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Research Paper

Forecasting the Future of Four-Wheeled Electric Vehicles through Predictive Analytics

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Abstract:
Predictive analytics is a data-driven crystal ball that helps in beautifully predicting future happenings based on the past. The technology is important for such rapid expansion in an industry like electric vehicles (EVs) in the country. We provide services to the sector of EVs.
A lot of benefits arise from the predictive analysis of four-wheeler EVs. One, of course, is battery health; batteries can anticipate problems via predictive analytics, and owners can adapt their charging patterns accordingly to optimize battery life. These smart charging systems can leverage predictive analysis to optimally channel energy demands from EVs to avoid grid over stresses while also ensuring the location of charging stations where they are most needed. Analytics may also help with range predictions and route-planning, considering real-time parameters such as traffic and weather.
This smartening of the cities shall not just be traffic management but energy conservation as well, hence benefitting society. Charging stations can replenish EVs while utilizing solar and wind energy, hence furthering the agenda of cleaner energy in India. With the use of this technology, a great deal more than mere predictive insight is given to policymakers and investors regarding consumer actions in the future.
This way, predictive analytics works toward alleviating the challenges involved in owning EVs and improves convenience and cost-effectiveness. This is helping manufacturers, service providers, and policymakers create a whole new, much better and more sustainable EV ecosystem-expectations and analytic predictions changing the entire age of lower maintenance costs, much reduced energy consumption, and vastly improved reliability-for a future where electric mobility is much more accessible, efficient, differently sustainable, and intelligent; predictive analytics is key in enabling that future.

Keywords: *Forecasting, Future trends, Electric Vehicles, Predictive analytics, Battery Optimization, and Charging Infrastructure.*

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I. Introduction

As human evolved over centuries, they have made things convenient around them one of them is vehicles. With the raising concerns of environment people have started using more environment friendly options such as EV Vehicles.

Four-wheeler electric vehicle (EV) adoption forecasting in India has been transformed, spurred by growing environmental awareness and faster technology advancement. It was more focused on the technical feasibility and greenness, initially speculative, in the early 2000s and 2010s. But the mid-2010s were marked with a shift as the government came up with policies like NEMMP 2020 and the FAME scheme, leading to market-based forecasts such as subsidies and infrastructure spending. The late 2010s and beyond have seen the shift in EV forecasting with data analytics and machine learning, with the ability to deal with humongous data like consumer habits and charging point usage.

This research aims to capitalize on such developments by formulating sophisticated predictive models for making well-informed predictions regarding the development of four-wheeled EVs in India. For this, the research will examine the multi-dimensional drivers of EV take-up in economic, social, technological, and policy contexts; formulate robust predictive models with machine learning and statistical methods; evaluate the impact

of government policy and charging infrastructure; and present actionable insights to stakeholders for decision-making.

However, there is an underlying problem: current models cannot sense Indian market subtleties, i.e., regional differences and evolving infrastructure. Specifically, there is scant research for employing advanced predictive analytics in India, particularly integrating advanced policy impacts, infrastructure growth rates, consumer price sensitivities, and socioeconomic factors. Additionally, a lack of authentic data on the second-hand market of EVs and income level differences between urban and rural areas in adoption comes in the way of effective production and infrastructure planning and thus impedes India's transition to clean transport.

This research roads into the domain of EV adoption forecasting in India in the growing line and paves new ways to impact. Besides theoretically making some contribution in drawing detailed predictive models that consider specific features of this Market, the study intends to furnish stakeholders-policymakers, manufacturers, and infrastructure developers-with more precise and actionable insights. This research proposes the use of advanced predictive analytics in transcending the usual forecasting methods, as they tend to fail in grasping the dynamic nature of the uptake of electric vehicles. The value here lies in its very essence to provide predictions for the various key players in the value chain. These will enable accurate and timely forecasts, thereby allowing decision-makers in formulating incentives in sector-specific modes, in proposing infrastructure developments, in optimizing production and stock levels, and in facilitating investment decision-making regarding market entry and growth. Additionally, it will assist establishing strong predictive models aimed at addressing regional variances and market dynamics specific to India, thereby addressing shortcomings existing to date. Enhanced projections for the adoption of electric vehicles would help this research further in expediting India's transition toward sustainable transport and achieving climate-change objectives.

India now stands at the crossroads of a very delicate institution toward achieving a much-sought-for sustainability in mobility. While the world is heading on electric mobility, the unique socio-economic structure, coupled with the fast-expanding infrastructure of India, gives rise to both opportunities and challenges. Diverse consumer choices, dispersed income, and unequal regional disparity-all characteristics of India's automotive sector-drive the steep demand for electric vehicles.

Also, infrastructure establishment such as charging station rollouts behaves very differently between urban areas and rural settings, creating a dynamic and multi-faceted environment. Current predictive models, designed mainly for developed economies, do not do justice to these insistent and outstanding complexities. They generalize particular assumptions without taking into account unique policy stimuli like the FAME Scheme and certain state-level incentives to promote electric vehicles in India.

Filling a tiny gap between current forecasting techniques and the requirements of the Indian market, this study wishes to ensure a more humane transition toward electric mobility. Propitious models for contextual predictions help the stakeholders make decisions on the basis of data, boost four-wheeler electric vehicle adoption, and help India in achieving its overall aims of carbon emission abatement in the interest of energy security.

II. Literature Review

The overall literature review deals with the latest trends in the market of electric vehicles, talking about increased sales and a tendency towards electric automobiles in the automobile sector. It discusses the green advantages of using electric vehicles to cut down harmful greenhouse gases into the atmosphere and discusses the economic dimensions of this changeover from internal combustion engines to electric vehicles ***(Sofana Reka S, Prakash Venugopal, Ravi V, 2022)***. The research paper also aims to bring electric vehicles into smart grids and green smart cities by the perspective of big data analytics. Big data generated from electric vehicles, drivers, and infrastructure can optimize charging processes, improve battery management, and enhance grid interaction ***(Dr. Erol-Kantarci, 2017).*** The authors develop a two-step noise reduction technique and engineer 39 domain features based on reconstructed battery charging data segments for predicting capacity fade for large-format LiFePO4 batteries for application in electric vehicles ***(Jingyuan Zhao, Heping Ling, 2023).*** Important determinants of the future demand for electric vehicles in the UK are discussed. A system dynamics model is applied in order to explore a series of those factors such as subsidy, vehicle range, number of charging points, emission rates, and tax on EV uptake and CO2 emissions. The study suggests that though government subsidies indeed add to the increase in adoption, the roles of word-of-mouth transmissions and average vehicle lifespan, besides shrinking the gap of differences in emission reductions, may be more central. ***(Simon Shepherd, Peter Bonsall, 2012).*** There is also an empirical analysis of the effects of artificial intelligence (AI) on electric vehicle technology innovation by employing a machine learning-based text mining model and the international patent classification (IPC) co-occurrence network analysis, using patent data filed from 1980 to 2017. Based on artificial intelligence algorithms classified, the study demonstrates the dynamic changing pattern of the convergence of artificial intelligence and electric vehicle technology and reveals how artificial intelligence has affected electric vehicle technology innovation over time***. (Mekyung Lee, 2020).*** The article describes an integration framework and how it harmonizes the integration of electric vehicles into existing power systems. It talks about the various

