International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

Sustainable Transition of Electric Four-Wheeler Vehicle for Urban Dwellers

Dipakkumar Panchal[1], Dr. Harsha Rathore[2]
[1]Research Scholar, School of Business and Management, Institute of Advanced Research, Koba Institutional Area, Gandhinagar, Gujarat, India.
[2]Assistant Professor, School of Business and Management, Institute of Advanced Research, Koba Institutional Area, Gandhinagar, Gujarat, India.
Emails: *dipakspanchal@gmail.com[1], harsha.rathore@iar.ac.in[2]*

Abstract
Electric Vehicles (EVs) are a promising solution to the environmental impact of fossil fuels and vehicle pollution. They offer an excellent alternative for commuting with zero environmental impact, especially given the scarcity of natural resources and rising fuel prices. E-vehicles support green energy and significantly reduce pollution. Effective marketing is needed to raise awareness of their benefits and motivate consumer adoption. This study aims to explore consumer perceptions and intentions towards Electric 4-wheeler vehicle adoption (herein referred as Electric Vehicle). In India, adopting electric vehicles (EVs) is essential for fuel saving, zero carbon dioxide emissions, and promoting green energy. However, meeting customer expectations and providing high-quality EVs is challenging. Despite the need to consider existing products and demand, EVs still represent only a small fraction of total vehicle sales in the country.

Keywords: *Electric Vehicles, Environmental Impact, Fossil Fuels, Vehicle Pollution, Zero Environmental Impact, Green Energy, Pollution Reduction, Consumer, Fuel Saving, Zero Carbon Emissions.*

1. Introduction
Fossil fuels are the primary energy source globally, and urbanization is increasing energy use. Burning fossil fuels generate significant greenhouse gas emissions, causing climate change (Gahlaut et al., 2024; Kamran et al., 2021). The transportation sector currently contributes 23% of global greenhouse gas emissions, expected to rise to 50% by 2030 (Jaiswal et al., 2021). This indicates the need for significant changes to reduce the environmental impact (Egbue & Long, 2012) of the transportation system. Urbanization and increased car usage, especially in new-economy countries like India, are major factors influencing the automobile industry's growth, posing various challenges. In India, road travel is the predominant mode of transportation, with 64.4% of goods and 90% of passengers using roadways (Ministry of Road Transport and Highways). The growing demand for vehicles has led to the expansion of the automobile industry. However, automobiles generate various pollutants, including hydrocarbons, carbon monoxide, nitrogen oxides, and particulates. Electric vehicles (EVs) offer a solution to reduce pollution and are gaining popularity worldwide. The current requirements focus on fuel saving, zero carbon dioxide emissions, and adopting green energy through electric vehicles (EVs). In India, meeting customer expectations and providing high-quality EVs is challenging, as they still represent a small fraction of total vehicle sales. The Indian government has taken several steps to promote EVs, including initiatives in the 2025 budget by Finance Minister Nirmala Sitharaman to make India a global EV manufacturing hub. This study aims to identify factors influencing the purchase decision of electric cars. The Indian government aims to have only electric vehicles (EVs) on the road by 2030 and is promoting hybrid and electric vehicle sales. Initiatives include tax deductions for loans used to purchase battery electric vehicles (BEVs) and the establishment of incubation centers for BEV start-ups. Despite these efforts, BEV adoption was only 1% in 2020. The industry is gradually shifting from internal combustion engines to EVs, which are more energy-efficient, emit fewer greenhouse gases, and produce less noise. Electric vehicles (EVs) have become a cleaner and more efficient alternative to gasoline-powered cars. With advancements in battery technology, a growing charging infrastructure, and

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

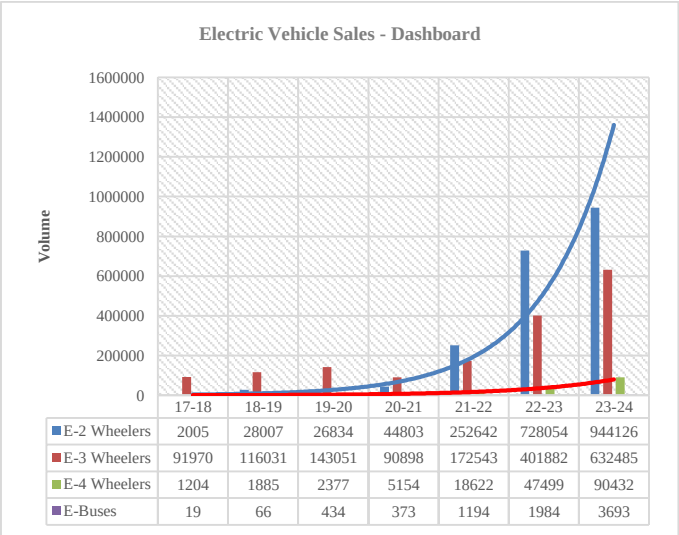
increasing consumer demand, EVs are now a viable option for many drivers worldwide. Powered by electricity stored in batteries and using electric motors, EVs are changing the way we think about driving. India, the third largest automobile market globally, is pushing for greener options. The automotive sector contributes 7.1% to India's GDP and provides significant employment. The Economic Survey 2023 predicts a 49% CAGR for the domestic electric vehicle market from 2022 to 2030, with 10 million annual sales by 2030. The EV industry is also expected to create around 50 million direct and indirect jobs by 2030. The Indian government aims to achieve 30% electrification of the vehicle fleet by 2030, introducing incentives and policies to support EV growth. The FY24 Union Budget boosted the industry by promoting electric vehicle production, hydrogen fuel adoption, and new technologies. In the 2024-25 Union Budget, Finance Minister Nirmala Sitharaman allocated INR 35,000 crore for capital investments to achieve energy transition and net-zero targets by 2070. The government will also support Battery Energy Storage Systems with a capacity of 4,000 MWH through viability gap funding. The government has launched initiatives like the Faster Adoption of Manufacturing of Electric Vehicles Scheme–II (FAME-II) and the Production Linked Incentive Scheme (PLI) to support electric vehicle manufacturers. The Budget allocated INR 51.72 billion (approximately $631 million) to the FAME-II scheme, an 80% increase from previous years, to subsidize and promote clean energy vehicles. Reduced custom duty on Lithium-ion batteries and excise duty exemptions on natural gas and biogas may lead to more foreign electric vehicles being imported to India. Despite central and state government policies promoting electric vehicles (EVs) through incentives, infrastructure development, and research, India's EV adoption rate lags behind predictions and the global average. Analyzing consumer perception across different regions is essential to address this EV divide. (FAME-II). India's electric vehicle market is set for significant growth, driven by supportive government policies, rising consumer awareness, and technological advancements. This transition towards sustainable transportation offers a great opportunity for local and international companies to invest in and contribute to the EV ecosystem. This study aims to bridge the gap by comparing consumer perceptions across different demographics. Understanding these differences will help develop more effective government policies and marketing strategies [1-4].

2. Research Purpose and Questions

This study aims to understand consumer perceptions and barriers to adopting electric vehicles (EVs) in an emerging economy, focusing on India. It employs a comparative approach to analyze regional differences in perceptions and investigates how Indian customers integrate sustainability into their EV purchasing decisions across different demographics. The research results will help policymakers and auto manufacturers revise strategies to make the Indian transport sector more sustainable [5-11].

