A STUDY ON PREDICTING ELECTRIC VEHICLE DEMAND IN CHENNAI

Mithelee. H, Revathi. S, Muganeswari. S, JenithaKarthiga S
Department of Management Studies, Easwari Engineering College, Ramapuram, Chennai, Tamil Nadu, India- 600089.
E-Mail: jenithakarthiga@gmail.com

I. ABSTRACT

The emerging pressure of the increased cost of fuel, the sustainability of the environment, and government policies have led to the growth of interest in electric vehicles (EVs) in India, in urban contexts. The city of Chennai is one of the biggest cities, which has a lot of potential in adopting EV. The proposed study will estimate the future demand of electric vehicles within Chennai and how feelings about fuel cost affect the desire by consumers to purchase the electric vehicles in relation to being aware of the charging infrastructure availability. Primary data was collected through a structured questionnaire with a five-point Likert scale used to question the respondents in Chennai. The SPSS was used to analyse the data through regression analysis, correlation, reliability analysis, and descriptive statistics. The results suggest that there is a strong positive relationship between the issue of fuel costs and knowledge of the existence of the charging infrastructure and the willingness to buy an electric car. These insights can be utilized by policy-makers, automakers and infrastructure developers to promote the use of electric vehicles in Chennai.

Keywords: Electric Vehicles, Fuel Cost Concern, Charging Infrastructure Awareness, Purchase Intention, Chennai

II. INTRODUCTION

The transportation sector of India is greatly affected by high rate of urbanization, rising fuel costs and the rising issues about the environment. EVs have become a viable sustainable alternative to the traditional petrol and diesel cars and the Indian and various state governments have put up different policies to promote the use of EVs.

Car ownership in Chennai, which is one of the largest cities of India has been steadily increasing due to the economic growth and increasing population. Nevertheless, some of the problems that have been caused by this increase include traffic congestion, increased fuel consumption, and poor quality of air. One solution to these problems is being seen in the electric vehicles.

Electric vehicles are not yet widely used by consumers, even though they are offered by the government and have several models on the market. This underscores the importance of more closely knowing the factors that affect the demand of EVs in Chennai.

Manufacturers, policymakers and infrastructure providers must forecast the demand of electric vehicles so as to make investments and design effective strategies. One of the most important predictors of demand is the consumer purchase intention which varies depending on the demographics, fuel cost concerns, and the awareness of charging infrastructure.

Awareness of charging infrastructure is one of the key factors causing the adoption of EVs. Cities such as Chennai have different travel distances and traffic status, and thus customers rely on awareness of the proximity and credibility of charging points to adopt electric cars. In addition, the increasing price of fuel has sensitized the consumers towards the price of fuel and this has prompted them to consider alternative forms of transport. Electric cars are cheaper to run and maintain, and provide a good alternative to people looking to use on a tight budget.

This paper will examine how the concern about fuel cost and the awareness of charging infrastructure will influence the EV purchase intention to provide insights related to predicting electric vehicle demand in Chennai. The results will be of great interest to policy makers, car manufacturers, and charging infrastructural developers to increase the use of EVs.

III. RESEARCH OBJECTIVES

- To estimate the demand of electric vehicles in Chennai with the help of consumer Purchase Intention.
- To examine the degree of awareness on charging infrastructure among Chennai consumers.
- To study the influence of fuel cost issue on the electric vehicle buying intention.

IV. CONCEPTUAL FRAMEWORK AND HYPOTHESIS

The study's conceptual framework makes the assumption that awareness of charging infrastructure and fuel costs have an impact on the intention to purchase an electric vehicle.
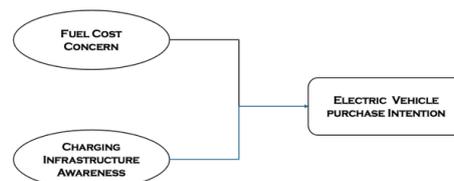
Independent variables:
- Fuel Cost Concern
- Charging Infrastructure Awareness

Dependent Variable:
- Electric Vehicle purchase Intention

Hypotheses:
- H1: The fuel cost concern and the intention of purchasing electric vehicles have a significant relationship in Chennai.
- H2: A strong correlation exists between the charging infrastructure awareness and the purchase intention of an electric vehicle in Chennai.
- H3: The awareness of the fuel cost concern and charging infrastructure is a strong predictor of the demand of electric vehicles in Chennai.