stakeholders involved, the simulation studies undertaken, and the larger implications of increased adoption of electric vehicles on grid configuration and overall energy consumption patterns. The study asserts that effective forecasting is very vital in addressing the challenges of EV integration**. *(K. C. Akshay, G. Hannah Grace, Kanimozhi Gunasekaran & Ravi Samikannu, 2023).*** The Internet of Vehicles (IoV), where people, fleets of electric vehicles (EVs), utility, power grids, distributed renewable energy, and communications and computing infrastructures are connected, has emerged as the next big leap in smart grids and city sectors for a sustainable society. Meanwhile, decentralized and complex grid edge faces many challenges for planning, operation, and management of power systems. Therefore, providing a reliable communications infrastructure is vital. ***(Bhaskar Rimal, Bikrant Poudel, 2022).*** The hybrid energy storage systems are a practical tool to solve the issues in single energy storage systems in terms of specific power supply and high specific energy. These systems are especially applicable in electric and hybrid vehicles. Applying a dynamic and coherent strategy plays a key role in managing a hybrid energy storage system. The data obtained while driving and information collected from energy storage systems can be used to analye the performance of the provided energy management method. Most existing energy management models follow predetermined rules that are unsuitable for vehicles moving in different modes and conditions. Therefore, it is so advantageous to provide an energy management system that can learn from the environment and the driving cycle and send the needed data to a control system for optimal management. In this research, the machine learning method and its application in increasing the efficiency of a hybrid energy storage management system are applied. ***(John William, Paitoon Chetthamrongchai, 2022).*** The research aims at reviewing the change of the world from fossil fuel-burning vehicles to electric cars in reducing pollution. Further, the paper analyses the genesis of electric hybrids and sources of their supply, advantages and disadvantages, and the key components. Other challenges on electric vehicles are discussed, and solutions proffered, noting that renewable energy can create a pollution-free atmosphere. ***(Sumathy Muniamuthu, S. Krishna Arjun.M. Jalapathy, S. Harikrishnan, 2018).*** The document combines advanced discrete choice models with diffusion models in order to predict the market share of electric vehicles. It stresses the emphasis on consumer preference and experience as it impacts the adoption of electric vehicles, considering that conventional methods often underestimate long-term demand for EVs. This study is referenced to give a more accurate prediction framework based on the complexity of consumer behaviour and market dynamics. ***(Anders Fjendbo Jensen, Elisabetta Cherchi, Stefan Lindhard Mabit, Juan de Dios Ortúzar, 2017)***. The performance and life of a battery in an electric vehicle represent some of the most vital parameters related to the total efficiency, economy, and acceptability of electric vehicles. In the face of growing electric vehicle demand, the best utilization of the battery management system becomes paramount. Key predictors of battery degradation and performance variability are determined in the present study by applying techniques of advanced data analytics, such as machine learning algorithms and statistical models. The present research will make use of an aggregate dataset comprising historic metrics of the performance of each battery, real-time use data from EVs, and environmental vectors such as temperature and humidity. It aims to develop predictive models identifying patterns and correlations that can give insight into better battery management strategies. The conclusions drawn will include practical recommendations on battery maintenance, better charging practices, and prolonging their lives. This research helps to further expand general knowledge about the ways predictive analytics might be used to help solve some of the most important issues facing electric vehicle battery technology. ***(Sharo Paw, Wint Wah Loon, 2024).***

Research Gap:

i) There has not been much study taken place in India with respect to this topic.

ii) This study investigates the EV sector in India, its prominence and its rate of adoption by the general population.

iii) While there is significant research on forecasting electric vehicle adoption based on advancements, environmental impacts, few studies incorporate how government policies, subsidies (such as income levels, urban vs. rural adoption rates, laws, economic changes) and regional infrastructure challenges (charging stations, grid capacity) influence the future growth of 4-wheeled electric vehicles across different states and demographics in India. Developing predictive models that address these factors could offer more accurate forecasts and tailored policy recommendations.

Objectives of the Study:

The objective of the research paper, forecasting the Future of Four-Wheeled Electric Vehicles through Predictive Analytics is to study and predict major trends in the electric vehicle (EV) industry.

- With the analyses of historical data and present market conditions, it will be anticipated that EV adoption will give an increasing growth on technology advancement as well.
- The study looks into the policy and regulations of the government as it influences manufacturing, pricing, and infrastructure set up regarding Electric Vehicles.
- Consumer understanding and preferences are also important to know how demand for electric vehicles might change over time.

- One of the aspects also is to study the competitive scene: forecasting the role of traditional automakers, tech companies, and new entrants.
- It will also look into the developments made towards charging infrastructure and what such a development does for mass EV adoption.
- The research also includes some of the wider economies and environmental effects of the adoption of electric vehicles for instance, job creation or decrease in carbon emission.
- The utmost end of this research would be turning actionable insights for manufacturers, investors, and policymakers to strategically guide the rapidly changing industry.

Scope of the study:

i) The study is conducted for 50 respondents.
ii) The study is conducted within the geographical borders of Bangalore.
iii) The study is conducted between the period of March 1st to March 22nd, 2025.

III. Research Methodology:

i) Size of the Study:

The sample size taken up for the study is 50 respondents.

ii) Source of Data Collection:

The data was collected using Primary and Secondary sources of data collection.
The primary data was collected through a questionnaire.
The secondary data collected is the published information from reports, research papers, articles, and the internet.

Sampling Technique:

Convenience Sampling was used to collect the data. A simple random sample is a randomly selected subset of a population. In this sampling method samples are collected by taking samples that are conveniently located around a location or Internet service.
Convenience sampling is a method of non-probabilistic sampling that involves collecting samples from easily accessible locations or sources, such as computer science classes or online platforms.

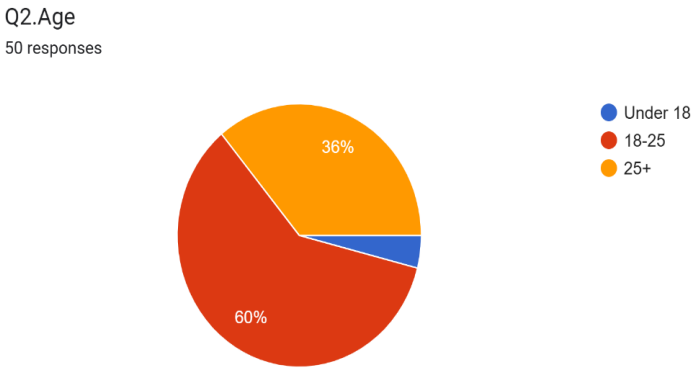
Data Analysis:

Data analysis is the process of inspecting, cleaning, transforming, and modelling data to extract useful information, draw conclusions, and support decision-making. In the context of the study conducted on Forecasting the Future of Four- wheeled Electric Vehicles through Predictive Analytics, data analysis involves examining the collected information from the questionnaire responded by 50 respondents.

Q2. Age.

