

Comparison of Electric and Conventional Vehicles in Indian Market: Total Cost of Ownership, Consumer Preference and Best Segment for Electric Vehicle

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Abstract: This research covers the area of electric vehicles stanch for personal vehicle and its relevant market including the background information about the topic. The research is focusing on the research of current situation for the buyers and the less and more favourable conditions in Indian automobile industry. The principal of the report is a comparative research of electric vehicle and conventional vehicles. In addition to this, the research focuses on the total cost of ownership of owning Electric vehicle instead of the conventional vehicle in the Indian market. The research also emphasizes on manufacturer perspective by finding out the best segment to launch an electric vehicle in India. In addition, the research assumptions are used in the formation of a questionnaire focusing on finding out about the awareness of electric vehicles among the publicity nowadays. The final statement that is going to be approved or rejected is the electric vehicles as a better alternative to the conventional vehicle in India.

Keywords: electric vehicles, battery electric vehicles, plug-in, hybrid vehicles, conventional vehicles, Indian car market

1. Introduction

1.1 Background of study

It is not the 21st century that gave birth to the Electric vehicles rather the first small-scale electric car was developed in late 1820's by Porsche, and after half a decade in early 1830's, the first fully powered electric car was developed. Due to the lack of rechargeability of the batteries of the electric cars built around that time, the research and development and the focus of automobile industry around the globe shifted on vehicles powered by crude oils. From past two decades, electric vehicles gained a lot of attraction over traditional vehicles powered by crude oils with Tesla's Roadster pulling into the market. Due to the increased awareness amongst people relating to the environmental contamination the crude powered vehicles caused and with the increased exploitation of the limited conventional sources the shift towards Electric Vehicles can be seen, though gradually. Many companies like General Motors, Tata, Honda, Tesla and Toyota started mass production of electric and hybrid vehicles to eliminate the issues linked with fully powered gasoline engine vehicles.

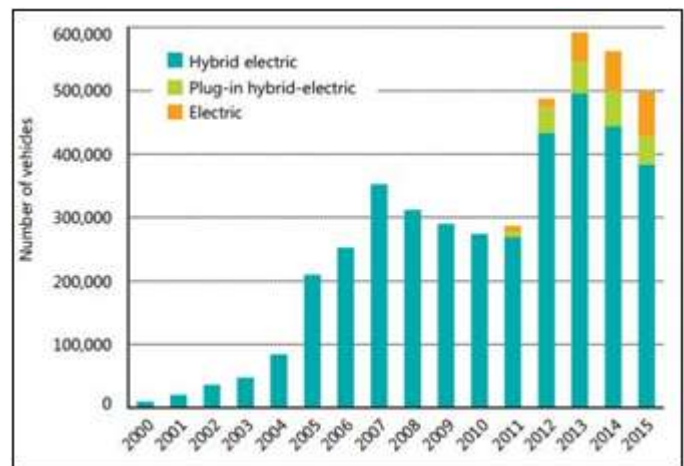


Figure 1: Increase in number of EV sold globally since 2000

(Source: https://www.rita.dot.gov/bts/sites/rita.dot.gov/bts/files/publications/pocket_guide_to_transportation/2017)

A late start in the EV adoption but the sales since the last two years has shown a remarkable increase of 39% [1]. A huge change was observed in previous years in Electric Vehicle Industry around the world with different countries adopting to become fully electrically powered, but no major change had been seen in Indian market. One of the major causes behind this is the lack of infrastructure for electric vehicles in India. But the change is expected in future as Indian governments is taking initiative to create a desired infrastructure for electric vehicles and to fully change the automobile to electric by 2030.

1.2 Factors for the shift towards Electric Vehicle

Large number of automakers such as Toyota, Mahindra and Lexus ventured into Electric Vehicle territory in last couple

of decades. In addition, automakers like Tesla have made a great impression in the electric vehicle industry by launching models like Roadster and Model-X. Altogether, with the arrival of Electric vehicles to the market space, the sustainability of conventional gasoline powered vehicles is in question. Environmental and financial benefits of electric vehicles claim to be a much better choice. In addition, electric vehicles use environmental friendly and cleaner sources of energy reducing carbon emissions and fully electric vehicles promise no tailpipe emission at all. According to a study by the Union of the Concerned Scientists, electric vehicles reduces greenhouse gases by more than 25% compared to gasoline powered vehicles. Charging these Electric Vehicles by renewable sources of

energy like wind, hydroelectric and solar power, and electric vehicles can cut greenhouse gas emission drastically [2].

Technical advancement results in increase in battery capacity up to 110% by 2020-2025 and can result in price reduction by 40-45% [3]. Electric vehicles offers reduction in cost in term of driving experience and overall maintenance cost of the car. Moreover, the prices of gasoline are fluctuating in India ever since the adoption. Uniquely electricity prices are more static as compared to gasoline. Consequently, electric vehicles are much cheaper for the consumers and offer static cost of driving.

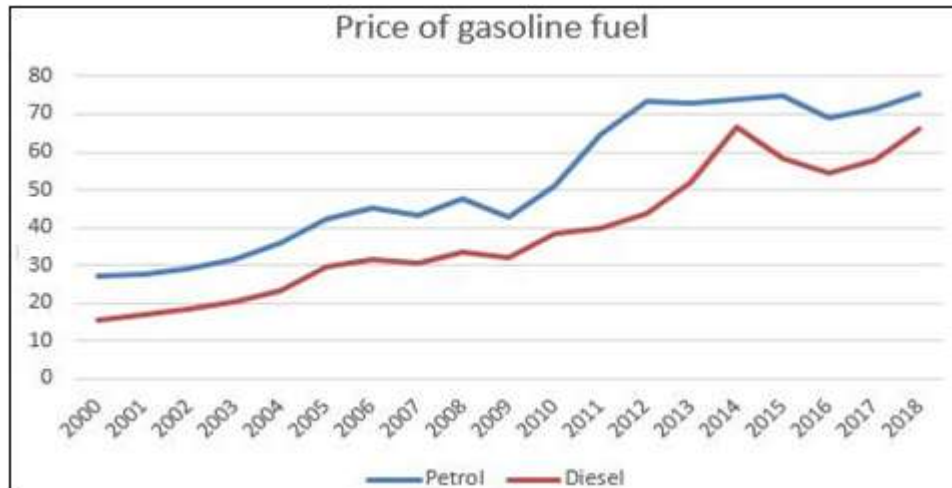


Figure 2: Price of Gasoline Fuel

1.3 Research Question

Out on the open country roads in India, have you ever wondered about good looking, standing out of the crowd cars which are silent and promise zero tailpipe emission? What technological developments are going around making the electrical system more efficient and offering same or comparative performance as of the gasoline-powered engines? Electric vehicles on Indian roads are in very small numbers that you can even count on your fingertips due to the lack of infrastructure to support its efficient use. This is one of the major concern in India as the resources of gasoline are limited and almost vulnerable and the modes of transportation are largely entirely dependent on gasoline-powered vehicles be it private vehicles, public vehicles such as trains, buses, cabs, bikes.

