



CP-302: Capstone Project: Mid-Semester Report

Modelling and analysis of Electric Vehicle adoption in India

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Table of Contents

1. Abstract	4
2. Introduction.....	4
3. Motivation.....	5
4. Objectives.....	6
5. Methodology.....	6
• 5.1 Factor Selection Based on Literature Review	
• 5.2 Stated Preference (SP) Experimental Design	
• 5.3 Data Collection and Analysis Plan	
6. Work Progress So Far.....	8
7. Findings and Results.....	8
8. Future Work Proposed.....	13
• 8.1 Immediate Next Steps	
• 8.2 Data Analysis Using Advanced Models	
• 8.3 Proposed Recommendations and Final Report	
9. Conclusions.....	13
10.References.....	14

List of Figures

Figure1.	Education Level Distribution.....	9
Figure2.	Analysis of Two-Wheeler Ownership Types.....	9
Figure3.	Breakdown of Two-Wheeler Ownership.....	10
Figure4.	EV Price Preference : A Slice of the Market.....	10
Figure5.	What Factor Drives EV Choice in the Budget Category?.....	11
Figure6.	What Factor Drives EV Choice in the Mid-Range Category?..	11
Figure7.	What Factor Drives EV Choice in the Premium Category?.....	12
Figure8.	Overall Market Preference : EV Vs. Conventional.....	12



1. Abstract

As India moves towards its "net zero" target, the adoption of electric vehicles (EVs) has become a national priority. This project aims to analyze the key factors influencing consumer choice for electric two-wheelers in the city (Chandigarh). A Stated Preference (SP) survey was designed and administered to gather primary data from residents, building upon insights gained from a comprehensive literature review.. The survey evaluates consumer trade-offs between critical attributes such as upfront cost, operating cost, driving range, and various financial and non-financial policy incentives. Advanced statistical methods, such as discrete choice modeling, will be employed to quantify how consumers value specific features, to identify the most significant drivers and barriers to EV adoption. The expected outcomes will provide actionable recommendations for policymakers and vehicle manufacturers to create a more effective ecosystem for accelerating the transition to electric mobility in Chandigarh.

2. Introduction

The global transition towards a green economy is heavily reliant on the adoption of electric mobility. Electric Vehicles (EVs) offer significant benefits over conventional internal combustion engine (ICE) vehicles, including being

more economical, efficient, and environmentally friendly. For India, a nation that is the third-largest carbon emitter and highly dependent on crude oil imports, accelerating EV adoption is critical to achieving its ambitious "net zero" target by 2070 and enhancing energy security.

The Government of India has recognized this imperative and introduced several policy interventions to promote EV manufacturing and adoption, most notably the "Faster Adoption and Manufacturing of Electric Vehicles" (FAME-I & FAME-II) policy frameworks. These policies aim to bridge the price gap between EVs and ICE vehicles through upfront subsidies and other incentives. Despite these efforts, mass adoption faces significant hurdles. Consumer concerns often revolve around high upfront purchase prices, driving range limitations ("range anxiety"), and the availability of charging infrastructure. Studies show that the upfront cost of an EV and its charging equipment is a primary deterrent for potential buyers.

While national-level policies and broad consumer trends have been studied, there is a need for localized research to understand how these factors manifest in specific urban environments. Chandigarh, with its planned infrastructure and progressive stance on green initiatives, presents an ideal case study. This project addresses this gap by investigating the specific perceptions, preferences, and barriers related to the adoption of electric two-wheelers among the residents of Chandigarh. Through primary data collection, this report aims to provide a granular understanding of the local market and offer targeted insights to drive EV adoption in the city.

3. Motivation

The global imperative to combat climate change is crystallized in the United Nations' Sustainable Development Goals (SDGs). The transportation sector is a significant contributor to global greenhouse gas (GHG) emissions, making its decarbonization essential for achieving SDG 13 (Climate Action). Electric Vehicles (EVs), with zero tailpipe emissions, represent a cornerstone technology in the strategy to reduce the carbon footprint of mobility. By transitioning from internal combustion engines to electric power, cities can drastically cut down on pollutants, which not only mitigates climate change but also improves air quality and public health. This directly supports SDG 11 (Sustainable Cities and Communities), which aims to make urban centers more inclusive, safe, resilient, and sustainable. This project, by exploring the driver of EV adoption in Chandigarh, aims to provide actionable insights that align with these critical global sustainability targets.

