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Exploring the Green Energy: Factors Influencing Battery Electric Vehicles Adoption in Madhya Pradesh Region

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ABSTRACT

Electric vehicles (EVs) are quickly becoming a viable alternative to vehicles powered by fossil fuels such as gasoline, diesel, and compressed natural gas (CNG), which has prompted customers to think about these vehicles as a means to alleviate the increasing environmental problems brought about by fuel depletion and greenhouse gas (GHG) emissions. The point of this article is to explore potential elements that effect consumers' intentions to adopt electric vehicles. To accomplish this, the author conducted in-depth interviews with a wide range of stakeholders, including suppliers, academics and consultants, BEV owners, prospective consumers, and government officials. A study is carried out in Madhya Pradesh with the aim of determining the elements that influence the decision to purchase electric automobiles. An innovation diffusion theory–based questionnaire was developed to elucidate both the consumer's perspective and the factors impacting the widespread adoption of electric vehicles. Before purchasing an electric vehicle, consumers should weigh the advantages and disadvantages listed via multiple response analysis. The study's findings will shed light on customer preferences, which in turn will assist policymakers in India in developing policies that encourage the purchase and usage of electric vehicles.

Keywords: Electric Vehicle Adoption, Sustainability, Green Energy, Purchase Intention
JEL Classifications: M31, D12, O33, L62, R41, Q53, Q42

1. INTRODUCTION

The automotive sector consumes fuel and pollutes the air. Due to the availability of high automobiles, numerous metro-cities are experiencing high level of air pollution. It's becoming common issues in cities of India and many areas of the world. By making use of electric vehicles technology driven by electricity for a valuable green transportation choice for decreasing harmful emissions and safeguarding fossil fuels (Richardson, 2013; Esen and Yuksel, 2013; De Souza et al., 2018).

Electric vehicles can be identified in four different segments, battery electric vehicles (BEV), hybrid electric vehicles (HEV), plug in hybrid electric vehicles (PHEV) and fuel cell electric vehicles (FCEV). While comparing these vehicles hybrid electric vehicle still uses petrol for operating its engine. The plug-in electric vehicles are charged on running for a distance by charging station (Sikarwar et al., 2023). The fuel cell electric vehicles can be operated in both way electrical and petrol operated engine system (Khare et al., 2023). The battery electric vehicle emits zero carbon footprints and operated on electricity, which is more effective and structured for green environment. Nowadays Electric vehicles are worked as a weapon for environment, which stores carbon emission and green energy. Tata motors in India leads the electric vehicles market by 2.4 per cent. Because electric vehicles emit fewer greenhouse gases than cars powered by petroleum, an increasing amount of them may assist to minimize concerns about the environmental and petroleum usage. The Indian government has paved the way for activities using electric automobiles with the goal to promote green methods of travel and government cars be electric by 2030. It also intends to progressively phase out all corporate vehicle deployments and place non-fossil-fuel-

powered vehicles in every city by 2030. One of the primary causes is increasing carbon emissions. Low quality air has an effect on breathing, among other things. The initiative of Indian government has begun carrying out a number of initiatives to protect and safeguard the ecosystem. The primary purpose for pushing electric vehicles is to create an eco-friendlier green transport atmosphere (Asati et al., 2024; Asati et al., 2024). The aim of the research is to connect and evaluate the key component influencing Madhya Pradesh region customers' intentions to adopt Electric Vehicles. The study will be analytical in nature, with data sourced through an online survey completed by a simple random sampling of Madhya Pradesh users. The information gathered will be examined statistically, using the methods of regression and structural equation modelling. These approaches will assist us in determining which factors have the greatest influence on customers' decisions to purchase EVs and how. The findings of this study will help us improve our knowledge about the factors that encourage EV acceptance.

The above can be useful for lawmakers as well as commercial groups since it would provide data for the creation of particular strategies and approaches. The study's outline is presented below: A brief introduction ensures by a full review of the research conducted on the issue of electric vehicles acceptance and the numerous elements that impact customers' purchasing decisions.

