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DEPARTMENT OF STATISTICS

A Data Driven Study of Motivators and Barriers to Electric Vehicle Adoption

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A Data Driven Study of Motivators and Barriers to Electric Vehicle Adoption

Project submitted to the University of Kerala in partial fulfillment of the requirements for the award of the Degree of Bachelor of Science in Statistics

By

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Approval

This project has been examined and approved as meeting the requirements for the partial fulfillment of the Degree of Bachelor of Science in Statistics.

Jolly Kumari R Date:

(Supervisor)

Rev. Dr. Gigi Thomas Date:

(Head of the Department)

Declaration

I, GOVIND M NAIR (2200306) declare that this project is our work, except where due reference is made, and it has never been submitted for a Degree at this or any other University or Institution of Higher Learning.

GOVIND M NAIR (2200306)

Date:

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Abstract

This project takes a thorough look at how consumers view traditional cars compared to electric vehicles. The main goal is to dig deeper than just the surface of survey results and really uncover the insights that reveal what is holding back the adoption of EVs. To achieve this, I started with the process of cleaning and organizing the raw survey data. Following that, I performed an in-depth Exploratory Data Analysis, utilizing visualization tools to identify initial trends in the demographics and opinions of the respondents. To take our findings further, I crafted and tested several specific, statistically valid hypotheses using non-parametric methods like the Mann-Whitney U Test, Kruskal-Wallis H Test, and the Chi-Square Test for Independence. In the end, the report wraps up by bringing together the analytical findings into strategic recommendations for stakeholders, showcasing the importance of a data-driven approach.

CONTENTS

CHAPTER 1:INTRODUCTION

CHAPTER 2:RESEARCH METHODOLOGY

CHAPTER 3:DATA EXPLORATION

3.1 Introduction

3.2 Demographic overview of survey respondents

3.3 Consumer perception: Barrier VS. Advantages of EVs

3.4 Hypothesis testing and Findings

3.4.1 Does driving an EV affect purchase likelihood?

3.4.2 Does income group affect purchase likelihood?

3.4.3 Do EV owners spend less weekly on energy than conventional vehicle owners?

3.4.4 Is there a link between wanting government incentives and wanting more EV options?

CHAPTER IV:FINDINGS AND CONCLUSION

4.1 Findings of the Study

4.2 Conclusion

Reference

Appendix

CHAPTER 1
INTRODUCTION

1.1 BACKGROUND OF THE STUDY

Transportation is a cornerstone of modern society, enabling economic growth, social interaction, and the movement of goods and people. For over a century, this landscape has been dominated by conventional vehicles powered by internal combustion engines (ICE). However, growing concerns over environmental impact, greenhouse gas emissions, and the volatility of fossil fuel prices have catalysed a global shift towards more sustainable solutions. This study aims to dissect these factors through a data-driven lens.

1.2 THE RISE OF ELECTRIC VEHICLES (EVs)

Electric Vehicles (EVs) are automobiles powered by electric motors that draw their energy from rechargeable batteries. Unlike conventional vehicles that run on gasoline or diesel, EVs rely on electricity for propulsion. The use of EVs is gaining popularity due to their numerous advantages, primarily their zero-emission nature, which makes them an environmentally friendly alternative. They are also more energy-efficient and often have lower long-term operating costs.

1.3 CONVENTIONAL VEHICLES

Conventional vehicles use an internal combustion engine fueled by gasoline or diesel to power the wheels. This has been the dominant technology for over a century, benefiting from a well-established manufacturing base and a ubiquitous refueling infrastructure (gas stations).