- How do customer perceptions influence their purchase intentions of electric vehicles (EVs) in India, and how does this influence vary across different settlement hierarchies?
- How do Indian customers incorporate sustainability considerations into their electric vehicle (EV) purchasing decisions, and how do these considerations vary across different demographics?

3. Overview of The EV Sales in India (SMEV 2025)



	17-18	18-19	19-20	20-21	21-22	22-23	23-24
E-2 Wheelers	2005	28007	26834	44803	252642	728054	944126
E-3 Wheelers	91970	116031	143051	90898	172543	401882	632485
E-4 Wheelers	1204	1885	2377	5154	18622	47499	90432
E-Buses	19	66	434	373	1194	1984	3693

Figure 1 Electric Vehicle Sales

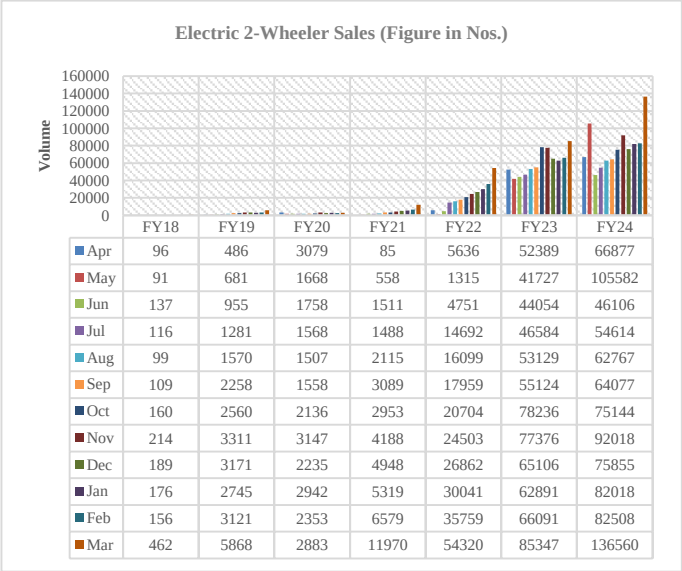
International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

Table 1 Sales of Electric Vehicle

Category	17-18	18-19	19-20	20-21	21-22	22-23	23-24
E-2 Wheelers	0.09%	1.38%	1.32%	2.21%	12.46%	35.92%	46.59%
E-3 Wheelers	5.57%	7.03%	8.67%	5.51%	10.46%	24.37%	38.35%
E-4 Wheelers	0.72%	1.12%	1.42%	3.08%	11.13%	28.41%	54.09%
E-Buses	0.24%	0.85%	5.59%	4.80%	15.38%	25.55%	47.57%

From the above table 1 & Figure 1, sales of electric vehicles have seen significant growth across all categories. From FY 20-21 to FY 21-22, the average growth rate increased from 3.90% to 12.36%. Further, from FY 21-22 to FY 23-24, the average growth rate surged to 46.65%. This indicates a strong willingness among people to purchase electric vehicles [12-17].

3.1. Electric 2-Wheelers Sales

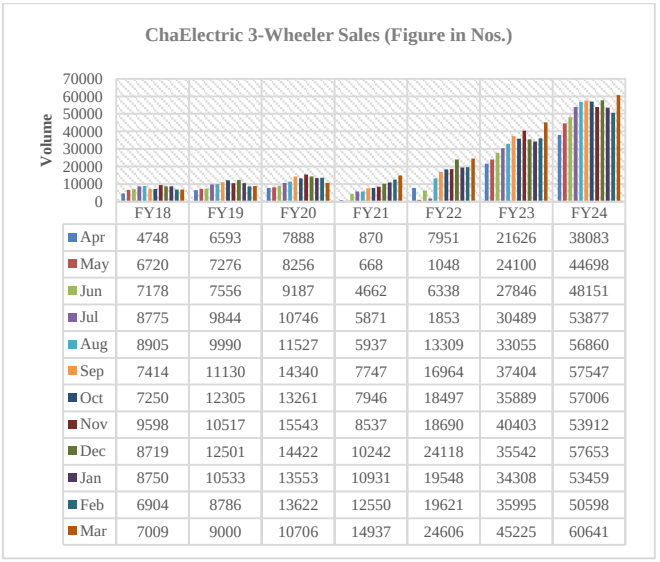


	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Apr	96	486	3079	85	5636	52389	66877
May	91	681	1668	558	1315	41727	105582
Jun	137	955	1758	1511	4751	44054	46106
Jul	116	1281	1568	1488	14692	46584	54614
Aug	99	1570	1507	2115	16099	53129	62767
Sep	109	2258	1558	3089	17959	55124	64077
Oct	160	2560	2136	2953	20704	78236	75144
Nov	214	3311	3147	4188	24503	77376	92018
Dec	189	3171	2235	4948	26862	65106	75855
Jan	176	2745	2942	5319	30041	62891	82018
Feb	156	3121	2353	6579	35759	66091	82508
Mar	462	5868	2883	11970	54320	85347	136560

Figure 2 Electric 2-Wheelers Sales

March sales showed significant growth compared to previous months, shown in Figure 2.

3.2. Electric 3-Wheelers Sales

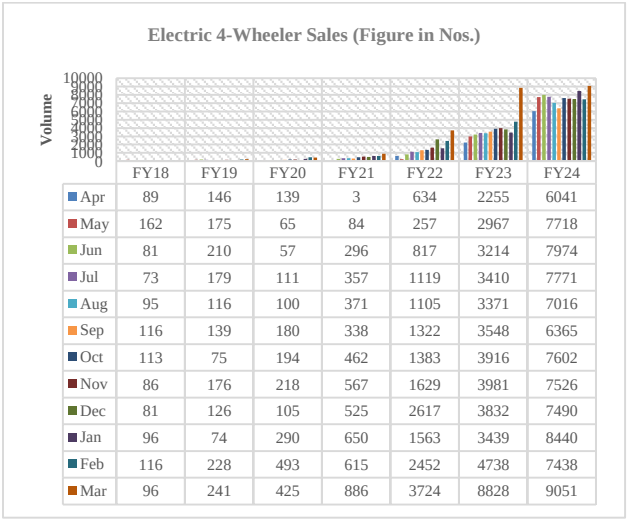


	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Apr	4748	6593	7888	870	7951	21626	38083
May	6720	7276	8256	668	1048	24100	44698
Jun	7178	7556	9187	4662	6338	27846	48151
Jul	8775	9844	10746	5871	1853	30489	53877
Aug	8905	9990	11527	5937	13309	33055	56860
Sep	7414	11130	14340	7747	16964	37404	57547
Oct	7250	12305	13261	7946	18497	35889	57006
Nov	9598	10517	15543	8537	18690	40403	53912
Dec	8719	12501	14422	10242	24118	35542	57653
Jan	8750	10533	13553	10931	19548	34308	53459
Feb	6904	8786	13622	12550	19621	35995	50598
Mar	7009	9000	10706	14937	24606	45225	60641

Figure 3 Electric 3-Wheelers Sales

The Figure 3-Wheeler segment shows the highest sales trend in November-December for solar sales per year [18].

