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Consumer Adoption of Electric Vehicles and Its Contribution to Sustainable Transportation: Evidence from Pune District

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Abstract:

Electric vehicles market has witnessed growth in countries like China, Norway, the United States, Germany, and the Netherlands have emerged as leaders. Countries are adopting electric vehicles due to increasing environmental concerns, technological advancements, and supportive government policies. India has become fast growing EV market with FAME, PLI, Incentives and local policies and increasing awareness towards environmental sustainability. Maharashtra is one of the leading states promoting EV Market. The state has implemented a comprehensive EV policy aimed at increasing EV adoption, expanding public charging infrastructure, attracting investment in EV manufacturing, and reducing greenhouse gas emissions. Major cities Like Mumbai, Pune, Nagpur, and Nashik have experienced increasing registrations of electric vehicles. Pune has emerged as one EV hub in last decade due to Growing environmental awareness, higher fuel prices, government incentives, and improved charging infrastructure, strong automotive manufacturing ecosystem, research institutions, IT sector, and start-up culture. Consumers have adopted EVs due to increased awareness towards environment and sustainability.

This research paper aims to analyse effect of macro factors on electric vehicles consumer behavior. The scope of this paper is limited to study political, economic, social, technological, legal and environment factors and its relation with consumer behavior. This research paper highlights descriptive research and analytical research with reference to MACRO environmental factors and its relation towards EVs Consumer acceptance and sustainability. Simple random sampling is used. Primary data was collected through EV owners from November 2025 to April 2026. This research is Descriptive and explanatory research with quantitative approach, used structured questionnaire using 5-point Likert scale. This study confines to Pune District with 400-500 respondents using 5-point Likert scale, simple random sampling techniques are used. SPSS AMOS 21 is used for descriptive and inferential statistical analysis. The result of the research is analysed and findings are further discussed in this paper.

Keywords: Consumer behavior, Electric Vehicles, Sustainability.

Introduction:

Electric Vehicle market is a dynamic segment of Indian economy. Its dynamic and complex market nature sets a platform to understand, to study and to do specific research in an area of Electric Vehicles market. Electric vehicle market is driven by various favourable factors like government incentives, Pollution free, hiked fuel prices, increased environmental awareness and many more.

Electric Vehicles market is at a nascent stage and is projected to expand as per market trends. This is an opportunity to researchers, marketers and manufacturers to study this

developing sector of Global economy. EV market has many opportunities like technological innovations, low or negligible running and maintenance cost, no carbon emission, reduced dependency on fossil fuel whereas it has many challenges like too high initial cost, range-anxiety, charging infrastructure, fast changing technological advancements, perception of batteries and also addressing these communications.

In such EV market dynamic and critical scenario, it become crucial and critical to study consumer behavior in Pune district of Maharashtra and embrace sustainable mobility and change the future.

Research Objectives:

This research papers have following research objectives:

- To analyse effect of macro factors (PESTEL) on electric vehicles consumer behavior.
- To examine the relationship between sustainability concerns and consumer purchase intention.
- This study is limited to Pune District area and focuses to study EV two -wheelers only.
- The data is collected from EV two-wheelers.

Research Methodology:

This research paper highlights descriptive research and analytical research with reference to MACRO environmental factors and its relation towards EVs Consumer acceptance and sustainability. Simple random sampling is used. Primary data was collected through EV owners.

Research Design:

This study adopts a **descriptive and analytical research design**.

- Descriptive research is used to understand consumers' awareness, perceptions, attitudes, and purchase intentions towards electric vehicles.
- Analytical research is employed to examine the influence of various factors on consumer behavior and sustainable transportation.

Research Questions:

1. Which PESTLE factors have influence on consumer behavior?
2. Which PESTLE factors have strong impact, moderate impact and low impact on consumer behavior?
3. Does sustainability affect consumers behavior towards EVs?

Study Area:

The study is confined to Pune District, Maharashtra, one of India's major automobile and IT hubs. Pune has witnessed rapid growth in electric vehicle adoption due to government incentives, increasing charging infrastructure, environmental awareness, and the presence of automobile manufacturers. This study is limited to Pune District area and focuses to study EV two -wheelers only. The research data is collected from EV two-wheelers.

Nature and Sources of Data:

Primary Data: Primary data is collected through a **structured questionnaire** administered to consumers residing in Pune District.

Secondary Data: Secondary data is collected through all published and open-ended sources.

Sampling Design:

Population: Residents of Pune district who are exiting/potential EV buyers.

Sampling Technique:

Convenience Sampling: Random Sampling technique.

Sample Size: 464 respondents.