1.4 ELECTRIC VEHICLES VS CONVENTIONAL VEHICLES

Electric Vehicles (EVs) and Conventional Vehicles are two types of automobiles that are powered differently. Conventional vehicles run on fossil fuels, typically gasoline or diesel, while EVs are powered by electricity stored in batteries. Conventional vehicles have been the dominant mode of transportation for over a century. They are powered by internal combustion engines that burn fuel to create energy to power the vehicle. The engine is typically connected to a transmission that transfers the energy to the wheels, propelling the car forward. On the other hand, EVs use electric motors and batteries to generate power and propel the car forward. The batteries store electricity, which is used to power the electric motor that drives the wheels. EVs do not have a traditional combustion engine or a transmission, but rather a single-speed transmission.

One of the primary advantages of EVs is that they are much more environmentally friendly than conventional vehicles. They produce zero emissions, reducing air pollution and greenhouse gas emissions. Additionally, EVs are much more energy-efficient than conventional vehicles, with electric motors being up to three times more efficient than internal combustion engines.

However, there are also some challenges associated with EVs, including the high cost of batteries, limited driving range, and the need for a robust charging infrastructure. Conventional vehicles, on the other hand, are more affordable and have a well-established refueling infrastructure. In conclusion, while EVs and conventional vehicles differ in their power source, both have their advantages and disadvantages. As technology advances, it is likely that we will see a shift towards more widespread adoption of EVs as they become more affordable and practical.

1.5 LIMITATIONS OF THIS STUDY

- The survey sample of 232 respondents is relatively small and heavily skewed towards a younger (18-25), lower-income demographic.
- People with EVs who have responded to this study is comparatively less.
- It is difficult to determine how honestly the participants answered the items in the questionnaire; this may affect their answer choices.

1.6 SUMMARY

The four chapters that make up the current study cover the data collection process, numerous statistical tests, and their conclusions.

The first chapter serves as an introduction, providing a broad overview of the subject.

The second chapter, titled "Research Methodology," describes the numerous approaches taken in the study's analysis. The data source and sample, sample size, data cleaning process, and statistical methods including the Mann-Whitney U Test, Kruskal-Wallis H Test, and the Chi-Square Test for Independence are all covered. The major objectives of the study are also covered in the second chapter.

The third chapter is structured as a Data Exploration and explains the respondents' age group and income distribution as well as the types of vehicles they own. It also discusses the consumer perceptions of the advantages of EVs, such as environmental benefits, and the barriers, such as cost and lack of charging infrastructure. It details the hypothesis tests on how driving experience and income affect purchase likelihood, compares weekly energy spending, and investigates the link between wanting government incentives and wanting more EV options.

The study's results and conclusion are presented in the fourth chapter. This chapter summarizes the key findings from the statistical analysis and concludes with data-driven recommendations for industry and policymakers to accelerate the adoption of electric vehicles.

CHAPTER 2

RESEARCH METHODOLOGY

2.1 INTRODUCTION

Research methodology provides a systematic plan to resolve a research problem. This study employs a quantitative methodology (means the research is based on numbers and statistics) to analyze survey data, ensuring that the conclusions drawn are valid, reliable, and directly supported by statistical evidence. The workflow progressed from data preparation to exploratory analysis and finally to rigorous hypothesis testing.

2.2 DATA SOURCE AND SAMPLE

The primary data source for this project is a survey conducted to gather opinions on conventional vs. electric vehicles. The final cleaned dataset used for analysis consists of 232 responses. The survey captured a range of demographic data as well as specific opinions related to vehicle ownership, costs, advantages, and barriers.

2.3 DATA CLEANING AND PREPROCESSING

The raw CSV data required significant cleaning to be usable for analysis. Key steps included:

- Renaming Columns: Verbose column names from the survey were shortened for easier coding.
- Standardizing Responses: Categorical values like income brackets were standardized with prefixes for correct sorting.

- Handling Multi-Select Fields: A simplified owner_type column was created to classify respondents as 'Conventional', 'Electric', or 'None'.
- Type Conversion: Numerical and categorical data were converted to their appropriate data types for analysis.