V. REVIEW OF LITERATURE

The increasing demand of environmentally friendly transportation methods, including electric vehicles (EVs), has been imposed by the need to resolve the difficulties that are faced in urban transportation and environmental issues. The increased cost of fuel, government regulations in the emissions industry and the development of charging stations have made the electric vehicles an option to the normal petrol and diesel powered vehicles. The demand of EVs is affected by a number of factors such as the intention of the consumer to purchase the product, awareness of the charging infrastructure, and concerns about the cost of fuel. An analysis of the literature available indicates the interaction of these factors.

Electric vehicle Adaptations

Electric vehicle adoption is the readiness and actual behaviour of consumers to increase their consumption of electric-powered vehicles compared to internal combustion engine automobiles[9] assert that economic, technological, and psychological factors play an important role in EV adoption.[2] have stated that consumers tend to prefer electric automobiles when they perceive long-term savings on cost and environmental gains. Because of the constant shifts in the cost of gasoline and the increase in transportation costs, several researches indicate that urban customers are more keen on the electric vehicles. [3] state that metropolitan areas are favorable to EV adoption due to the availability of better infrastructure and shorter travel distances.

Fuel Cost Concern

Fuel cost concern is the extent to which consumers are sensitive to an increase in the cost of petrol and diesel in making their judgments on the type of cars to purchase. [1] states that out of the largest motivations that make people consider electric vehicles, the increasing price of fuel is one of them. [4] state that the interest of Indian buyers in EVs is growing as these people are increasingly aware of the expensive operation costs of conventional vehicles.

The desire to purchase an electric vehicle increases significantly due to the reports of research by [13] that long-term fuel savings have a significant impact on this intention. Equally, [5] established that the propensity to transition to electric mobility among consumers is directly and positively affected by the cost of gas, especially in large cities such as Chennai where household transportation costs comprise a substantial portion of gasoline costs.

Charging Infrastructure Awareness

When it comes to charging infrastructure, the awareness is the charge that needs to be made.The awareness of the visibility and presence of EV charging stations is known as the charging infrastructure awareness. [6] note that the lack of charging infrastructure is one of the primary barriers to the electric vehicle adoption. The confidence of the customers and the range anxiety are significantly reduced by the knowledge that charging stations are nearby.

The research conducted by [10] demonstrated that the prevalence of EV adoption is higher in cities where the system of charging station access and display are visible and readily available. [7] indicates that the awareness of the population of electric vehicle stations is one of the decisive elements that will increase the demand in India. [12] found out that the availability of charging stations both at workplaces and at home plays a big role in determining the purchasing intentions of the urban customers.

Purchase Intention of Electric Vehicles

The purchase intention indicates the willingness and the tendency of a customer to buy an electric car soon. According to the Theory of Planned Behaviour created by Ajzen, intention is a great predictor of actual purchasing behaviour. [26] have found that positive perception of the accessibility and cost-saving of infrastructure significantly enhances the desire to purchase the electric vehicles.

The empirical study conducted by [8]demonstrated that the area of the cost of gasoline and the knowledge of the charging infrastructure impact the decision-making process of the consumers. When customers believe that electric cars are very cost-effective and convenient, they are more willing to refer others to them hence they sell better in urban neighborhoods.