In response to this problem, we are trying to investigate the problems in adoption of electric vehicle in India and trying to find out the consumer awareness and expectations from Electric Vehicle. We will also try to find out the best segments to launch electric vehicles in four-wheeler marketplace in India. Furthermore, we will find out the total cost of ownership of an electric vehicle over a conventional gasoline powered vehicle to aware the customers about the environment friendly and a budget control offering.

1.4 Objective of the Study

The purpose of this study is to measure the significance of electric vehicles when resources of gasoline are diminishing. The study will discuss the different approach of introducing electric vehicles in Indian market when Indian customers rely more on the gasoline-powered vehicles due to ease of availability of gasoline. There have been several attempts of introducing electric vehicles in India by big Indian players like Mahindra. As a matter of fact, Indian customers were not ready to embrace electric vehicles due to lack of infrastructure to support the system and their low performance compared to gasoline powered vehicle. However, the study focuses on the target customers of electric vehicles and suitable price range in which they should be launched to have a competitive edge in the Indian market. We will stress on the conceptual framework to establish the relationship between different factors associated with electric vehicles and to reach to the expected outcome.

2. Literature Review

2.1 Introduction

With advancement in technology and innovation in today's era, there is a significant push of technology in one of the world's largest automobile industry. The automobile industry is now shifting more on the technology front and biggest step is the introduction of electric vehicles. There are

both big players like Tesla, Toyota, General Motors and Lexus working globally but in the Indian market, major players are Tork, Emflux Motors and Ather Energy. Indian firms are focusing in the core area of strength in the development of the electric vehicle. Bigger firms instead of producing types of equipment required for an electric vehicle such as batteries, motors, and the internet of things (IoT) tend to merge with smaller firms. This is the current area where Indian firms have an upper hand. Big firms merge with smaller firms to enhance their system capabilities and to reduce the production time of the final product. In many countries such as China, Germany and United States, the demand for Electric vehicle increased rapidly in last decade. But still, due to disadvantages like lack of charging stations, less range of vehicle and many more, electric vehicles are considered as the second preference for the personal vehicle.

Indian firm producing electric vehicles (2 wheelers or 4 wheelers) on a massive scale. The study finds that 83 Indian firms are working toward Electric Vehicle, it can be clearly seen that the Electric vehicle industry in India is in its initial phase. In addition, in the competitive world, there is a great pressure on these firm to increase the efficiency and effectiveness. In the coming years with the increase in awareness among the population regarding electric vehicles, it can be expected that there will be more than 250 companies in India working toward electric vehicles. The Electric Vehicle can be seen rarely in the Indian market. This is due to the fact that almost every company is in production phase. A large number of electric vehicle are being used by Indian Government in Public Transportation. Electric Vehicles are now been used by government of India in the Capital city Delhi. Karnataka government also announced the purchase of 650 electric vehicle to add in their fleet. This is a small step by Karnataka government in making Karnataka the Electric Vehicle (EV) capital of India.

2.2 Indian Electric Vehicle Market Presence

This literature review has certain objectives towards the Electric Vehicles Industry in India. Currently, there is no

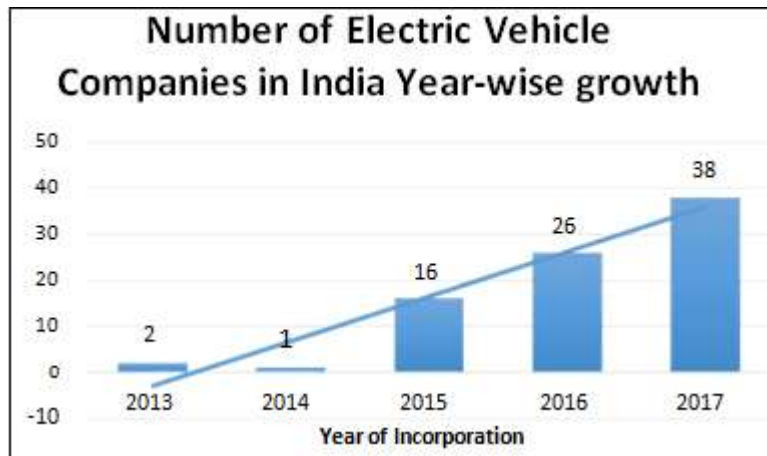


Figure 3: Number of Electric Vehicle Companies in India Year-wise growth

In addition, according to Make in India initiative by the Indian government, “Six million-plus hybrid and electric vehicles to be sold annually, by 2020”. Furthermore, in the coming decade, electric cars segment will contribute to a greater extent in Indian Automobile Industry. Since the Domestic market share of two-wheelers was 80% in 2015-16 whereas passenger vehicles and commercial vehicle domestic market share was only 14% and 3% respectively. It is expected that there will be 50.6 million units of 2-

wheelers to be produced annually in India by 2026. Tork Motors and Hero Motors took the first initiative of entering into 2-wheeler electric vehicle segment in India. Regardless of a huge market share of 2-wheelers in India, most of the firms still prefer to make their presence in the 4-wheeler market. To put it differently, the profit margin in 2-wheelers are much lesser compared to 4-wheelers.

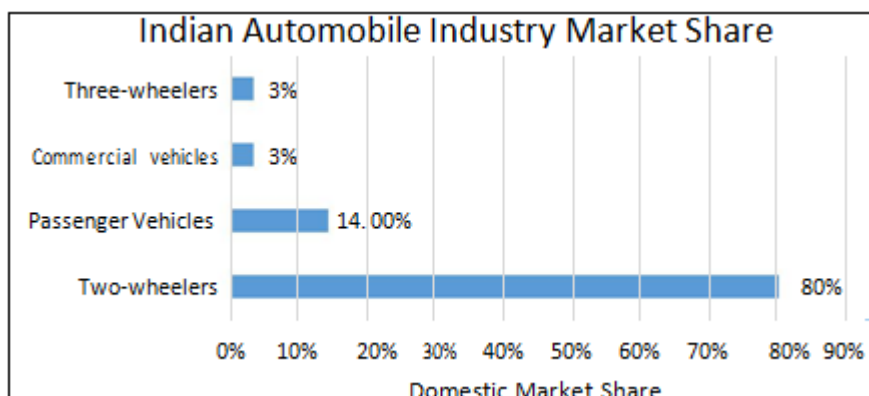


Figure 4: Indian Automobile Industry Market Share

2.3 Major Problems in Indian Market

In electric vehicle industry, there are different multiple players influences that can bring the change in the industry. Currently, government policies have a major role in Indian electric vehicle industry. Lack of charging stations and no availability of space to create infrastructure for charging stations for electric vehicles. Not to mention that the range of electric current vehicles in India till date is very less. As a matter of fact, the distance range is not more than 110km in full charge even for 4-wheeler electric vehicles in India. In reality, it is of no use for intercity commute, making it appropriate to cover only short distances. Battery charging is another major concern as it takes 4-6 hours to fully charge the battery. To say nothing of quick charging, it also takes around 30minutes to charge the battery up to 80%. Although the electric vehicle is a sustainable option, to set up initial infrastructure cost is much higher. In spite of high initial infrastructure cost, the benefit is long term.

