding EVs' adoption, this study includes both the sales forecast technique and sentiment analysis to support the manufacturers and policy makers regarding the future of EVs.

2 Statement of Purpose

The purpose of this study is to explore electric vehicle (EV) adoption through two distinct but interconnected approaches: studying the adoption rate with the help of sales figures and investigating customer behavior with the help of the sentiment analysis of the reviews.

In the first part of the study, the researcher seeks to use the Bass Diffusion Model, the Generalized Bass Model (GBM), and the Uncertain Bass Model to forecast and analyze the data on electric vehicle sales. These models will assist in tracing the rate at which the EVs will be adopted and even determine the rate at which they may be adopted in certain markets. Using sales history and combining it with such factors as governmental support, technological developments, and market trends, this part of the study will provide information on the rate of EVs' popularity in such regions as South Korean, China, and the United States.

The second part of the study will involve the use of sentiment analysis to analyze the consumers' reviews. Thus, through the analysis of opinions expressed in the online reviews, social media, and other similar platforms, the study seeks to assess the consumers' perceptions of EVs. This consists of investigating parameters that are instrumental in consumers' decision-making process, for example, price, environmental concern, efficacy, and charging facilities. Through sentiment analysis, it will be possible to establish more frequent themes and sentiments that cause consumers to engage in the EV market.

3 Literature Review

The usage of electric automobiles has been on the rise in the last decade due to technology improvement, government support and growing consciousness level of the people regarding the importance of environmental conservation. In a bid to decipher the pattern of EV adoption, the researchers have used a variety of forecast models and analyzed the impact of consumers' attitude. This paper has a focus on a number of reviews on the subject of the EV adoption prediction, including the usage of such models as the Bass Diffusion Model, as well as the impact of the sentiment analysis on consumers [1].

1. Analyzing Sales Data for Predicting the Trends in the Adoption of EVs Data related to sales has been most helpful in analysis to determine the trends of the EV market. The other popular tool is known as the Bass Diffusion Model that divides the market into two groups of customers, which are the early customers known as innovators and the other group known as imitators, and it estimates how fast new technologies such as EVs will diffuse (Singhal et al., 2024) [8]. The model has also been used in different regions to predict the trends of the EV market, growth. For example, Park and Shin (2024) used a diffusion model to forecast alterations in electricity use in South Korea as the utilization of EVs grows. Their work incorporates both the macroeconomic variables with technological adoption and diffusion and sheds light on the additional load that EV will bring about [5].

Ning et al. (2024) further developed the diffusion model in the context of China with adding temporal and spatial factors as the regional characteristics influence the sales forecast of EVs. These models offer a framework of how the forces of the market and push from the government impact the rate of adoption [4]. Likewise, Patil et al. (2023) used the Bass model to the multigenerational technologies in India and also highlighted that Bass model can be used for forecasting not only the initial time adoption but also the subsequent generations of the technology [6].

Kemala et al. (2024) provided a literature on the various forecasting techniques for EV ownership including time series and diffusion models and comparison between the two. Their work asserts that Bass model and its derivatives continue to attract considerable popularity in explaining the up-take of technological products such as EVs [3].

2. Consumer review analysis can also be done with the help of sentiment analysis. Although sales data and diffusion models give the quantitative picture of the adoption curve, consumers' perception influences the demand

for EVs. It is possible to demonstrate that sentiment analysis methods, which can use NLP, enable scholars to glean significant information from clients' reviews, posts, and other feedbacks. These insights assist in understanding main drivers influencing consumers' decisions like the price, environmental factor, and the issue of charging infrastructure.

Pham (2023) focused on the consumer reviews in the Nordic countries, to understand how the sentiment affects the use of EV in Finland, Sweden and Norway. This is because, through the study of the public opinions as identified by Pham, some of the main factors that affect consumers include vehicle performance, the effects of the vehicle on the environment, and the government policies that influence the buying behaviour. This kind of analysis can give more detailed insight of customers' laid-back inclinations that can be hard to decipher through sales figures [7].

Jung, Schröder, and Timme (2023) extended the analysis to show how exponential growth of battery electric cars is affected by consumers' perception on technology trends and charging stations. Their research proves that positive consumers attitude towards the products will increase its uptake, especially if the issues of inconvenience and cost are addressed by the manufacturers and policy makers [2].