The methodologies applied will be described and examined in the paper's third part. We will discuss how we chose our sample, set up the survey, and gathered our data. The fourth portion will cover the findings of our statistical analysis. The last portion of the study report will summarize the main results, examine their implications for policy and practice, and provide suggestions for future research. The intention of this study is to explore every aspect that purchasers of Madhya Pradesh examine before choosing upon an EV. This study aims to develop a successful strategy for encouraging the broad adoption of electric vehicles (EVs) in Madhya Pradesh by determining their key attributes and their relative consequences. The study's findings will help politicians, researchers, and entrepreneurs achieve an ecologically friendly and sustainable transportation system. The theory of planned behaviour (TPB) is the most regularly utilised. The study found that subjective standards, attitudes, and perceived behavioural control has distinct impacts on intention and behaviour (Singh et al., 2023; Gupta et al., 2023). Sustainability and incentive programmes will have a direct impact on electric vehicles.

This work investigated the effects of hedonic motivation, that has an advantageous effect on purchase intentions (Singh et al., 2023; Hasan et al., 2023). The value of the price represents one among the additional factors that came into the use of personal acceptance or utilizing the setup (Khatimah et al., 2019; Wu et al., 2017; Hasan et al., 2023). Eco-friendly actions of electric vehicles can help to enlarge the goal to buy EVs (Yong et al., 2015; Berkeley et al., 2017a; Hawkins et al., 2013a). Furthermore, broad electric car adoption is strongly dependent on solid electric vehicles policies on guidelines, as those accepted by China, Germany and California and India (Langbroek et al., 2016; Dwivedi et al., 2024).

Earlier research on increasing EV adoption has focused on limited policy tools, but it is important to include potential hazards and government assistance, as well as consumer expectations (Jain et al., 2022; Rebelo et al., 2023; Wahl et al., 2020). In India, researchers found that social influence, monetary incentives and policies affect the acceptance of electric vehicles (Jain et al., 2022; Yong et al., 2015; Wolf and Seebauer, 2014). The survey found a link between external policies, infrastructure, incentives, and communication are connected electric vehicles adoption (Bakker et al., 2014; Sierzchula et al., 2014). Our analysis revealed that policy measures and price value have a considerable beneficial influence on consumer purchasing intentions (Berkeley et al., 2017b; Lopes et al., 2011; Khazaei, 2019a). Therefore, hedonic motivation, price value, facilitating conditions, environmental concerns, and policy measures grab increased straight into consideration than the component from the initial (PLS-SEM).

2. RECAP OF ELEMENTS INFLUENCING BATTERY ELECTRIC VEHICLE ADOPTION

Numerous research investigations have explored numerous aspects impacting battery electric vehicles purchasing intention, covering population functions, automobiles effectiveness, emotional and social status demands, government legislation, price, concerns about the environment, and services (Bakker et al., 2014; Witarsyah et al., 2017). Elements impacting battery electric vehicles adoption are cost, revenue, use expenditures and processing cost are between than the ultimate important reasons influencing the acquiring of electric vehicles powered by batteries (Zhuge and Shao, 2019; Verma et al., 2024; Hasan et al., 2024; Dixit et al., 2024; Mishra et al., 2024). The longevity of the batteries of electric vehicles is an aspect that influences their appeal; hence, this issue needs to be addressed. This increases the probability of purchasing a battery-powered electric vehicle.

2.1. Research Hypothesis

The proposed (PLS-SEM) research model is detailed in the following section.

2.1.1. Policy Measures (PM)

Monetary strategy and size arise as an important element in determining the intent to buy. If authorities do not encourage electric vehicles people may be less likely to purchase them (Langbroek et al., 2016; Wang et al., 2017). In emerging economies, monetary and non-monetary incentives include subsidies, rebates, and tax reductions, while non-monetary initiatives try to make it easier for people to buy and use electric cars.

> Hypothesis 1 (H1). Policy measures have a significant positive result on EV purchase intention.

2.1.2. Performance Expectancy (PE)

While the environmental benefits, EV market adoption remains limited, particularly in emerging economies, owing to customer motivation, awareness, and EV traits (Abbasi et al., 2021). Electric vehicles are connected with several advantages, including reduced

consumption of energy and pollution in the air. The vehicle sector refers to "performance expectancy" in potential consumers' idea that electric vehicles (EVs) will improve journeys and efficiency. Previous study has indicated that performance expectation plays a significant part in nicely affecting the propensity to acquire EVs (Jain et al., 2022; Khazaei, 2019b).

