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ADOPTION OF ELECTRIC VEHICLES AMONGST INDIAN CONSUMERS: A LITERATURE REVIEW

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ABSTRACT

Now-a-days environmental concern is a problem that is affecting everyone throughout the world. People are becoming aware of the deteriorating environmental condition globally. To counteract the effects of fossil fuel pollution and address environmental issues, electric vehicles (EVs) are strongly advocated around the world. An electric motor replaces an internal combustion engine in electric cars. The government is also providing incentives and subsidies to promote EVs. The use of Electric vehicles is rising globally. Electric vehicles produce little or no air and noise pollution and also reduce the dependence on fossil fuels. People in India are now switching slowly to EVs as sales of EVs in India are rising gradually. This study aims to review the studies on consumer adoption of electric vehicles and identify the factors that are affecting electric vehicle adoption. This study will help in providing suggestions to the policymakers to devise policies that will lead to creating awareness, faith, and demand for EVs. Also, this study will add to the existing literature related to the adoption of EVs.

Keywords: *Electric Vehicles, EV Adoption, UTAUT, Environmental Concerns.*

Introduction

Nowadays Environment pollution is affecting everyone globally. Toxic emissions from conventional vehicles that run on petrol and diesel are one of the main sources of air pollution. As per Health Effects Institute's (HEI) State of Global Air Initiative, Delhi is the world's most polluted city in terms of annual average population-weighted PM2.5 concentrations (Gandhiok, 2022). Electric vehicles (EVs) are widely recommended across the world as a way to mitigate the impacts of fossil fuel emissions and address environmental challenges. Some governments throughout the world are pushing people to switch to electric vehicles by providing financial incentives. Electric car acceptance has been found to vary across various geographic and economic contexts. By 2030, the government wants to sell 80% of two- and three-wheelers, 70% of commercial, and 30% of private electric vehicles (Sharma, 2019). The objective of this research paper is to examine the numerous factors that affect a consumer's adoption of electric vehicles. The abbreviation EV stands for electric vehicle. EVs are either totally or partly powered by electricity. Because they have fewer moving parts to repair, electric cars have lower running costs. They are also very environmentally friendly because they use little to no gasoline or fuel. The automotive business, which has been around for over a century, is undergoing a change. Individual mobility patterns have shifted as a result of the growing expense of fossil fuels and the environmental effect of their emissions. Electric cars are progressively replacing internal combustion engines in the automobile industry (EVs).

As per Khurana (2020), there are following different types of electric vehicles:

- **HEV:** Hybrid electric vehicles (HEVs) have an engine and an electric motor and are fueled by both gasoline and electricity. The braking mechanism generates electricity, which charges the battery.
- **BEV:** BEVs lack an engine and they instead rely on electric motors for propulsion, with batteries storing energy. They charge the battery using external power sources. These cars are also referred to as plug-in automobiles., electric autos, or battery electric vehicles (BEVs).

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- **PHEV:** Plug-in hybrid electric cars (PHEVs) are similar to HEVs but have a smaller engine and higher-capacity batteries. The batteries are charged either through the braking system or through an external electric charging source.

India's commitment to limiting pollution and lowering its carbon footprint is growing. As the nation imports almost 80% of its total need for crude oil, or over $100 billion, the government wants carmakers to switch to electric vehicle production, so that it helps in reducing reliance on foreign fuel imports, protecting the country from currency swings (Pandey, 2021).

Literature Review

One of the most critical difficulties is identifying the factors that lead individuals to accept and use accessible solutions. Different writers employ various variables to assess user behavior and acceptability. Many hypotheses have been suggested by various scholars for researching the acceptance of innovation, which in this case is electric automobiles. TAM and UTAUT are the two most often used methodologies for determining the acceptance of an invention. Davis established the technology acceptance model (TAM) to describe the behavioral intention of potential users to employ an innovation, and it is now one of the most commonly used, powerful, and robust models (as cited in (King & He, 2006). The Unified Theory of Acceptance and Use of Technology (UTAUT) was suggested by Venkatesh et al. (2003). The UTAUT model entails six main constructs viz. behavioural intention, usage behaviour, social influence, facilitating conditions, performance expectancy and effort expectancy has been found to be a useful theoretical model for predicting consumers' adoption intention. In the following table 32 research papers on EV have been summarised to identify the factors influencing its adoption. Studies post 2012 have been analyzed. 13 Indian studies and 19 foreign studies have been reviewed.The study used a secondary literature that includes research papers, reports, and viewpoints from national/ international institutions in order to understand consumer purchasing behavior and factors impacting EV adoption.