Research Instrument:

A structured questionnaire consistent of two sections:

Section A: Demographic Profile: Age, Gender, Marital Status, Education level, Total members of family, Total family income, Occupation.

Section B: All Macro/PESTLE factors cum variables are measured on a 5-point Likert Scale (1 = Strongly Disagree to 5 = Strongly Agree).

Variables of the study:

Independent Variables: All Macro/PESTLE factors (Political, Economic, Social, Technological, Legal, Environmental factors.

Dependent Variables: Consumer behavior (Purchase decisions) towards Electric Vehicles.

Reliability & Validity:

Reliability: Reliability is the scale's capacity to yield consistent results. It refers to how reliable a measuring device is and measures instruments trustworthy. Cronbach alpha is used to examine construct reliability in this study. Reliability is assessed using Cronbach's Alpha, with a value of 0.70 and above is threshold.

Validity: Master validity is measured through Discriminant Validity (Validity Analysis & HTMT Analysis) and Convergent Validity (factor loadings and Average Variance extracted). Master validity is measured through Discriminant Validity (Validity Analysis & HTMT Analysis) and Convergent Validity (factor loadings and Average Variance extracted).

Statistical Tools:

The collected data is analysed using SPSS AMOS 21.

Descriptive statistical techniques include: Frequency, Percentage, Mean, Standard Deviation.

Inferential Statistics: Reliability (Cronbach's Alpha), Discriminant Validity (Validity & HTMT analysis) and Convergent Validity (Factor loadings and Avg. Variance extracted). Confirmatory factor analysis, Regression Analysis, ANOVA is used.

Findings and Interpretation:

Interpretation for Demographic Data:

1. It can be found that, the age group of 21–35 comprises the majority of respondents, followed by the age group of 36–50. The majority of responders (90.9%) are in the 16–50 age range.
2. It can be found that, the bulk of respondents (99.8%) came from male strata, with female strata coming in second.
3. It can be found that, the majority of respondents (98.5%) are married, with single respondents coming in second.
4. It can be found that, the majority of respondents (97.4%) are from graduate strata, followed by ITI/12th/Diploma and master's strata.
5. It can be found that, the majority (78.0%) of respondents are from the four (4) members group, followed by the three (3) member group.
6. It can be found that, the majority (68.5%) of respondents earn less than 8 lakhs/pa, followed by the 8-15 income bracket.
7. It can be found that, the majority of respondents (77.8%) belong to the service group, with the business/shops group coming in second.

Interpretation for Electric Vehicles Ownership:

1. It can be found that, the majority of respondents (96.8%) own one (01) EV 2W car, followed by zero (00) EV 2W cars.
2. It can be found that, the majority of respondents (97.8%) own zero (00) EV 4W vehicles, with one (01) EV 4W vehicles coming in second.
3. It can be found that, the majority of respondents (42.9%) who own and like to travel by EV 2-W go between 21 and 50 kms, followed by fewer than 20 kms.
4. It can be found that, the majority of respondents (30.2%) go 51–75 km by EV 4-W, followed by 76–100 km.
5. It can be found that, the majority (59.6%) of the respondent have registered their EV with MH14 followed by MH12 for EV 2W.
6. It can be found that, the majority (41.6%) of the respondent have registered their EV 4-W with RTO MH14 followed by RTO MH12.
7. It can be found that, the majority of respondents (96.8%) are charging EV batteries at home parking, followed by at home and office parking.

Interpretation for Macro/PESTEL Factors (R-I):

1. Economic Factors:

Macro-environmental factors heavily shape electric vehicle (EV) adoption. When analysing these decisions, researchers has used

the **PESTLE framework** to map the uncontrollable, external forces: **Political**, **Economic**, **Social**, **Technological**, **Legal**, and **Environmental variables.**

1. It can be found that, majority (39.9%) of the respondent are agreed to Government Policies w.r.t. EV Incentives & Tax Exemption. Mean is = 4.019 & SD is 1.0421. Government policies (incentives and tax exemptions) regarding EVs are significant factors that have a moderate impact on EV purchasing decisions, according to the mean value.
2. It can be found that, majority (58.6%) of the respondent are strongly agreed to Fuel prices-current. Mean is = 4.351 & SD is 0.9544. Fuel prices are a significant element that has a moderate impact on EV purchasing decisions, according to the mean value.
3. It can be found that, majority (54.5%) of the respondent are strongly agreed to Economic growth rate of India. Mean is = 1.194 & SD is 01.1062. Based on value of mean, it can be observed that, India's economic growth rate is a significant factor that has a moderate impact on EV purchase decisions.