3.3. Electric 4-Wheelers Sales



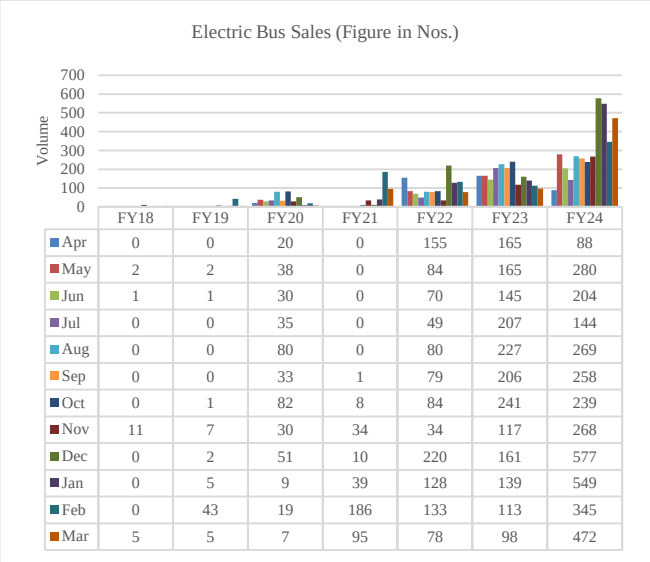
	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Apr	89	146	139	3	634	2255	6041
May	162	175	65	84	257	2967	7718
Jun	81	210	57	296	817	3214	7974
Jul	73	179	111	357	1119	3410	7771
Aug	95	116	100	371	1105	3371	7016
Sep	116	139	180	338	1322	3548	6365
Oct	113	75	194	462	1383	3916	7602
Nov	86	176	218	567	1629	3981	7526
Dec	81	126	105	525	2617	3832	7490
Jan	96	74	290	650	1563	3439	8440
Feb	116	228	493	615	2452	4738	7438
Mar	96	241	425	886	3724	8828	9051

Figure 4 Electric 4-Wheelers Sales

Due to Covid-19, Figure 4 vehicle sales decreased in FY 21. However, subsequent years saw significant growth in net sales, particularly in March. This data shows notable growth in the 4-wheeler category as well [19].

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

3.4. Electric Bus Sales



	FY18	FY19	FY20	FY21	FY22	FY23	FY24
Apr	0	0	20	0	155	165	88
May	2	2	38	0	84	165	280
Jun	1	1	30	0	70	145	204
Jul	0	0	35	0	49	207	144
Aug	0	0	80	0	80	227	269
Sep	0	0	33	1	79	206	258
Oct	0	1	82	8	84	241	239
Nov	11	7	30	34	34	117	268
Dec	0	2	51	10	220	161	577
Jan	0	5	9	39	128	139	549
Feb	0	43	19	186	133	113	345
Mar	5	5	7	95	78	98	472

Figure 5 Electric Bus Sales

The electric bus Figure 5, category is driven by government policy, with major implementation at the state level for Municipal Corporation Bus Services. Sales are demand-driven and based on government fiscal policy and incentives for higher vehicle utility.

4. Literature Review

This chapter provides the theoretical foundation for electric vehicle (EV) adoption, focusing on factors influencing purchase intentions and perceived risks. It covers the global context of EV adoption, dynamics in emerging economies, and the Technology Acceptance Model (TAM) for understanding consumer behavior. It also addresses psychological and practical barriers to EV adoption and introduces a conceptual framework for the study [20-25].

4.1. Worldwide Scenario of EV Adoption

Electric vehicles (EVs) are considered the future of automobiles and a solution to environmental hazards caused by fossil fuel emissions. EV adoption offers numerous benefits, including reduced greenhouse gas emissions, improved safety, cost savings, lower maintenance, and a sustainable solution for pollution (Singh Patyal et al., 2021). Governments worldwide have implemented financial and non-financial incentives to promote EVs, such as tax credits, rebates, and access to high-occupancy vehicle lanes (Ghatikar et al., 2017; European Automobile Manufacturers Association, in press). As a result, the EV market has grown steadily, with global stock surpassing 10 million units in 2020, a 43% increase from 2019. Battery electric vehicles (BEVs) accounted for 67% of new registrations, with China leading in total EV ownership and Europe having the highest annual registrations (Das & Bhat, 2022). Norway has the highest per capita EV ownership. In 2020, Europe led new EV registrations with 1.4 million units, followed by China with 1.2 million and the United States with 295,000. Germany and France saw 395,000 and 185,000 new registrations, respectively, while the UK had 176,000. Major EV markets include Germany, the UK, France, Norway, Italy, Switzerland, the Netherlands, and Sweden. Promising growth is also seen in Australia, Austria, Canada, Spain, Italy, New Zealand, and Japan. (Das & Bhat, 2022) [26-28].

4.2. Type of Electric Vehicles and Technology

Electric vehicles (EVs) use electric motors for propulsion instead of traditional gasoline or diesel engines (Egbue & Long, 2012). There are four main types of EVs: battery electric vehicles (BEVs), hybrid electric vehicles (HEVs), plug-in hybrid electric vehicles (PHEVs), and fuel cell electric vehicles (FCEVs) (Larminie & Lowry, 2012). BEVs are powered entirely by rechargeable batteries, produce no direct emissions, and have lower operating costs, making them ideal for short commutes and city driving. HEVs combine a gasoline engine with an electric motor and battery, offering increased fuel efficiency and reduced emissions, suitable for long commutes and highway driving (Chau & Wong, 2002). Hybrid electric vehicles (HEVs) can be charged from an external source, allowing them to operate in all-electric mode for a limited range before switching to hybrid mode (Sovacool & Hirsh, 2009). Plug-in hybrid electric vehicles (PHEVs) are ideal for short distances in all-electric mode but can use gasoline for longer trips. They can be charged at home or public charging stations. Fuel cell electric vehicles (FCEVs) use hydrogen fuel cells to generate electricity, emitting only water vapor (Energy Efficiency and Renewable Energy, 2021). They have a driving range similar to gasoline-powered vehicles

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

and can be refueled quickly, but hydrogen fueling stations are currently limited. EV technology has gained attention for its potential to reduce greenhouse gas emissions and dependence on fossil fuels. With more EVs and widespread charging infrastructure, EVs are expected to become increasingly popular among consumers, Figure 6 [29-31].