S.NO	CHOICES	NO OF RESPONDENTS	PERCENTAGE
1	Under 18	2	4%
2	18-25	30	60%
3	25+	18	36%
	TOTAL	50	100%

Interpretation: 4 % respondents are from Under 18 years category whereas 60% are from 18-25 years and 36% are from 25+ category.



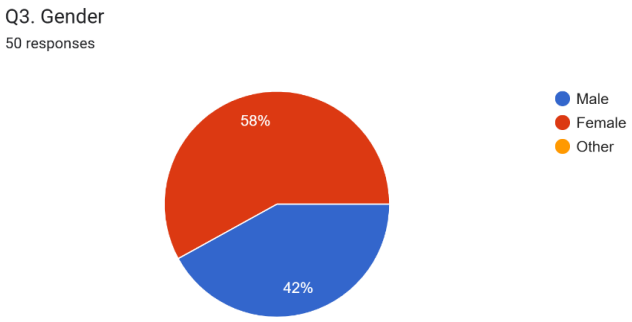
Analysis : Of the respondents, 60% were aged 18-25 and 36% were older than 25 years, indicating an appropriate context on electric vehicles' (EV's) attitudes in the survey sample. The large share of 18-25-year-olds indicates

some heightened interest and involvement by younger adults in EV technology that might reflect increased receptivity to technological innovations and social awareness towards the environment. As would be expected, this category might as well indicate an extended inclination toward the eventual long-term value and reliability focus. In fact, the group of under 18 respondents, which still holds almost negligible at 4%, generally shows that such type of demographic may not have direct powers to purchase but has substantial indirect powers of influence for family purchases. Basically, distributions reflect the best cohorts of young adult (18-25) responses indicating that most of the survey captures the insight of adults that are more likely early adopters as well as drivers in the EV-the-cycle market. To this end, the profile could produce more participants who, by coincidence, might have more characteristics that interest technology or may have demonstrated active participation in the sustainable transportation environment.

Q3. Gender.

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Male	21	42%
2	Female	29	58%
3	Other	--	--
	TOTAL	50	100%

Interpretation: 42% respondents are males, 58% are females.



Analysis: It is possible that women are more engaged in electric vehicles. This may be because of environmental concerns, safety features, or vehicle design. It is necessary to understand if this finding was representative of the greater population or if it was a bias in the study.

Q4. How familiar are you with the concept of predictive analytics?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly familiar	10	20%
2	Familiar	31	62%
3	Not very familiar	8	16%
4	Not at all familiar	1	2%
	TOTAL	50	100%

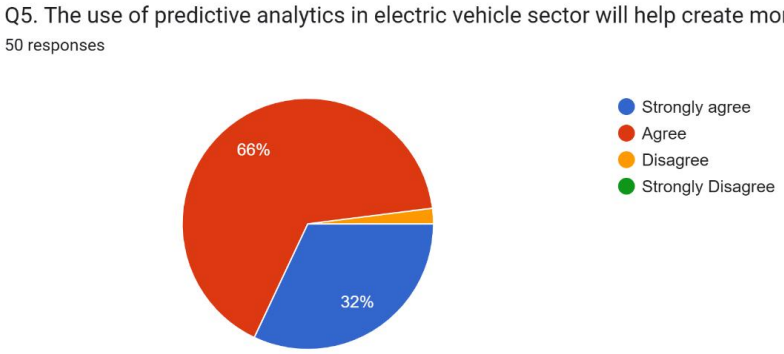
Interpretation: 20% of the respondents are strongly familiar with the concept possessing a vast knowledge, 62% are familiar, 16% are not that familiar whereas 2% is not at all familiar

Analysis: The results of the survey show that respondents tend to be fairly familiar with predictive analytics. In total, 82% of respondents (20% strongly familiar, 62% familiar) are at least somewhat familiar with the concept. This suggests that predictive analytics is becoming more recognized and familiar to people, likely due to applications across various industries growing. However, 16% of respondents say they are "not that familiar", showing that there is still a need for education and awareness in the general public about the capabilities and benefits of predictive analytics. Only 2% of respondents claim they are "not at all familiar", meaning that only a small minority are niche with limited exposure to predictive analytics. Overall, these results indicate there is a good amount of understanding to build upon buy-in and application of predictive analytics in the electric vehicle sector.

Q5. The use of predictive analytics in electric vehicle sector will help create more sustainability.

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly agree	16	32%
2	Agree	33	66%
3	Disagree	1	2%
	TOTAL	50	100

Interpretation: 32% respondents reported they strongly agreed with the statement that predictive analytics would help sustainability in electric vehicle sector, 66% reported that they agreed, 2% respondents voted that they disagreed with the statement.



Analysis:

• High Perceived Positive Impact: - Respondents exhibit a noteworthy high level of agreement on the perception that predictive analytics contributes to sustainability. This indicates an overarching assumption about the predictive analytics having a positive environmental impact.

- When exploring the depth of this assumption, the results show almost all respondents believed there was a relatedness between the two.

• Validation of Hypothesis: - The data collected provide strong empirical support to the hypothesis that predictive analytics would act as a driver of sustainability.

- This speaks to the research question and validates the exploration of this relationship.

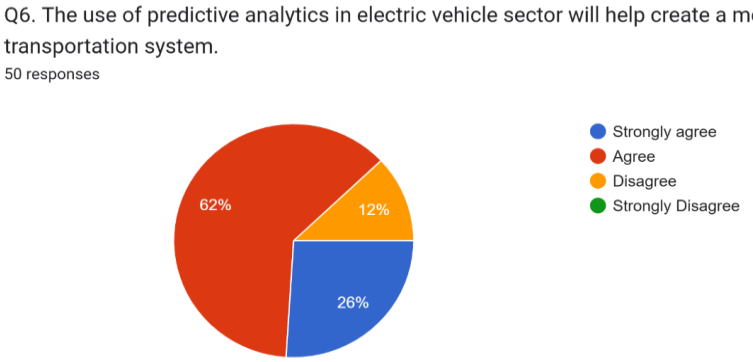
• Identification of Consensus: - The low-disagreement factor indicates strong consensus to respondents suggesting a collective understanding of potential benefits to the technology. A consensus supports the relevancy of the results.

• Importance Prominence: - The analysis indicates deliverables importance, as it relates to the interest in predictive analytics and sustainability in the EV industry. To put it another way, there may be opportunity for predictive analytics to come into alignment with sustainable environmental goals.

Q6. The use of predictive analytics in electric vehicle sector will help create a more sustainable transportation system.?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	13	26%
2	Agree	31	62%
3	Disagree	6	12%
4	Strongly Disagree	--	--
	TOTAL	50	100

Interpretation: 26% respondents strongly agreed with the statement that predictive analytics in the electric vehicle sector would help create a more sustainable transportation system, 62% agreed and 12% disagreed.