2. Technological Factors:

1. It can be found that, majority (56.5%) of the respondent are strongly agreed to Battery Charging Technology. Mean is = 4.405 & SD is 0. 8311.Thus, it is found that, Battery Charging Technology is important factor moderately affecting EV purchase decisions.
2. It can be found that, majority (58.0%) of the respondent are strongly agreed to Speed Acceleration. Mean is = 4.444 & SD is 0.8398. Speed acceleration is a significant factor that has a substantial impact on EV buying decisions, according to the mean value.
3. It can be found that, majority (70.0%) of the respondent are strongly agreed to Driving Range (Km/Charging). Mean is = 4.616 & SD is 0.6762. As per value of mean, it is insighted that, Driving Range (Km/Charging) is a crucial factor that significantly influences EV purchase decisions.
4. It can be found that, majority (40.1%) of the respondent are strongly agreed to Charging Infrastructure. Mean is = 3.817 & SD is 01.2706. The mean result indicates that charging infrastructure has somewhat significant impact on EV purchase decisions.

3. Environmental Factors:

1. It can be found that, majority (70.7%) of the respondent are strongly agreed to Emission of CO2. Mean is = 4.545 & SD is 0.8855. based on the mean value it can be observed that Emission of CO2 is very important factor strongly affecting EV purchase decisions.
2. It can be found that, majority (33.4%) of the respondent are agreed to Recycling/Deposition of Battery. Mean is = 3.114 & SD is 1.3605. As per mean value, it is disclosed that, Recycling/Deposition of Battery is neutral/no effect factor affecting EV purchase decisions.

4. Legal Factors:

1. It can be found that, majority (29.3%) of the respondent are strongly agreed to Regulations for reducing Emission. Mean is = 3.306 & SD is 1.521. As per value of mean it can be suggested that Regulations for reducing Emission is neutral/no effect factor affecting EV purchase decisions.
2. It can be found that, majority (34.7%) of the respondent are strongly agreed to All Legal norms for EVs. Mean is = 3.724 & SD is 1. 2733.Hence, as per estimate for mean, it is disclosed that, All Legal norms for EVs are important factor moderately affecting EV purchase decisions.
3. It can be found that, majority (39.2%) of the respondent are strongly agreed to Safety Laws for EVs. Mean is = 3.573 & SD is 1.4441. The mean value indicates that safety laws are a significant consideration that has a moderate impact on EV purchase decisions.
4. It can be found that 32.5% of the respondents said that Battery Disposal Laws as a factor affecting EV buying decisions is strongly disagreed,19.6% said disagreed, 20.3% were neutral, 12.9% said agree, 14.7% said strongly agree. Hence, majority (20.3%) of the respondent are strongly agreed to Battery Disposal Laws for EVs. Mean is = 2.575 & SD is 1.4274. The mean figure indicates that battery

disposal laws have no influence or are neutral when it comes to EV purchases.

5. Social-cultural Factors:

1. It can be found that, majority (48.7%) of the respondent are strongly agreed to Society influences on Eco-friendly living. Mean is = 1.138 & SD is 1.0731. As per value of mean, it can be found that, society influences on eco-friendly living is important factor moderately affecting EV purchase decisions.
2. It can be found that, majority (49.8%) of the respondent are strongly agreed to Cultural influence on modern living and being responsible citizen. Mean is = 1.119 & SD is 1.1445. It can be insighted that Cultural influence on modern living and being responsible citizen is important factor moderately affecting EV purchase decisions based on mean value.
3. It can be found that, majority (17.7%) of the respondent are strongly disagreed to Influence of early EV adopters. Mean is = 2.091 & SD is 1.2350 based on the mean value it can be concluded that Influence of early EV adopters is unimportant factor affecting low in EV purchase decisions.

MACRO/PESTLE Analysis:

In this study, researchers have undertaken PESTLE factors and its impact on purchase decision making of electric vehicle customers. PESTLE factors mean political, economic, social & cultural, technological, legal and environment factors. These factors are uncontrollable factors in the hands of customer and industries and no one has control on these factors so they are uncontrollable factors. They indirectly shape the behavior of the consumers. The extent to which PESTLE factors have impact on purchase decision making in general and with specific reference to this study is elaborated in the form of findings in the following section.

1. Political Factors:

Political factors for electric vehicles include financial incentives and subsidies, production linked incentives (PLI), State level mandates/restrictions on petrol/diesel/CNG vehicles, targets for Greenhouse Gases Emission Rules, Licensing restrictions on importing crude oil, National Climate targets, local infrastructure facilities are the factors might have direct and indirect impact on electric vehicles customers purchase behavior. Researcher have studied influence of financial incentives and subsidies on electric vehicles purchase decisions and it is concluded that, it has strong influence on purchase decisions of customers.