Hypothesis 2 (H2). Performance expectancy has a negative impact on EV purchase intention. But it can be improvised by changing the market price which is suitable for every type of people.

2.1.3. Social Influence (SI)

Social influence refers to how people, such as close companions, affect their choices. Social influence refers to a worker's and supervisor's ability to shape how individuals exhibit emotions through technology. Social influence effect refers to the extent that customers accept other people's opinions while purchasing and using an electric vehicle (EV). As EVs lead technical advancements in the automobile industry, they often become a sign of affluence for their owners (Axsen et al., 2013; Osswald et al., 2012). Previous study shows that social influence has a major impact on adoption intentions (Bhat et al., 2022; Cui et al., 2021). Although encouraging the purchase and usage of electric vehicles (Yang and Chen, 2021). Social influence plays an important role in shaping behavioural plans.

Hypothesis 3 (H3). Social influence has a negative result on EV purchase intention. We should focus on features of EV like battery and quality, due to which people influence their purchasing decisions and electric vehicles is the future of our country.

2.1.4. Environmental Concern (EC)

Environmental concerns are becoming rapidly important in purchase decisions, driven by global difficulties. Emissions of carbon dioxide from automobiles contribute to global warming and influence consumer buying choices (Hawkins et al., 2013b). By the way, customers' environmentally friendly attitudes have a significant influence on purchasing EVs (Li et al., 2022). Overall, having an essential part with EV acceptance goals (Nazneen et al., 2018; Wu et al., 2019). Attention to the environment concern is considered an especially relevant component in my study (Degirmenci and Breitner, 2017). Concentrate on sustainability concerns over mobility and pricing. This effects potential purchasers' willingness to spend money for an EV (Thananusak, 2017). Electric vehicles (EVs) are going to play a significant role in lowering environmental pollution in the motor vehicle industry. Environmentally friendly people are more willing to use electric vehicles (EVs).

Hypothesis 4 (H4). Environmental concern has a significant positive result on EV purchase intention.

2.1.5. Facilitating Conditions (FC)

Facilitating conditions relates to the accessibility of innovation, institutional methods, and assets, such as software, equipment's, and expertise, that facilitate the application of innovation. Facilitating conditions have been recognised as a key component influencing user attitude. According to this view, various other variables, such as perceived control is enabling situations of Human Behaviour and adaptability that influence the aforementioned structure. Recent research suggests that environmental factor will play a vital role in determining adoption intentions. The Investigations on owners' willingness to adopt electric vehicles yielded similar findings (Zhou et al., 2021).

Hypothesis 5 (H5). Facilitating conditions has a significant positive result on EV purchase intention.

2.1.6. Price Value (PV)

Numerous study and cultural contexts have highlighted that pricing effects purchasing intention (Sierzchula et al., 2014). Owners of enterprises can increase earnings by operating at a high cost, while customers choose low-priced products and quality goods.

Hypothesis 6 (H6). Price value has a significant positive result on EV purchase intention.

2.1.7. Hedonic Motivation (HM)

Hedonic motivation refers to the satisfaction or happiness gained at the beginning of implementing innovation. The sense of enjoyment influences customer adoption and usage of novel innovations (Gunawan et al., 2022). The current study found that hedonic motivation influences the desire to adopt EVs (Schuitema et al., 2013). Moreover, the influence of hedonic intentions on behavioural intention is stronger in the case of consumers continuing to environmentally friendly buying behaviours. According to (Zhou et al., 2021), Hedonic motivation includes a driving delight that can increase consumers' desire to purchase electric vehicles.

Hypothesis 7 (H7). Hedonic motivation has a significant positive result on EV purchase intention.