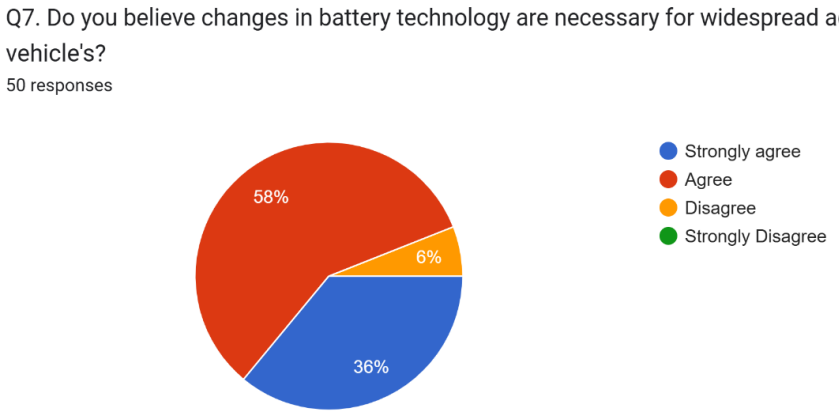


Analysis: The survey data indicates a strong, but not unanimous, agreement about predictive analytics being a positive factor in a more sustainable transportation system for electric vehicles. For example, 26% of respondents strongly agreed, and 62% agreed, so that together they sum to 88% total agreement. However, 12% - a respectable number - disagreed that predictive analytics is a positive factor in sustainable transportation. This disagreement suggests that the complexities and potential negative aspects of the role of predictive analytics in EV based transportation systems requires further exploration. The disagreement could stem, in part, from views of sustainability in the life cycle of electric vehicles, namely, with regard to battery disposal. Respondents may consider the environmental footprint from the production and disposal of batteries to be far greater considerations than potential positive contributions from predictive analytics, even if engines are operated optimally and routes have been pre planned using predictive analytics. Therefore, while the majority, in the generality, would acknowledge the opportunity for potential, the higher degree of disagreement rests on a significant minority.

Q7. Do you believe changes in battery technology are necessary for widespread adoption of electric vehicles?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	18	36%
2	Agree	29	58%
3	Disagree	3	6%
4	Strongly Disagree	--	--
	TOTAL	50	100

Interpretation: 36% respondents reported they strongly agree that advancement in battery technology would help widespread adoption of Electric vehicles, 58% respondents agreed meanwhile, 6% respondents disagreed.



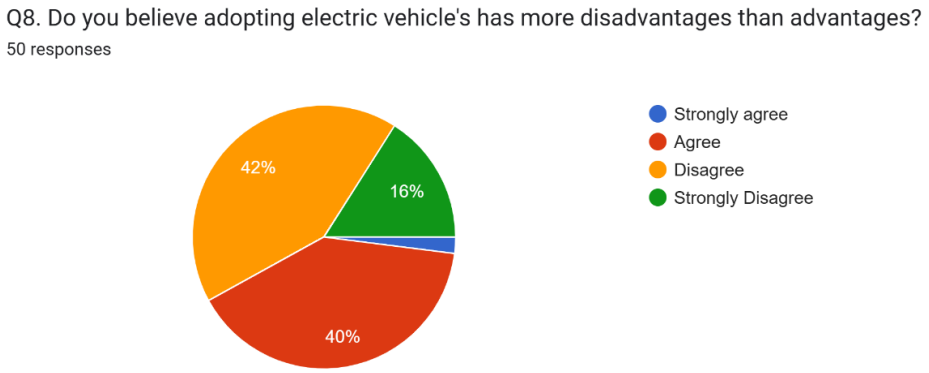
Analysis: The survey results showed a resounding agreement surrounding the need for improved battery technology in order to increase the adoption of EVs. Thirty-six percent (36%) strongly agreed, and fifty-eight

percent (58%) agreed for a combined total of ninety-four percent (94%) who agreed. This reflects a commonly held belief that improved battery technology will be necessary for the EV markets expansion. There is much agreement and only six percent (6%) of respondents disagreed meaning the number of individuals who held a contrary opinion to the majority was a very small minority. The overall aggregate of agreement suggests a strong sentiment around battery technology playing an important role in the future of EVs and suggests that the enhanced battery technology should be pushed toward the forefront of future research.

Q8. Do you believe adopting electric vehicles has more disadvantages than advantages?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	1	2%
2	Agree	20	40%
3	Disagree	21	42%
4	Strongly Disagree	8	16%
	TOTAL	50	100

Interpretation: 2% respondents reported that they strongly agree with the statement that the adoption of Electric Vehicles has more disadvantages than advantages, 40% respondents agreed, 42% disagreed and 16% strongly disagreed.



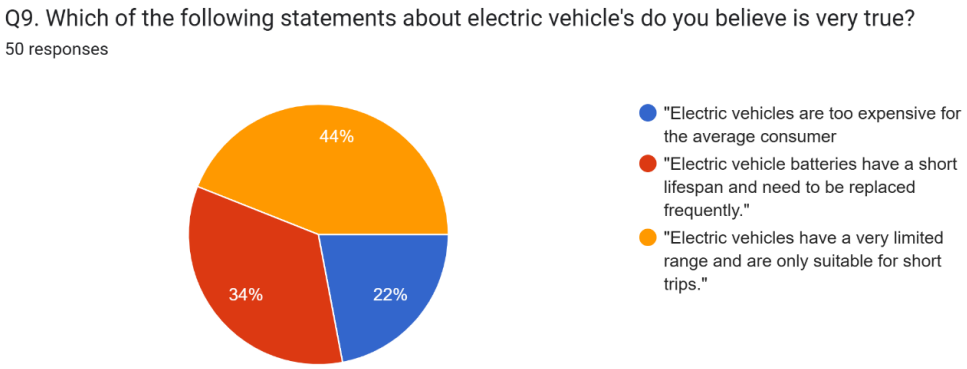
Analysis: The survey results indicate that there is a general assumption the upside of electric vehicles (EVs) outweighs the downside, as 58% of the respondents disagreed or strongly disagreed, which might indicate a developing awareness of the environmental benefits of EVs (e.g,. less emissions, low cost of operation, etc.).. This positive sentiment may also be supported by a perceived increase in performance, and desire to achieve energy independence. However, the notable 42% of respondents who agreed, indicates there are still considerable concerns which are possibly related to the higher upfront price point, range, availability of charging options and issues around battery life. This was duly noted, and while EVs show a positive trend overall, it was also important to note valid concerns when attempting to influence more widespread adoption of a sustainable mode of transport.

Q9. Which of the following statements about electric vehicle's do you believe is very true?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	"Electric vehicles are too expensive for the average consumer"	11	22%
2	"Electric vehicle batteries have a short lifespan and need to be replaced frequently."	17	34%
3	"Electric vehicles have a very limited range and are only suitable for short trips"	22	44%
	Total	50	100%

Interpretation: 22% respondents reported that they believed electric vehicles are too expensive for the average consumer, 34% respondents reported that they believed electric vehicles batteries have short lifespans and need to be frequently replaced, 44% respondents

Reported that they believed electric vehicles have a limited range and are only suitable for short trips.

