Enablers & Challenges in the adoption of E-Cars: A Customers perspective with reference to Agra City

Amber Dubey

Dayalbagh Educational Institute, Agra-282005, India

E-mail: amber.dubey97@gmail.com

Prof Sunita Malhotra

Dayalbagh Educational Institute, Agra

Background: The automobile Industry, is witnessing new changes and one such change is of introduction of Electronic Vehicles (EVs). EVs refer to all those vehicles (2-wheelers, 3-wheelers, and 4-wheelers that require the support of Electricity for working and smooth functioning. This research paper has highlighted and analyzed the enablers and challenges in the adoption of Electric Cars with reference to Agra City. The literature reviewed by the researchers did not cover/give emphasis on the enablers and challenges, with respect to the adoption of E-Cars from the perspective of Customers. The Government of India especially the Automobile Dealers is now focusing on more and more production of E-Vehicles, (one of such Vehicles being E-Car) and also spreading more and more awareness regarding the importance of E-Vehicles. Besides this, the literature reviewed by the researchers did not focus anywhere on the challenges faced by the customers before purchasing Electric Cars.

Aims and objectives: To study the enablers in the adoption of E-Cars from the perspective of Customers and To study the challenges faced in the adoption of E-Cars from the perspective of Customers

Materials and Methods: The researchers selected 20 target respondents in Agra owing E-Cars with whom the questionnaires were shared. In this study, Descriptive Statistics and Inferential Statistics have been used to analyze the data. The software used by the researchers for Data Analysis were IBM-SPSS and MS-Excel.

Results: It was found that lower registration Fees are the most significant enabler in purchasing an E-Car & Price is the most significant challenge faced in purchasing an E-Car.

Keywords

E-scooters, E-Bikes, E-Cars, E-Vehicles, Challenges, Enablers

Introduction

Someone has rightly said, that, "Change is Inevitable". We can see and witness the same in every field and the same goes for Automobiles. All vehicles—two-wheelers, three-wheelers, and four-wheelers—that depend on electricity for proper operation are referred to as electronic vehicles or E-Vehicles. The two-wheeled electric vehicles are e-scooters and e-bikes. Whereas the range of Electric 4-wheelers is restricted to E-Cars, the range of Electric 3-wheelers is limited to only E-Rickshaws. Over time, there has been a steady rise in the awareness of electric vehicles in India. This has led to a rise in the daily demand and adoption of EVs, with the Indian government and media playing a major role in this process. Indian automakers are now developing e-vehicles, such as the TATA Tiago.
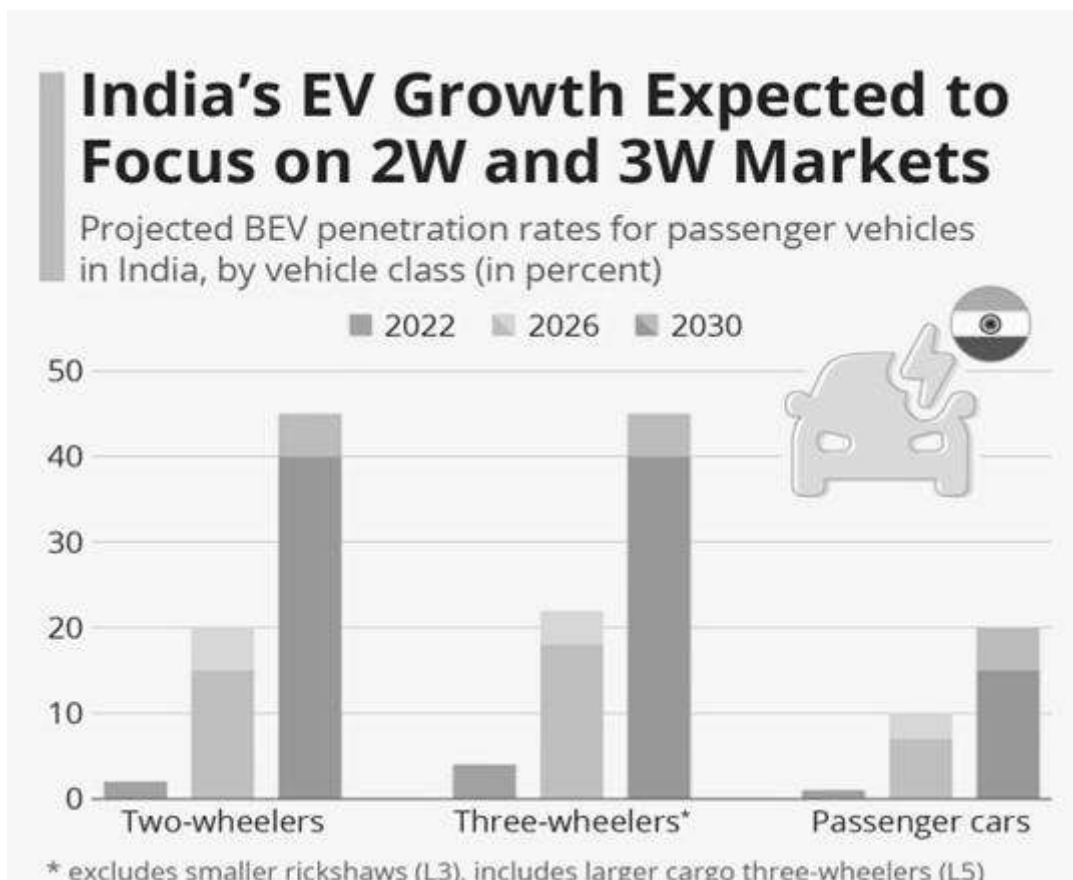