4. Objectives

The primary goal of this project is to identify and analyze the key factors influencing the decision of consumers in Chandigarh to adopt electric two-wheelers. The specific objectives are:

- To analyze the socio-demographic profile of potential and existing EV users in Chandigarh and its influence on their vehicle purchase decisions.
- To assess the relative importance of various vehicle attributes (e.g., purchase price, running cost, range, subsidies) in the consumer's choice between an electric two-wheeler and a conventional two-wheeler.
- To evaluate consumer preferences and choices under different hypothetical vehicle and policy scenarios, as presented in the stated preference experiment.
- To identify the most significant drivers (e.g., long-term fuel cost savings) and barriers (e.g., high upfront cost) to the adoption of electric two-wheelers in the city.
- To propose data-driven recommendations for policymakers, manufacturers, and other stakeholders to create a more effective ecosystem for accelerating EV adoption in Chandigarh.

5. Methodology

To achieve the project objectives, a quantitative research methodology was employed, centered around a Stated Preference (SP) discrete choice experiment.

5.1 Factor Selection Based on Literature Review

- **Upfront Cost (Price):** Consistently identified as a primary barrier. Research by Gong et al. (2021) and Li et al. (2022) confirms that the high upfront investment is a critical consumer concern.
- **Operating Costs (Fuel Cost):** The prospect of "long-term fuel cost savings" is cited as a major benefit of EV ownership (Gong et al., 2021).
- **Driving Range:** "Range anxiety" is a well-documented practical barrier, and its inclusion is critical for quantifying its influence on consumer preference (Gong et al., 2021; Li et al., 2022).

- **Initial Subsidies:** Direct financial incentives are a cornerstone of EV policy. Referencing India's FAME-II policy (Yadav et al., 2024), this attribute is crucial for modeling the impact of government support.
- **Registration Fee Discount:** This represents another direct financial incentive used in policy mixes to reduce the initial cost burden (Li et al., 2022).
- **Purchase Loan Interest Rate:** This factor was included to test the importance of financing terms, an economic variable that influences overall affordability.
- **Reserved Parking (with/without Charging):** The lack of accessible public charging infrastructure is a major concern that amplifies range anxiety (Gong et al., 2021).
- **Ban of two-wheelers in certain areas:** This non-financial policy tests consumer response to regulations, a concept related to market-based instruments explored in China (Li et al., 2022).

5.2 Stated Preference Experimental Design

Scenario Generation: A fractional factorial design was used to create the choice scenarios. A fractional design, generated using principles often implemented in software like Ngene, selects a smaller, statistically efficient subset of scenarios to estimate the main effects of each attribute.

Blocking: The experimental design was blocked by price range ("Budget," "Mid-Range," "Premium") to reduce the cognitive load on respondents and improve data quality.

5.3 Data Collection and Analysis Plan

A Stated Preference (SP) analysis is a powerful technique used to understand how individuals make complex choices. Instead of just asking what they prefer, respondents are presented with a series of hypothetical but realistic choice scenarios. In each scenario, they must choose between different options (e.g., EV A, EV B, or a conventional scooter), where each option has a unique combination of attributes like price, range, and operating cost. By observing the trade-offs respondents make across multiple scenarios, we can statistically estimate the value they place on each attribute.

This method allows for the collection of rich data from each participant. While we have successfully collected responses from 135 individuals so far, each

person completed multiple choice tasks. This has resulted in a robust dataset of nearly 1,000 observations that will be used for detailed modeling