2.4 DATA REPRESENTATION: EXPLORATORY VISUALIZATIONS

The initial step in the analysis was an Exploratory Data Analysis (EDA). This involved creating graphical representations of the data to identify patterns, trends, and outliers. Bar charts were used extensively to visualize the frequency distributions of categorical data. These visualizations were created using the seaborn and matplotlib libraries in Python.

2.5 STATISTICAL TESTING OF DATA

To validate the observations from the EDA, several non-parametric statistical tests were employed. These tests are ideal for this dataset as they do not assume a normal distribution for the data, which is often the case with survey responses on a Likert scale.

2.5.1 MANN-WHITNEY U TEST

A non-parametric test used to compare whether the distributions of a continuous (or ordinal) variable differ between two independent groups. It assesses whether one group tends to have higher values than the other without assuming a normal distribution.

In this study, it is used to compare purchase likelihood between individuals who have and have not driven an EV, and weekly energy spending between conventional and electric vehicle owners.

2.5.2 KRUSKAL-WALLIS H TEST

A non-parametric test used to compare the distributions of a continuous or ordinal variable among three or more independent groups. It evaluates whether at least one group differs significantly from the others in terms of their median ranks. This test does not assume normality and is used when the assumptions of one-way ANOVA are not met.

In this study, it is used to examine the effect of income levels (with three or more groups) on the likelihood of purchasing an EV.

2.5.3 CHI-SQUARE TEST FOR INDEPENDENCE & CRAMER'S V

Chi-Square Test is a test used to determine whether there is a significant association between two categorical variables. It evaluates whether the observed frequencies in a contingency table differ significantly from the frequencies expected if the variables were independent. In this study, it is used to explore the relationship between wanting government incentives and wanting more EV options, both of which are categorical responses.

Cramer's V is a measure used to determine the strength of association between two categorical variables after a significant Chi-Square test. It yields a value between 0 (no association) and 1 (perfect association), and is particularly useful when variables have more than two categories.

2.6 MAJOR OBJECTIVES OF THE STUDY

The primary goal of this statistical study is to analyse consumer sentiment and behaviour regarding electric versus conventional vehicles. To achieve this, the study focuses on the following major objectives:

- To assess the impact of having driven an electric vehicle on the likelihood of purchasing one.
- To determine if income level influences the likelihood of purchasing an EV.
- To compare the weekly energy spending of EV owners versus conventional vehicle owners.
- To investigate the relationship between the desire for government incentives and the demand for a wider variety of EV models.

CHAPTER 3
DATA EXPLORATION

3.1 INTRODUCTION

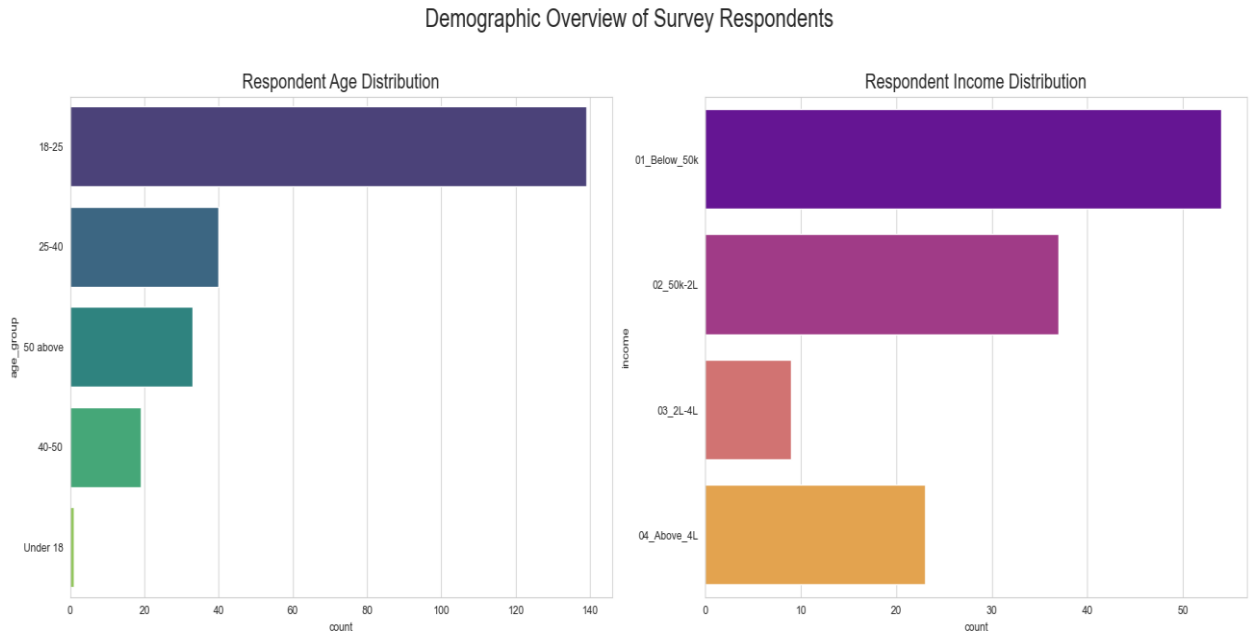
Data exploration is the initial and crucial phase of data analysis. It involves examining and visualizing the dataset to uncover initial insights, identify patterns, and detect anomalies. This process helps in understanding the broader context of the data before conducting detailed statistical tests. This chapter presents a visual exploration of the survey data, followed by the results of the statistical hypothesis tests designed to answer key research questions.

