

Electric Vehicles Acceptance and Knowledge Identification in India using Naive Bayes and k -Nearest Neighbor Classifiers



Vishnu M. R., Rahul Ashok, L. Nitha

Abstract - In order to identify the effect electric vehicles have made in India, we ensue a survey under trend analysis to find a panacea and overall understanding people have about electric vehicles. We used Naive Bayesian and k -Nearest Neighbor for analyzing customer opinion regarding the use of electric vehicles. As pollutants keep on polluting the atmosphere it's more and more appropriate to start using electric vehicles. Electric vehicle support in India is low as of now but is expected to have sufficient support as of 2030. The main objective of our research is to identify the electric vehicles acceptance by people and to identify the knowledge people have about electric vehicles. The result was mainly based on retail price and sufficient support being made available. We used Weka 3.8.4 for experimenting the result. The results found out that positive environmental effects on a large amount of customers for choosing electric vehicles. Customer focuses on price and appropriate charging facilities while they choose to buy electric vehicles. In finding the result, the k -nearest neighbor method showed more accurate results than Naive Bayes when done on large datasets.

Keywords: k -Nearest Neighbor classifier, Naive Bayes classifier, KDD, Data mining.

I. INTRODUCTION

Data mining is the task of drawing out the fruitful data from a huge data set. It is the inspection of data models in enormous sets of data using miscellaneous software. Data mining is oriented on well-founded data collection, warehousing and processing of data. It is utilized for structuring machine learning models that build applications including search engine technology. Data mining can also be termed as Knowledge Discovery in Databases (KDD) [11]. The world is at the verge of change from internal combustion engine vehicles to electric vehicles (EV) as we see the impact of climate change and global warming along with the rapid depletion of hydrocarbon fuel which are limited resources. The rise of clashes in the Middle East and global tensions has also led to rise in oil prices all over the world. The electric vehicles will bring a solution for these accumulating problems. The EV runs purely on electricity. As no hydrocarbon fuel is used for the working of EV the concern for pollution can be removed as none is created by electricity.

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India has taken pledge (as per Paris Climate Agreement) to decrease the overall greenhouse gases emission into the atmosphere as it is among the top three countries which causes most greenhouse gas emissions in the world. China and the USA comes after India in greenhouse gas emissions. Currently China and the USA have 50% of EV in the world. Even though the questionnaire mainly focuses on electric cars and electric 2 wheelers we believe the factors that affect the future of EV in India including electric bus, electric autos and other such EVs will be common.

As all these events unfold we believe it's a necessity to identify the scope of EV in India, perspective of people, people's opinions regarding the EV acceptance, and the deciding factors that would be the major factors that decide the future of EV. We are finding this very same thing through this research of our survey by collecting data of 250 people from all over India by letting them answer the questionnaire made for figuring out this objective. As India aspires to be an EV nation by 2030 these factors could help in identifying the overall factors that are going to affect EV implementation. However we may look at it, electric vehicles are far superior to the internal combustion engine vehicles or hydrocarbon fuel vehicles. The research is done with the help of Weka using k -nearest neighbor and Naive Bayes classifiers.

II. LITERATURE REVIEW

The electric vehicles are improving as new and new companies are getting more involved in the electric vehicle field, Like Tata and Ashok Leyland's electric vehicles. As the topic of electric vehicles in India is a relative topic as of now because of the Paris Climate agreement there are several research papers available on its different aspects. According to Laurent Dupont, Julien Hubert, Claudine Guidat, Mauricio Camargo [1] were able to identify the relation between individuals and innovations. They identified the factors that decide how social groups take the evolving technology of electric cars and thus finding out its potential acceptance and enabling the use of electric vehicles technology. Specific User eXperience (UX) method approach is found through the AttrakDiff-2 questionnaire. Another study found out that retail prices have a major effect on electric vehicles usability and purchases [2]. Retail prices had a major effect on customer behavior on buying electric vehicles and Total Cost of Ownership (TCO) model was used to get the results. Research shows that maintenance costs of electric vehicles are declining to a range of 14% to 26% [3].