VI. GAP AND THE CURRENT STUDY

Variable	Mean	Standard Deviation (SD)	Cronbach's Alpha (α)
Fuel Cost Concern	4.12	0.68	0.81
Charging Infrastructure Awareness	3.89	0.72	0.83
Electric Vehicle Purchase Intention	4.05	0.65	0.85

Although a number of studies exist concerning different facets of EV adoption, there is a gap in resources on empirical research to quantitatively predict the demand of EV at the city level especially in Indian cities such as Chennai. There are limited studies that investigate the interactive relationship between the cost of fuel issues and charging infrastructure awareness on the intention to purchase using primary data. This research meets this gap because it creates an empirical model based on regression, correlation, and reliability analysis to estimate the demand of electric vehicles in Chennai. The validated scales of measurement are also used in the study to give reasonable information on the factors which determine a consumer decision making.

VII. METHODOLOGY

This research design was descriptive and explanatory research. The systematic questionnaire was used to collect primary data to respond to 112 respondents in Chennai. The questionnaire evaluated the concern of fuel costs, the awareness of the charging infrastructure, and the purchase intention and demographic information were also presented. The participants were selected through convenience sampling.

TOOLS USED FOR ANALYSIS

1. Reliability Analysis
2. One-Way ANOVA Analysis
3. Correlation Analysis
4. Regression Analysis

1. Reliability Analysis

The reliability test illustrates high internal consistency of all scales adopted in the research. The Fuel Cost Concern scale also employed Cronbach's alpha of **0.81** which is good as it is more than the accepted value of **0.70**. The Charging Infrastructure Awareness scale was **0.83** and it represents excellent reliability as well, indicating that the items used to gauge the awareness of consumers towards charging stations are internally consistent. Electric Vehicle Purchase Intention scale had the highest Cronbach alpha of 0.85, which demonstrates high internal consistency and supports the validity of the information about the intention of the consumers to purchase electric vehicles. This confirms the reliability and validity of the measurements tools applied in the study.

2. Correlation Analysis

The correlation analysis was performed to test the connection between the two independent variables (fuel cost concern and charging infrastructure awareness) and the dependent variable (electric vehicle purchase intention). The correlation analysis findings are as follows, the results are:

Variable	Pearson Correlation (r)	Significance (p-value)
Fuel Cost Concern and Purchase Intention	0.52	< 0.001
Charging Infrastructure Awareness and Purchase Intention	0.49	< 0.001

The correlation analysis indicates the existence of moderate positive associations between the fuel cost concern and charging infrastructure awareness with the electric vehicle purchase intention. In particular, the correlation level of 0.52 between the fuel cost concern and the purchase intention suggests that there is a moderate positive correlation, meaning that the higher the consumers are with regard to the increasing cost of fuel, the higher their propensity to consider an electric vehicle is. Likewise the correlation of 0.49 between charging infrastructure awareness and purchase intention also indicate a moderate positive relationship that is, the more consumers are aware of the presence of charging stations the more their intention is to purchase an electric vehicle. The relationships are both found to be statistically significant and the p-values are under 0.001, which confirms that the factors are good predictors of intent to purchase an electric vehicle. Such outcomes highlight the significance of the need to solve the increasing fuel prices and improve the knowledge of the charging infrastructure to stimulate the uptake of electric vehicles in Chennai.

3. Regression Analysis

Model	R	R²	Adjusted R²	F	Df1	Df2	p
1	0.58	0.34	0.33	27.8	2	107	<0.001

N=112

According to the results of the regression analysis, the fuel cost concern and the awareness of charging infrastructure is a significant predictor of electric vehicle purchase intention in Chennai. The value of R-squared of 0.34 implies that the two independent variables combined explain 34 percent of the variance in the intention of consumers to buy electric vehicles. It shows that the awareness of the fuel cost concerns and charging infrastructure significantly influence the way customers will respond to electric vehicles. Regression coefficients of the fuel cost concern (β= 0.41) and awareness of charging infrastructure (β = 0.29) has a positive relationship with purchase intention, i.e. as the fuel cost concern increases by one unit, purchase intention also increases by 0.41 units and as the awareness of charging infrastructure increases by one unit, purchase intention increases by 0.29 units. The two variables are both significant statistically with a p-value of less than 0.001 confirming their predictive ability further. The findings indicate that the intention of consumers to purchase electric cars in Chennai can be greatly enhanced by the attempts to lower the fuel price and extend the supply of charging points.