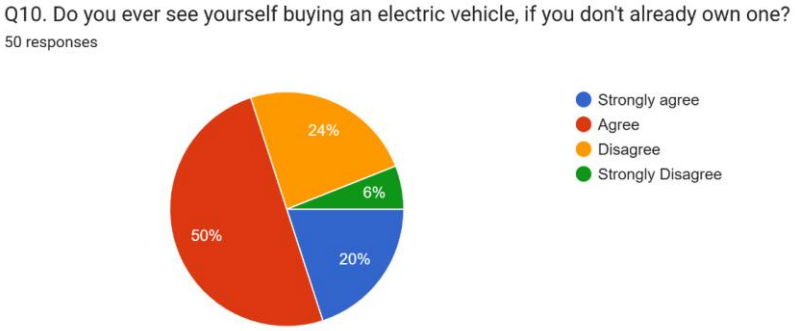


Analysis: The survey results revealed three broad but perceived truths about batteries (EVs) that shape public perception. The largest group (44%) thinks that EVs have limited range, most likely resulting from media representation of the EVs and the limited range of even earlier models. Idea-limiting "range anxiety" discourages the use of EVs for all but very short trips. The second-largest group of respondents (34%) believes that an EV has limited battery life and that one should replace it frequently. This is likely to stem from worries about battery life due to heavy usage, the cost of replacing the batteries, and hence the cost that goes into long-term ownership. The last group of 22% would think that EVs are simply too expensive for the average person. While we have shown the EVs being categorized due to higher upfront purchase prices as compared to gasoline-powered vehicles, this alone provides a huge barrier preventing consumers from purchasing them. These perceived truths constructed from a mixture of media, cost, and battery enhancement present significant barriers to EV adoption for the average consumer or even some consumers.

Q10. Do you ever see yourself buying an electric vehicle, if you don't already own one?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	10	20%
2	Agree	25	50%
3	Disagree	12	24%
4	Strongly Disagree	3	6%
	TOTAL	50	100

Interpretation: 20% respondents reported that they strongly agree and see themselves buying an electric vehicle in the future, if they don't already own one, 50% respondents reported they agreed, 24% respondents reported that they disagreed and 6% respondents reported that they strongly disagree and they don't see themselves buying an electric vehicle.



Analysis:

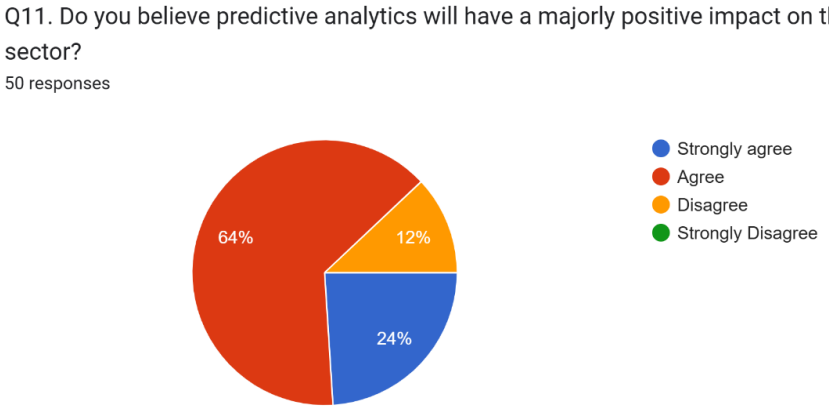
A significant majority of respondents, 70% (20% strongly agree, 50% agree) indicated that they could see themselves purchasing an electric vehicle (EV) in the future, given that they do not already own one. This suggests very strong interest in the adoption of EVs, from the population studied, and moderately good interest in EVs from the sample size taken. However, incredibly, 30% of respondents (24% disagree, and 6% strongly disagree) do not see themselves purchasing an EV.This shows that a large portion of the population is still unwilling or

unconvinced to even consider switching to an EV, and thus barriers to adoption are still evident. This perhaps demonstrates the importance of gathering further input from respondents who would not even consider the prospect of purchasing an EV in order to maximize total adoption.

Q11. Do you believe predictive analytics will have a majorly positive impact on the electric vehicle sector?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	12	24%
2	Agree	32	64%
3	Disagree	6	12%
4	Strongly Disagree	--	--
	TOTAL	50	100

Interpretation: 24% respondents reported that they strongly agree with the statement of predictive analytics having a positive impact on the electric vehicle sector, 64% respondents reported they agree meanwhile, 12% respondents reported that they disagree with the statement.

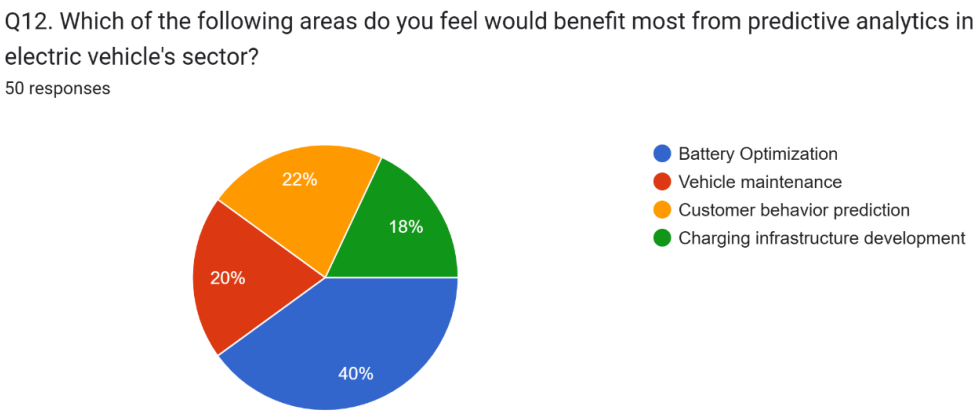


Analysis: An overwhelming majority of respondents, 88 percent (24 percent strongly agree, 64 percent agree) state a high level of conviction that predictive analytics will very much benefit the eV sector. It is indeed a good indication that predictive analytics will see improvements and advancement in the eV sector-a very strong conviction moving it. That a considerable number agrees indicates that somehow, respondents see predictive analytics optimizing some areas of EV technology and services, thereby enhancing performance, efficiency, and user experience. The fact that a minority, 12 percent, disagreed indicates possible reservations regarding what could be the potentials and limitations of predictive analytics in the EV sector. All in all, this paints a positive picture regarding predictive analytics and its impact, nay its future impact, in the EVs domain.

Q12. Which of the following areas do you feel would benefit most from predictive analytics in electric vehicle's sector?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Battery Optimization	20	40%
2	Vehicle maintenance	10	20%
3	Customer behaviour prediction	11	22%
4	Charging infrastructure development	9	18%
	TOTAL	50	100%

Interpretation: 40% respondents reported that they believed battery optimization would benefit the most from predictive analytics in the Electric Vehicle sector, 20% respondents reported for vehicle maintenance, 22% respondents reported for customer behaviour prediction and 18% respondents reported for charging infrastructure development.