Figure 1: Projected penetration rates of Battery Electric Vehicles for passenger vehicles in India by vehicle class, (in percent)

Source: Statista and Bain & Company

Like any other vehicle, when a customer purchases an E-Car, there are various factors that affect his decision-making process, which has been discussed in this research in the form of Enablers & Challenges. Openness to new experiences, price consciousness, self-environmental concern, esteem, and social effect were the most substantial predictors of EV purchasing motive. (Cui et al. (2021)). While reducing operating expenses is the main driver for early adopters in Korea, the bulk of Chinese

buyers were swayed to purchase an electric vehicle by environmental concerns. (Chu W, et al. (2019))

Studies on Factors affecting the purchase aims of E-Vehicles of Customers

A theoretical framework was developed to identify the key variables influencing customers' choices to purchase EVs on the basis of the "Technology Acceptance Model" (TAM), "Innovation Diffusion Theory" (IDT), and "Theories of Planned Behavior" (TPB). **(Tu & Yang (2019)).** Demographic factors have a substantial effect on customers' goal of purchasing EVs in Beijing, whereas subjective standards and non-monetary incentive policies do not have a notable influence on consumers' intentions to purchase EVs in Beijing. The attitudes of customers toward buying electric vehicles in Beijing are significantly positively influenced by policy measures related to monetary incentives, product perception, cognitive status, and perceived behaviour control. **(Huang & Ge (2019)).** Price consciousness, self-esteem, social influence, environmental concern as well as openness to new experiences are the most substantial predictors of EV purchasing motives. **(Cui et al. (2021)). (He et al. (2017))** investigated how consumer perception and personality affect or influence their propensity to purchase EVs using a well-established personality-perception-desire paradigm. Customers' attitudes, which are influenced by various factors such as perceived benefit (both positive and negative), new product knowledge (both positive and indirect), perceived risk (both positive and negative), and brand trust (both positive and indirect), are the main determinant of their goal to purchase EVs. **(Yang et al. (2020)).** Consumers' aims to purchase electric automobiles are positively and significantly affected by a variety of factors, including their attitude, perception of value, assignment of responsibility, perceived consumer efficacy, subjective and personal norms, and understanding of the implications **(Asadi et al. (2021)). Zhang et al. (2018)** demonstrated the manner in which consumers' objectives for purchasing electric vehicles are influenced by motivation and perceptions. **Shalender & Sharma (2020)** predicted the adoption intention of 326 customers with respect to EV purchases using an extended TPB model. Speed, environmental concern, charging infrastructure, and