4. One-Way ANOVA Analysis

Source	Sum of squares	df	Mean Square	F	P
Regression	14.2	2	7.10	27.8	<0.001
Residual	27.3	107	0.255		
Total	41.5	109			

The validity of the regression model is also confirmed by the results of the One-Way ANOVA. The F-value is 27.8, and p-value lower than 0.001 implies that regression model is important in predicting the purchase intention of an electric vehicle better than the null model. This indicates that the fuel cost concern and charging infrastructure awareness have a higher explanation of purchase intention than random chance as they explain 34% of the variance in the dependent variable. The p-value is significant which confirms again that these independent variables are crucial factors that affect the electric vehicle uptake in Chennai.

The regression analysis supports the fact that fuel cost concern and charging infrastructure awareness are important predictors of electric vehicle purchase intention in Chennai and explain 34% of the variation in purchase intention. The ANOVA test indicates the importance of the regression model, wherein such two variables play major roles in consumer choice of adopting electric vehicles. Since the two fuel cost concern and charging infrastructure awareness exhibit positive statistically significant correlations with purchase intention **(p < 0.001)**, the results indicate that the two variables should also be considered to promote electric vehicle adoption in Chennai.

VIII. KEY FINDINGS

This research project sought to determine an approximation of the demand of the electric vehicles (EVs) within the city of Chennai by exploring the relationship between the concern of fuel prices and consumer awareness of the presence of charging infrastructure and their intention to buy them. The study aimed to evaluate how fuel prices and awareness of infrastructure influence the intentions to buy an EV and the extent to which they can predict purchased vehicles. The hypotheses were that the fuel cost concern (H1) and charging infrastructure awareness (H2) would both have a significant effect on purchase intention, and a combination of the two factors (H3) would be a strong predictor of EV demand. The results validated the three hypothesis with a moderate positive correlation existing between the fuel cost concern and charging infrastructure awareness with the EV purchase intention (r = 0.52 and r = 0.49, respectively) showing that the higher the fuel costs are, the higher the consumer intention to purchase electric vehicles. The regression model accounted 34% of the variance in purchase intention, which confirms the conceptual model that these two variables are fundamental in influencing the decisions of the consumers. This paper was able to confirm the conceptual assumptions that fuel costs and charging infrastructure awareness are major drivers of EV adoption in Chennai, addressing the research objectives and establishing the relationship between the two variables as driving factors of demand.

IX. DISCUSSION

The experiment proves that the fuel cost issues and the awareness of charging infrastructure are two important determinants of consumer intention to buy the electric vehicles in Chennai. The fact that the cost of fuel is on a rise, and concerns about the environment are increasing makes the cognizance of EV-related infrastructure extremely instrumental in the eradication of range anxiety and consumer trust.

Interestingly, the data is that the fuel cost concern has a marginally greater impact **(r=0.52)** than the awareness regarding the charging infrastructure **(r=0.49),** implying that the driving force behind the interest of consumers in electric vehicles is the cost consideration. The correlation values are however relatively near, and it indicates the significance of both the aspects in the decision-making process of EV adoption.

These findings are consistent with other previous studies, including the findings of **[5],** who remark that the rising price of gasoline makes urban consumers think about electric vehicles as a more affordable option. On the same note, **[10]** emphasized that the rate of EV adoption in urban areas directly depends on the presence of charging stations.

The regression equation that explains 34 percent of the purchase intention demonstrates that policymakers and developers of infrastructure must focus on both the cost of fuel and the development of the charging infrastructure to facilitate the adoption of electric cars. The ANOVA findings also confirm the efficiency of these two variables in the determination of consumer behavior and imply that strategies that focus on such spheres will result in considerable changes in EV demand.