3.2 DEMOGRAPHIC OVERVIEW OF SURVEY RESPONDENTS

The following plots provide an overview of the age and income distribution of the survey participants. This comparison is crucial for several reasons:

1. To Establish the Sample Profile: The following plots provide an overview of the age and income distribution of the survey participants. The majority of respondents fall into the 18-25 age group. The income distribution is varied, with a significant portion of respondents in the "Below 50k" and "NA" categories, the latter likely representing students. Placing these two key demographic variables together immediately tells the reader *who* was surveyed, which is a foundational step in any statistical study.
2. To Provide Context for Other Findings: This demographic profile is the lens through which all other data should be viewed. For example, when you later analyse the barriers to owning an EV, the high concern over cost becomes much more understandable. A younger, lower-income group is naturally more price-sensitive, which adds significant weight and explanation to that finding.
3. To Identify Study Limitations: Presenting this comparison upfront is a critical part of a good analysis because it transparently shows the limitations of your

sample. It acknowledges that the survey results are primarily from a specific group and may not be generalizable to the entire population of potential car buyers, which would include more individuals from older and higher-income groups.



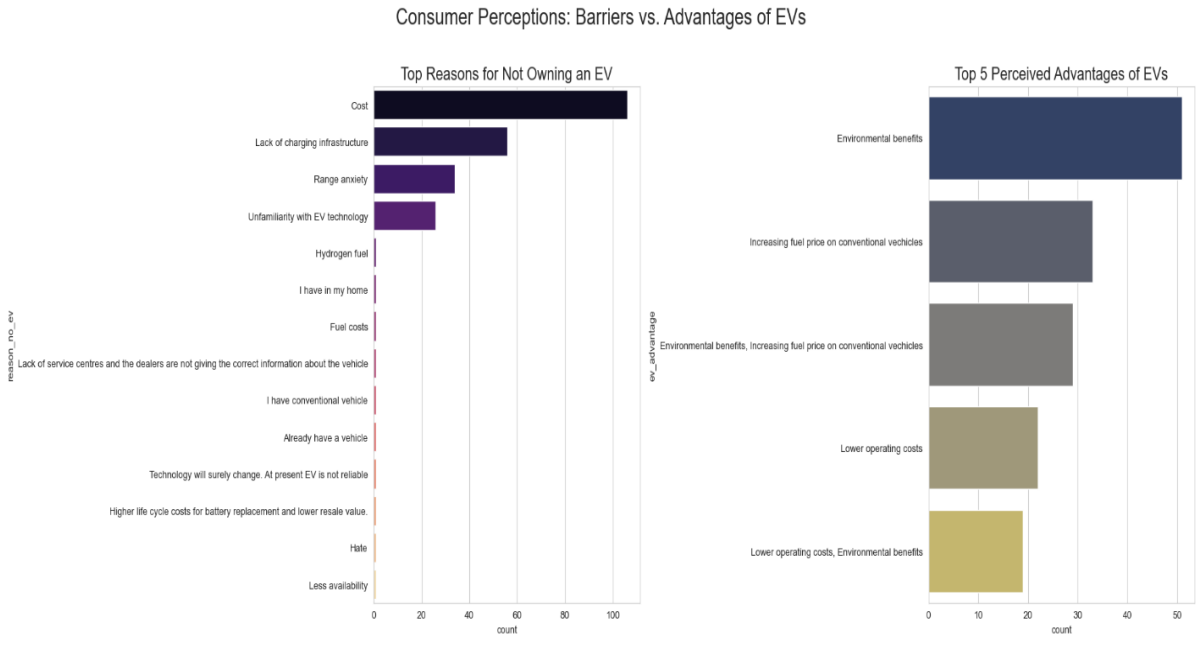
3.3 CONSUMER PERCEPTIONS: BARRIERS VS. ADVANTAGES OF EVS

The following plots provide an overview of consumer perceptions regarding Electric Vehicles. This comparison is crucial for several reasons:

1. To Establish the Perception Profile: These plots reveal a clear distinction between the recognized benefits of EVs and the practical barriers preventing their adoption. The primary reasons for not owning an EV are practical concerns like the lack of charging infrastructure and high initial cost. Conversely, the most cited advantages are environmental benefits and the rising cost of fuel for conventional vehicles. Placing these two opposing viewpoints side-by-side immediately tells the reader *what* the respondents

think, establishing the core conflict in their decision-making process.