3. The willingness of consumers to purchase goods and services as well as, the assessment of market trends and consumer behavior is another significant factor that helps in the integration of forecasting models and sentiment analysis. They are accomplishing the analysis of the EV market by integrating the sales data models and the sentiment analysis. Literature such as Wang et al. (2024) and Singhal et al. (2024) suggest that the use of consumer feedback together with diffusion models can improve the prediction of the take up of EVs. It also provides a more fluent view of how the external factors that influence the adoption, for instance, changes in policies, emergence of new technologies, and changes in consumer attitude, come into play [9], [8].

Using the combination of sales data and the analysis of consumer reviews, we can provide a more detailed and well-grounded prognosis of the further development of the EV market. Such an integration not only improves the reliability of the forecasts but also offers relevant suggestions to manufacturers and policymakers to boost the sales of electric vehicles.

4 Objectives of the Study

The research covers the goals, and we plan to state them in order. Using forecasting models to ascertain the level of adoption of EVs and analyzing the sentiment of consumers on the same.

To predict and refine EV adoption trends using forecasting models: The rate of adoption of EVs will be forecast using the Bass Diffusion Model, Generalized Bass Model (GBM) and Uncertain Bass Model. Such models shall take into consideration factors like market trends, government incentives, technologies and unpredictability in the rate of adoption of EVs among the different regions.

To analyze consumer sentiment using Natural Language Processing (NLP): This objective focuses on the application of NLP on Twitter and Reddit data to extract data that contain sentiments on electric vehicles. The study will reveal the consumer choice drivers, including price sensitivity, environmental consciousness, and charging stations based on the analysis of information posted on these forums. For the time being, we are using Google Forms for the sanity check on reviews, and we will work to find better input data.

5 Research Design and Methodology

This project seeks to make electric vehicle (EV) adoption forecast by employing a global dataset that contains necessary features such as region, powertrain type, and adoption data in various calendar years. Furthermore, the study will also analyse sentiments of consumers on electric vehicles from feedbacks obtained from social media platforms such as Twitter and Reddit.

The data set has the information about the adoption of electric vehicles over the years with the division by the region and type of vehicle including electric and hybrid vehicles. Some of the forecasting models to be used include the Bass Diffusion Model which will indicate how the diffusion of EVs will occur through the market with the consumers being split into early adopter and imitators. Incorporation of external factors including region incentives, market conditions and technological advancement in the Generalized Bass Model (GBM) will give a more accurate forecast. For this reason, the Uncertain Bass Model will include factors such as changes in the demand for automobiles, changing policies among others giving it more flexibility in

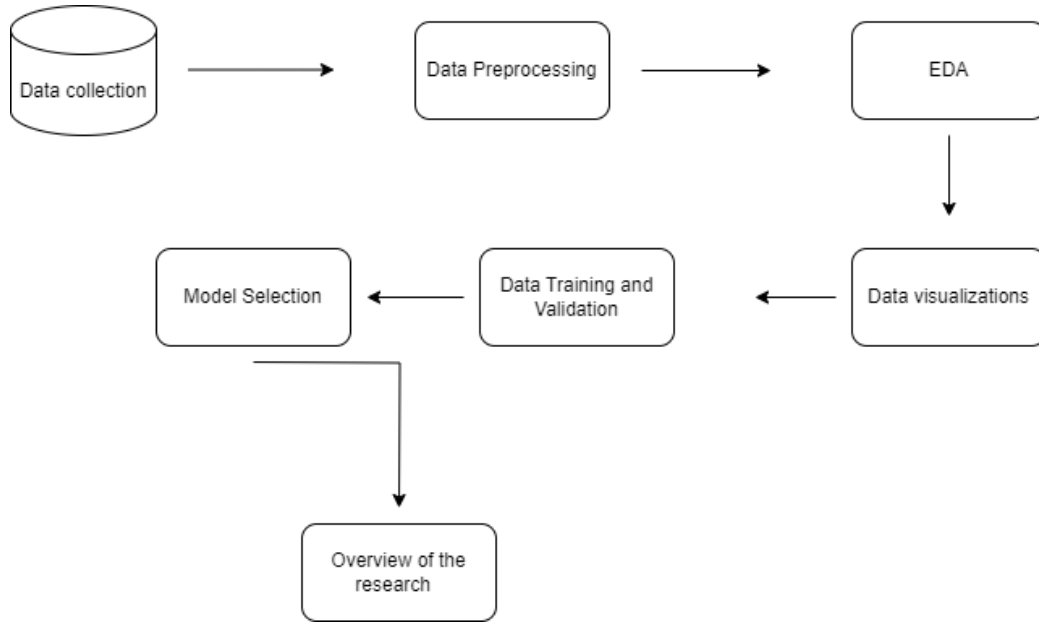


Figure 1: Adoption Trends

predicting the uptake of EVs.