The analysis done by Ankit Kumar, S K Choudhary, Chethan K N gave a huge insight towards EV and its working [4]. They identified a lot of facts related to electric vehicles and their study mainly focused on India. It shows most of the problems electric vehicles face and how electric motors work. It proves that electric engines are far superior to Hydrocarbon Fuel Engines or Internal Combustion Engine (ICE) vehicles. This paper gives different perspectives on electric vehicles and facts related to them. It provided many ideas for our questionnaires in conducting our research.

Numerous studies are carried out to compare internal combustion engine cars and electric car owners of 663 Norwegian cars with 11% response rate [5]. Both car owners exhibited the highest level of knowledge towards EV. EV owners exhibited a high degree of normative and environmental beliefs. MANCOVA an extension of covariance method ANCOVA was used along with multinomial logistic regression to get the results. Another analysis shows review of different types of EV like hybrid, plug-in hybrid vehicles and full electric vehicles [6] which focuses on electric trains and how to make it energy efficient. They found some of the major roadblocks which prevent the making of energy efficient powertrain. Most of these roadblocks are applicable to all EVs.

It's the first research to summarize about PEV market characteristics and to find incentive policies in PEV adoption at provincial level and certain other impacts it has [7]. A research on charging scheduling strategy gives an optimal solution for different EVs, transportation, power network and stations. It drives away the common problems that people would have when talking about electric vehicles. By providing different charging facilities to private EVs and public transport EVs, it avoids the main headaches of being put on waiting for other EVs to charge. Even different charging network load was considered along with some other main ideas to find an optimal solution. It is based on a simulation platform utilizing MatLab and MatPower.

Another study by Anat Tchetchik, Liat I. Zvi, Sigal Kaplan, Vered Blass focused on normative goals to identify the effect of innovativeness and driving hedonism, also the interaction with pro-environmental attitudes and user experience of customers choosing an ICE, Hybrid and Electric cars [9] using extending Roger's diffusion of innovation model. It helps in identifying the choice process of customers. A study focused on thermodynamics and energy usage of electric vehicles [10] was done by Efsthathios E. Michaelides. The electric grid of charging facilities will be strained if simultaneous charging occurs. It also identifies the effect of EVs and increased utilization of renewable energy sources. It's done from a thermodynamics point of view and starts with friction / resistance forces that must be overcome by all road vehicles. Most of these ideas from all references give an optimal solution for a better future for EVs in India as well as for other nations.

III. EXPERIMENT & EVALUATION

A survey with a pre-prepared questionnaire was done for relevant dataset collection. The dataset consists of 250 peoples' opinions. We divide the datasets into two. One with a large dataset of 250 and smaller dataset containing 90 datasets. This is done so as to do a comparative study on Naive Bayes and *k*-Nearest Neighbor. The results are passed

into Weka as an .arff file after filtering the fields. We took a percentage split of 75% for all test cases. That is 75% data is used as the training set and the rest as the test set. Each field is compared using Naive Bayes and *k*-Nearest Neighbor to see the accuracy of each field, thus finding which classifier shows more accuracy with the given amount of datasets. The results are in Table 1.

IV. RESULT AND DISCUSSIONS

Table 1 - ACCURACY: All done with 75% percentage split

FIELDS	Naive Bayes - 250 datasets	<i>k</i> -Nearest Neighbor- 250 datasets	Naive Bayes - 90 datasets	<i>k</i> -Nearest Neighbor- 90 datasets
Encouraging Factors to own an EV	54.838	58.064	45.45	40.91
Discouraging Factors against owning EV	58.064	64.516	27.27	22.73
Vehicle Preference EV/HEV/ICE	64.516	67.741	77.27	63.64
Future of EV (peoples opinion)	50	53.225	36.36	36.36
Annual Income Of survey takers	40.32	50	49.91	31.82