2. To Provide Context for Other Findings: This perception profile is the lens through which the study's findings on purchase intent should be viewed. For example, when the statistical analysis later shows a mixed likelihood of purchasing an EV in the next 5 years, this graph provides the "why": the practical barriers like infrastructure and cost are currently outweighing the appeal of the long-term environmental and financial benefits for many consumers.
3. To Identify Market Challenges: Presenting this comparison is critical because it transparently shows the current challenges within the EV market from a consumer perspective. It highlights that the potential for growth (driven by the recognized advantages) is being held back by significant, unresolved issues (the barriers). This suggests that to accelerate EV adoption, industry and government efforts need to be focused on mitigating these specific disadvantages.



3.4 HYPOTHESIS TESTINGS AND FINDINGS

To dig in deeper into the survey data, four hypotheses were formulated and tested using appropriate statistical methods. The findings provide quantitative support for several key trends in consumer sentiment.

3.4.1 DOES DRIVING AN EV AFFECT PURCHASE LIKELIHOOD?

H_0: The distribution of purchase likelihood scores is the same for those who have driven an EV and those who have not.

H_1: The distribution of purchase likelihood scores is higher for those who have driven an EV.

Test: Mann-Whitney U Test

Result: The test yielded a P-value of 0.0316. Since this is less than the significance level of 0.05, we reject the null hypothesis. The mean likelihood score for those who have driven an EV was 3.08, compared to 2.71 for those who have not.

Conclusion: Yes. There is a statistically significant association. Those who have had firsthand experience with an EV show a higher likelihood to purchase one in the future.

3.4.2 DOES INCOME GROUP AFFECT PURCHASE LIKELIHOOD?

H_0: There is no difference in purchase likelihood scores across the different income groups.

H_1: There is a significant difference in purchase likelihood scores across the different income groups.

Test: Kruskal-Wallis H Test

Result: The test yielded a P-value of 0.2703. Since this is greater than 0.05, we fail to reject the null hypothesis.