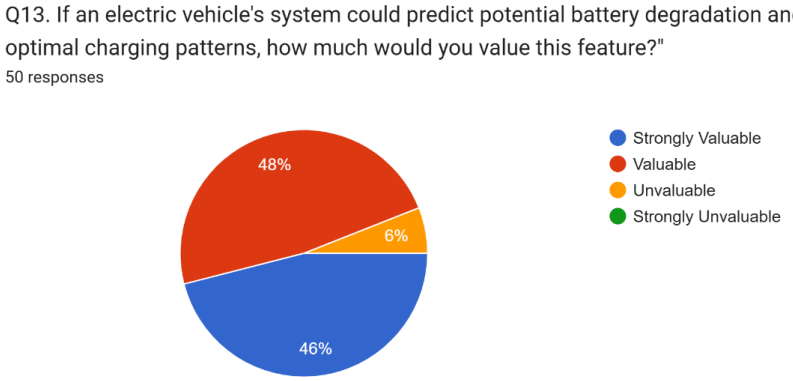


Analysis: According to the survey results, battery optimization would be the best use of predictive analytics in the EV sector, with 40% of respondents in this category. This reflects the attraction to the role the battery plays on performance and longevity within the EV sector. The second most favoured was forecasting customer behaviour, with 22% of the responses viewing this as very useful since there is a necessity for customized services and enhanced user experience. Vehicle operation and charging infrastructure development saw 20% and 18% responses, respectively, which implies that they are of concern, yet bead optimization and customer behaviour prediction are deemed much higher than the two applications on this point. This suggests a strategic vision on battery related improvement and customers oriented application of predictive analytics for the EV industry.

Q13. "If an electric vehicle's system could predict potential battery degradation and recommend optimal charging patterns, how much would you value this feature?"

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Valuable	23	46%
2	Valuable	24	48%
3	Unvaluable	3	6%
4	Strongly Unvaluable	--	--
	TOTAL	50	100%

Interpretation: 46% respondents reported that they would strongly value a feature that could predict battery degradation and recommend optimal charging patterns in an electric vehicle system, 48% respondents reported they would value it, 6% respondents reported the feature would be unvaluable to them.



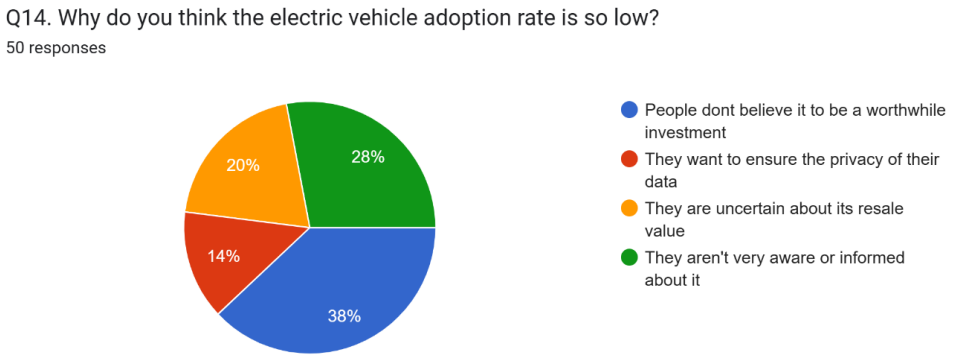
Analysis: Almost all of the respondents, at an alarming rate of nearly 94% (comprising 46% who stated very valuable and 48% just valuable), consider this EV feature of anticipating battery degradation and suggesting best charging to be very valuable. This actually emphasizes the strong leaning towards going forward with systems that will assist in controlling the battery in a proactive manner, and thereby pointing out some of the advantages related to controlling the battery degradation to enhance efficiency and utilize the battery for longer. The strength of the answer supports the need for battery health to potential and existing EV owners. The extremely low proportion of 6% of the respondents, who do not value this feature, presumably either have less concern regarding

battery degradation or feel no need to be provided with charging optimization suggestions. In general, this indicates the high demand in the market for such desirable features with smart battery management systems in EVs.

Q14. Why do you think the electric vehicle adoption rate is so low?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	People don't believe it to be a worth-while investment	19	38%
2	They want to ensure the privacy of their data	7	14%
3	They are uncertain about its resale value	10	20%
4	They aren't very aware or informed about it	14	28%
	TOTAL	50	100%

Interpretation: 38% respondents reported that the reason for the low adoption rate for electric vehicles according to them is that they don't believe it to be a worthwhile investment, 14% respondents reported that its due to customers wanting to ensure data privacy, 28% respondents reported it to be the uncertainty of the resale value, 28% respondents reported that its due to lack of awareness surrounding Electric Vehicles.

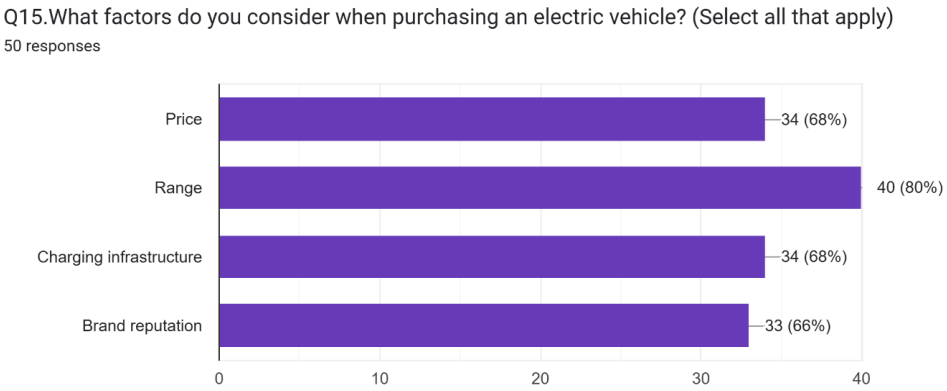


Analysis: The survey shows there are various factors contributing to owning electric vehicles at lower rates. Among them, the most common factor stated by the respondents (38%) was that EVs are not worthy of the big investment they appear to bear, meaning the total cost of ownership both upfront and throughout the long term is not justified. Another 28% of the respondents cited economic uncertainty arising out of resale values perceived to be low and little public knowledge on EVs. Followed by 14% support to consumers are concerns for privacy of data over the connected vehicle (CV) technology, which is likely to be part of most EV adoptions. This indeed highlights the rather complex relations often defined by consumers between financial, information-related, and privacy barriers toward the consideration of EV options.

Q15.What factors do you consider when purchasing an electric vehicle? (Select all that apply)

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Price	34	68%
2	Range	40	80%
3	Charging infrastructure	34	68%
4	Brand reputation	33	66%

Interpretation: This question allowed for the choosing of multiple options. Most respondents reported that 'Range' is the factor they would consider the most when purchasing an electric vehicle.