Price differences all have a major effect on the decision to buy an EV. **Swaroop et al. (2022).** examined the behavioral aim to adopt EVs in India and the implications of financial incentive schemes, perceived value, personal norms, and perceived behavioral control. Additionally, it validated how real use affects sustainability aspects including perceived impacts on the economy, society, and environment. **Soodan & Saha (2023).** designed to predict the intentions of Indian consumers to purchase electric cars. Two elements of the TPB model—attitude and subjective norms—in conjunction with two modified constructs—openness to experience and environmental concern—significantly explained the desire to buy an EV. Perceived behavioral control, or PBC, was shown to be minimal. **Mishra & Malhotra (2019)** aimed to assess the many factors influencing the inclination of Indians to buy EVs by presenting a utility theory-based model that combines psychological and economic aspects. The study examined the impacts of performance features, environmental concerns, financial rewards, ownership cost,

infrastructure support, and social influence on Indian customers' purchase intention towards EVs using confirmatory factor analysis in AMOS version 25. According to the report, environmental concerns and performance characteristics are the 2 primary factors affecting Indian consumers' decisions to buy EVs. **Gurudath & Rani. (2021)** The study's objective was to draw attention to how crucial it is to match buying intentions with crucial marketing variables that affect the purchase of EVs. According to the study, the majority of people planning to buy electric cars were men; the Hyundai Kona and TATA Nexon had the highest brand awareness among these cars; product reviews and advertisements were the main ways to spread the word about these cars; and factors like safety, service warranties, price, lifespan, speed, and pick-up were considered to be very important when buying an electric car. When it comes to electric cars, elements like the test drive, low noise, trend, delivery time, and product upgrade were seen to be critical. Low noise levels, modern technology, and environmental friendliness were considered to be very satisfying features of electric

Studies on factors Affecting the rate of adoption of E-vehicles

Reducing operating expenses is the main driver for early adopters in Korea, whereas the bulk of Chinese buyers are influenced to purchase an EV by environmental concerns. **(Chu W et al. (2019)).**

Tiwari et al. (2023) examined how financial incentive schemes, subjective norms, perceived value, personal norms, and perceived behavioral control affected the behavioral intention to adopt EVs in India. It also confirmed how real-world use affected sustainability dimensions like perceived effects on the environment, society, and economy. The study found that while the financial incentive policy had little effect, personal norms had a good impact on behavioral intention to embrace e-vehicles. The study validated the theoretical efforts of TPB and NAM (Norm Activation Theory) to arrive at a comprehensive model because of the complex links between numerous socio-psychological elements and the purchase of e-vehicles. **Das & Bhatt (2022)** designed to compile a summary of the policies pertaining to electric vehicles that the Indian federal and state governments have implemented to assess the impact, relationship, and applicability of these regulations on the nation's adoption of EVs. **Campisia et al. (2022)** provided a descriptive statistical analysis in two dimensions to determine the acceptability of shared e-mobility connected to the user's profile.

Other Studies

Haustein & Jensen (2018) contrasted the socio-demographic, attitudinal, and mobility habits of users of conventional vehicles (CVs) and battery electric vehicle (BEV) users.

Meisel & Merfeld (2018). recommended monetary rewards for services related to electric vehicle ownership.

Kumar & Rana (2023) discussed the prospects and challenges that India's battery-switching stations

face. The study concluded that EV customers would prefer the idea of battery swapping stations given the current situation of EVs in India. With the ongoing improvements in quick charging technology, the increasing range of electric vehicles, and the slowing rate at which EV batteries charge, battery swapping may prove to be a successful strategy in the long run, or it may eventually become outdated. It's feasible that commercial electric vehicles will eventually find success with battery swapping as a business model.