6. Work Progress So Far

- **Comprehensive Literature Review and Survey Design:** An in-depth review of contemporary research was completed to establish a theoretical foundation for the project. Key research papers informed the survey's design:
 - The paper '**Incentives and concerns on vehicle-to-grid technology expressed by Australian employees and employers**' highlighted the centrality of economic factors, showing that Australian consumers are primarily motivated by reducing upfront and daily transport costs.
 - '**Fuel demand, carbon tax and electric vehicle adoption in India's road transport**' underscored the potential of policy levers in the Indian context, finding that reducing electricity prices and taxing conventional fuels could significantly boost EV adoption.
 - '**From government to market? A discrete choice analysis of policy instruments for electric vehicle adoption**' justified the exploration of novel market-based policies by demonstrating that instruments like Personal Carbon Trading (PCT) could be more powerful than existing incentives in China. This review directly informed the selection of factors and the design of the Stated Preference experiment, and the web-based survey instrument has been finalized and tested.
- **Primary Data Collection (Ongoing):** The survey is being administered via face-to-face interviews at high-footfall public locations across Chandigarh to capture a diverse and representative sample of the city's population.
 - The designated survey locations are: Sector 17, Elante Mall, Sector 28, Sector 22, and Sukhna Lake.
 - To date, more than 100 survey responses for the electric two-wheeler study have been successfully collected.
 - The project's vision is to gather a robust dataset, with a minimum target of 100 responses from each of the five designated survey locations.
 - Concurrently, a parallel pilot survey for four-wheeler EVs was also conducted, yielding nearly 100 responses. This data provides broader context but its analysis is not within this project's scope.
- **Initial Data Compilation:** The collected responses are being systematically compiled, cleaned, and prepared for the subsequent analysis phase.

7. Findings/Results

- **Descriptive Statistics of the Sample:** A summary of the socio-demographic characteristics of the survey respondents from Chandigarh.

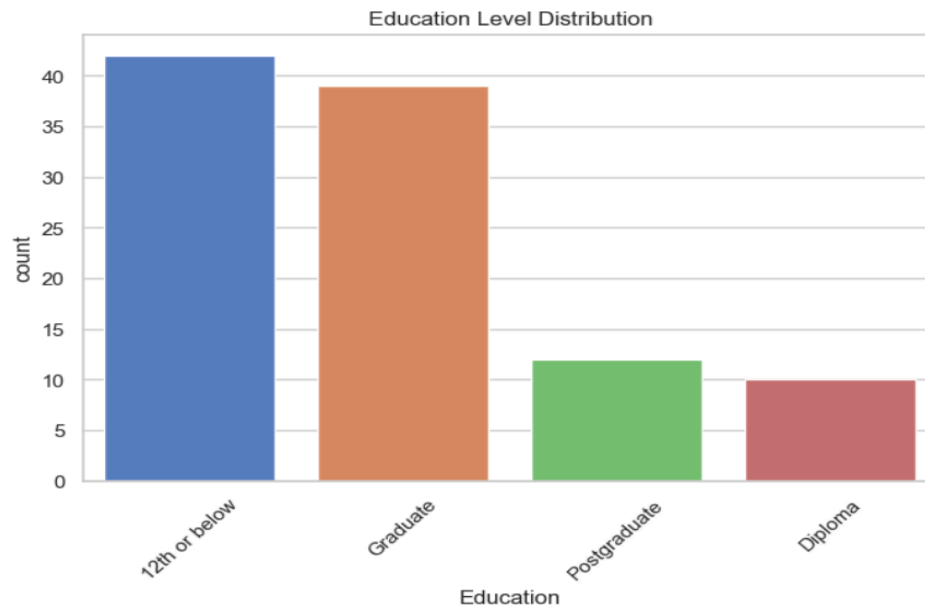


Figure1:

As the data shows, responses were gathered from individuals across all academic levels, from 12th standard or below to postgraduates.