India is a country where the electric supply isn't still available in every town, city or village. The electric vehicles in such cities would restrain the daily power need. Presently big players like Lexus are offering hybrid technology in which a vehicle can run on 100% electric motor up to the speed of 60-80kmph and above that speed the vehicle will switch to gasoline-powered motor. No doubt, this can answer a lot of concerns faced in Indian Electric Vehicle

Industry. Consequently this solution increase the manufacturing cost and eventually the cost of vehicle will increase to a greater extent when compared to only gasoline-powered motors. Actually, to shift the Indian consumers on electric vehicles, electric vehicles should be made available at a cheaper price or to some extent at same price range as of gasoline-powered vehicles.

2.4 Conceptual Framework

The conceptual framework has been derived from the theories that have been mentioned above. All the discussed points have been then analysed for the major factors that they represented. All the factors have been collected to understand at what stage they actually impact. Likewise, factors are segregated into stages according to the suitability. The first stage is to define the purpose, which includes the purpose of the study or the objectives trying to achieve. Setting up the boundaries will be the second stage and it includes the issues to be faced and losses of entering into electric vehicle industry. The third stage is creating values, which need to be considered not only to increase the economic value but also to create wellbeing among stakeholders (customers, producers, sellers etc.). The last and fourth stage is evaluating values. It is to determine the positive and negative outcomes from the electric vehicle industry in India.

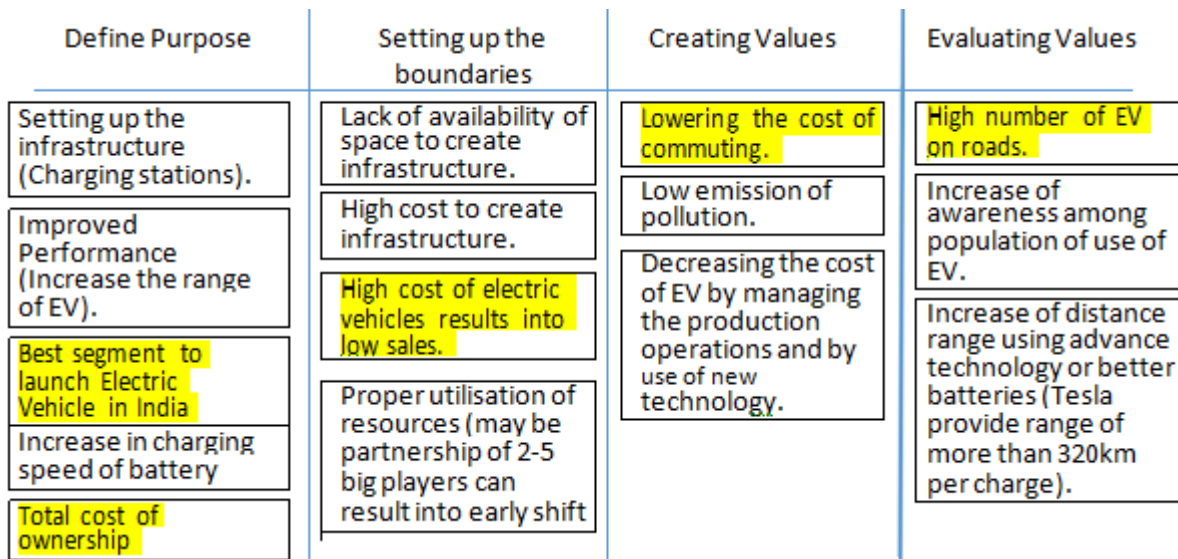


Figure 5: Conceptual Framework of Indian Electric Vehicle Industry

In the above conceptual framework, the stages are self-explanatory. The conceptual framework is a network of interlinked concepts used to make distinctions and organize an idea. The conceptual framework is important to understand the various concepts used and the way concepts are correlated to each other.

2.5 Research Gap

The current study tells us the need of an extensive research required in the field of electric vehicles. A large number of studies already exist in the field of Electric Vehicle both in technical as well as management aspects. But almost no or very limited study has been done which are totally keen on

the Electric Vehicle Industry in India. However, the research on "Analysis of Indian Electric Vehicle Industry" is still limited to very basic principles and thus no tangible conclusion can be made based on existing researches as the Indian market is very diverse compared to markets like China, Germany and United States where the demand of Electric vehicles are decent. To create a business model, it requires an in-depth understanding of Indian Automobile Industry as well as of Electric Vehicle Industry.

Keeping in mind the research gaps discussed above, there has been an attempt in this research to focus on below research questions:

What will be the best segment for manufacturer to launch electric vehicle in India? What will be the total cost of ownership of owning an electric vehicle?

What factors Indian customer expects from Electric Vehicle instead of a gasoline-powered vehicle?

The conceptual framework has been taken as a foundation to develop research questions. However, the answers will be kept flexible and impartial to understand the wider point of view of the respondent. The interview has been taken of people working in Electric Vehicle Industry worldwide and in our domestic market i.e. India. Some interview might be taken on emails, calls, video conference or by arranging physical meeting due to widespread of industry people around the globe. The responses can further be used to make a business model for Electric Vehicle Industry in India and to some extent for small improvisation in Automobile Industry.

3. EV Market Share

3.1 EV Buying Options

We have identified 3 categories of Electric vehicles available in India:

1) Battery Electric vehicle

Automakers like Mahindra are offering full powered electric vehicles in India. These vehicles have no internal engines powering the vehicle other than battery. That means there is no tailpipe emission. In case of recharging the battery, battery is plug into electric source. There are no gear levels

in fully powered electric vehicles since EV have only electric drivetrain.

2) Hybrid electric vehicle

Hybrid vehicles have parallel electric battery with internal combustion engine. Battery is charged by regenerative energy from brakes and kinetic energy of moving parts of engine. There is no option to charge the battery by plugin. In India currently Maruti Suzuki, Toyota and Lexus are providing Hybrid vehicles.

3) Plug in Hybrid electric vehicle

In plug in hybrid electric vehicle, electric motor is in parallel with internal combustion engine. Plug in hybrid electric vehicles are more affordable than hybrid electric vehicles since electric vehicles can be charged and can be driven on fully electric motor without use of internal combustion engine up to the speed of 60kmph.