Table 2: Synthesized Matrix of Literature Review

S.No	Name	Journal Of Publication	Title Of Publication	Year Of Publication	Type of Study		Nature Of Study	
					International	National	Quantitative	Qualitative
1	Xiuhong He, Wenjie Zhan & Yingying Hu	Journal of Cleaner Production	Consumer purchase intention of electric vehicles in China: The roles of perception and personality		✓		✓	
2	Xiang Zhang, Xue Bai & Jennifer Shang	Journal of Cleaner Production	Is subsidized electric vehicles adoption sustainable: Consumers' perceptions and motivation toward incentive policies, environmental benefits, and risks		✓		✓	
3	Meisel, S., & Merfeld, T.	Transportation Research Part D: Transport and Environment,	Economic incentives for the adoption of electric vehicles: A classification and review of e-vehicle services	2018	✓			✓
4	Jui-Che Tu & Chun Yang	Sustainability	Key Factors Influencing Consumers' Purchase of Electric Vehicles		✓		✓	
5	Xiangqian Huang & Jianping Ge	Journal of Cleaner Production	Electric vehicle development in Beijing: An analysis of consumer purchase intention		✓		✓	
6	Wujin Chu, Meeja Im, Mee Ryoung Song & Jooyoung Park	Transportation Research Part D: Transportation and Environment	Psychological and behavioral factors affecting electric vehicle adoption and satisfaction: A comparative study of early adopters in China and Korea	2019	✓		✓	
7	Mishra, S. and Malhotra, G.	Theoretical Economics Letters	Is India Ready for e-Mobility? An Exploratory Study to Understand e-Vehicles Purchase Intention			✓	✓	
8	Chun Yang, Jui-Che Tu & Qianling Jiang	Sustainability	The Influential Factors of Consumers' Sustainable		✓		✓	

S.No	Name	Journal Of Publication	Title Of Publication	Year Of Publication	Type of Study		Nature Of Study	
					International	National	Quantitative	Qualitative
			Consumption: A Case on Electric Vehicles in China	2020				
19	Kumar Shalender & Naman Sharma	Environment, Development, and Sustainability	Using the extended theory of planned behaviour (TPB) to predict the adoption intention of electric vehicles in India	2020		✓	✓	
10	Lixin Cui , Yonggui Wang , Weiming Chen , Wen Wen & Myat Su Han	Energy Policy	Predicting determinants of consumers' Purchase Motivation for electric vehicles: An application of Maslow's hierarchy of Needs Model	2021	✓		✓	
11	Shahla Asadi, Mehrbakhsh Nilashi , Sarminah Samad, Rusli Abdullah, Marwan Mahmoud, Monagi H. Alkinani & Elaheh Yadegaridehkordi	Journal of Cleaner Production	Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia		✓		✓	
12	Gurudath.M.N., Dr. Meena Rani.	PalArch's Journal of Archaeology of Egypt / Egyptology	Purchase Intention of Electric Vehicles: An Empirical Study in Bangalore			✓	✓	
13	Kumar Das, P., & Younus Bhatt, M.	Environmental Science and Pollution Research,	Global electric vehicle adoption: implementation and policy implications for India.	2022		✓		✓
14	Reddi Swaroop, K., Murali Someswararao, K. V. V., Gurunatha Naidu, N., & Nagaraj, K. V.	Journal of Positive School Psychology	A Study On Factors Influencing On Purchase Of E-Vehicles With Reference To South India.			✓	✓	
15	Campisia, T., Ticali, D., Ignaccolo, M., Tesoriere, G., Inturri, G., & Torrisi, V.	Transportation Research Procedia	Factors influencing the implementation and deployment of e-vehicles in small cities: a preliminary two-dimensional statistical study on user acceptance		✓		✓	
16	Jeykishan Kumar & Singh Rana	Power Research Journal of CPRI	Battery Swapping Stations- A Viable Option for Faster Adoption of EVs in India			✓		✓