Conclusion: No. The analysis did not find a statistically significant effect of income on the stated likelihood to purchase an EV. This suggests the appeal and desire for EVs are broadly distributed across different economic brackets within this sample.

3.4.3 DO EV OWNERS SPEND LESS WEEKLY ON ENERGY THAN CONVENTIONAL VEHICLE OWNERS?

H_0: The distribution of weekly spending ranks is the same for EV and conventional vehicle owners.

H_1: The distribution of weekly spending ranks is different.

Test: Mann-Whitney U Test

Result: The test yielded a P-value of 0.0002. This is highly significant ($p < 0.05$), so we reject the null hypothesis.

Conclusion: Yes. There is a significant difference in weekly energy spending. The median spending rank for conventional vehicle owners was 3.0 (representing the ₹500-1000 range), while for EV owners it was 2.0 (representing the ₹50-100 range).

3.4.4 IS THERE A LINK BETWEEN WANTING GOVERNMENT INCENTIVES AND WANTING MORE EV OPTIONS?

H_0: There is no association between a respondent's support for government incentives and their desire for more EV options.

H_1: There is an association between the two opinions.

Test: Chi-Square Test for Independence & Cramer's V

Result: The test yielded a P-value of 0.0000 ($p < 0.05$). The Cramer's V effect size was 0.306, indicating a moderate strength of association.

Conclusion: Yes. A significant association exists. People who believe the government should offer incentives are also highly likely to want more EV models available on the market.

CHAPTER IV
FINDINGS AND CONCLUSION

4.1 FINDINGS OF THE STUDY

- The largest group of survey respondents consists of young adults (18-25) who are students and have limited or no income.
- The majority of participants own a conventional vehicle, most commonly a 2-wheeler.
- The main driver for considering an EV is its environmental benefit, while the primary barrier is the high upfront cost.
- Having driven an EV has a statistically significant positive effect on a person's likelihood to purchase one ($p = 0.0316$). This proves that experiential marketing is a powerful tool for this product category.
- The desire to purchase an EV does not significantly differ across income levels ($p = 0.2703$). The appeal of EVs is broad, even if the financial capacity to own one is not.
- EV owners report significantly lower weekly energy costs compared to their conventional vehicle counterparts ($p = 0.0002$). This validates a key marketing claim.
- There is a strong statistical association between the public's desire for government purchasing incentives and their demand for a wider variety of EV models ($p < 0.0001$).

4.2 CONCLUSION

This statistical study provides valuable insights into the complex landscape of consumer sentiment regarding conventional versus electric vehicles. The analysis reveals compelling evidence that consumer attitudes are shaped by a practical assessment of benefits versus barriers. While long-term advantages like environmental sustainability and lower operating costs are widely acknowledged, the immediate hurdles of high initial cost and the perceived lack of adequate charging infrastructure remain the most significant deterrents.

The statistical tests reinforce these observations with compelling evidence. The most impactful finding is the strong correlation between test-driving an EV and an increased likelihood of future purchase, highlighting the power of direct experience. Furthermore, the study indicates that the desire for EVs is not confined to high-income brackets, as purchase likelihood was found to be independent of income level. This broad appeal is contrasted by the clear financial benefit for current EV owners, who spend significantly less on weekly energy costs. Finally, the strong link between the call for government incentives and the demand for more market variety suggests that consumers are looking for a joint effort from policymakers and manufacturers to make the switch to electric more feasible and attractive.

To capitalize on these insights, **industry and policymakers** should focus on strategies that bridge the gap between consumer aspiration and ownership. Based on the findings, the following recommendations are proposed:

1. **Invest in Experiential Marketing:** Given the proven "Test Drive Effect," manufacturers and dealerships should prioritize initiatives like extended test drives and vehicle loaner programs to give potential customers firsthand experience with EV performance.
2. **Shift Marketing Focus to TCO:** Since cost is a primary barrier but desire is universal, marketing campaigns should de-emphasize the sticker price and focus on the Total Cost of Ownership (TCO), highlighting the statistically

proven weekly savings on energy.