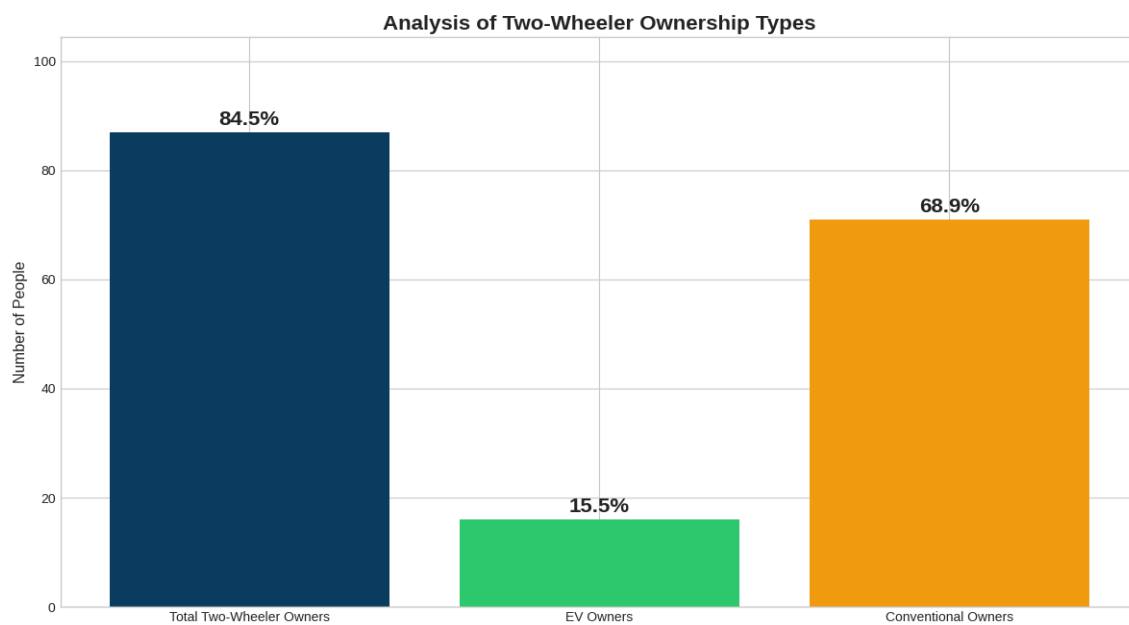


Figure2:

From the graph we can see almost 84% of total respondents owns a two wheeler

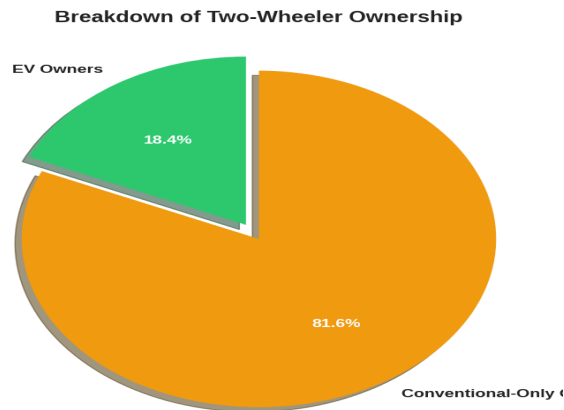


Figure3:

It can be clearly seen from pie chart that very less (18%) people own an electric vehicle