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S.No	Name	Journal Of Publication	Title Of Publication	Year Of Publication	Type of Study		Nature Of Study	
					International	National	Quantitative	Qualitative
17	Tiwari Kumar, D., Tandon, U; & Mittal, A.	Environment, Development and Sustainability	Analyzing adoption of eVehicles among Indian consumers: a novel approach towards sustainable transport			✓	✓	
18	Soodan, V., & Saha, S.	International Journal of Applied Management Science	Applying an extended theory of planned behaviour to predict Indian customer's e-vehicle purchase intention	2023		✓	✓	
19	Saraswat, S., Abdullah, A., & Talib, F.	International Journal of Management and Decision-Making	Analysis of barriers to electric vehicles adoption: an integrated Pareto cum FUCOM approach.		✓		✓	✓
20	Tiwari, D. K., Tandon, U., & Mittal, A.	Environment, Development and Sustainability	Analyzing adoption of eVehicles among Indian consumers: a novel approach towards sustainable transport.			✓	✓	
21	Suri, A., Deepthi, B., & Sharma, Y.	SAE International Journal of Sustainable Transportation, Energy, Environment, & Policy,	Dynamics of Adopting Electric Vehicles in India: A Grounded Theory Approach.	2024		✓	✓	

Source: Author's own compilation

Materials & Methods

Research Universe of the researchers comprised of all people owing E-Cars. The research population comprised all people owing E-Cars in Agra. Researchers selected 20 target respondents owing E-Cars in Agra. For sampling, the researchers have employed Snowball Sampling. The contact Numbers of the Target respondents were used as a Sampling Frame by the researchers. Researchers collected primary data via questionnaires and secondary data via research papers and websites. Questionnaires were shared with the respondents for data collection. Researchers have used a 5-point Likert Scale for collecting responses via questionnaires. Researchers used MS Excel & IBM SPSS for Data Analysis. The objectives & hypothesis framed by the researchers, statistical tests & tools used by the researchers have been tabulated below.

OBJECTIVE 1: To study the enablers in the adoption of E-Cars from the perspective of Customers

Table 1: Research Variables

Variable of Study	Source	Meaning	Statistical Tool of Analysis
Environment Friendly	Author	E-Vehicles are Environment Friendly as they don't cause Air Pollution	T-Test
Ease in Driving	(BENEFITS OF ELECTRIC VEHICLES, n.d.)	Since e-vehicles lack gears and intricate controls, they are simple to operate.	T-Test
Less Registration Fees	(BENEFITS OF ELECTRIC VEHICLES, n.d.)	Registration Fees and Road Tax are less for E-Vehicles, as compared to the traditional/conventional petrol and diesel vehicles	T-Test
Convenience of charging E-Cars	(BENEFITS OF ELECTRIC VEHICLES, n.d.)	E-Vehicles can be charged easily at Home, which saves the problem of waiting in long ques in fuel filling stations to get the fuel filled in vehicles that run on petrol/diesel/CNG	T-Test

Source: Author's own work

OBJECTIVE 2: To study the challenges faced in the adoption of E-Cars from the perspective of Customers

Table 2: Research Variables

Variable of Study	Source	Meaning	Statistical Tool of Analysis
Price	Author	The prices of E-Car may be more than that of Conventional Cars	T-Test
Lack of Financial Incentives	Author	At the time of purchasing a Car, a Car Dealer offers Financial Incentives in the form of discounts, etc. to the Customer.	T-Test
Limited Brands	Author	In India E-Car is an emerging concept and as of now there are very few automobile brands in India offering E-Cars, which may result in a challenge of limited brands and limited variety when a customer decides to purchase an E-Car	T-Test
Less Variants	Author	It refers to the challenge of less variety/models in a particular brand dealing in Cars	T-Test

Source: Author's own work

Table 3: Objective Wise Methodology

S.No	Objective	Statistical Test
1	To study the enablers in the adoption of E-Cars from the perspective of Customers	T-Test
2	To study the challenges faced in the adoption of E-Cars from the perspective of Customers	T-Test

