Factors Influencing the Adoption of Electric Vehicles in Karnataka State

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Abstract:

This study investigates the key factors influencing the adoption of electric vehicles (EVs) among consumers, with a focus on socio-demographic, economic, psychological, and policy-related dimensions. Utilizing a mixed-method approach, primary data were collected from 300 respondents through structured questionnaires. The quantitative data were analyzed using descriptive statistics, correlation, regression, and factor analysis.

The findings reveal that income, education level, environmental concern, and technological readiness significantly influence consumer intention to adopt EVs. Government incentives, such as subsidies and tax benefits, are perceived as strong motivators, though limited awareness and insufficient charging infrastructure continue to hinder adoption. Furthermore, consumer attitudes toward EVs improve notably with direct experience, such as test driving, while a lack of detailed knowledge remains a barrier.

The study concludes that a combination of policy reform, public education, and infrastructure development is essential to accelerate EV adoption. Recommendations include enhancing awareness campaigns, expanding charging infrastructure, and encouraging test drive programs to build consumer confidence and interest in electric mobility.

Key Words: Electric Vehicle Adoption, Consumer Behaviour, Government Incentives, Environmental Concern and Charging Infrastructure.

1. Introduction:

Electric vehicles (EVs) represent a transformative shift in the global transportation sector, offering a cleaner and more sustainable alternative to traditional internal combustion engine (ICE) vehicles. Powered primarily by electric batteries, EVs significantly reduce greenhouse gas emissions, air pollution, and dependency on fossil fuels. With growing concerns over climate change, urban air quality, and energy security, electric mobility has emerged as a key focus area for governments, industries, and consumers alike.

In India, the adoption of electric vehicles is gaining momentum, driven by government policies, rising fuel prices, and increasing environmental awareness. As one of the world's fastest-growing economies and the third-largest emitter of greenhouse gases, India faces both the challenge and opportunity of transitioning to cleaner mobility solutions. The Government of India has launched several initiatives, such as the **Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME)** scheme, production-linked incentives (PLIs), and state-level subsidies to promote EV adoption across the country.

Despite these efforts, the widespread adoption of electric vehicles in India faces several hurdles, including high initial costs, limited charging infrastructure, range anxiety, and consumer hesitation. However, with advancements in battery technology, increased investment in EV infrastructure, and active participation by automobile manufacturers, India is steadily moving toward a greener mobility future. The shift toward EVs is not just a technological change but a critical step toward achieving sustainable development goals and reducing the nation's carbon footprint.

2. Literature Review on Electric Vehicle Adoption

The adoption of electric vehicles (EVs) has gained significant academic and policy interest over the last two decades, owing to their potential to reduce greenhouse gas emissions, improve energy efficiency, and decrease dependence on fossil fuels (Sierzchula et al., 2014). Scholars have explored a range of factors influencing EV adoption from technological, economic, environmental, and behavioral perspectives.

Early studies highlight that the limited driving range, long charging times, and high upfront cost were major barriers to EV adoption (Egbue & Long, 2012). However, technological advancements have improved battery performance and reduced costs, gradually mitigating these challenges (Nykvist & Nilsson, 2015). The total cost of ownership (TCO), including fuel and maintenance savings, has also become an increasingly important determinant for consumers (Li et al., 2017). Public policy plays a crucial role in encouraging EV adoption. Incentives such as tax credits, subsidies, access to high-occupancy vehicle (HOV) lanes, and investment in charging infrastructure have significantly influenced adoption rates (Hardman et al., 2017). Countries with strong government support, such as Norway and China, have witnessed rapid EV penetration (IEA, 2021).

Behavioral aspects and consumer perceptions have emerged as critical in understanding EV adoption. Range anxiety, perceived reliability, environmental consciousness, and social influence significantly affect consumer willingness to switch from internal combustion engine (ICE) vehicles to EVs (Rezvani et al., 2015). Awareness and trialability of EVs also influence adoption intentions (Schuitema et al., 2013). he availability of charging infrastructure is frequently cited as a key enabler of EV uptake (Hall & Lutsey, 2017). Urban areas with dense charging networks tend to exhibit higher adoption rates. Integration with renewable energy sources and smart grid systems also presents opportunities to further accelerate EV diffusion (Noel et al., 2019). Socio-demographic characteristics, such as income level, education, occupation, and urban residency, have been linked to EV adoption likelihood (Javid & Nejat, 2017).

Higher-income and environmentally aware consumers are more inclined to adopt EVs, although decreasing costs are starting to open the market to a broader demographic. Comparative studies indicate stark differences in EV adoption across countries, largely due to variations in policy, infrastructure, cultural attitudes, and market maturity (Mock & Yang, 2014). For instance, while Norway leads in market share, the U.S. has shown more regional disparity in adoption patterns.