2. Economic Factors:

Customers in Indian market are price-sensitive and as electric vehicles cost of recharge is negligible or low as compared to CNG/Petrol and Diesel prices, customers in Pune region, it is found that, many educated people are shifting to electric vehicles as per this study. In electric vehicle purchase decisions, at macro level, following factors which are directly and indirectly might influence customers purchase decisions: Prevailing fuel cost and its volatility, Central & State Government subsidies, Total Cost of ownership (TCO), Purchase price, Financing options availability, resale value, scrap value, economic growth rate of India, prevailing inflation rate. Researcher have studied influence of Government policies like financial incentives and subsidies, ongoing fuel prices, economic growth rate of India, Road tax and exemptions, income tax exemption and flexible credit facility on electric vehicles purchase decisions and it is concluded that, financial incentives and subsidies have strong effect, ongoing fuel prices, economic growth rate of India, Road tax and exemptions, income tax exemption and flexible credit facility have moderate effect on purchase decisions of customers.

3. Social and Cultural Factors:

In consumer behavior studies, societal factors play a crucial role in shaping up customer behavior. Social factors influencing electric vehicles include family members & relatives, friends & relatives, peer influence, tech-savvy/modern living, environmental responsibility/eco-friendly living, status symbol, being responsible citizen, influence of early adopters are the factors might have direct and

indirect impact on electric vehicles customers purchase behavior. Researcher have studied influence of eco-friendly living, Modern/Tech savvy living, family members & relatives on electric vehicles purchase decisions and it is concluded that, it has moderate influence on purchase decisions of customers.

4. Technological Factors:

Electric vehicle as a technology is new to the Indian market and its market is evolving. Technological factors for electric vehicles include battery life, battery type, battery capacity, battery safety, battery technology, range, range anxiety, charging time, charging speed, purchase price, sustainability, total cost of ownership, Acceleration, driving performance, vehicle technology, tech-operated features, public charging stations and its availability, etc. are the factors might have direct and indirect impact on electric vehicles customers purchase behavior. In this research, researcher have studied driving range, driving time, public charging stations and its availability, purchase price, driving range has shown strong influence, whereas battery technology, battery charging time, acceleration, charging infrastructure has moderate influence on purchase decisions of customers.

5. Legal Factors:

Legal factors for electric vehicles include regulations for reducing emission, Safety laws, Battery disposal laws, legal norms for EVs are the factors might have direct and indirect impact on electric vehicles customers purchase behavior. Researcher have studied all these factors and its influence on customers purchase decisions and it is concluded that, legal norms and safety law have moderate influence on electric vehicles purchase decisions of customers.

6. Environment Factors:

Environment factors for electric vehicles include being responsible citizen, pro-environment attitudes, emission of Co2, alignment with sustainability goals, and environment concerns towards EV production/recycling/disposition of Electric vehicles battery etc. have direct and indirect impact on electric vehicles customers purchase behavior. Researcher have studied being responsible citizen, pro-environment attitudes, emission of co2 and its influence on customers purchase decisions and it is concluded that, being responsible citizen, pro-environment attitudes have moderate impact and emission of co2 and its influence on customers purchase decisions have moderate influence on electric vehicles purchase decisions of customers.

Conclusion for Macro environmental factors:

Following table elaborates concluding remarks on macro/pestle environmental factors affecting EV purchase decisions:

Macro environmental factors extent of effect on EV Customers Behavior:

Marketing Mix Variable	Sub-variable	Strong affect	Moderate affect	Neutral/ No affect
Economic factors	Govt. Policies		Moderate	
	Fuel prices		Moderate	
	Economic growth rate of India		Moderate	
Technological factors	Battery charging Technology		Moderate	
	Speed acceleration		Moderate	
	Driving range	Strong		
	Charging infrastructure		Moderate	

Marketing Mix Variable	Sub-variable	Strong affect	Moderate affect	Neutral/ No affect
Environmental factors	Emission of CO2	Strong		
	Recycling/Disposition of battery			No
Legal factors	Regulations for Reducing emission			No
	All legal norms of EVs		Moderate	
	Safety Laws		Moderate	
	Battery Disposal Law			No
Social-cultural factors	Eco-friendly living		Moderate	
	Modern & responsible living		Moderate	
	Influence of early adopters			No

(Source: Self-developed based on data collection and data analysis).

(Note: The data included in this research paper is a snapshot of a Ph.D. thesis and its authors own Ph.D. work.)