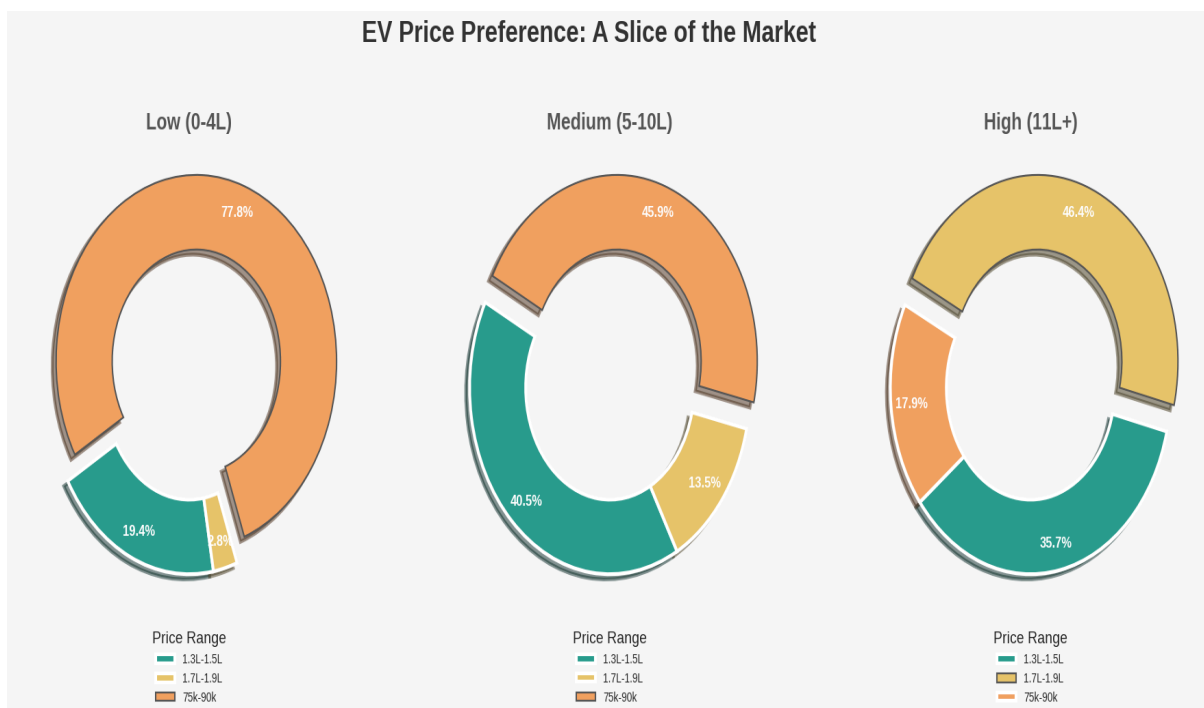


Figure4:

Low-income (0-4L):
About 78% want the cheapest EVs.

Medium-income (5-10L):
Around 46% prefer mid-priced EVs, while 41% still want cheap Ones.

High-income (11L+): Nearly 46% prefer EVs, with 36% still Going for cheaper ones.

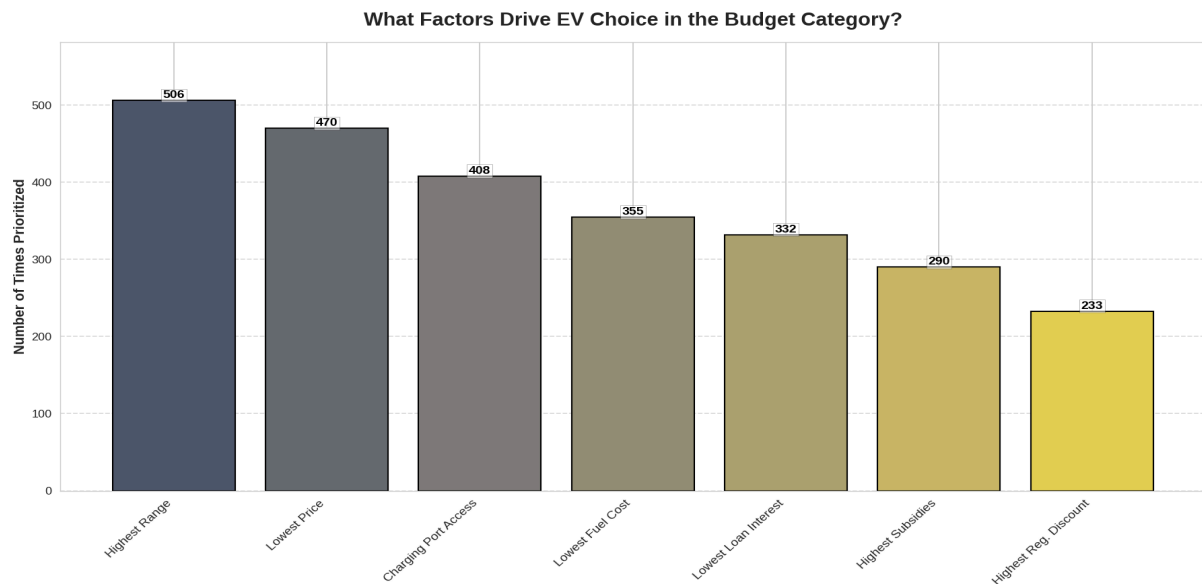


Figure5:

Budget EV buyers care most about long driving range and low price, while subsidies and registration discounts matter the least.