The data from twitter and Reddit will be processed using natural language processing in order to analyze the sentiments of the consumers. By searching for terms such as “electric vehicle”, “battery range” and “charging station”, the desired posts will be collected, pre-processed, and explored. VADER or TextBlob, for example, will assign each post as being positive, negative, or neutral in sentiment. Furthermore, Latent Dirichlet Allocation, LDA will be applied for topic modeling to establish what are the most important topics of concern to consumers which may include charging infrastructure or vehicle prices.

Last of all, the information from the forecasting models and the sentiment analysis will be combined. This approach will give a clear picture regarding the trends of electric vehicles and the sentiments of consumers which will be useful in addressing the various concerns and fast-tracking the usage of electric vehicles among the various stakeholders such as manufacturers and policymakers.

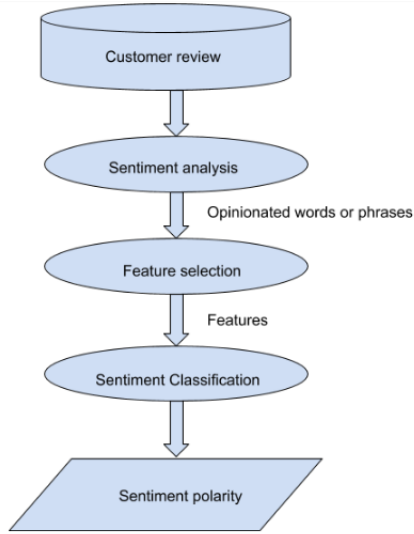


Figure 2: Consumer Analysis

6 Dataset Explanation

This dataset, Global EV Sales (2010-2024), provides a high-level summary of the sales of electric cars (EVs) in various nations and areas. There are projections for the future together with historical trends, spanning the years 2010 to 2024. Perceiving the growth in EV sales over time and forecasting future trends is made easier with the help of this data. Year: Sales information illustrating the rise in popularity of EVs from 2010 to 2024. Country/Region: Monitors sales by nation, with a focus on major markets such as China, the United States, and Europe, to see which regions are EV adopting more quickly. Vehicle Type: Enables comparisons between completely electric and hybrid vehicles by separating Battery Electric Vehicles (BEVs) from Plug-in Hybrid Electric Vehicles (PHEVs). Sales Volume: Provides an overview of all EV sales, making it simpler to analyze the rate of market expansion. Users can compare the performance of various regions. The data projection for 2024 helps in understanding potential future market growth. It provides important insights into the factors influencing the global shift to electric vehicles as well as helps in the research of those factors. This dataset is taken from Kaggle. Here is the external source Dataset

7 Team Contribution

1. **Teja** is responsible for the work as he was the Team Lead. He has contributed to collecting research papers, proposal writing, and processing literature reviews.
2. **Pavan** participated in project Brainstorming, literature review, proposal writing, and gathering data.
3. **Spandana** participated in project brainstorming, data gathering, and proposal writing.
4. **Chintureddy** participated in Data gathering and proposal writing.

8 Conclusion

This proposal is a synergistic combination of quantitative and qualitative methodologies in order to have a more complete understanding of electric vehicle (EV) adoption trends. Diverse Forecasting Models: Wholly appraised such usage of different forecasting models and approach like Bass Diffusion Model, Generalized Bass Model (GBM), Uncertain Bass Model that supports an explicit interpretation of the various market factors influencing growth trends. This many-sided approach not just boosts the reliability of the forecasts, but also adds diversity to the analysis by consisting of a number of various possibilities. Furthermore, it is a wise move to include sentiment analysis based on Twitter and Reddit data. This allows us to tap into the diversity of consumer opinion, providing a finger on the pulse of public sentiment towards EVs. For example, the use of Natural Language Processing (NLP) and related models to understand sentiments as positive, negative, or neutral; and the extraction of a mapping between such factors influencing consumer decision can be very enlightening. This not only increases the insights we have around consumer behaviors but also fits neatly into our other data analytics avenues.

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