Battery electric vehicle	Hybrid electric vehicle	Plug in hybrid electric vehicle
Mahindra e2o	Maruti ciaz diesel	Toyota Prius
Mahindra EVerito	Maruti Ertiga Diesel	

3.2 EV Worldwide market share

Looking at the picture from a global perspective China is leaping on to become the leader in the electric mobility. With all the hoopla going around the companies like Tesla the sales have barely put a dent in comparison to gasoline vehicles.[4] , the aim of the various countries like France, Britain, China, India, Germany are moving towards fully powered vehicles but lack of charging infrastructure , battery prices, and public acceptance stands as barriers for the growth of EV.

China is selling the most range capacity for e-cars in the world

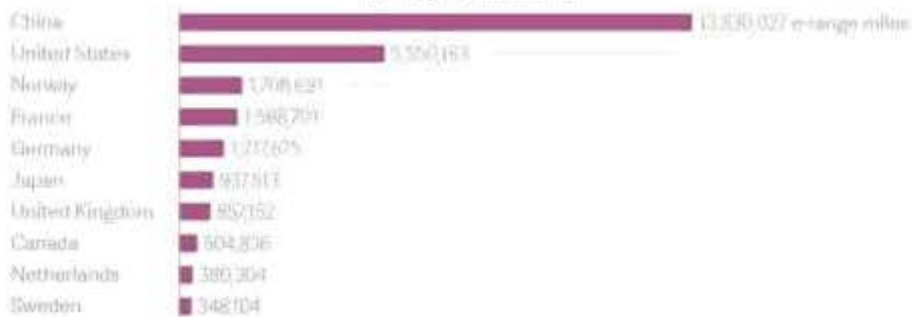


Figure 7: EV worldwide market share

Source: Depicts the global market movement towards EV "https://qz.com/1102552/ladies-and-gentlemen-the-winners-and-losers-of-the-electric-car-race-so-far/"

The real impact is happening in the largest car markets: US and China with combined sales of 45.5 million car per year. China leaped its way in 2014 and has never slowed down yet growing at twice the global average rate of 20%.the world is moving towards fast EV adoption and soon the gasoline cars would be replaced.

3.3 EV Market in India

The EV is a new born baby in India contributing to a 0.1% market share as compared to the big market players like China, Europe, and US etc. With the government envisaging to fully power India with EV the shift towards electric powered vehicles can soon become a reality in India with govt. Plans to increase the EV market storage to 4.7GW by 2022. Nearly 200 stations are planned to be set up around Delhi, Jaipur, and Chandigarh. [5]

Exhibit 01: Electric Vehicle Storage Opportunities (GW) in India till 2022 and the Anticipated Growth

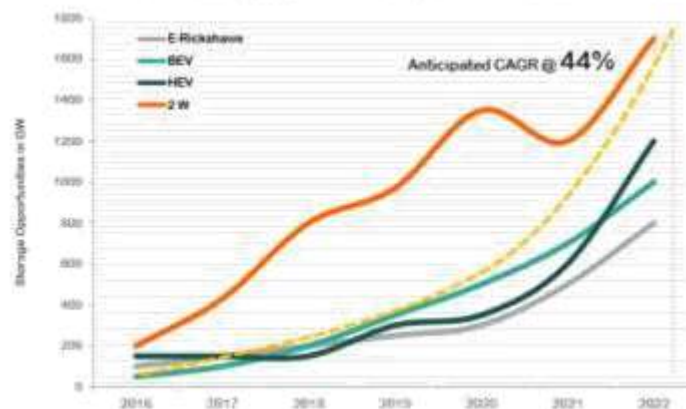


Figure 8: EV storage opportunity

Source: Anticipated Growth with time with sales of EV "https://enincon.com/wp-content/uploads/2017/07/Flyer-EV-Market-in-India_enincon.pdf"

The government has forecasted a market share of 50% through sales of electric vehicle by 2022 with an anticipated increase of 44%. There are various opportunities for the Indian market to expand and flourish and soon India would become a fully electric vehicle powered country.

4. Research Methodology

4.1 Introduction

The aim of this chapter is to establish an appropriate methodological approach undertaken to analyse the factors involved in examining the Electric Vehicle industry in India. In this chapter, we will discuss the methodology used for the research along with the intent behind the preferred methodology. We will start with the merits and demerits of qualitative and quantitative approach and will discuss the motives of application of qualitative approach chosen for the current study. Further, we will discuss the sample taken for the research, how the data was collected from sample and why a particular set of respondents were chosen. This chapter will also discuss the practical and real scenario reasons for the considered sample. The chapter will end with the limitations allied with the used methodological approach and exploration of ethical constructs over the research.

4.2 Qualitative and Quantitative Approach

There have been number of debates about which research methodology should be used in what kind of study. Maxwell (2008) in his study (Designing a Qualitative Study) explained qualitative study as multi-focussed since it doesn't restrict the study into specific dimension and opens up the study into different directions. [6] He also states that the qualitative study is mostly carried out in natural setting which gives the interpretation a greater value. To gain the insights and various factors involved in the study, it is best to keep the surveys and interviews open ended. Further, there are some limitations associated with qualitative approach since researcher's own experience, opinion and perspective to transcript the interviews can impact the results of study and thus impact the outcomes of the study.

Furthermore, quantitative research methodology has been supported by more researchers. The reason being it provides

data which gives clear results and is free from opinions. Quantitative approach involves working on data and understanding the study outcomes totally based on the analysis of data in different ways. Quantitative approach is free from bias and researcher's opinion. The results based on quantitative approach are inclined toward quantifying objects and forming a structured and strong base out of the research. However, quantitative approach remains restricted to only research questions and does not expand according to the study as in case of qualitative approach (Bryman, 2005).

4.3 Research Methodology – Quantitative Approach

The research methodology that has been implemented for this study is quantitative analysis. The literature review is based on theoretical understanding which leads to conceptual framework for understanding the electric vehicle industry in India. The research involves empiric work carried out from sample of respondents who owns a vehicle. Sample includes data from secondary and reliable sources to provide more credibility to the research. Quantitative approach involves collecting data for specific scenario that can be used with some well-known theories to develop a concrete result or outcome. The major motive behind selecting quantitative approach is to provide reliable unbiased results.

4.4 Data

The research paper categorises the personal vehicle into three categories the battery electric vehicle, plug-in hybrid electric vehicle, conventional vehicle, where the main criterion of the purchase is includes the cost dimension and the quantitative differences between them. The purchase price, operating cost, maintenance cost, and cost of fuel with 40km per day drive as a base summarized as the total cost of ownership.

Since the cost and monetary factors are not the only factors of the purchaser's consideration while purchasing a vehicle and besides the personal needs of the user he/she may have other needs as well and the later in the study the research also include a qualitative differences of the models, namely the awareness of the electric vehicle, the pleasure experience while driving the vehicle, experience of its everyday use,

and overall every vehicle's overall elaboration quality and used material.