2.1.8. Purchase Intention (PI)

Perceived attitudes and consumer behaviour have a substantial impact on actual actions, especially purchasing intention serving as an important role when it comes to utilisation behaviour. The aim of this study is to raise customer knowledge of the harmful environmental effect of standard combustion of petroleum engines. To reduce greenhouse gas emissions, customers need to adopt environmentally conscious viewpoints and purchasing actions. The reason for this is to create an awareness of ethical duty to the environment and leading to the development of personal rules to promote sustainable behaviour (Sánchez et al., 2018). While consumers are aware of this, they might be compelled to support electric vehicles and accordingly succeeding hypothesis was proposed:

Hypothesis 8 (H8). EV Purchase Intention has a significant positive result on EV user behaviour.

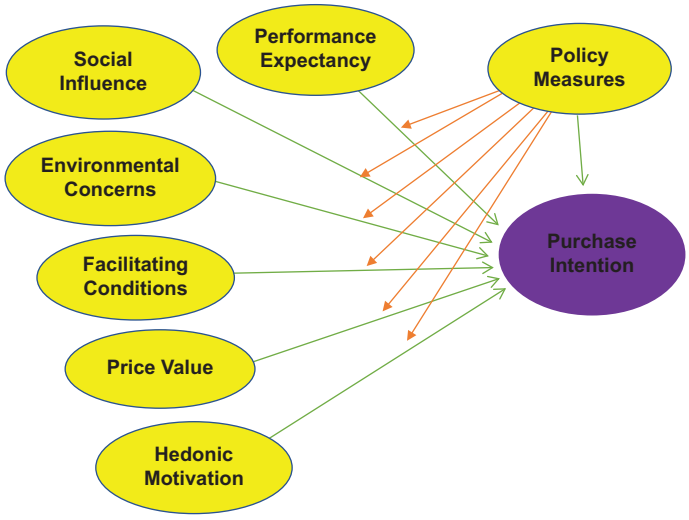
3. MATERIALS AND METHODS

This study utilised a quantitative survey of electric vehicles owners in Madhya Pradesh region to test hypotheses. The

data was examined by partial least squares structural equation modelling (PLS-SEM). The conceptual model consists of 8 hypothesis and conceptual model is shown in Figure 1. This is particularly noticeable that Delhi NCR gives beneficial incentives such as cheap VAT, rebates, and lower Tarif on corporate automobiles. These things may be done in future for Madhya Pradesh region to increase the use of electric vehicles adoption.

We have used a probability based, straight forward random sampling technique. The chosen method aimed to ensure fair and equal opportunities for all peoples of Madhya Pradesh Region to participate in our study. The questionnaire was administered to EV holders and non-EV holders using Google Forms between July 14th and September 15th 2023. During the first phase of data collection process, a notable quantity of responses, specifically 130, were gathered. To increase the sample size, an additional round of data collection was conducted between November 25th and December 14th, 2023. During the second phase, a significant number of 118 responses were collected.

Figure 1: Conceptual Framework of the Study



4. RESULTS

The analysis design was established based on the study conducted by (Manutworakit and Choocharukul, 2022). The hypothesis was examined through a quantitative research methodology, employing the PLS-SEM approach and the Smart PLS 4 software with model as shown in figure 2.

The results of the examination suggest that a single component can explain 61% of the overall variation, hence excluding the potential presence of Common Method variation (CMV) in the dataset. In order to employ the PLS-SEM method, it is necessary to assess the dependability of both the outer and inner models (Kumar Jain Pinaki Dasgupta, 2021).

All of the remaining item loadings are more than 0.7. Table 3 presents the intersecting validity and mediating assessments of the reflective form. The Table 1 displays the outer loadings, Cronbach's alpha, and extracted average variance (AVE), along with details regarding the items utilised to assess each construct. Outer loadings ranging from 0.711 to 0.981 signify a robust association between the research thing and the theoretical frameworks they were intended to assess. The constructs in the study exhibit a notable level of inner stability, as evidenced by the alpha values (line up from 0.70 to 0.75) associated with each construct. The AVE values (0.527 to 0.939) show a significant level of shared variance between each construct and its corresponding measurements. If the values of the composite reliability criteria exceed 0.7, it is probable that the overall reliability of the entity in question is high. The outcome of this work shows a well-known measuring of constructs exhibit good levels of reliability and convergent validity.