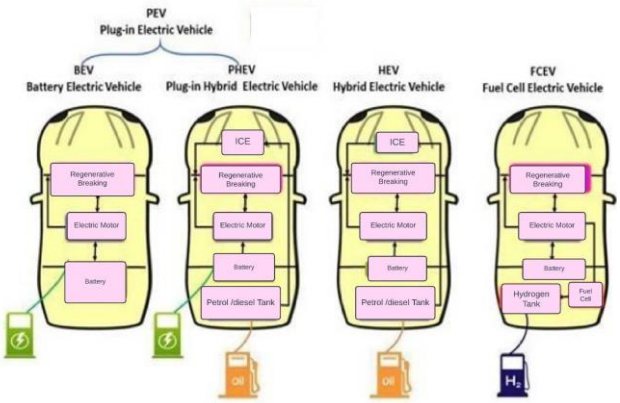


Figure 6 Electric Vehicle Types (Singh Patyal et al., 2021)

4.3. Consumers Insight and buying intentions towards EVs

Consumers' buying choices for electric vehicles depend on various factors, including range, battery capacity, charging time, acceleration, maximum speed, and price. These specifications significantly influence customers' buying intentions during the pre-purchasing phase (Mandys.,2021). Regular users of electric vehicles understand the key factors to consider when purchasing a new model. In Southeast Asian countries, the trend towards electric vehicle consumption is new, and it will take time for consumers to fully understand and adopt sustainable vehicle models. Customers value the total distance an electric vehicle can cover on a single charge (Simolin et al.,2021), the battery's energy preservation capacity, charging time, acceleration, maximum speed, and price. These factors significantly impact buying choices during the pre-purchasing phase. Approximately 70% of tier-one consumers in India have shown willingness to adopt electric vehicles, indicating high acceptance of digital models across the country (Bhat et al.,2022). Customers are willing to pay more for electric vehicles based on their specifications (Featherman et al.,2021), despite the higher cost for most audiences in India. This demonstrates an increased willingness among Indians to adopt electric vehicles over conventional models.

4.4. Developing Markets Situation in India

Developing markets like India are addressing environmental degradation by emphasizing electric vehicles (EVs). In 2012, the Indian government introduced the National Electricity Mobility Mission Plan (NEMMP) and launched the FAME-India scheme in 2015 to promote EVs. Phase I of FAME-India focused on technology development, demand creation, charging infrastructure, and pilot projects but fell short of fuel-saving and CO2 reduction targets. Many state governments also promote EV adoption through policies offering subsidies, tax exemptions, and financial support for charging infrastructure. FAME II targets widespread EV adoption and charging infrastructure in megacities, national highways, and corridors, aiming to create a solid domestic EV ecosystem (Jain et al., 2022; Singh Patyal et al., 2021). Initially set from 2019 to 2022, FAME II's budget increased to INR 100 billion (USD 1.45 billion) and was extended to March 2024 (Mint, 2021as cited in Jain et al., 2022). Many state governments in India also promote EV adoption through policies offering subsidies, tax exemptions, and financial support for charging infrastructure (Das & Bhat, 2022). Despite various initiatives, India lags behind the top three EV markets – China, Europe, and the United States – in terms of EVs per 1,000 people (PricewaterhouseCoopers (PwC) report). These regions have higher EV shares on the road, with 0.94%, 0.5%, and 0.45% for passenger cars, respectively. In 2019, India's EV sales were nearly 0.76 million, primarily driven by electric two-wheelers (16.4%) and three-wheelers (83%), representing less than 3% of total vehicle sales (Tarei et al., 2021). With an ambitious goal of 30% EVs by 2030, the current adoption rate is slow and requires critical analysis [32-37].

4.5. Enabling factors of EV adoption

Despite the advantages of EVs and policy support, significant barriers hinder their widespread adoption in developing countries like India, where they

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

represent a small market fraction. Research has identified high initial costs and prices as key barriers to EV adoption, providing valuable insights for policymakers to strengthen initiatives. (O'Neill et al., 2019). In India, studies have identified government incentives and consumer characteristics as critical barriers to EV adoption. These barriers can be categorized as technical, financial/economic, and attitudinal Berkeley et al. 2017). Researchers use terms like "attitudinal," "psychological," and "behavioral" to describe barriers related to consumer perception and awareness. Similarly, obstacles concerning the upfront cost and total cost of ownership (TCO) of EVs are often referred to as "economic" or "financial". (Tarei et al., 2021).

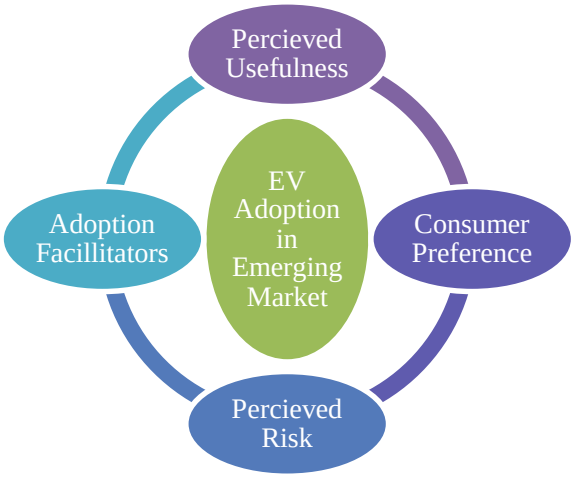


Figure 7 Conceptual Framework

Figure 7, Though perceived ease of use and usefulness influence customers' attitudes towards electric vehicles, several barriers hinder their choices (Xu et al.,2020). These include range anxiety, charging infrastructure, high up-front purchase price, resale value, performance concerns, and lack of awareness (Tarei et al.,2021). The factors mentioned above negatively impact customers' buying behavior and hinder regular electric vehicle consumption. Developing countries like India face challenges such as a lack of charging facilities, affordability concerns, and a higher ratio of customers. These factors raise barriers to positively motivating customers to purchase electric vehicles. Despite the trend towards EV adoption, these elements complicate the situation for many who prefer electric vehicles over conventional gasoline-powered ones (Wardle.,2021).

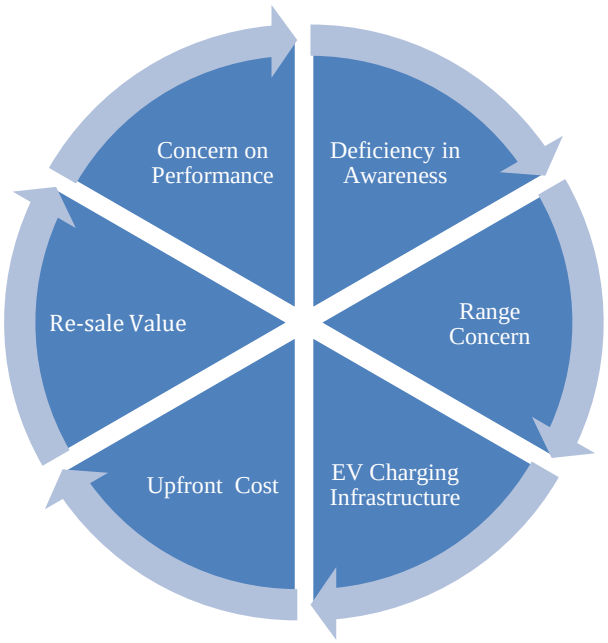


Figure 8 Enabling factors of EV adoption

4.5.1. Range Concern

One of the significant challenges facing electric vehicle (EV) adoption is battery range and range anxiety. Range anxiety is the stress or worry experienced by EV drivers fearing they may run out of power before reaching their destination or a charging station (Rauh et al., 2015). Compared to traditional gasoline-powered vehicles, most EVs offer a shorter driving range on a single charge (S. Goel et al., 2021), which can deter mainstream consumers. Research indicates a negative correlation between battery range and consumer purchase behavior towards EVs. While many battery electric vehicles (BEVs) can travel around 250 kilometers on a single charge, newer models are reaching ranges closer to 400 kilometers (S. Goel et al., 2021). This range restriction and related anxiety act as resistance to EV adoption, with studies showing that BEVs with a range of more than 200 km are preferred among customers (Globisch et al., 2018; Singh Patyal et al., 2021), shown in Figure 8 [38-41].