3. **Advocate for and Publicize Infrastructure Growth:** The strong link between incentives and market demand indicates that public-private partnerships to expand the charging network are critical. Publicizing this growth can also help alleviate consumer anxiety.

Ultimately, by leveraging these data-backed insights, **industry and policymakers** can craft more effective strategies to address consumer concerns, build market confidence, and accelerate the adoption of electric vehicles.

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APPENDIX

PERSONAL DETAILS

1. Please enter your Name:

2. What is your age?

Under 18
18-25
25-40
40-50
50 above

SOCIO-ECONOMIC DETAILS

3. What is your current status?

Working
Student
Others

4. What is your income?

Below 50000
50000- 2 lakh
2 lakh-4 lakh
Above 4 lakh
NA

CASE STUDY ON CONVENTIONAL VEHICLES VS ELECTRIC VEHICLES BASED DETAILS

5. Do you own a conventional vehicle or an electric vehicle?

Conventional Vehicle
Electric Vehicle
NA

6. What type of vehicle do you own?

2-wheeler Conventional vechicle
4-wheeler Conventional vechicle
2-wheeler Electric vechicle
4-wheeler Electric vechicle
Other

7. How many vehicles do you own?

0-2
3-5
More than 5

8. How much do you spend on fuel per week (if you own a conventional vehicle)?

Less than Rs 100
100-500
500-1000
Above 1000

9. If you own an EV how often do you use public EV charging stations?

Less often	1
	2
	3
	4
More often	5

10. How much do you spend weekly on charging your EV (if you own an electric vehicle)?

0-50
50-100
100-200
200 above

11. Do you relay on solar for charging EV?

Yes
No
NA

12. How concerned are you about the environmental impact of vehicles?

Not at all concerned
Slightly concerned
Moderately concerned
Very concerned
Extremely concerned

13. What do you believe is the biggest advantage of owning an EV?

Lower operating costs
Environmental benefits
Quieter ride
Better driving experience
Increasing fuel price on conventional vechicles
Other

14. What do you believe is the biggest disadvantage of owning an EV?

Limited range
Lack of charging infrastructure
Higher upfront costs
Longer charging times
Battery Failures
Other

15. Besides air pollution do you think since EVs are much quieter than conventional vehicles, it contributing to lesser noise pollution?

Yes
No
Maybe

16. Do you believe that EVs and Hybrid vehicles will eventually replace gasoline-powered vehicles?

Yes
No
Maybe

17. If you have never owned an EV, what is the primary reason for this?

Cost
Range anxiety
Lack of charging infrastructure
Unfamiliarity with EV technology
Other

18. Have you ever driven a electronic vehicle?

Yes
No

19. Do you believe that there should be more EV options available on the market?

Yes
No
Maybe

20. How likely are you to purchase an EV or hybrid vehicle in the next 5 years?

Less likey	1
	2
	3
	4
More likey	5

21. What was your overall impression on EVs?

Less likey	1
	2
	3
	4
More likey	5

22. Do you believe that the government should provide incentives for individuals to purchase EVs or hybrid vehicles?

Yes
No
Maybe

23. Why do you think people prefer conventional vehicles over electric vehicles?

Low maintance
Availability of gas stations
Parts easily available
Modifications easily done
Other

24. As EV is quieter than conventional cars does it leads to more accidents?

Yes
No
Maybe

25. Do you think EVs have better resale values than conventional vehicles?

Yes
No
Maybe

26. In your opinion what vehicle has better mileage?

Electric Vehicles
Conventional Vehicles
Don't Know

27. In your opinion which vehicle is better to maintain?

Conventional Vehicles
Electronic Vehicles

28. Do you think your income influences you when you buy a vehicle?

Yes
No
Maybe