S. No.	Authors & Year	Objectives	Variables	Research methodology	Findings
1.	Manutworakit & Choocharukul (2022)	To identify the factors that impact adoption of battery electric vehicles by Thai car owners.	Performance Expectancy, Social Influence, Facilitating Conditions, Effort expectancy, Price value, policy Measures, Hedonic Motivation, Environmental Concern, Purchase Intention, and use behavior	403 participants in Bangkok (PLS-SEM).	Except for price value and policy measures, factors that positively affect purchase intention include performance expectancy, social influence, hedonic motivation, effort expectancy, and environmental concern. Purchase intention influences use behavior favorably. Purchase intention and usage behavior are not considerably influenced by facilitating conditions.
2.	Bhat et al. (2021)	To assess the influence of several latent variables on consumer behavior toward the adoption of an electric vehicle.	Environmental enthusiasm, technological enthusiasm, perceived benefits, performance expectancy, facilitating conditions, anxiety (or perceived risk), social image, social influence, adoption intention	675 respondents, SEM	Except facilitating conditions and anxiety, all other selected factors have positive influence on adoption intention of consumer for an electric vehicle.
3.	Tarei et al. (2021)	To study EV barriers through an empirical study	Technological, infrastructural, financial, behavioral, and external barriers.	Quantitatively Best-Worst Method is used for ranking and prioritizing the important barriers. sub-barriers are analysed using interpretive structural modelling	EV adoption is influenced by factors like performance and range, total cost of ownership, a lack of charging infrastructure, and a lack of consumer awareness.
4.	Jayasingh et al. (2021)	To explore the factors that affect consumers' adoption intention electric two-wheelers.	Environmental concern, perceived economic benefit, charging Infrastructure, and social influence, attitude, Purchase Intention, gender as moderating effect	Purposive sampling 182 respondents, PLS-SEM using R	Environmental concern, Perceived economic benefit, charging infrastructure significantly influence attitudes towards electric two-wheelers. Females are more inclined towards EV
5.	Shalender & Sharma (2021)	To explore adoption intention of consumers towards the EV purchase.	Attitude, subjective norm, perceived behavioral control, moral norm, environmental concern, Adoption Intention	326 respondents PLS-SEM	All the selected variables have a positive relation with adoption intention of buyers. TPB is appropriate theory
6.	Ajitabh Dash (2021)	To explore and analyze the factors affecting adoption or acceptance of EVs in India.	Environmental Concern, Subjective norms, knowledge of EV are independent variables Attitude, Willingness to adopt is dependent variable	355 respondents from Delhi Simple random sampling SEM	The association between environmental concern, EV knowledge, subjective norm, and attitude toward EVs is statistically significant. Similar to this, attitude has a huge role in adoption decisions.