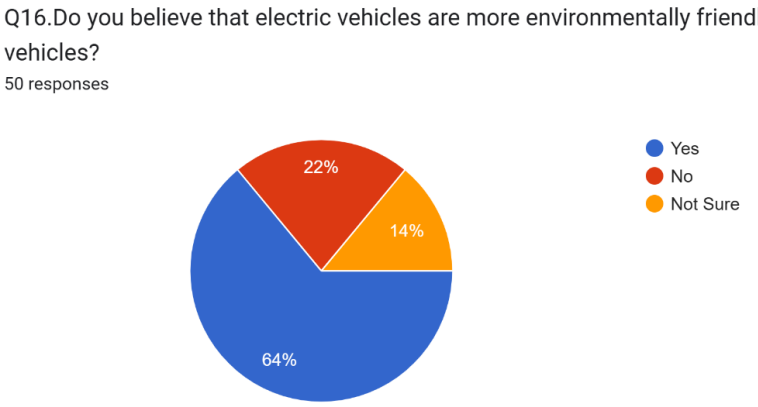


Analysis: Results from the survey reveal that the factor that generally increases much is 'range.' This indicates that travel distance capability is the consideration most crucial for consumers. By this emphasis on range, one can deduce that the usability of EVs viewed by possible buyers must be greater as travel pathways are becoming more complex and taking more time to charge while traveling without an often interruption. Such emphasis on movement distance further implies the rationale behind range focus amongst manufacturers as the increased travel distance would be something positive for consumer behaviour to move EVs to a more habitual behaviours.

Q16. Do you believe that electric vehicles are more environmentally friendly than traditional vehicles?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Yes	32	64%
2	No	11	22%
3	Not sure	7	14%
	TOTAL	50	100%

Interpretation: 64% respondents reported that electric vehicles are more environmental friendly than traditional vehicles according to them, 22% respondents reported that they are not, while 14% reported that they are not sure about the same.

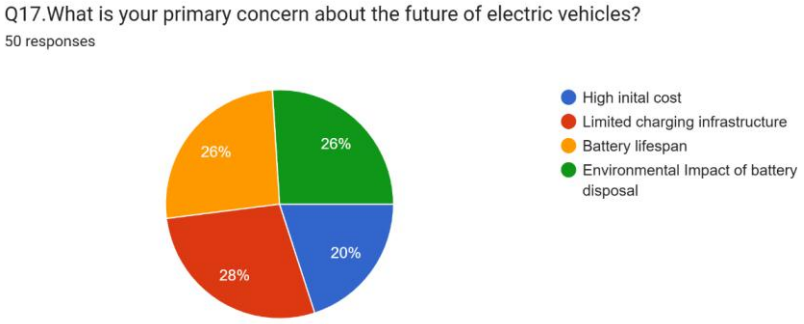


Analysis: The survey indicates that 64% of the respondents believe electric vehicles (EVs) are in fact more environmentally friendly than conventional vehicles. This indicates a strong belief in EV as a cleaner vehicle option, which may be backed up by their understanding of no tailpipe emissions and their potential to lower carbon footprints. However, 22% of the respondents, a promising proportion, did not agree with that statement, indicating there is at least some level of concern or scepticism around whether it is fair to categorize EVs as greener because of the entire environmental impact equation including battery production and electricity so on. 14 %percent were uncertain, indicating some level of uncertainty or, an unaware, confusion around the potential environmental benefit of EVs. Public education and information around the environmental impacts associated with the LCA of EV ownership would likely resolve the public scepticism reported, and hopefully increase public known awareness or completely lacking public known awareness around the topic.

Q17. What is your primary concern about the future of electric vehicles?

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	High initial cost	10	20%
2	Limited charging infrastructure	14	28%
3	Battery lifespan	13	26%
4	Environmental impact of battery disposal	13	26%
	TOTAL	50	100

Interpretation: 20% respondents reported their primary concern to be the high initial cost, 28% respondents reported for limited charging infrastructure, 26% respondents reported their concern to be the battery lifespan, and 26% respondents reported the environmental impact of battery disposal to be their concern.

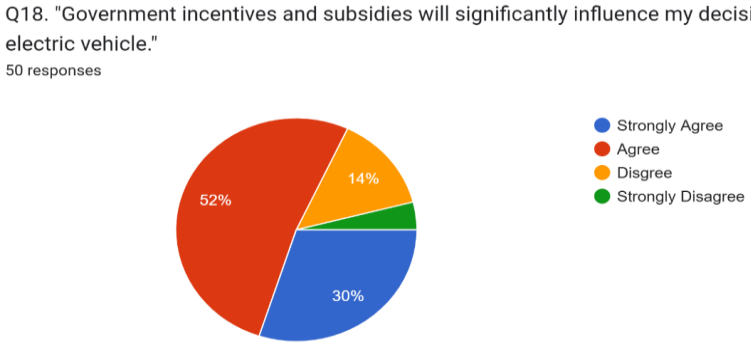


Analysis: The surveys indicate a fairly even spread among primary concerns about the future of electric vehicles (EVs), which creates somewhat of an intricate issue in line with large-scale adoption. Some 28% of all the respondents chose charging infrastructure as their main concern, indicating the need for developing reliable and robust charging networks that would allay range anxiety and bolster the general use of EVs. Relatedly, 26% feel that battery life and disposal of environmental waste posed comparable prime concerns, reflecting worries about EVs involving long-term ownership costs as well as the sustainability of the technology behind EVs. What concerned 20% of others was that the high initial outlay for them to obtain an EV creates subsequent costs associated with the use of that EV going onwards. The survey provides evidence that there is a range of issues related to infrastructure, battery sustainability, and cost that stand in the way of EV technology working for future modes of transportation, while accepting that it is really poised to make a difference in sustainable transportation.

Q18. "Government incentives and subsidies will significantly influence my decision to purchase an electric vehicle."

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	15	30%
2	Agree	26	52%
3	Disagree	7	14%
4	Strongly disagree	2	4%
	TOTAL	50	100%

Interpretation: 30% respondents strongly agreed that government incentives and subsidies would significantly influence their decision to purchase an Electric vehicle, 52% agreed, 14% disagreed whereas 4% strongly disagreed.

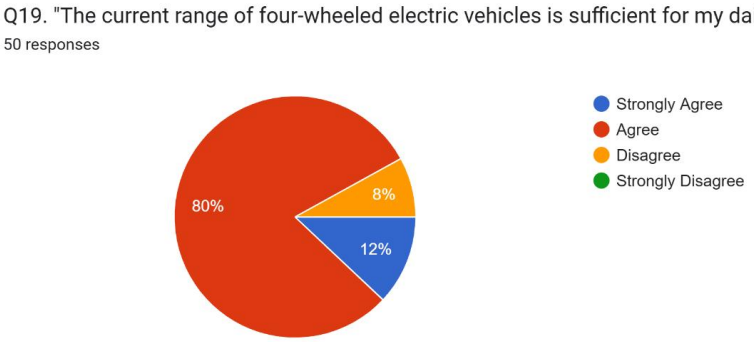


Analysis: A conspicuous subset of respondents, 82% (30% strongly agree, 52% agree) consented that government incentives and subsidies would have a significant bearing on their decision to purchase an electric vehicle (EV). This underscores the huge potential impact that financial incentives can exert on EV adoption. The percentage of strong agreements indicates that cost is a key barrier and that government support can help to break that financial barrier, thus making EVs accessible to a larger audience. A large percentage of respondents agreed to this factor, but they strongly did not agree, indicating they feel government incentives can influence their decision. The respondents in the minority that disagreed or strongly disagreed, making up 18% of respondents (14% disagree, 4% disagree strongly), likely has alternative priority in the factors influencing their decision-whether personal environmental values, technologies, or having sufficient financial means toward purchasing an EV without the help of subsidies. This implies financial incentives are a considerable driver for EV purchase, although these incentives are not the sole determinant.