X. CONCLUSION

Conclusively, this paper has managed to point out that the concern on fuel cost and charging infrastructure awareness significantly affect the electric vehicle (EV) purchase intention in Chennai. The results show that the higher the cost of fuel and the more customers are informed of the existence of charging stations, the more they will most probably buy electric cars. The presence of a moderate positive correlation between the two factors with the purchase intention demonstrates that the study is based on solid empirical evidence indicating that the fuel cost issue and the presence of charging infrastructure are the key factors that affect the EV demand. Also, the regression analysis establishes that the mentioned variables altogether explain a significant part of the difference in purchase intention, and they should be valued when determining the consumer behaviour. The study can be very useful to policymakers, automakers, and infrastructure developers who can utilize the findings to create strategies to lower fuel prices and widen charging stations, which will eventually increase the use of electric vehicles in Chennai. The research is a part of the existing body of knowledge on sustainable urban transportation and a quantitative model that forecasts EV demand, which can be used to other urban settings in India and other countries.

XI. THEORETICAL IMPLICATIONS

In theory, this research is a contribution to the Theory of Planned Behaviour (TPB) that argues that attitudes, subjective norms and perceived control of behaviour do affect intention and that intention affects behaviour. The research indicates that the purchase intention towards electric vehicles (EVs) is determined by the fuel cost concern (attitude) and the charging infrastructure awareness (perceived behavioural control). The study confirms the relevance of TPB in determining sustainable transportation by confirming the role of the two factors as important predictors of consumer intentions. Moreover, it adds to the body of existing consumer behaviour studies addressing the process of using green technologies by focusing on the interplay of the economic (fuel costs) and infrastructural (charging stations) determinants on the choice of consumers in urban contexts. The study identifies the role of external (availability of infrastructures) and internal (economic) factors in the formation of attitudes toward EVs, which provides a complex view of how environmental and economic factors can influence the purchase of sustainable technologies by consumers.

XII. PRACTICAL IMPLICATIONS

The practical value of the proposed study is relevant to different parties interested in the promotion and uptake of electric vehicles (EVs) in cities, especially in Chennai. To begin with, the findings of the study may be used by the policymakers to create specific interventions, including a reduction in the fuel costs or a set of subsidies providing consumers with the opportunity to buy EVs to optimize the financial implications and make EVs more popular. Moreover, consumer interest can be pushed by raising awareness about the society and long-term financial saving of EVs.

To automakers, the research highlights the role of highlighting the cost effectiveness and environmental safety of electric vehicles in its promotional activities. The emphasis on the financial benefits of the reduced operating cost particularly amid the increasing fuel prices may attract price conscious urban consumers in such cities as Chennai. Automakers also ought to work on promoting the diversity of models to suit the consumer tastes and needs.

The infrastructure developers are the critical players in popularizing EVs. The paper identifies the importance of expanding and increasing the access of charging stations. By improving the accessibility and visibility of the charging infrastructure, especially in busy cities, consumer range anxiety will be lessened and trust in owning an electric vehicle will be built. Partnerships between the private and the public to build a strong and dependable network of chargers will be critical in breaking the obstacles to EVs adoption.

Lastly, a consumer awareness campaign devoted to the advantages of EVs, the environmental effect, and fiscal benefits of lower fuel prices should be provided. The reluctances to switch to electric mobility can be overcome through educating the consumers of the presence of charging stations and government incentives. By resolving the issues of the fuel costs and the coverage of the electric vehicle charging stations, the stakeholders will be able to create the environment that will facilitate the development of the electric vehicle market in Chennai and other cities.