most discouraging was found out to be 'Price', 'charging facility' and 'long recharge time'. The next field shows the choice of customers when they were given a choice to select either ICE vehicles, HEV vehicles or EV. Most showed more interest towards EV than the actual expected behavior of customers which was considered to be ICE vehicles. It shows that the customer behavior or trend is improving for EV in India than we thought. 250 datasets of data showed accuracy of 67.41 in *k*-Nearest Neighbor and 64.516 in Naive Bayes. While in 90 sets Naive had an accuracy of 77.27 while *k*-Nearest Neighbor showed an accuracy of 63.64 only. The last field is taken for considering the financial study on customer behavior. Most were in the range of three lakh to six lakh. The 250 datasets showed accuracy of 50 in Naive Bayes and 53.225 in *k*-Nearest Neighbor. While in the case of 90 datasets it showed accuracy of 40.32 in Naive Bayes and 50 in *k*-Nearest Neighbor.

```

Time taken to build model: 0 seconds

=== Evaluation on test split ===

Time taken to test model on test split: 0 seconds

=== Summary ===

Correctly Classified Instances      34      54.8387 %
Incorrectly Classified Instances    28      45.1613 %
Kappa statistic                    0.08
Mean absolute error                0.2116
Root mean squared error            0.3192
Relative absolute error            95.006 %
Root relative squared error        98.9195 %
Total Number of Instances         62

=== Confusion Matrix ===

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Fig 1

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Time taken to build model: 0 seconds

=== Evaluation on test split ===

Time taken to test model on test split: 0 seconds

=== Summary ===

Correctly Classified Instances      36      58.0645 %
Incorrectly Classified Instances    26      41.9355 %
Kappa statistic                    0.2592
Mean absolute error                0.1847
Root mean squared error            0.3357
Relative absolute error            82.9272 %
Root relative squared error        104.0325 %
Total Number of Instances         62

=== Confusion Matrix ===

 a b c d e f <-- classified as
29 1 0 4 3 0 | a = Positive environmental effect
 3 0 0 0 1 0 | b = Brand
 4 0 0 1 1 0 | c = Long Life Battery
 3 0 0 4 0 1 | d = Fast charging battery
 2 0 0 0 1 0 | e = Less Maintenance and service cost
 1 0 0 1 0 2 | f = Price

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Fig 2

These figures show both classifications results shown in Weka for Encouraging factors field with *k*-Nearest Neighbor having the highest accuracy, for 250 datasets. Fig 1 shows the Naive Bayes result for 250 datasets with an accuracy of 54.838. Fig 2 shows the *k*-Nearest Neighbor result for 250 datasets with a higher accuracy of 58.064.

From these readings we found that the accuracy of Naive Bayes and *k*-Nearest Neighbor vary. When a dataset containing 250 data was used to train, the accuracy of *k*-Nearest Neighbor classifiers is high when compared to Naive Bayes classifiers. But when we take the datasets with 90 records, majoritively Naive Bayes classifiers have more accuracy. From the readings we found out that the most encouraging factor that people look at when thinking about buying an EV are mainly the positive environmental effect it has and the second most thing people count on before buying an EV is Fast Charging Facilities. No one wants to stay in a charging grid that lasts for a long while during their

travels. Positive Environmental effects have a major influence on customers' decision to buy electric transport medium.[8] Ideas such as providing fast charging facilities and separate charging facilities for private and public EV could really benefit the cycle of EV transportation. As it would be an optimal solution towards most of the problems faced towards charging facilities of EV. The third most factors that encourage a customer for the choice of EV were its Brand. Well obviously no one wants to buy an EV of an untrusted company or brand. So the sales would be higher for EV of superior Brands. We found out that most of the customers have income ranging from 3 lakhs to 6 lakhs. These data can be made use for financial studies based on customer behavior on purchasing an EV.