Q19. "The current range of four-wheeled electric vehicles is sufficient for my daily needs."

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	6	12%
2	Agree	40	80%
3	Disagree	4	8%
4	Strongly disagree	--	--
	TOTAL	50	100%

Interpretation: 12% respondents reported that they strongly agree with that the current range of electric vehicles is sufficient for their daily needs, 80% respondents agreed, whereas 8% respondents disagreed.

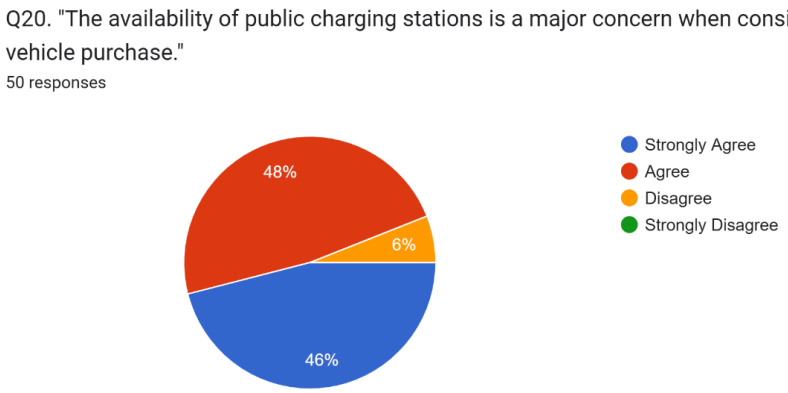


Analysis: A substantial majority of the survey respondents, 92% (12% strong agree, 80% agree) indicated that usability for their daily routines is good today for the now offered range of four-wheel electric vehicles (EVs). Thus, in the opinion of those surveyed, the current range capabilities of EVs adequately meet the typical travel needs. This positive view on range adequacy is most likely indicative of normal commuting or local travel distances fitting well within the current range capabilities of EVs. Perhaps the contrary viewpoints of the small 8% group of respondents pertaining to this aspect are due to their concern about their daily travel needs either exceeding the current average achievable range as well as about the possibility of traveling beyond that limit. This underscores the need to appreciate travel patterns in the personal realm and gives an unrelenting imperative to find and implement mechanisms to increase EV range, aimed at addressing individual mobility needs.

Q20. "The availability of public charging stations is a major concern when considering an electric vehicle purchase."

S. NO	CHOICES	RESPONDENTS	PERCENTAGE
1	Strongly Agree	23	46%
2	Agree	24	48%
3	Disagree	3	6%
4	Strongly disagree	--	--
	TOTAL	50	100%

Interpretation: 46% respondents reported that they strongly agree with the availability of public charging stations being a major concern when considering buying an electric vehicle, 48% respondents reported they agree whereas 6% respondents reported they disagree.



Analysis: A notable 94% of respondents (46% strongly agree, 48% agree) have serious concerns about the availability of public charging stations when contemplating the purchase of an EV. This suggests that the perceived lack of convenient public access to charging may be one of the top possible reasons to influence potential EV buyers. The large majority of respondents who agree strongly likely reflects practicality in terms of their concerns over range anxiety and the inconvenience a lack of public charging stations may pose over a longer road trip, or in areas with limited infrastructure for EV charging. The significant percentage of respondents who disagree (6%) most likely have nearby access to EV charging stations or charge at home or proximity to home, which represents how regional infrastructure determines the current effectiveness of an EV.

IV. Findings:

- Young adults that are between the ages of 18 and 25, with 36% being over the age of 25, are important drivers of EV adoption, as evidenced by the fact that they are the majority of respondents (60%). Women may be interested in EVs, as evidenced by the 58% female respondents. 82% of respondents said they were familiar with predictive analytics, suggesting that more people are becoming aware of its uses in the EV industry.
- The vast majority (98%) thought predictive analytics could help the EV industry become more sustainable. Predictive analytics could contribute to the development of a more sustainable transport system, according to 88% of respondents. Additionally, according to 88% of respondents, predictive analytics is helping the EV industry.
- The most advantageous use of predictive analytics was deemed to be battery optimisation (40%), with customer behaviour prediction (22%). 94% of respondents thought that widespread EV adoption would require advances in battery technology. 42% of respondents believed that EVs had more drawbacks than benefits, citing issues with cost, range, and accessibility to charging stations. 30% were not convinced, but 70% saw themselves purchasing an EV in the future. –
- The main issues with EVs were their high initial costs (20%), short battery lifespan (26%), and inadequate charging infrastructure (28%). 28% said they were unaware of EVs, and 38% thought they were not a good investment. With 44% of respondents thinking EVs were only appropriate for short trips, range anxiety was still a major obstacle.
- The availability of public charging stations worried 94% of respondents. 82% of respondents said that government incentives and subsidies would have a big impact on their decision to buy. While 22% were still dubious, 64% of respondents thought EVs were more ecologically friendly than conventional cars.

V. Suggestions:

- Enable Clients – Five And Main Invest Corp should develop straightforward tools based on sophisticated predictive analytics that not only informs customers about the most suitable EV option but also helps customers to optimize their maintenance and charge cycles.
- Pre emptively Plan Infrastructure- Ensure that cities and financing entities comprehend how deeply adoption of EVs is predicted to impact charging station demand, so that they plan effectively and utilize resources in the most economical manner
- Think on a Broader Scale- Commence a study designed to capture the supply chains for various components, for instance, batteries, and their interrelationship to gauge the market and production capacity with respect to demand.

- Eliminate Dependence On Subsidies- Investigate other financial incentives applicable to the use of EVs, like tax breaks and lower tariffs, and analyze how these could be crafted to estimate users' attitudes toward the adoption of EVs.
- Identify EV Adoption Issues- Try to promote electric vehicles adoption by finding ways that some stakeholders are not considering, especially their emissions from production and disposal of batteries approximately for EVs.
- Encourage Battery Innovations - Encourage research targeted towards enhancing the life and recycling of batteries while focusing on what role predictive analytics can play towards enabling these innovations.
- Give Attention to After Sale Service - Study how post sale service can be improved and leveraged to enhance the owners experience of servicing maintenance for optimal driving experience through usage pattern predictive analytics.
- Partner with the Universities: Start this work by partnering with academic institutions and research organizations that have expertise in sustainable transportation and capable analytical tools to conduct this study.

VI. Conclusion:

Analysis of forecasting the future of four-wheeled electric vehicles (EVs) through predictive analytics is an investment worth making to know the opportunities and pitfalls in the EV market. The research indicates that even though public awareness of electric cars is growing, extensive use is abated by a variety of reasons including the high cost of initial purchase, battery life concerns, lack of charging stations, and uncertainty of resale value. Despite these challenges, the compelling advantages that predictive analytics can bring to stakeholders to foresee the demand and adoption of four-wheeled electric vehicles (EVs) can be formulated through consideration of historical data, market trends, technology evolution, and macroeconomic factors. Predictive models can provide insight into future sales volumes, needs of the charging infrastructure, battery production requirements, and the overall pathway of EV market penetration.

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