Source: Author's own work

The researchers framed the below-mentioned Research Hypothesis

1. H_1: Environment friendliness is a significant enabler in the adoption of E-Cars

2. H_2: Convenience and easiness in driving is a significant enabler in adoption of E-Cars

3. H_3: Less Registration Fees and Road Tax is a significant enabler in the adoption of E-Cars

4. H_4: The convenience of charging the vehicle at home, is a significant enabler in the adoption of E-Cars

5. H_5: E-Cars being expensive is a significant challenge faced while purchasing an E-Car

6. H_6: Car dealers not offering any financial incentives at the time of purchase is a significant challenge faced while purchasing an E-Car

7. H_7: Limited Brands is a significant challenge faced while purchasing an E-Car

8. H_8: Fewer Variants being offered at the time of purchase is a significant challenge faced while purchasing an E-Car

CONCEPTUAL FRAMEWORK

Figure 2: Conceptual Framework

Source: Author's own work
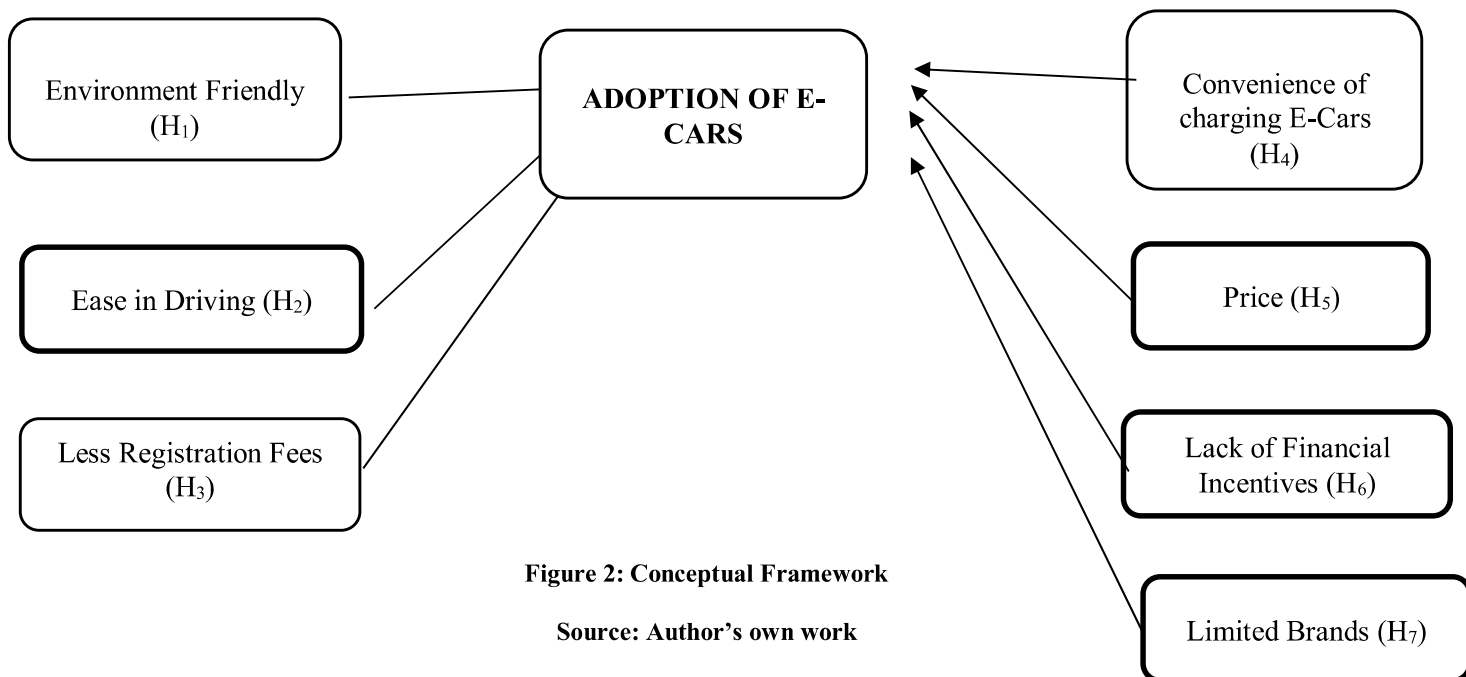
Results and Observations

1. Reliability & Validity Analysis -The researchers calculated Cronbach Alpha as a measure of reliability, whose value came out to be 0.93.