To perceive the public awareness about the electric vehicle a survey is been done and the results obtained are put into test with the aim of understanding the people's knowledge of and interest of electric vehicles in India. To achieve the objectives of the study an online questionnaire will be filled by random members from the society. [7] The results obtained from this survey would be further analysed to understand the general consumer behaviour in terms of automobile purchase.

4.5 Quantitative factors

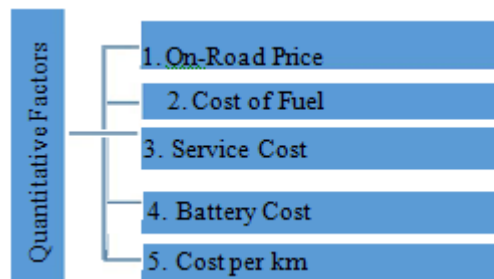


Figure 9: Quantitative Factors

4.5.1 Quantitative Factors – Total cost of ownership (after 6 years)

	Mahindra e2o	Mahindra Everito	Mahindra Verito	Maruti Ciaz Hydrid	Maruti Ertiga	Honda Jazz	Toyota Prius
Fuel & Transmission	Electric, Auto	Electric, Auto	Diesel, Manual	Diesel, Manual	Hydrid Diesel, Manual	Diesel, Manual	Plug in hybrid, Auto
kms per day				40			
kms per month				1200			
kms per year				14400			
Cost per unit kwh / Liter (Rs)	0.0005714	0.0005714	66.3	66.3	66.3	66.3	75.12
Mileage per unit (km-p-kwh / kpl)	4.4	4.4	21	28.09	24.53	27.3	26
On-Road Price (Lakhs)	7.9	10.58	7.455	9.71	9.02	7.44	45.09
Cost per km (Rs)	0.0001299	0.0001299	3.1571429	2.3602706	2.7028129	2.4285714	2.8892308
Service cost per year (Rs)	2500	2500	5293.2	3797.125	3742.5	3230.0909	19507.5
Battery cost for 4th year (Rs)	200000	200000	0	0	0	0	0
Total Ownership Cost:							
At the end of 1 year (<i>Lakhs</i>)	0.03	0.03	0.51	0.38	0.43	0.38	0.61
End of 2 years	0.05	0.05	1.02	0.76	0.85	0.76	1.22
End of 3 years	0.08	0.08	1.52	1.13	1.28	1.15	1.83
End of 4 years (incl. new battery)	2.1	2.1	2.03	1.51	1.71	1.53	2.44
End of 5 years	2.13	2.13	2.54	1.89	2.13	1.91	3.06
End of 6 years	2.15	2.15	3.05	2.27	2.56	2.29	3.67

Figure 10: Total Cost of Ownership

The main aim of this study is to determine and compare total cost of ownership of vehicles in Indian market in timeframe of 6 years. For this comparison we are comparing 7 different car models of different brands present in fully electric, gasoline powered, plug-in hybrid and hybrid cars. Total cost of ownership is an accounting method used to decide the cost of a product in long run. Since the on-road price of vehicle is subjective to owner, hence we are not taking on-road price of vehicle into accounts. We are taking cost of service, cost of fuel, cost of battery and cost of fuel per km into account to determine total cost of ownership in timeframe of 6 years.

There are certain assumptions to be made to determine total cost of ownership are:

On-road price of vehicle is subjective to owner, hence not taken into accounts. Cost of 1L petrol is Rs. 75.12

Cost of 1L diesel is Rs. 66.3

Cost of 1kwh electricity is Rs. 0.77

Consumer drive their car 40km per day that sums up to 14400km per year

At the end of 6 years, it is calculated that the owner need to spend 2.15L in time frame of 6 years if owner opt for fully powered electric vehicle. Total cost of ownership of 6 years

is gasoline powered car of same brand of same model is 3.05L. This means that if owner buys fully powered electric vehicle, owner saves 29.5% of cost of spending on vehicle for 6 years. Additionally if customer goes for hybrid cars instead of gasoline powered cars, 20.6% saving in cost can be seen.

Secondary factors such as insurance cost are neglected in this comparative study. The main motive behind the non-consideration of secondary factors is that these costs are same irrespective of fuel source. These costs depend on the cost of vehicle which is subjective to customer.

4.5.2 Quantitative Factor- Best segment to launch EV for Manufacturer

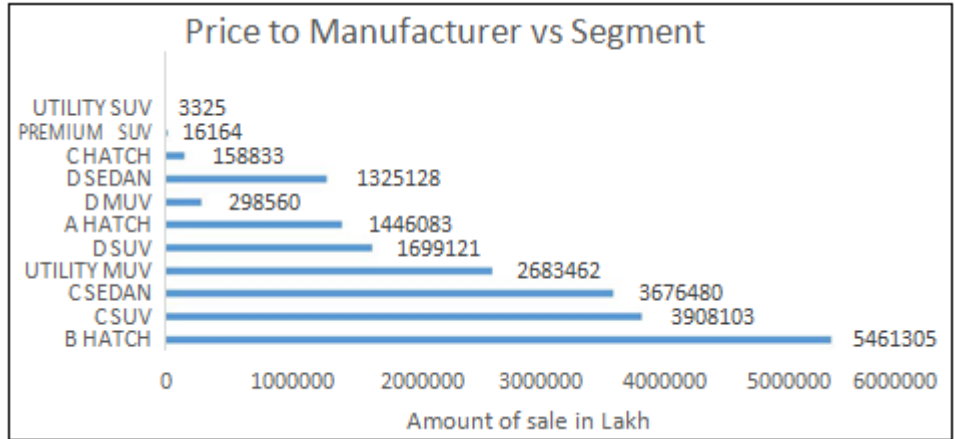


Figure 11: Segmentation of vehicle

Classification by Category

- a) Segment Cars (under 800 CC) - Entry Level Cars with Length under 3.6 Meter
- b) Segment Cars (1200CC in Petrol and 1300CC in Diesel) - Compact Cars with Length under 4 Meter
- c) Segment Cars (1200-1600CC) - Mid Size Cars with Length greater than 4 Meter
- d) Segment Cars (1.6 Litre - 2 Litre) - Mid Executive Cars with Length greater than 4 Meter

In this research, we studied on 83 different car models offered by 15 brands across different segments. We calculated the average number of units to be sold of each car model in a year. Taking average ex-showroom price we calculated the cost each model generates in a year. In addition to this we segmented all the models by body type and segment. Hatchback, sedan, SUV and MUV are different body types. In addition we sum up all the cash generated by each segment and further classified into A, B, C and D segment. B segment Hatchback comes on top followed by C segment SUV and C segment sedans.