The provided information about Internal design assessment for a model of structure analysed Applying a partial least squares SEM method. Specifically, they mentioned the outputs in Table 2. The table displays seven hypotheses (H1, H2, H3, H4, H5, H6, H7) along with them of corresponding β values, and P values. The

Figure 2: PLS Model after Analysis

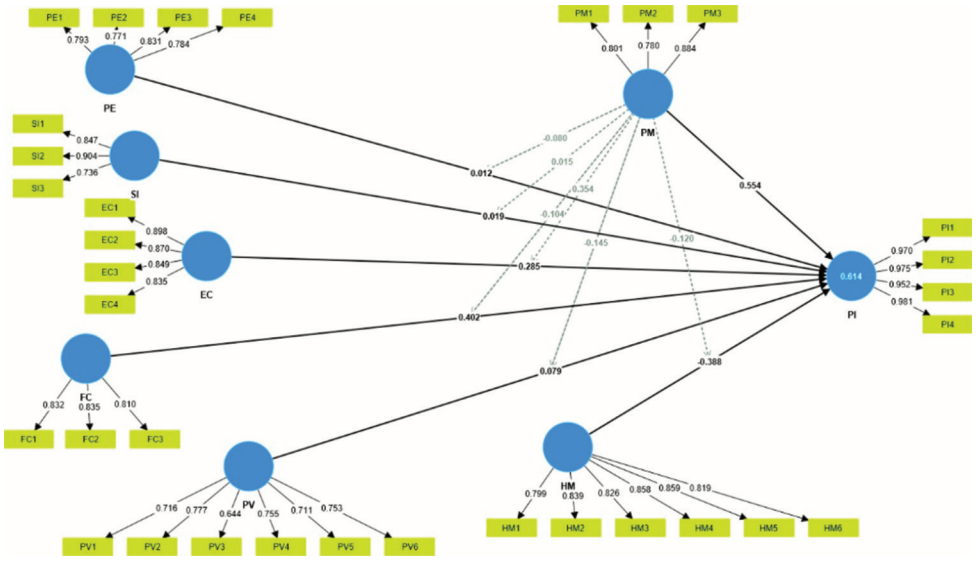


Table 1: Factor loadings

Factor Name	Items value	Cronbach's alpha	AVE
PM			
PM1	0.801	0.71	0.573
PM2	0.780		
PM3	0.884		
PE			
PE1	0.793	0.75	0.632
PE2	0.771		
PE3	0.831		
PE4	0.784		
SI			
SI1	0.847	0.73	0.687
SI2	0.904		
SI3	0.736		
EC			
EC1	0.898	0.70	0.744
EC2	0.870		
EC3	0.849		
EC4	0.835		
FC			
FC1	0.832	0.72	0.681
FC2	0.835		
FC3	0.810		
PV			
PV1	0.716	0.75	0.527
PV2	0.777		
PV3	0.644		
PV4	0.755		
PV5	0.711		
PV6	0.753		
HM			
HM1	0.799	0.71	0.694
HM2	0.839		
HM3	0.826		
HM4	0.858		
HM5	0.859		
HM6	0.819		
PI			
PI1	0.970	0.74	0.939
PI2	0.975		
PI3	0.952		
PI4	0.981		

PM: Policy measures, PE: Performance expectancy, SI: Social influence, EC: Environmental concern, FC: Facilitating conditions, PV: Price value, HM: Hedonic motivation, PI: Purchase intention, AVE: Average variance

Table 2: Hypothesis testing with internal fit

IV->DV	Hypothesis	B	P	Hypothesis status
PM→PI	H1	0.554	0.05	Accepted
PE→PI	H2	0.012	0.07	Rejected
SI→PI	H3	0.019	0.09	Rejected
EC→PI	H4	0.285	0.02	Accepted
FC→PI	H5	0.402	0.01	Accepted
PV→PI	H6	0.079	0.04	Accepted
HM→PI	H7	0.388	0.02	Accepted

PM: Policy measures, PE: Performance expectancy, SI: Social influence, EC: Environmental concern, FC: Facilitating conditions, PV: Price value, HM: Hedonic motivation, PI: Purchase intention, AVE: Average variance