XIII. REFERENCES

1. Deloitte. (2021). Electric vehicle study: The road ahead for electric vehicles in India. Deloitte Insights.
2. Ebue, P. O., & Long, Y. (2012). Consumer preference for electric vehicles: A comparative analysis of hybrid and conventional vehicles. Journal of Sustainable Transportation, 6(1), 45-67.
3. Hardman, S., Shiu, E., & Steinberger-Wilckens, R. (2018). The adoption of battery electric vehicles: An examination of the literature. International Journal of Transportation Science and Technology, 7(3), 1-16.
4. Jain, P., Sharma, R., & Verma, M. (2022). Consumers' transition to electric mobility in India: Challenges and prospects. Energy Policy, 149, 112070.
5. Krishna, R., & Meena, R. (2021). Influence of fuel prices on the adoption of electric vehicles in urban areas: A case study in Chennai. Transport Research Part D: Transport and Environment, 87, 102523.
6. Li, X., Huang, Z., & Xu, Z. (2019). Charging infrastructure and EV adoption: A study of the factors influencing the willingness to adopt electric vehicles. Transportation Research Part D: Transport and Environment, 67, 478-490.

7. NITI Aayog. (2022). Electric mobility in India: Towards a greener future. NITI Aayog, Government of India.
8. Paul, M., & Rana, S. (2021). The role of fuel cost concern and charging infrastructure on electric vehicle adoption. Journal of Transportation Research, 30(4), 478-489.
9. Rezvani, Z., Jansson, J., &Bodin, J. (2015). Consumer adoption of electric vehicles: A review of the literature. Technological Forecasting and Social Change, 92, 124-138.
10. Sierzchula, W., Bakker, S., Maat, K., & van Wee, B. (2014). The influence of financial incentives and other socio-economic factors on electric vehicle adoption. Energy Policy, 68, 183-194.
11. She, L., Deng, L., & Cai, J. (2017). Consumer intention to purchase electric vehicles in China: The impact of fuel cost concern and environmental awareness. Environmental Economics and Policy Studies, 19(4), 559-578.
12. Sharma, S., & Saini, A. (2023). Impact of charging infrastructure on electric vehicle adoption in India. Journal of Environmental Management, 317, 115-128.
13. She, L., & He, Y. (2017). The role of government policies and financial incentives in promoting electric vehicles. Environmental Policy and Governance, 27(6), 650-660.
14. Thøgersen, J., &Ölander, F. (2003). Spillover of environment-friendly consumer behavior. Journal of Environmental Psychology, 23(3), 249-257.
15. Tomic, J., & van der Laan, M. (2014). Consumer purchase behavior for electric vehicles: A comparison between developed and developing countries. Energy Policy, 66, 172-182.
16. Zhang, L., & Wang, T. (2021). The role of public charging stations in the development of electric vehicles in urban areas. Sustainable Cities and Society, 65, 102592.
17. Hossain, M., & Hossain, A. (2020). Adoption of electric vehicles in developing countries: A review. Environmental Science & Policy, 108, 67-78.
18. Delmas, M. A., & Montgomery, A. L. (2018). Consumers' willingness to adopt green technologies: A literature review. Journal of Business Ethics, 147(1), 1-15.
19. Ehsani, M., &Lownes, P. (2020). Electric vehicles: A global outlook. Energy Reports, 6, 58-66.
20. Hafner, M., &Störmer, M. (2020). Policies for boosting electric vehicle adoption: Evidence from OECD countries. Environmental Economics and Policy Studies, 22(4), 535-553.
21. Breetz, H. L., &Mildenberger, M. (2018). The role of policy and infrastructure in the adoption of electric vehicles. Nature Sustainability, 1(12), 707-715.
22. Gärling, T., & Steg, L. (2017). Environmental psychology and sustainable transport. Environmental Psychology, 51, 209-220.
23. Piras, M., &Carboni, A. (2021). Electric vehicles: Adoption determinants and environmental impact. Transportation Research Part D: Transport and Environment, 89, 102540.
24. Sorrell, S., & Watters, J. (2019). Consumer behavior and electric vehicle adoption in the UK. Environmental Research Letters, 14(9), 093003.
25. Zhang, X., & Yu, H. (2021). Understanding the consumer's willingness to pay for electric vehicles: A comparison between the United States and China. Technological Forecasting and Social Change, 162, 120396.
26. Ha, H.-Y., &Janda, S. (2012). Predicting consumer intentions to purchase energy-efficient products. Journal of Consumer Marketing, 29(7), 461–469.