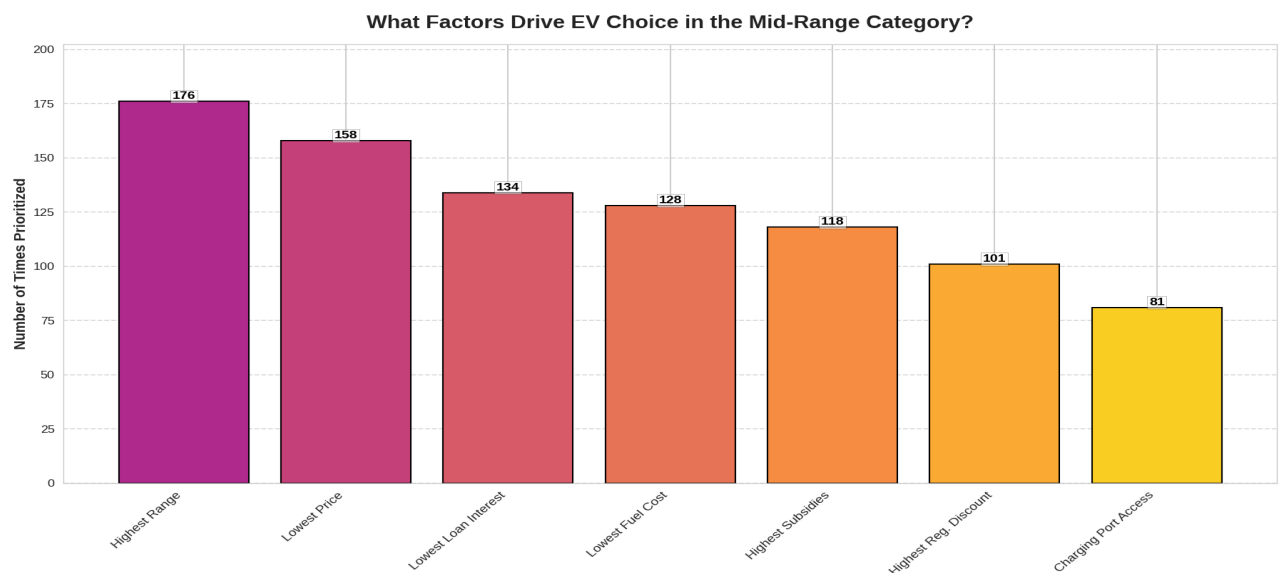


Figure6:

Mid-range EV buyers care most about driving range and price, somewhat about loans, running cost, and subsidies, and least about charging port access.

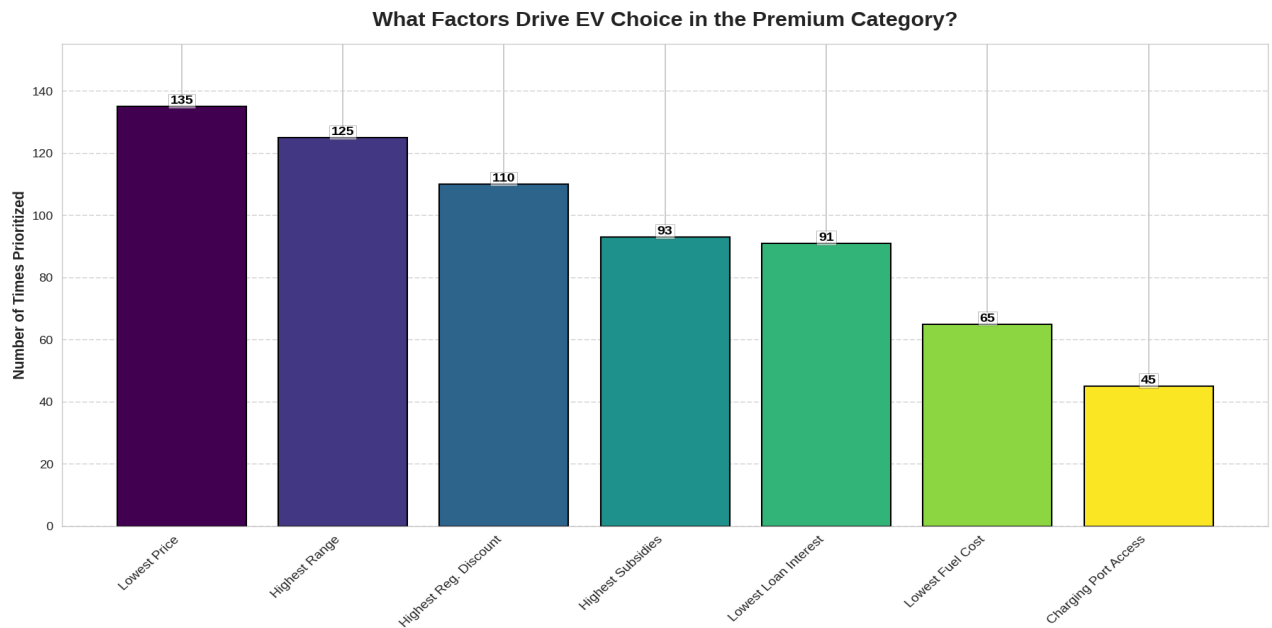


Figure7:

Premium EV buyers mainly prioritize price and range, give moderate importance to discounts, subsidies, and loan rates, and care least about fuel cost and charging access.