If a manufacturer plans to launch an electric vehicle in Indian market, B segment hatchback is one of the best segments to make maximum sales. Positives of B segment hatchback are tax benefit from government resulting into low cost of vehicle. Large volume of sales on B segment hatchback vehicle will make more number of customers to opt electric vehicle in same segment. After tapping B segment hatchback market, manufacturer can offer more electric vehicles in C segment SUV and C segment Sedan market to further increase the market presence of Electric Vehicle.

4.6 Qualitative Factor Comparison

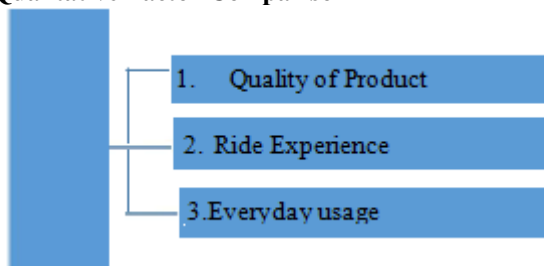


Figure 12: Qualitative Factors

4.6.1 Quality of Product

Comparison of quality of material used is most important qualitative factor of distinction of different car models. Quality is subjective to brand products and every brand has different measure of quality of material. Quality of product has no significance on the usage of fuel be it gasoline, electric or hybrid. Quality has significant role in deciding the on-road price of vehicle but in similar segment the price difference doesn't alter much. For the same reason, we have calculated the total cost of ownership by neglecting the cost of vehicle as it depends on manufacturer and choice of consumer.

4.6.2 Pleasure of ride

Pleasure of ride depends on many factors and preference of customer. Some customer wants quick acceleration and more power and at the same time some customer wants pleasant ride. It again depends on the manufacturer and the way manufacturer tune the suspension, and power source of vehicle. Currently in India, fully powered electric vehicles are not much powerful compared to hybrid and gasoline powered motors. This means that typical riding specifications are manufacturer specific and is one of the major qualitative factor.

4.6.3 Everyday usage Experience

Final qualitative factor is everyday usage experience and is directly related to propulsion system used. Fully powered electric vehicles has slight disadvantage in everyday usage experience due to low range in one charge. It makes electric vehicle inconvenient to use for long distance run and gasoline powered and hybrid vehicles score more in this aspect. Electric vehicles are very silent and calm making electric vehicle a better alternative to use as a city commute vehicle.

5. Results

5.1 Conclusion from Quantitative study

In this research, we did quantitative analysis to find out the best segment for manufacturer to launch an electric vehicle in Indian market. B segment hatchback comes out on top followed by C segment SUV and C segment sedan. These three segments holds the major market share in Indian

Automobile market and are most profitable segments for manufacturer. Tax benefits due to length shorter than 4 meter further attract customer and manufacturer on above stated segments. The tax benefits reduce the cost of vehicle by 10% and are one of the best segments for manufacturer to launch an electric vehicle.

Secondly we did total cost of ownership analysis to find comparison in total cost of ownership of electric vehicles in comparison to hybrid and gasoline powered vehicles. Electric vehicles have the lowest total cost of ownership for 6 years which also include Rs. 200000 battery cost and regular maintenance cost. But the cost to drive electric vehicle is much less than hybrid and conventional vehicles which makes electric vehicle to be most cost effective.

5.2 Survey

It is clear from previous chapters that there is a potential of electric vehicles in Indian market and manufacturer like Mahindra already stepped into fully powered electric vehicles market and other manufacturers like Hyundai and Honda are in queue to tap this market segment. In fact, in reality it is non common to spot an electric vehicle on Indian roads. In order to find out, how the new EV trend on the automobile market is perceived by the public, particularly individual persons, the next part of this research sets as its aim to find out more about this matter. For this purpose online questionnaire was constructed, consisting of questions concerning the topics touched in this research and perception of electric vehicles in Indian market. The answer of this questionnaire was collected using Google form circulated on social media and through direct mails. Both the channels lead to total responses of 103 respondents.

5.1.1 1st Question

The first question aimed at the categorisation of the respondents on the basis of Name, Age, and Gender.

The sample comprised of random respondents and out of which 29 of the respondents belonged to the Age group of 18-25, 21 belonged to the age group of 25-40, and the rest that is the majority of our respondents belong to the age 40+.

5.1.2 2nd Question

The second question was focused at the favourability of the Electric vehicle segment in India by asking the user if she/he had an electric vehicle driving experience before.

The result indicated that the vast majority (84.5%) had no experience whatsoever of driving an EV,. Only 14.6% had driven an EV.

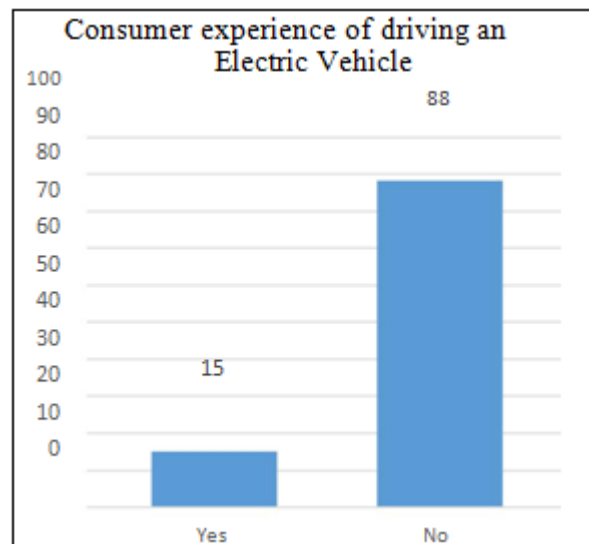


Figure 13: Experience of driving an EV

The study clearly indicates that overall new particularity of the Ev market and the non-ubiquity of the electric vehicle is the reason why many people haven't had the experience of driving an electric vehicle.

5.1.3 3rd Question

The third question in the questionnaire concerned the awareness of different EV models on the current market. This question is interconnected with the chapter 3.1 EV buying options in India and 4.4 Data. The majority (62.1%) of the participants marked here as their choice as the first option that is Tesla followed by 13.2% people being aware about Electric Vehicles and how Hyundai is stepping into the league.

The conclusion of this is then that the public awareness of the EV models among the respondents is quite little, due to a 60% majority of respondents knowing only 1 company. Considering the fact that almost every major car manufacturer nowadays includes in their product portfolio at least one EV model, the public awareness of the market remains not fully discovered, also considering that solely 15% of respondents can think of at least 6 different EV manufacturing companies.

5.1.4 4th question

The fourth question of the study was directed at finding out the monthly expenditure on their driving vehicle that would throw a light on the quantitative measures of the study i.e. the total cost of ownership and would highlight the favourability and feasibility of electric vehicle segment.