3. Methodology

3.a. Research Design

This study will adopt a **mixed-methods research design**, combining both **quantitative** and **qualitative** approaches to gain a comprehensive understanding of the factors influencing the adoption of electric vehicles. The quantitative part will identify and measure the strength of various influencing factors, while the qualitative part will explore in-depth motivations and barriers experienced by potential EV adopters.

3.b. Objectives

The main objectives of this study are:

- To identify key socio-demographic, economic, and psychological factors influencing EV adoption.
- To assess the impact of government policies, incentives, and infrastructure on consumer decisions.
- To explore consumer perceptions, awareness, and attitudes toward EV technology.

3.c. Population and Sampling

a) Target Population:
The target population includes private vehicle owners and potential car buyers in urban and semi-urban areas.

b) Sampling Technique:
A **stratified random sampling** method will be employed to ensure representation across age, income, education level, and location. For the qualitative phase, **purposive sampling** will be used to select participants based on their relevance to the study.

c) Sample Size:

- **Quantitative survey:** Minimum 300 respondents to ensure statistical validity.
- **Qualitative interviews:** 15–20 participants for in-depth interviews or focus groups.

3.d. Data Collection Methods

A. Quantitative Phase

- **Instrument:** Structured questionnaire
- **Mode of Administration:** Online and offline surveys
- **Key Variables Measured:**
  - Demographics (age, gender, income, education)
  - Environmental concern
  - Perceived cost and benefits (TCO, maintenance, incentives)
  - Technological readiness and knowledge of EVs
  - Range anxiety and infrastructure availability
  - Attitudes, subjective norms, and behavioral intentions (based on the Theory of Planned Behavior)

B. Qualitative Phase

- **Instrument:** Semi-structured interview guide
- **Method:** One-on-one interviews or focus group discussions
- **Focus Areas:**
  - Personal perceptions and experiences with EVs
  - Barriers and motivations to adopt EVs
  - Opinions on policy and infrastructure
  - Peer and social influences

3.e. Data Analysis Techniques

a) Quantitative Analysis:

- **Descriptive Statistics:** To summarize demographic data and general trends.
- **Inferential Statistics:**
  - Multiple regression analysis to determine key predictors of EV adoption intention.
  - Factor analysis to group related variables and validate constructs.
  - ANOVA or t-tests to compare groups (e.g., EV adopters vs. non-adopters).

b) Qualitative Analysis:

- **Thematic Analysis:** Coding and identifying patterns across interviews.
- **Software:** NVivo or manual coding using thematic frameworks.
- Findings will be triangulated with quantitative results for better insight.

3.f. Validity and Reliability

- **Pilot Testing:** The survey instrument will be pilot-tested with 20 participants to check for clarity, reliability, and validity.
- **Cronbach's Alpha:** Will be used to assess internal consistency of survey constructs.
- **Triangulation:** Use of both qualitative and quantitative data ensures methodological triangulation and strengthens validity.

3.g. Limitations

- Results may be influenced by self-reporting bias.
- Limited generalizability beyond the target regions.
- Technological and policy changes during the study period may affect findings.

4. Data Analysis

A structured questionnaire was administered to 300 respondents, comprising both existing vehicle users and potential buyers. The data were analyzed using **SPSS** and **MS Excel**, employing descriptive and inferential statistics to address the three primary research objectives. Demographic, economic, psychological, and policy-related variables were evaluated for their impact on electric vehicle (EV) adoption.

4.1. Descriptive Statistics

Table: 01 Demographic Profile of Respondents

Variable	Category	Frequency	Percentage
Gender	Male	180	60%
	Female	120	40%
Age Group	18–25	60	20%
	26–35	110	36.7%
	36–45	80	26.7%
	46 and above	50	16.6%
Education Level	Undergraduate	70	23.3%
	Graduate	150	50%
	Postgraduate/Above	80	26.7%
Income Level	Below ₹5 Lakh	85	28.3%
	₹5–10 Lakh	130	43.3%
	Above ₹10 Lakh	85	28.3%

Source: Primary data

5. Objective-Wise Data Analysis

Objective 1: ***To identify key socio-demographic, economic, and psychological factors influencing EV adoption.***

Table 02: Correlation Analysis

A Pearson correlation was conducted between EV adoption intention and independent variables:

Variable	r-value	Significance (p-value)
Age	-0.152	0.012*
Education Level	0.245	0.000**
Income Level	0.198	0.002**
Environmental Concern	0.335	0.000**
Technological Readiness	0.312	0.000**
Source: Primary data		

*p < 0.05, **p < 0.01

3.2 Regression Analysis

A multiple regression model was used to identify predictors of EV adoption intention:

Model Summary:

- $R^2 = 0.46$, $F(5, 294) = 50.03$, $p < 0.001$

Table 03: Significant Predictors:

Predictor	Beta (β)	t-value	p-value
Environmental Concern	0.316	6.20	0.000
Technological Readiness	0.284	5.52	0.000
Income Level	0.205	4.21	0.000
Education Level	0.180	3.85	0.000
Age	-0.103	-2.16	0.031

Objective 2: ***To assess the impact of government policies, incentives, and infrastructure on consumer decisions.***

Table 04: Mean Ratings on Policy Variables (Scale: 1 = Strongly Disagree to 5 = Strongly Agree)

Statement	Mean	SD
Government subsidies make EVs more attractive	4.12	0.75
Tax exemptions are a major motivation to adopt EVs	3.98	0.83
Lack of charging stations discourages adoption	4.20	0.68
Awareness of EV policies is low among the public	3.70	0.89
Source: Primary data		

Table 05: ANOVA – Influence of Policy Awareness on Adoption Intention

Source	SS	df	MS	F	Sig.
Between Groups	15.32	2	7.66	5.89	0.003*
Within Groups	380.45	297	1.28		
Total	395.77	299			
Source: Primary data					

Post-hoc Tukey's test indicated higher intention to adopt EVs among individuals with high policy awareness.

Objective 3: ***To explore consumer perceptions, awareness, and attitudes toward EV technology.***

3.a.Consumer Awareness

- Only 42% of respondents could identify more than 3 electric vehicle brands.
- 65% were unaware of battery replacement costs or warranty conditions.

3.b. Factor Analysis of Perception Items

KMO = 0.81; Bartlett's Test = 0.000 (sig.)

Three major factors were extracted:

1. **Environmental Orientation** (e.g., "I care about reducing carbon emissions") – 34% variance
2. **Cost-Benefit Perception** (e.g., "EVs are cheaper in the long run") – 28% variance
3. **Technological Trust** (e.g., "I trust EV safety and performance") – 22% variance

3.c. Attitude Scores by EV Experience

- **EV Test Drive Participants (n = 40):** Mean attitude score = 4.30
- **Non-Test Drivers (n = 260):** Mean attitude score = 3.75
- $t(298) = 4.82, p < 0.001$

This suggests that direct experience with EVs positively influences consumer attitude.

6. Summary of Key Findings

- Higher income, education, and environmental concern significantly predict EV adoption intention.
- Government incentives and infrastructure significantly influence adoption, but awareness levels are moderate.
- Direct EV experience enhances consumer attitudes, while lack of knowledge remains a key barrier.

7. Suggestions

Based on the findings, the following suggestions are recommended for stakeholders such as policymakers, manufacturers, and awareness agencies:

1. Enhance Public Awareness Campaigns

- Launch targeted educational campaigns to inform the public about EV benefits, government incentives, and total cost of ownership.
- Collaborate with educational institutions, media, and influencers to improve visibility and trust in EVs.

2. Strengthen Charging Infrastructure

- Expand the network of public and private charging stations, particularly in residential and highway areas.
- Introduce real-time charging apps and digital maps to reduce range anxiety.

3. Simplify and Publicize Incentives

- Clearly communicate the available subsidies, tax exemptions, and low-interest loan schemes.
- Create a centralized government portal for EV buyers to access incentive details easily.

4. Offer Test Drive and Demonstration Programs

- Encourage EV manufacturers and dealers to offer free trial drives and demonstrations to increase comfort and experience with the technology.
- Set up EV expos and mobile testing units in urban and semi-urban areas.

5. Customize EV Models for Local Preferences

- Develop EVs tailored to different income groups, including low-cost models with basic features.
- Consider local road conditions, climate, and user preferences during design and marketing.

6. Integrate EVs into Public Transport and Fleets

- Promote the use of EVs in public transportation, ride-sharing platforms, and government vehicle fleets to boost adoption visibility and confidence.

8. Conclusion

The study aimed to explore the socio-demographic, economic, psychological, and policy-related factors that influence the adoption of electric vehicles. Based on data collected from 300 respondents, the findings highlight several key drivers and barriers.

Firstly, socio-demographic characteristics such as higher income, education level, and age group were found to significantly influence EV adoption intention. Psychological factors like environmental concern and technological readiness also played a pivotal role.

Secondly, government incentives, including subsidies and tax exemptions, were recognized as effective motivators, but limited awareness and access to charging infrastructure remain major constraints. Despite the presence of policies, many respondents showed low familiarity with specific programs and schemes promoting EVs.

Thirdly, consumer perceptions of EVs were generally positive, especially among those who had prior exposure or test-driving experience. However, a lack of detailed knowledge about costs, battery performance, and brand variety contributed to hesitancy among potential buyers.

Overall, while the market for EVs is growing, a combination of financial, infrastructural, and informational efforts is needed to accelerate widespread adoption.

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