7.	Bansal et al. (2021)	To identify the EV characteristics that influence consumers' preferences for EVs, to calculate Indian customers' willingness to pay for EVs with better characteristics, and to measure the influence of reference dependency on WTP estimations.	On road purchase price, driving range, charging time, running cost, charging stations, policy interventions	1031 respondents from India. Discrete choice model (DCM) and SEM.	Customers are eager to pay more to minimize future running expenses, improve driving ranges, and reduce quick charging times.
8.	Shetty et al. (2020)	To investigate possible environmental and socio-technical barriers to EV acquisition and to assess if governmental policy and individual awareness influence customer decisions to acquire an EV.	Environmental benefits, environmental sensitivity and sustainability, perception of economic benefit and EV attitudes, Awareness, familiarity & Knowledge, government policies and car characteristics	1230 respondents from India and Sri Lanka, SPSS, smart PLS	Purchase behavior is influenced by EV functional characteristics, economic benefits, awareness and familiarity.
9.	Castillo et al. (2020)	To identify the factors that influence the purchase of an electric car and then compare the results with two panels of experts in consumer behavior and the automobile industry.	Range, charging time, low noise, acceleration, safety, reliability, price, perceived benefit, incentives, infrastructure	404 potential consumers in Spain. Computational intelligence algorithm. Expert views	According to the findings, the most reliable indicators of purchase intention are range, incentives, and reliability. Similarly, experts believe that selecting these three variables would be adequate to determine the purchase intention.
10.	Adhikari et al. (2020)	To propose a framework for identifying and analyzing the barriers to the usage of EVs.	17 barriers are classified into policy, economic, Technical, infrastructure, and social barriers in Nepal	The analytical hierarchical technique was used to examine and rank the obstacles after conducting a comparative survey to get comments from experts on them.	Infrastructure, economic, policy, and technical barriers pose more concerns than social barriers.
11.	Kumar *et al.* (2020)	To investigate the barriers to India's adoption of electric vehicles (EVs) by 2030 and to assess the government's policies on EV adoption		Secondary sources. Focus group study with 11 participants from academia and industry.	The sharing economy viewpoint offers the government a number of possibilities to manage the resources (the electric-powered transportation system) in the best possible way. When determining the target figures, the study contrasts the worldwide viewpoint.
12.	Khurana et al. (2019)	To determine the different factors that influence a consumer's adoption of an EV.	Perceived economic benefit; self-image; social influence; environmental concern; attitude; behavioral intention. Mediator- Attitude	214 existing car owners of the National Capital Region (NCR) Delhi, Pune and Mumbai. SEM	The BI's decision to accept EVs is unrelated to PEB. Instead, it has a significant favorable impact on ATT. Social influence and environmental concern have a big impact on ATT but only partially predict the BI. EC served as a lone predictor of BI. IM became a reliable predictor of BI for the wider adoption of EV. The findings showed that ATT was a highly reliable indicator of BI.
13.	Tu and yang (2019)	To develop a theoretical framework based on the (TPB), (TAM), and (IDT), and to investigate the major variables influencing consumer purchases of EVs.	Perceived Usefulness, Perceived ease of use, Compatibility, personal innovativeness, interpersonal influence, external influence, attitude toward behavior subjective norm, self -control ability, behavioral intention toward EV, self-efficacy, facilitating conditions, perceived behavioral control	300 respondents, Sampling Area-China, SEM	Seven of the nine characteristics are valid and, at varied weights, may influence customers' EV buying intentions. Self-control ability and external influence have the largest weights, implying that consumers place the most emphasis on these two characteristics.
14.	Barros and Padua (2019)	To investigate the extent to which financial incentives under Portugal's green tax reform, enacted in 2014, influence purchasing decisions for plug-in hybrid electric vehicles (PHEV).	Green tax reform, along with environmental awareness, technology, oil producer's independence, image factors, and several social-economic factors (current vehicle size, residence, income, household size and education level)	177 respondents SEM	Interest in buying a PHEV is mostly driven by financial incentives, with other factors coming in second. Driving smaller automobiles Education, living in larger cities, lower income levels, all have varied effects on interest in these vehicles. Financial incentives were discovered to be effective in offsetting the price gap between conventional automobiles and plug-in hybrids.
15.	Motwani and patil (2019)	To ascertain the people views and their awareness about the EVs, and responses to some of the drawbacks of electric vehicles	Mobility, recharging, tax benefit, RTO norms, subsidy, interior attributes, pollution, oil dependence, electricity demand	345 Consumer questionnaire from pune, judgmental sampling. Regression, r software	Mobility and recharging characteristics are crucial determinant for consumer's EV preference, RTO norm is least significant