Overall Market Preference: EV vs. Conventional

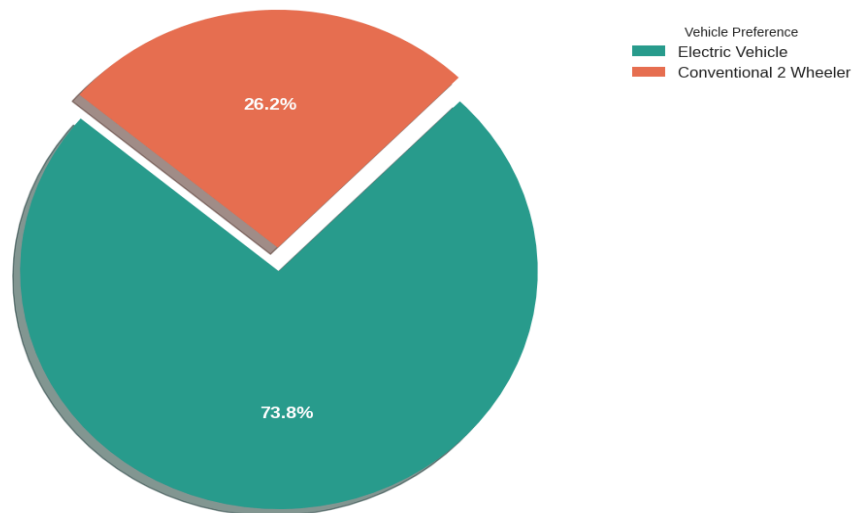


Figure8:

Nearly three-quarters (73.8%) of people surveyed prefer electric two-wheelers over conventional ones (26.2%).

8. Future Work Proposed

8.1 Immediate Next Steps :-

The project is progressing into its final stages. The immediate focus is on completing the data collection to achieve the target sample size from all designated locations in Chandigarh. Following this, the comprehensive dataset will be cleaned and prepared for rigorous statistical analysis.

8.2 Data Analysis Using Advanced Models :-

The core of the upcoming analysis will involve developing advanced **Machine Learning (ML) or discrete choice models**. These models are crucial for quantifying the **marginal impacts** of each vehicle attribute. This will allow us to understand precisely how a specific change (e.g., a ₹10,000 reduction in price or a 20 km increase in range) affects a consumer's probability of choosing an EV, while considering the effects of all variables taken together. This level of detail is essential for creating targeted and effective policies.

8.3 Proposed Recommendations and Final Report :-

The outputs from the statistical models will be translated into clear, actionable recommendations. For policymakers, we will suggest which incentives (e.g., upfront subsidies, registration discounts) offer the most impact per rupee spent. For manufacturers, our findings will highlight the specific features and price points that resonate most strongly with different consumer segments. All findings and recommendations will be compiled into the final project report.

9. Conclusions

The foundational work of this project is complete, including a comprehensive literature review and the successful design and initial deployment of a Stated Preference survey.

Our preliminary analysis of over 100 responses from Chandigarh residents reveals distinct consumer preferences across different market segments. A clear trend emerges where budget and mid-range buyers prioritize driving range and low price above all else, indicating that range anxiety and affordability are key hurdles. Conversely, in the premium segment, the upfront purchase price becomes the single most dominant factor, with these buyers also showing greater sensitivity to financial incentives like subsidies and registration

discounts. Across all scenarios, a strong underlying preference for electric vehicles (73.8%) was observed, signaling significant market potential. The project is well-positioned to complete its data collection and proceed with advanced modeling to deliver data-driven recommendations that can help accelerate the adoption of electric mobility in Chandigarh.

10. References

1. [Zhou, Y., Li, Y., & Zhao, X. \(2019\). *From government to market? A discrete choice analysis of policy instruments for electric vehicle adoption in China.* Energy Policy, 129, 110–120.](#)
2. [Yadav, P., et al. \(2024\). *Evaluating the impact of India's FAME-II policy on electric vehicle adoption.* Renewable and Sustainable Energy Reviews, 182, 113409.](#)
3. [Global sustainability frameworks and policy analyses, including UN SDGs and international EV adoption studies \(Zhou et al., 2019; United Nations, 2015\).](#)