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

4.5.2. EV Charging Infrastructure

India's charging infrastructure is still in its early stages compared to the vast network of gas stations, discouraging potential EV buyers. Limited availability and long charging times create range anxiety, which is strongly linked to the availability of charging stations (Singh Patyal et al., 2021). The recharging process differs significantly from routine gas station refueling, which might not be clear to consumers considering EVs (Berkeley et al., 2018). Concerns about electricity supply reliability, power quality, and the grid's ability to handle increased EV charging loads can erode consumer confidence in EVs as a viable transportation option (Tarei et al., 2021).

4.5.3. Upfront cost

A significant barrier to electric vehicle (EV) sales is their high purchase price compared to internal combustion engine (ICE) vehicles (Lévay et al., 2017). High upfront costs for EVs create a challenge, even with the promise of long-term fuel savings. The primary reason for the difficulty in adopting EVs in emerging economies is their low purchasing power (Meszaros et al., 2020). Consumers carefully weigh these factors alongside their budget, priorities, and the overall utility an EV offers compared to alternative options (Singh Patyal et al., 2021). The main reason for the price difference between EVs and ICE vehicles is the battery cost (Thiel et al., 2010). Lithium-ion batteries are expensive to produce due to high demand for materials and complex manufacturing. Research and development expenses and lower production volumes also contribute to higher prices

4.5.4. Re-Sale Value

Insufficient awareness about EV battery performance over time creates uncertainty in the resale market, discouraging potential buyers who worry about future value compared to gasoline vehicles. Despite a well-established pre-owned market, EV resale values remain higher, adding to concerns over the high initial purchase price and potentially discouraging buyers (Berkeley et al., 2018).

4.5.5. Concern on Performance

Many studies highlight consumer attitudes towards electric vehicle performance as a significant barrier to adoption. Concerns include safety, reliability, and power, with limited battery power being a key issue. Consumers often perceive EVs as having lower top speeds and potentially compromised performance. Additionally, research suggests concerns about long-term battery degradation impacting performance (Goel et al. (2021)).

4.5.6. Lack of Awareness

The electric vehicle (EV) market is still in its initial stages, representing only a minor portion of the overall vehicle market. This lack of adoption leads to a gap in consumer confidence and understanding of EVs as a viable option (Tarei et al., 2021). Potential buyers often lack awareness of various EV-related aspects, including the latest technologies, available models, and specific advantages over alternative fuel vehicles. This confusion makes it difficult for consumers to assess the true value proposition of EVs (Singh Patyal et al., 2021). A lack of understanding regarding government incentives, potential cost savings, and the underlying technology (particularly batteries) can significantly hinder informed decision-making. This overall gap in consumer knowledge about this emerging technology prevents them from confidently adopting EVs (P. Goel et al., 2021).

5. Methodology

This study uses a quantitative, cross-sectional survey design to examine consumer attitudes and behavior towards EVs in different demographic locations in India. Quantitative research allows for the collection and analysis of numerical data, providing insights into relationships between key variables across a diverse population. By including a large number of respondents, the study can gather various viewpoints and establish consistencies and variations in different groups. The quantitative method is economical and can cover a vast number of respondents through surveys. This research study aims to identify factors influencing Electric Vehicle (EV) adoption by consumers in India. Conducted from September to December 2023, the study focused on a small population in Ahmedabad, Gujarat. A quantitative methodology was used, employing a survey instrument and Exploratory Factor Analysis. The data was examined for sampling adequacy using Bartlett's test for correlation adequacy and the KMO sampling

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

adequacy test to ensure a good fit for factor analysis. In addition to closed-ended questions, the survey includes one open-ended question to capture any additional thoughts or concerns respondents may have about EV adoption. Respondents were also asked to rank their reasons for adopting EVs, enabling the analysis of the most important factors influencing their decision-making.

5.1. Sampling

The sample size for this study was based on standard practices recommended for research involving statistical analyses and surveys. Initially, 300 respondents were targeted, but 216 participated, enhancing the robustness of the analysis. Despite this, the final sample had biases, including a high proportion of respondents under 35 and fewer female respondents. Out of that, 172 samples were identified to conduct the present study. The targeted population included businessmen, corporate workers, and self-employed individuals, considering socio-demographic factors like age, gender, occupation, annual income, and number of cars owned. The questionnaire was distributed to respondents above the age of 21, with most participants being young professionals and recent graduates, reflective of the networks through which the survey was shared.

5.2.Questionnaire design

To conduct this study, a questionnaire was used as the research instrument. It was designed based on past literature to measure factors influencing consumers' adoption of Electric Vehicles. The questionnaire is divided into two parts. The first part collects basic information about the respondents, such as age, gender, occupation, annual income, and the number of cars owned. The second part includes questions related to assumed factors like price, vehicle performance, market awareness, and recharging facilities. A 7-point Likert scale was used for the questionnaire.

5.3. Factor Analysis

Factor Analysis is a significant instrument for analyzing data, used in the development, refinement, and evaluation of tests, scales, and measures (Williams et al., Citation2010). It is a multivariate statistical procedure commonly used in information systems, psychology, commerce, and education. It is also considered the approach of choice for interpreting self-reporting surveys (Bryant et al., Citation1999). Factor analysis reduces a large number of variables into smaller sets and provides construct validity. It is a data reduction technique used to find the number of factors affecting variables and their relationships (Yong & Pearce, 2013). There are two main types: Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA). EFA is used when there are no expectations about the number or nature of factors, helping researchers explore main variables to create a theory or model. CFA tests a proposed theory or model. This study uses EFA, with the Kaiser-Meyer-Olkin (KMO) Test and Bartlett's sphericity test to check sample adequacy. A KMO value of 0.5 is the minimum for proceeding with factor analysis, and Bartlett's test significance should be less than 0.05 (Williams et al., 2012).

5.4. Data Collection

Data were collected through a self-administered online survey shared via Google Forms, Physical Forms and interaction through personal meeting or telephonic conversation among the size. The survey consisted of Closed-ended questions, a ranking question and Open-ended question. This combination of question types ensured a comprehensive collection of both quantitative and qualitative data. The open-ended question allowed respondents to express concerns or provide insights not covered by the closed-ended questions, enriching the analysis with more detailed perspectives.

5.5. Data Analysis

Quantitative research involves statistical or numerical analysis to examine research hypotheses or questions. There are two forms of statistical analysis: inferential and descriptive. Descriptive analysis (Cooksey, 2020) draws conclusions about the population, while inferential analysis tests relationships between key variables like perceived risks, sustainability considerations, and EV purchase intentions (Yang et al., 2021). This study uses descriptive statistics, correlation, and regression analysis to analyze survey data. Ranking data identifies important factors influencing EV adoption, and open-ended responses are categorized

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

thematically to capture common insights

6. Results and Analysis

The quantitative analysis section examines responses from participants to understand customers' perceptions and barriers to electric vehicle adoption in India. The researcher used SPSS software to analyze the data, conducting various statistical tests such as frequency, descriptive statistics, correlation, and regression to present the findings.