Smart PLS 4 outputs indicate that the hypotheses H1, H4, H5, H6 and H7 have been accepted. This is because their P values are lower than 0.05, which suggests a connection with statistical significance existence among policy measures, Environmental Concerns, facilitating conditions, price value, hedonic motivation. The β values for Policy Measures, Environmental Concerns, facilitating conditions, price value, hedonic motivation is 0.554, 0.285, 0.402, 0.079, and 0.388 subsequently, and their relative P values are 0.05, 0.02, 0.01, 0.04, and 0.02. The R2 value for purchase intention to use EV (0.614) is proportionately big, proposes a forecaster adjustable account for a substantial amount of the variability in the standard shifting. The model indicate that values have a good predictive relevance and overall fit as shown in Table 4.

Table 3: Mediating table

Fit summary of model		
Test	Saturated model	Estimated model
SRMR	0.076	0.076
d_ULS	1.326	1.326
d_G	0.522	0.522
χ^2	745.415	745.415
NFI	0.832	0.832

Source: MS Excel and Word

Table 4: R^2 test

R^2		
Variable	R^2	R^2 adjusted
PI	0.614	0.607

PI: Purchase intention

5. CONCLUSION

The research paper examines the correlation between environmental concerns, and social influence on customer's purchase intentions towards electric vehicles (EVs). The exploration discovery supplies important awareness into the separate elements that influence the formation of individuals' intentions. The findings also indicate that there is corelation between consumers buying intention mindset for environmental concerns. The data indicates an increasing awareness among EV customers regarding the significance of sustainability and the urgent need to reduce carbon emissions. The increasing awareness of environmental issues has resulted in a greater tendency for customers to choose alternative transportation options, such as electric vehicles (EVs). This preference is primarily driven by the smaller ecological footprint of EVs compared to traditional vehicles. Additionally, the study examined perceived benefits of using electric vehicles (EVs) and how they influence customer's intentions.

The study suggests that there are several factors that influence the prospect of consumers to choose electric vehicles. The factors talk over potentials for price value, increased convenience, and a decreased reliance on fossil fuels. The result spotlight the practical factors that influence public purchasing motivation towards electric vehicles (EVs), including the potential for decreased money, convenient charging options, and the opportunity to reduce their carbon footprint and contribute to environmental concern safeguarding. The study conducted an analysis on how social factors impact consumer behaviour and intentions to utilise electric vehicles (EVs). The data show that factors such as policy measures, social influence, and facilitating conditions effect on creating the purchase intentions for EV.

5.1. Limitations and Implications

The study's outcomes have been confirmed by data that was gathered via surveys and analysed using statistical tools. We analysed and performed research using a number of people in Madhya Pradesh, enabling the outcome to be further extended to a larger population. The investigation improved the reliability and uniformity of my results by utilising sophisticated statistical approaches. This expertise aided to recognise important relationships among factors and generating relevant analyses. It is critical to acknowledge the research's problems. The research concentrated on looking into a certain group of peoples that could affect its importance to other populations. To acquire an improved awareness of different factors affecting people's choices to adopt electric vehicles (EVs), additional studies might broaden their study population to incorporate a broader spectrum of individuals. Finally, it is essential to keep in mind that the present research focused mainly on personal information, which raises the possibility of reaction bias. The research mostly examined objectives rather than practical execution of electric vehicles. Future study should include objective utilisation statistics in order to acquire an improved comprehension of the elements that influence the widespread adoption of electric vehicles (EVs). The above may result in a better understanding on the problem by making the relationship among willingness and actual behaviour. The main purpose of this research paper is to explore the effect of concerns about the environment on consumers preference to accept electric vehicles. The results of the study reveal a substantial correlation among environmental concerns and a desire for electric vehicles, highlighting the importance of sustainability when making transportation decisions. The partnership across corporations, governments, and policymakers can help promote electric vehicles (EVs) among mankind. The previously mentioned component has the capacity to benefit the ecosystem and support long-term viability. To achieve this purpose, it may be desirable to employ successful strategies based on the price benefits and effect of general factors.

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