TABLE 4: CRONBACH ALPHA

Variable	Value
Environment Friendly	.885
Ease in Driving	.885
Less Registration Fees	.958
Convenience of charging E-Cars	.867
Price	.787
Lack of Financial Incentives	.938
Limited Brands	.741
Less Variants	.687

Source: Author's own work

TABLE 5: KMO AND BARTLETT TEST

Variable	Value
Environment Friendly	0.577
Ease in Driving	0.935
Less Registration Fees	0.523
Convenience of charging E-Cars	0.650
Price	0.751
Lack of Financial Incentives	0.361
Limited Brands	0.903
Less Variants	0.682

Source: Author's own work

For Validity Analysis, researchers have used the KMO & Bartlett test of spherecity. In the above table, it can be interpreted that for all constructs the KMO Value is higher than 0.5, representing that the questionnaire has passed the validity test

2. **Gender:** There were 12 male respondents and 8 female respondents.

3. **Age:** There were two respondents who were in the 18–25 age range, six who were in the 25–30 age range, six who were in the 40–45 age range, and six who were above 50.

4. **Occupation:** 16 respondents were in the Service Sector, 2 respondents were Businessmen and the remaining 2 respondents were in some occupation other than the Business and Service Sector

5. **Income Bracket:** The income of 2 respondents was Less than Rs 3 LPA. The income of 6 respondents was between 3 LPA-6 LPA. The income of 6 respondents was between 6 LPA-9 LPA. and the Income of 6 respondents was More than Rs 15 LPA.

6. **No. of persons owing an E-Car:** 12 respondents owed an E-Car and 8 respondents did not owe an E-Car

7. **Brand Awareness-**12 respondents who owed an E-Car, were aware of 2-3 brands of electric cars on an average

8. **Brand Name of E-Car owed:** Out of the 12 respondents who owed an E-car, 10 respondents owed an E-Car of the brand named TATA and 2 respondents owed an E-Car of the brand named MG Hector

9. Results & Analysis of Hypothesis

TABLE 6-RESULTS AND ANALYSIS OF HYPOTHESIS

S.No	Hypothesis	P-Value	P-Value<=α
H_1	Environment friendliness is a significant enabler in the adoption of E-Cars	0.75	No
H_2	Convenience and easiness in driving is a significant enabler in the adoption of E-Cars	0.5	No
H_3	Less Registration Fees and Road Tax is a significant enabler in the adoption of E-Cars	0.01	Yes
H_4	The convenience of charging the vehicle at home is a significant enabler in the adoption of E-Cars	0.28	No
H_5	E-cars being expensive is a significant challenge faced while purchasing an E-Car	0.05	Yes
H_6	Car dealers not offering any financial incentives at the time of purchase is a significant challenge faced while purchasing an E-Car	0.16	No
H_7	Limited Brands is a significant challenge faced while purchasing an E-Car	1	No
H_8	Fewer Variants being offered at the time of purchase is a significant challenge faced while purchasing an E-Car	0.75	No

Source: Author's own work

Conclusions

Out of the below-mentioned enablers:

I. Environment Friendly

II. Ease in Driving

III. Less Registration Fees

IV. Convenience of charging E-Cars

Less Registration Fees is the most significant enabler of purchasing an E-Car

AND

2. Out of the below-mentioned challenges:

I. Price

II. Lack of Financial Incentives

III. Limited Brands

IV. Less Variants

Price is the most significant challenge faced in purchasing an E-Car

3. In India there is a variety of brands in E-Cars, but unfortunately, the respondents are aware of only 2-3 brands on average. Therefore, the Government and the Car Dealers dealing in E-Cars shall try to increase the visibility of their brands through various channels, viz: Newspapers, Internet, Banners, Pamphlets, etc.

ABBREVIATIONS

1. E-Cars: Electric/Electronic Cars

2. E-Vehicle: Electric/Electronic Vehicle

3. EV: Electric/Electronic Vehicle

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