6.1. Frequency Test

To measure participants' occurrence of responses for each survey question, a frequency test has been conducted to inform readers about the ratio of responses gathered from research participants

6.2. Demographic Analysis

The demographic evaluation is presented in the section below, prescribing information on the participants who were selected for the study.

Table 2 Descriptive Statistics

Descriptive Statistics			
Sr. No.	**Demographic Factor**		**Percentage of responses**
1	Gender	Male	56.4%
		Female	43.6%
2	Age group	25–34 years	62.8%
		35–44 years	33.1%
		45 years and above	4.1%
3	Occupation	Salaried employee	98.3%
		Owner of a firm	1.7%
4	Annual Income	At most 6 Lac	29.7%
		Above 6 Lac—less than 10 Lac	34.9%
		10 Lac—20 Lac	21.5%
		Above 20 Lac	13.9%
5	Number of cars owned	None	16.9%
		One	58.1%
		Two	22.7%
		Three or more	2.3%

6.2.1. On Gender Basis

The data collected shows that out of the sample of 172, 56.4% are males (97 respondents) and 43.6% are females (75 respondents). Since a majority of this study were males, it can be interpreted that the EV automobile industry should focus on the male counterpart of the society while designing the features of the product and the marketing strategies, shown in Table 2.

6.2.2. On Age Basis

In the data analysis, it was observed that a maximum percentage of respondents, that is 62.8% (108 respondents) belonged to the age group of 25–34 years followed by 33.1% (57 respondents) belonging to the age group 35–44 years and 4.1% (7 respondents) in the age group of 45 and above.

6.2.3. An Occupation Basis

98.3% of the sample (169 respondents) were salaried employees and 1.7% (3 respondents) had their own business.

6.2.4. An Annual Income Basis

A majority of the sample which is 34.9% (60 respondents) have their annual income above 6 Lac and less than 10 Lac. This is followed by those having an annual income of at most 6 Lac, which formed 29.7% (51 respondents) of the sample. Next to that, were those having an annual income of 10 Lac to 20 Lac, 21.5% (37 respondents) and lowest belonged to those whose income was above 20 Lac, which formed 13.9% of the sample size (24 respondents).

6.2.5. On Number of Cars Owned

16.9% of the sample size (29 respondents) did not own a car of their own. However, these respondents could be potential buyers of electric vehicles. The majority of the sample strength, 58.1% (100 respondents) owned one car. This was followed by 22.7% (39 respondents) who owned two cars. A minimum percentage of the sample size, 2.3% (4 respondents) owned three or more cars.

6.3. KMO and Bartlett's Test

The KMO-Bartlett's test measures sampling adequacy to check the suitability of the questionnaire data. It provides information on classifying or grouping survey items, helping categorize them into interpretable factors that better explain the constructs being investigated. It also explains how strongly an

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

item is correlated with other items in the EFA correlation matrix (Burton & Mazerolle, Citation2011). The results of this study indicate a KMO value of 0.764, which is greater than the acceptable index of 0.5. Hence, the number of samples used is sufficient and accepted. This suggests that some pattern of correlations exists in the data (Williams et al., Citation2010). The level of significance obtained is 0.000, which is significant ($p<0.05$). This indicates that the correlation matrix is not an identity matrix, suggesting that clusters of items are correlated. Therefore, we can now proceed with the Exploratory Factor Analysis (EFA), Table 3.

6.4. KMO and Bartlett's Test Result

Table 3 Communalities

Table 3 Communalities		
	Initial	**Extraction**
Q1	1.000	.646
Q2	1.000	.718
Q3	1.000	.718
Q4	1.000	.697
Q5	1.000	.500
Q6	1.000	.631
Q7	1.000	.705
Q8	1.000	.810
Q9	1.000	.761
Q10	1.000	.324
Q11	1.000	.750
Q12	1.000	.587
Q13	1.000	.787
Q14	1.000	.701
Q15	1.000	.570
Q16	1.000	.365
Q17	1.000	.719
Q18	1.000	.793
Q19	1.000	.781
Q20	1.000	.752
Q21	1.000	.459
Q22	1.000	.723
Q23	1.000	.784
Q24	1.000	.593
Q25	1.000	.660
Q26	1.000	.565

The Extraction Method used is Principal Component Analysis. The communalities extracted are above 0.3, the minimum acceptable level. The Total Variance Explained is 65.764%, which is acceptable, Table 4.

6.5. Factor Grouping Results

Table 4 Factors Grouping Results

Sl. No.	BARRIERS / FACTORS	ITEMS	
1.	Financial barriers/ Factors	Q8	I am confident that it is easy to maintain an EV.
		Q13	I would buy an EV if an excellent battery warranty is provided.
		Q9	I would want to buy an EV for the same price that I would buy a conventional vehicle.
		Q11	I do not consider buying an EV now because purchase prices may drop in next few years.
		Q14	I think that the cost of replacing an EV battery is very high.
		Q7	I think owning an EV is more cost effective than owning a conventional vehicle (ICE), in the long-run.
		Q15	Driving an EV helps me to spend less on fuel.
		Q12	The unknown cost of maintenance along with its repair is a major reason to stop me from adopting an EV.
2.		Q6	EV charging is difficult due to lengthy charge times.

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

	Vehicle Performance barriers /Factors	Q2	I would always be worried about running out of charge when driving an EV.
		Q4	I would only prefer to use the Electric Vehicle for short-distance journeys.
		Q1	While using an Electric Vehicle, I would have to plan my trips carefully.
		Q3	I would reduce the use of air conditioning in EVs in order to reduce the battery power consumption.
		Q5	The need for charging makes EVs very unpractical for everyday use.
3.	Lack of Charging Infrastructure	Q18	Charging an EV isn't possible with an ordinary electric socket.
		Q17	Lack of recharging facilities at home for overnight charging causes inconvenience when using an EV.
		Q16	It is difficult to use EVs for longer distances due to the lack of charging stations along the roadway.
4.	Environmental Concern	Q19	I believe that Electric Vehicles can reduce climate change.
		Q20	Driving an EV would express my environmental awareness.
		Q21	Driving EVs would reduce the consumption of natural resources.
5.	Societal Influence	Q24	The people around me think that I should purchase an EV.
		Q26	Driving the EV would make me feel socially responsible.
		Q25	The people close to me think that it is important to consider the environment when purchasing an EV.
6.	Awareness of EV's	Q23	I am aware of the technology used in EVs.
		Q22	I am aware that the battery warranty of an EV.