Proceeding to the outcomes of this question, 39.8% of the people reported that their monthly expenditure on their automobile ranges between 0-2000 while the other 36.9% people voted for the range between 2000-5000 with a 19% of people claiming that for them it reached up to 5000-10000.

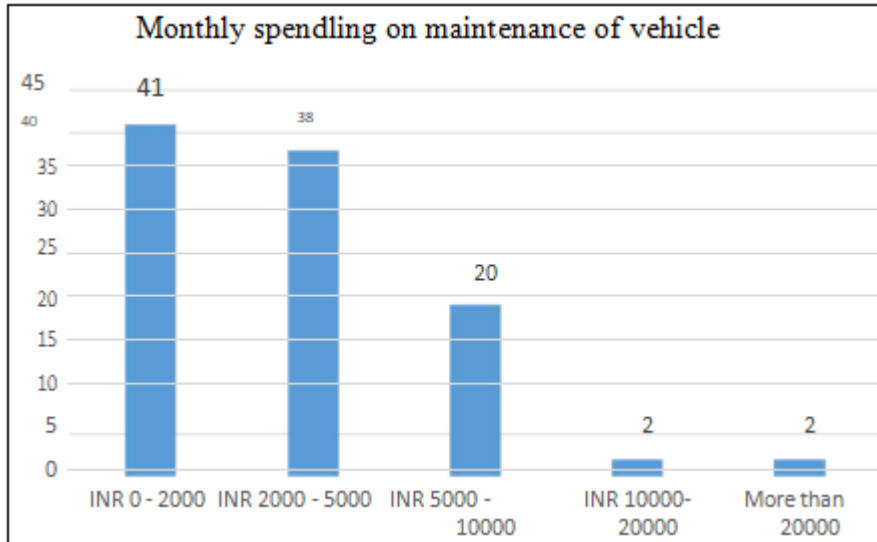


Figure 14: Consumer monthly expenditure

The conclusion of this answer leads to the assumption, that the obvious advantage of low maintenance and service costs is publicly a rather well known fact.

5.1.5 5th Question

The fifth question was a follow up of the previous question and targeted at using the responses obtained from the previous question to highlight if people believed that the purchase of electric vehicle would reduce the cost of service or the total cost of ownership eventually or not.

The majority 64.1% people believe that the electric vehicle would eventually reduce their service cost while 8.7% of the respondents were not really sure.

The results obtained from the study clearly indicate the shift towards a more powered engine and how skilled are people about this particular advantage of electric vehicle.

5.1.6 6th Question

The sixth question directed towards the respondents were based on their consideration of environmental factors while purchase of a vehicle. This question was aimed at highlighting the zero tail pipe emission fact of the electric vehicle and how the pollution levels around the world and the country could drastically change with the introduction. 81.6% of the population showed a green flag and 1.9% of the people really didn't ever thought about it.

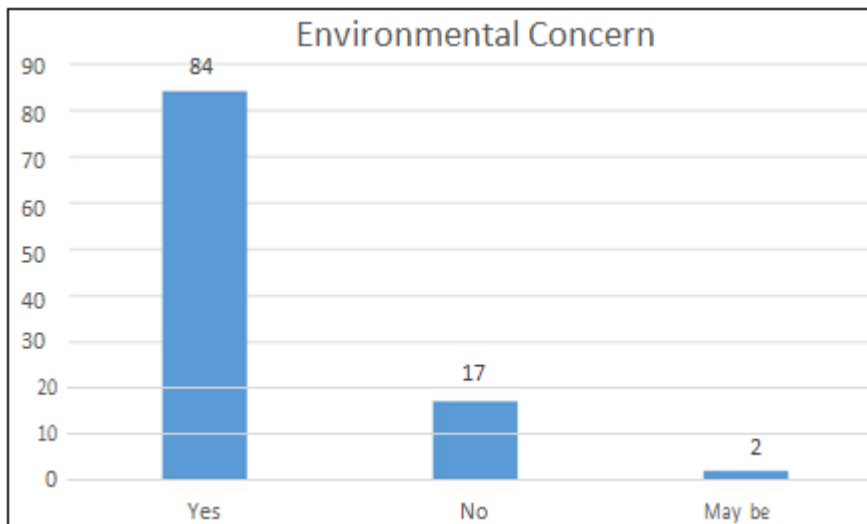


Figure 15: Environmental concern

It can be stated that the environmental impact plays a certain role in the personal vehicle selection process among a fragment of the asked public. This particular benefit of EVs could thus speak in favour for them for the majority of asked individuals, considering the environmental impact in their personal vehicle selection process.

5.1.7 7th Question

The seventh question of the study was targeted at finding out what electric vehicle meant to the respondents and whether it was the need of the hour and to find out their perception about this globally talked topic. The majority 68.9% of the people believed that electric vehicle was a more viable environmental friendly shift while 17.5% people voting it to be a necessity.

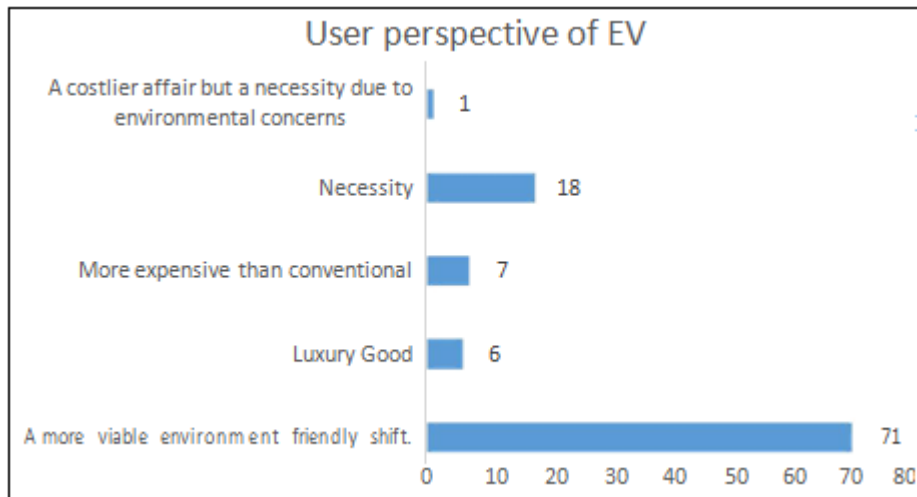


Figure 16: User perspective of EV

The result clearly demonstrates the public excitement and awareness about the EV and favourability of the introduction of this game changer technology with full supported infrastructure.

5.1.8 8th Question

The eighth question was aimed at understanding if the users would prefer to buy an electric vehicle while their car selection process with the available information about the electric vehicle they have.

The majority 57.3% of the people agreed on considering Electric vehicle while making their car selection process which indicates therefore a certain openness for the EV by the public nowadays, due to 50% admitting the consideration of an EV in their buying decision process. An interest for EVs nowadays is therefore obvious.