16.	Shankar & Kumari (2019)	Using a dual-factor model, this study investigates the enablers and inhibitors of EV adoption intention from the sellers' perspective.	Attitude, subjective norms, perceived behavior control, Environmental Concern perceived CSR Obligation, Sunk cost, Regret avoidance, inertia, perceived value, Switching cost, perceived threat, Intention to adopt, resistance to adopt	278 respondents from Delhi, Chennai, Mumbai, Kolkata, and Bangalore; TPB, TAM and Dual-Factor Theory, AMOS-SEM	Adoption is aided by attitude, subjective norms, and perceived behavioral control. Avoidance of regret, inertia in non-EV sales, and perceived threat may all lead to EV reluctance.
17.	Kumar et al. (2018)	To assess the commercial viability of an e-mobility pilot project by 2030 and identify the initial bottlenecks and solutions in order to scale up on a pan-India basis.	Commercial viability of EVs charging time, driving range, battery	Stakeholder interview, survey from 30 EV drivers	Bureaucratic challenges in establishing charging stations, as well as costly initial investment and long wait times, are impeding EV adoption.
18.	Bhalla et al. (2018)	To study the factors impacting the consumer acceptance of these vehicles.	Environment Concern, Cost of Vehicle, Comfort, Trust, Technology, Infrastructure, Social Acceptance	233 respondents, purposive sampling, Correlation, Innovation Diffusion Theory (IDT)	Perception is influenced by environmental issue and trust in technology, adoption affected by cost, infrastructure, and social acceptance
19.	Adnan et al. (2018)	To identify the key determinants influencing the consumer adoption of PHEVs in Malaysia.	Adoption, Attitude, Environmental Concern, Hyperbolic Discounting, Intention, Perceived Behavioral control, Personal Moral Norm, Subjective Norm	403 respondents, convenient Sampling, SPSS, PLS-SEM, TPB theory	Personal moral norm, Subjective norm, attitude and perceived behavioral control, all demonstrate an indirect effect that has influenced Malaysian customers' propensity to purchase PHEVs. TPB has good explanatory capacity.
20.	Wang et al. (2018)	To examine the key factors impacting consumer's acceptance of EVs.	Independent Variables EV technical performance, Consumer's characteristics, EV adoption context, EV value perception and communication Dependent variable EV public acceptance	458 respondents. Factor Analysis and SEM	Acceptance of EVs is significantly influenced by technical level, marketing, perceived risks, and environmental awareness. Only 18% of respondents are willing to replace their current cars with Electric vehicles.
21.	Vidhi & Shrivastava (2018)	This research looks at the many phases of an electric vehicle's (EV) lifecycle, how they affect emissions to the environment, and policy suggestions that are appropriate to the Indian market for different socioeconomic classes.	Encouraging shared electric mobility in densely populated cities like Delhi	Literature review, life style assessment	To minimize air pollution through the adoption of EVs, the government must encourage their sale, raise RE share in energy mix, and make manufacturing of EVs battery less polluting.
22.	Yang et al. (2018)	Contribute to the organic combination of consumer behavioral features and the growth of the EV market.	Purchase concerns, Degree of understanding, social status, Consumer perception, Attitudes	In-depth interview, Questionnaire, 343 respondents. SPSS, PCA for extracting factors	In order to determine the features of EV customers' behavior, the consumer behavior of EVs is studied and the feature categories are made simpler using factor analysis.
23.	Bansal & kockelman (2017)	This study reviews existing vehicle ownership models for India	Review over vehicle choices	the findings of nine expert interviews to learn more about Indians' travel habits and car preferences	Obstacles- lack of charging infrastructure, high upfront cost, public awareness
24.	N. Adnan et al. (2017)	To provide a framework for modifying consumers' environmental concerns while purchasing PHEVs.	Vehicle ownership costs, environmental concern, driving range, personal norm, subjective norm, attitude, charging time, intention, personal norm and perceived behavioral control.	Literature review	TPB is appropriate. The key conceptual frameworks and the methodological approaches used in the reviewed studies are outlined.
25.	Morton et al. (2016)	To ascertain the impact of customer innovativeness and views toward EV functional capabilities on EV preferences.	Innate innovativeness, actualized innovativeness, electrical vehicles attitudes, electrical vehicle preferences	Stratified random sampling, 406 respondents R.M- EFA, CFA	Preferences for (PHEVs) and other electric vehicles (BEVs) are highly influenced by adoptive innovativeness and attitude about the functional performance of EVs.
26.	Hao et al. (2016)	To examine the key factors impacting the purchase of electronic vehicles.	City, age, status, environment, income, car, maintenance, degree, comfort, price, battery, repair, Purchasing behavior and intention	574 Respondents, Regression analysis using OLS, Probit and Logit methods.	Monthly income, the number of cars owned by a family, sustainability, and vehicle comfort all have a significant impact on consumer purchase behavior. Furthermore, age, marital status, city of residence, the number of cars in a family, and policy knowledge with NEVs have all been shown to be important predictors of consumer purchase intentions.