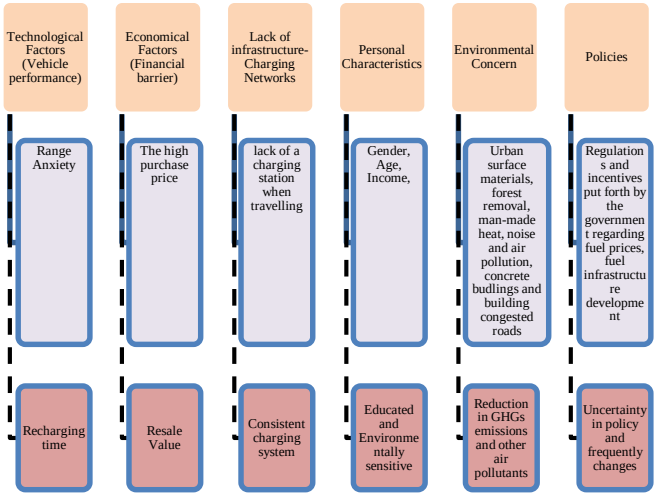


Figure 9 Factor Descriptions

7. Findings and Discussions of The Study

Figure 9. India has started late on the path to electrification, requiring a strong policy to catch up and move rapidly towards the goal of 100% pure electric technology. Currently, the penetration of electric vehicles in the market remains quite low in India, with approximately 0.1% in private vehicles, 0.2% in two-wheelers, and practically nil for commercial vehicles. This low penetration is due to several reasons, including a significant affordability gap, low consumer acceptance (lack of demand), low levels of electric vehicle manufacturing activities (lack of supply), and non-existent public charging infrastructure. However, with a concerted policy and enough time for it to bear fruit, these aspects could be well addressed.

7.1. The Findings of This Study Offer Valuable Insights for Various Stakeholders Involved in The Promotion and Adoption of EVS in India

- Policymakers should sustain and strengthen

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

policy incentives for EV uptake, as there is a positive correlation between sustainability perceptions and EV buying intentions. Subsidies and other incentives should promote environmental enhancement. Additionally, increasing the availability of recharging options is necessary to address range anxiety and perceived risks, making EVs more viable for consumers.

- To the automotive industry, consumer preferences and external factors highlight the need for marketing to focus on more than just the functional features of electric vehicles (EVs). Effective communication should include competitive models, systematic information delivery of EV benefits, and addressing perceived risks through innovation and reliable service networks. These components are crucial for enhancing the adoption trend of EVs
- Consumer education is crucial for reducing perceived risks and increasing confidence in electric vehicles (EVs). Educating the public about specific attributes of EVs, such as reliability, affordability, and environmental benefits, can help alleviate concerns. Highlighting real-life benefits and showcasing successful EV owners can also positively influence public perception and encourage adoption.

Conclusion

With India's aim to transform its automobile industry towards e-mobility, addressing the knowledge gap and barriers in EV adoption is crucial. This project identifies six factors influencing consumers' intention to adopt electric vehicles in India: financial factors, vehicle performance factors, lack of charging infrastructure, environmental concern, societal influence, and awareness of electric vehicles. These factors align with findings by Noel et al. (2020), highlighting financial barriers, vehicle performance barriers, and lack of charging infrastructure as major factors in EV adoption in the Indian context. Most personal vehicle buyers consider upfront purchase price, fuel efficiency, maintenance and service cost, and comfort features as key criteria. The high price of EVs, around 2 to 2.5 times more than conventional vehicles, is a major factor slowing market penetration. Consumers also face concerns about the range per charge offered. A higher battery capacity would increase the price of the EV, widening the price gap. However, EVs offer significant advantages in operating costs compared to conventional ICE vehicles. In India, the affordability index is lower than in developed economies due to lower per capita income. Manufacturers need to offer medium-range EVs to keep costs affordable for the masses. Studies suggest that awareness of EVs is low, including familiarity with technology, government schemes, and economic benefits. There is a direct correlation between knowledge of EVs and their adoption

Limitations of The Study

A limitation of this study is that it only included well-educated consumers, leaving out those with lower educational levels. The growth of EVs is expected to be faster in urban regions due to better infrastructure and higher per capita incomes, while rural areas remain unexplored. Further research is needed to understand EV barriers in rural India, which may differ from those in cities. However, one should bear in mind the limitations of this study in terms of the generalizability of results. The study primarily used survey data, which, while effective, is prone to response bias. Additionally, the sample size, though appropriate, was not large enough to fully encompass all aspects of the Indian market. Future studies could investigate EV owners' and potential consumers' attitudes using qualitative research methods, such as interviews. The analysis shows a higher proportion of male participants compared to females due to the convenience random sampling technique. Most participants are under-graduate and graduate students from various regions of India. Although older age groups (45-54 years, 55 and above) should be involved, their busy schedules and the researcher's network limitations made it challenging to include them in the study.

References

[1]. Gahlaut, T., Dwivedi, G., & Dwivedi,A. (2023). Analyzing the blockades to electric vehicle mobility in an emerging economy: Toward a triple bottom line sustainable

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

development. Sustainable Development, 1–15.https://doi.org/10.1002/sd.2709

[2]. Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy, 48, 717-729

[3]. Jaiswal, D., Kant, R., Singh, P. K., & Yadav, R. (2022). Investigating the role of electric vehicle knowledge in consumer adoption: evidence from an emerging market. Benchmarking, 29(3), 1027–1045. https://doi.org/10.1108/BIJ-11-2020-0579 Jaiswal, D., Kaushal, V., Kant, R., & Kumar Singh, P. (2021). Consumer adoption intention for electric vehicles: Insights and evidence from Indian sustainable transportation. Technological Forecasting and Social Change, 173, 121089. https://doi.org/10.1016/j.techfore.2021.121089

[4]. Hawkins, T. R., Singh, B., Majeau-Bettez, G., & Stromman, A. H. (2013). Comparative environmental life cycle assessment of conventional and electric vehicles. Journal of https://doi.org/10.1016/j.enpol.2012.06.009

[5]. Singh Patyal, V., Kumar, R., & Singh Kushwah, S. (2021). Modeling barriers to the adoption of electric vehicles: An Indian perspective. Energy, 237. https://doi.org/10.1016/j.energy.2021.121554

[6]. Singh, V., Singh, V., & Vaibhav, S. (2021). Analysis of electric vehicle trends, development and policies in India. Case Studies on Transport Policy, 9(3), 1180-1197

[7]. Sooriyaperakasam, N. (2020). Barriers to widespread adoption of plug-in electric vehicles in emerging Asian markets: An analysis of consumer behavioral attitudes and perceptions. Cogent Engineering, 7(1). https://doi.org/10.1080/23311916.2020.1796198 Singh Patyal, V., Kumar, R., & Singh Kushwah, S. (2021). Modeling barriers to the adoption of electric vehicles: An Indian perspective. Energy, 237. https://doi.org/10.1016/j.energy.2021.121554

[8]. Prakash, S., Dwivedy, M., Poudel, S. S., & Shrestha, D. R. (2018). Modelling the barriers for mass adoption of electric vehicles in Indian automotive sector: An Interpretive

[9]. Bhat, F. A., Verma, M., & Verma, A. (2022). Measuring and modelling electric vehicle adoption of Indian consumers. Transportation in Developing Economies, 8(1), 6.

[10]. Davis, F. D. (1989). Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology. MIS Quarterly, 13(3), 319. https://doi.org/10.2307/249008 Egbue, O., & Long, S. (2012). Barriers to widespread adoption of electric vehicles: An analysis of consumer attitudes and perceptions. Energy Policy, 48, 717–729.