V. CONCLUSION

The results showed that the majoritively Naive Bayes accuracy lowers as the number of datasets increases, whereas *k*-nearest neighbor accuracy increases as datasets increases. The study also helped in understanding customer behavior towards EV. The [8] allowed many ideas towards solving the charging problems that may come when considering EV. The amount of electric vehicles in India is rising as new developments are made in this field. Close enough an electric truck was developed by TATA in 2020. An electric bus was developed by Ashok Leyland which has a fast charging of 20s, Allowing fast mobility and unscathed traveling time and distance. These developments will surely help in improving the conditions for EV in Future India. The study also showed that even though some customers have a good opinion about EVs, they still have some attachments towards ICE vehicles. We propose to give predominant importance to facilitate the fast charging grid similar to the brand Ashok Leyland. Private and public electric vehicles can be provided with distinct charging facilities, which could be a better option to abstain long waiting time. This research work can be concluded that in both in public sectors and private segments, the introduction of such efficient EVs will be most acceptable by the people of India.

REFERENCES

1. Laurent Dupont, Julien Hubert, Claudine Guidat, Mauricio Camargo: "Understanding user representations, a new development path for supporting smart city policy Evaluation of the electric car use in Lorraine Region", *Technological Forecasting & Social Change* 142, 333–346, 2019
2. Romeo Danielis, Marco Giansoldati, Lucia Rotaris: "A probabilistic total cost of ownership model to evaluate the current and future prospects of electric cars uptake in Italy", *Energy Policy* 119, 268–281, 2018
3. Martin Weiss, Andreas Zerfass, Eckard Helmers: "Fully electric and plug-in hybrid cars - An analysis of learning rates, user costs, and costs for mitigating CO2 and air pollutant emissions", *Journal of Cleaner Production* 212, 1478–1489, 2019
4. Ankit Kumar, S K Choudhary, Chethan K N: "Commercial viability of electric vehicles in India", *International Journal of Mechanical Engineering and Technology (IJMET)* Volume 9, Issue 6, Article ID: IJMET_09_06_082, pp. 730–745, June 2018
5. Özlem Simsekoglu: "Socio-demographic characteristics, psychological factors and knowledge related to electric car use: A comparison between electric and conventional car drivers", *Transport Policy* 72, 180–186. (2018)

6. Dai-Duong Tran, Majid Vafaiepour, Mohamed El Baghdadi, Ricardo Barrero, Joeri Van Mierlo, Omar Hegazy: "Thorough state-of-the-art analysis of electric and hybrid vehicle powertrains: Topologies and integrated energy management strategies", *Renewable and Sustainable Energy Reviews*, volume 119, March 2020, <https://doi.org/10.1016/j.rser.2019.109596>
7. Jihu Zheng, Xin Sun, Lijie Jia, Yan Zhou: "Electric passenger vehicles sales and carbon dioxide emission reduction potential in China's leading markets", *Journal of Cleaner Production* 243, 118607, 2020
8. Yugong Luo, Guixuan Feng, Shuang Wan, Shuwei Zhang, Victor Li, Weiwei Kong: "Charging scheduling strategy for different electric vehicles with optimization for convenience of drivers, Performance of transport system and distribution network", *Energy*, 2020, <https://doi.org/10.1016/j.energy.2019.116807>.
9. Anat Tchetchik, Liat I. Zvi, Sigal Kaplan, Vered Blass: "The joint effects of driving hedonism and trialability on the choice between internal combustion engine, hybrid, and electric vehicles", <https://doi.org/10.1016/j.techfore.2019.119815>, *Technological Forecasting & Social Change*, volume 151, February, 2020
10. Efstathios E. Michaelides: "Thermodynamics and energy usage of electric vehicles", *Energy Conversion and Management* 203, 112246, 2020
11. Hyunjo Kim, Lucio Soibelman, Francois Grobler: "Factor selection for delay analysis using Knowledge Discovery in Databases", *Automation in Construction* 17, 550-560, 2008

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