27.	Lai et al. (2015)	To identify the elements that affect people's decisions about the use of fully electric automobiles.	Perception of environmental policies, Environmental concern, perception of electric vehicles, reception of economic benefit, behavioral intention	308 respondents, CFA, SEM	Environmental concerns and perceptions of environmental policy are antecedent elements of complete EV perception, which determines behavioral intent to purchase full electric vehicles. One of the major reasons influencing full-EV adoption is the sense of economic benefit.
28.	Afroz et al. (2015)	To identify the impact of selected independent variables on purchase intention of EV.	Attitude (ATT), subjective norms (SNs), PBC, purchase intention (PI) and purchase behaviour (PB). Individual consequences (ICs) and environmental consequences (ECs).	Convenient sampling 350 respondents. SEM.	ATT, SN and PBC greatly influence PI. Consumers are influenced by their relative and friends. Ability to purchase affect decision making.
29.	Wang et al. (2014)	To conduct a detailed analysis for better understanding of consumers' intention to adopt HEVs, by using an enhanced TPB model.	Environmental concern, attitude, subjective norm, perceived behavioral control, personal moral norm, adoption intention	433 respondents in china PLS, SPSS	Attitude toward HEVs, perceived behavioral control, subjective norm, and personal moral norm partially mediate the effect of consumers' environmental concern on their intention to adopt HEVs.
30.	Sang and bekhet (2014)	To investigate EV acceptability in Malaysia using the TPB framework.	Social influences, performance attributes, financial benefits, environmental concerns, demographics, infrastructure readiness and government interventions are IVs and usage intention is DV	Judgement sampling, 1000 respondents, linear regression-stepwise technique	Social influences, performance attributes, financial benefits, environmental concerns, demographics, infrastructure readiness and government interventions all play a role in EV acceptance.
31.	Peters and Dutschke (2014)	To discuss the elements that influence EV acceptance and adoption among various consumer groups during the diffusion process.	compatibility, Relative advantages, ease of use, observability, trialability, social norm are IVs and intention to purchase and use as a DV	969 Respondents, Factor analysis, regression (using step wise method)	EVs are only valued by certain groups, while other important groups, such as women, do not appear to be interested in EVs in the early market phase.
32.	Egbue and long (2012)	(1) To identify the socio-technical barriers to consumer adoption of EVs? And (2) How much weight does sustainability have in EV purchasing decisions?	Interests, knowledge, attitudes, perceptions, and barriers pertaining to EVs and perspective on sustainability.	481 responses from students and faculty from a technological university. Chi-square test	There is high degree of uncertainty with electric vehicles. Battery range and cost are biggest concern. EV attitudes, knowledge, and views are varied by gender, age, and education level.

Conclusion

Electric Vehicles have come out as one of the prominent solutions for degrading environmental pollution. EVs will help in curbing environment pollution and reducing PM 2.5 concentrations. This study has reviewed existing studies in India and abroad on purchase intention and perception of consumers for the adoption of electric vehicles. Furthermore, various factors that impact the adoption of EVs have been identified. According to the study's findings, the most important elements impacting Indian customers' adoption of EVs are price, charging infrastructure, battery technology, environmental concern, and EV ecosystem. According to the review of papers unified theory of acceptance and use of technology (UTAUT) model, and Technology Acceptance Model the Theory of Planned Behaviour can be useful in understanding the consumers perception and adoption intention of electric vehicles. As an enlightened society we must see Electric vehicles as the need of the hour and foresee the long-term benefits of a cleaner environment, increased energy efficiency, and a sustainable replacement of fossil fuels.

Limitations and Future Research Directions

The main limitation of the study was a paucity of studies with respect to the adoption of Electric Vehicles in India. More Indian studies might have further expanded the discussion and insights. The literature review suggests that the study on the adoption of EVs is rapidly emerging in a global context. However, in an Indian context, till now, relatively less research has been done in the same field. There is a lack of qualitative studies as we have found only a few such researches in the review. Future studies can conduct structured interviews and focus group discussions for getting useful insights from the experts and users of the EV industry.

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