[11]. Larminie, J., & Lowry, J. (2012). Electric vehicle technology explained. John Wiley & Son

[12]. Berkeley, N., Bailey, D., Jones, A., & Jarvis, D. (2017). Assessing the transition towards Battery Electric Vehicles: A Multi-Level Perspective on drivers of, and barriers to, take up. Transportation Research Part A: Policy and Practice, 106, 320–332. https://doi.org/10.1016/j.tra.2017.10.004

[13]. Berkeley, N., Bailey, D., Jones, A., & Jarvis, D. (2017a). Assessing the transition towards battery electric vehicles: A multi-level perspective on drivers of, and barriers to, take up.

[14]. Sovacool, B. K., & Hirsh, R. F. (2009). Beyond batteries: An examination of the benefits and barriers to plug-in hybrid electric vehicles (PHEVs) and a vehicle-to-grid (V2G) transition. Energy Policy, 37(3), 1095-1103. https://doi.org/10.1016/j.enpol.2008.10.005

[15]. Mandys, F. (2021). Electric vehicles and consumer choices. Renewable and Sustainable Energy Reviews, 142, 110874.

[16]. Government of India, M. of H. I. and P.

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

enterprises. (2019). FAME India Scheme. Jain, N. K., Bhaskar, K., & Jain, S. (2022). What drives adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support. Research in Transportation Business and Management, 42. https://doi.org/10.1016/j.rtbm.2021.100730

[17]. Simolin, T., Rauma, K., Viri, R., Mäkinen, J., Rautiainen, A., & Järventausta, P. (2021). Charging powers of the electric vehicle fleet: Evolution and implications at commercial charging sites. Applied energy, 303, 117651.

[18]. Berkeley, N., Bailey, D., Jones, A., & Jarvis, D. (2017b). Assessing the transition towards battery electric vehicles: A multi-level perspective on drivers of, and barriers to, take-up.

[19]. Berkeley, N., Jarvis, D., & Jones, A. (2018). Analyzing the take up of battery electric vehicles: An investigation of barriers amongst drivers in the UK. Transportation Research

[20]. Bhat, F. A., Verma, M., & Verma, A. (2022). Measuring and modelling electric vehicle adoption of Indian consumers. Transportation in Developing Economies, 8(1), 6.

[21]. Chau, K. T., & Wong, Y. S. (2002). Overview of power management in hybrid electric vehicles. Energy Conversion and Management, 43(15), 1953-1968. https://doi.org/10.1016/S0196-8904(01)00148-0

[22]. Chaturvedi, B. K., Nautiyal, A., Kandpal, T. C., & Yaqoot, M. (2022). Projected transition to electric vehicles in India and its impact on stakeholders. Energy for Sustainable Development, 66, 189–200. https://doi.org/10.1016/j.esd.2021.12.006

[23]. Cherry, K. (2024). What Is a Cross-Sectional Study? [online] Verywell Mind. Available at: https://www.verywellmind.com/what-is-a-cross-sectional-study-2794978 [Accessed 6 Jul. 2024]

[24]. Das, P. K., & Bhat, M. Y. (2022). Global electric vehicle adoption: implementation and policy implications for India. Environmental Science and Pollution Research, 29(27), 40612–40622. https://doi.org/10.1007/s11356-021-18211-w

[25]. Franke, T., & Krems, J. F. (2013). What drives range preferences in electric vehicle users? Transport Policy, 30, 56–62. https://doi.org/10.1016/j.tranpol.2013.07.005

[26]. Goel, P., Sharma, N., Mathiyazhagan, K., & Vimal, K. E. K. (2021). Government is trying, but consumers need to buy: A barrier analysis for electric vehicle sales in India.

[27]. Goel, S., Sharma, R., & Rathore, A. K. (2021). A review on barrier and challenges of electric vehicle in India and vehicle to grid optimization. Transportation Engineering, 4, 100057. https://doi.org/10.1016/j.treng.2021.100057

[28]. Das, P. K., & Bhat, M. Y. (2022). Global electric vehicle adoption: implementation and policy implications for India. Environmental Science and Pollution Research, 29(27), 40612–40622. https://doi.org/10.1007/s11356-021-18211-w

[29]. Schneider, D. (2022). What's to Like? Facebook as a Tool for Survey Data Collection - Daniel Schneider, Kristen Harknett, 2022. [online] Sociological Methods & Research. Available at: https://journals.sagepub.com/doi/full/10.1177/0049124119882477 [Accessed 8 Jul. 2024].

[30]. Mandys, F. (2021). Electric vehicles and consumer choices. Renewable and Sustainable Energy Reviews, 142, 110874.

[31]. O'Neill, E., Moore, D., Kelleher, L., & Brereton, F. (2019). Barriers to electric vehicle uptake in Ireland: Perspectives of car-dealers and policy-makers. Case Studies on Transport Policy, 7(1), 118–127. https://doi.org/10.1016/j.cstp.2018.12.005

International Research Journal on Advanced Engineering and Management
https://goldncloudpublications.com
https://doi.org/10.47392/IRJAEM.2025.0273
e ISSN: 2584-2854
Volume: 03
Issue: 05 May 2025
Page No: 1712 - 1726

[32]. Singh Patyal, V., Kumar, R., & Singh Kushwah, S. (2021). Modeling barriers to the adoption of electric vehicles: An Indian perspective. Energy, 237. https://doi.org/10.1016/j.energy.2021.121554

[33]. Singh, V., Singh, V., & Vaibhav, S. (2021). Analysis of electric vehicle trends, development and policies in India. Case Studies on Transport Policy, 9(3), 1180-1197.

[34]. Wu, Y., & Zhang, L. (2017). Can the development of electric vehicles reduce the emission of air pollutants and greenhouse gases in developing countries? Transportation

[35]. Xie, R., An, L., & Yasir, N. (2022). How innovative characteristics influence consumers' intention to purchase electric vehicle: A moderating role of lifestyle. Sustainability, 14(8), 4467.

[36]. Factors influencing adoption of electric vehicles – A case in IndiaSriram K V, Lidwin Kenneth Michael, Sumukh S. Hungund & Mabelle Fernandes | (2022) Factors influencing adoption of electric vehicles – A case in India, Cogent Engineering, 9:1, 2085375, DOI: 10.1080/23311916.2022.2085375

[37]. Xu, G., Wang, S., Li, J., & Zhao, D. (2020). Moving towards sustainable purchase behavior: examining the determinants of consumers' intentions to adopt electric vehicles. Environmental Science and Pollution Research, 27, 22535-22546.

[38]. A Study On Factors Influencing The Purchase Of Electric Vehicles In Indian Auto Mobile Market Journal of Contemporary Issues in Business and Government Vol. 28, No. 04, 2022 P-ISSN: 2204-1990; E-ISSN: 1323-6903 Prof. Rajesh, Dr. Rajasulochana, Dr. M. Kethan

[39]. Faster Adoption & Manufacturing of Electric Vehicles in India, Ministry of Heavy Industries, Government of India

[40]. SMEV (Society of Manufacturers of Electric Vehicles)

[41]. Energy Efficiency and Renewable Energy (EERE). (2021). Fuel Cell Electric Vehicle