5.1.9 9th Question

The ninth question was targeted in finding out the biggest concern of the people while making an EV purchase. This question was aimed at understanding the lack of the growth of the EV market in the country. The majority 30.1% of the people voted for a poor charging infrastructure as their major concern while buying an electric vehicle followed by 25.2% of the people worried about the battery performed with varied climate change, 24.3% voting for higher purchase price while 16.5% people showing distress about the one-time charge range.

Factors regarding purchase of electric vehicle are

- Battery Performance with Changing Climate Poor Charging Infrastructure
- Higher Purchase Price Availability
- Environmental factor side by side maintenance cost and fuel cost Not having pick up and speed
- Lower one charge range

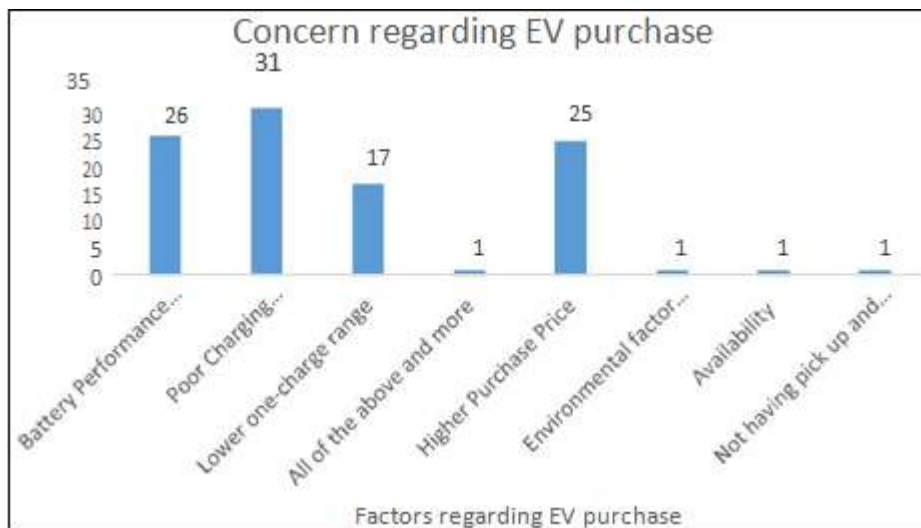


Figure 18: Concern regarding EV purchase

The results clearly indicate that because of the lack of sustainable infrastructure to support the electric vehicle growth the market is falling.

5.1.10 10th Question

The tenth question aimed at finding out the parameters that would convince individuals to buy electric vehicles. The aim of the question was to identify the basic flaw in the

implementation system and helps manufacturers identify the need and promote measures to grow the market.

sales in the country while the next major segment 39.2% people voted for a reasonable affordable price.

The majority 51.5% of the people voted that a reliable charging infrastructure would efficiently improve the EV

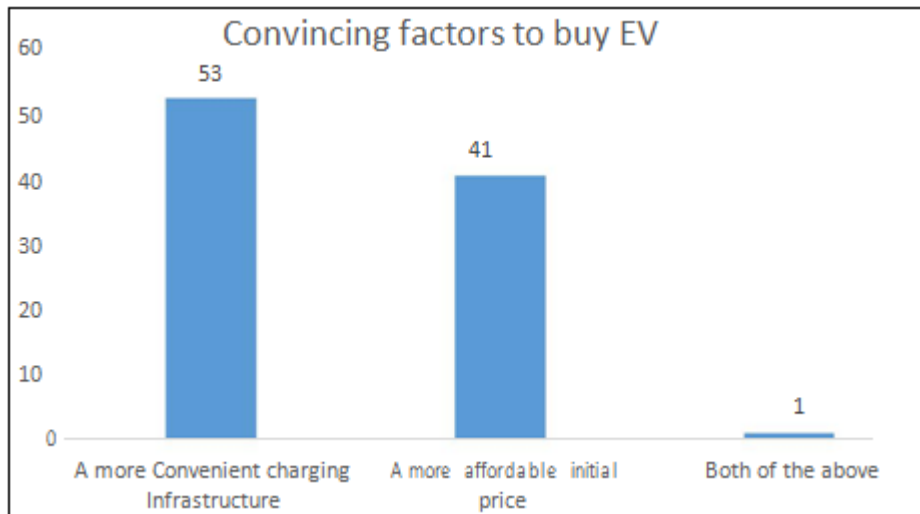


Figure 19: Convincing factor to buy EV

The results obtained clearly indicate the primary concern of the vehicle that is lack of proper infrastructure to facilitate the proper use of the electric vehicle. To some the initial offered price also stands out to be an issue.

5.1.11 11th Question

The last question of the study aimed at finding out whether people believed that EV would bring about the new automobile revolution. Being environment friendly and economical would this change the world of automobiles.

The majority 91.3% respondents believed that EV would bring about a global change and would revolutionise the automobile industry once and for all promoting better environmental conditions.

5.2 Summary

Framework has been made to find out the consumer preference of consideration to buy an Electric Vehicle or Hybrid Vehicle in India. Based on the literature review we have identified the dependent and independent variables that can lead to change the consumer preference to consider electric and hybrid vehicles. The responses from the respondents were taken in qualitative form and to analyse the dependence of one variable over other, we have converted the data into orthogonal matrix. In finding the dependence of one variable on other we have to neglect one of the variable same as case of Full profile conjoint analysis [10]. We have following Variables as per the questionnaire:

- 1) Gender
 Male Female
- 2) Experience of driving an electric or hybrid vehicle.
- 3) Monthly expense of respondents on their vehicle INR 0-2000

- INR 2000-5000 INR 5000-10000 INR 10000-20000
- More than INR 2000

4) Environmental Factors

Concern regarding purchase of electric vehicle

- Battery Performance with Changing Climate
- Poor Charging Infrastructure
- Higher Purchase Price Availability
- Environmental factor side by side maintenance cost and fuel cost
- Not having pick up and speed
- Lower one charge range

After orthogonal matrix, simple linear regression technique was used using Microsoft Excel. The coefficient of each variable tells the dependence on other variable which was neglected. Using regression the monthly expense consumer spends on their vehicle comes out to be a dependent variable with p value less than 0.05.

	<i>Coefficients</i>
Intercept	-0.143718762
Male	0.140215735
Experience of driving EV or hybrid	-0.116528133
0-2000	0.570542371
2000-5000	0.559664451
5000-10000	0.583426753
10000-20000	0.967591104
Environmental Factors	0.047542853
Battery Performance with Changing Climate	0.027155883
Poor Charging Infrastructure	0.031358116
Higher Purchase Price	-0.002874891
Availability	0.372533421
Environmental factor side by side maintenance cost and fuel	
cost	0.512823856
Not having pick up and speed	-0.556161424

Figure 20: Coefficient table

Taking gender as first variable, male customer has 0.14 times more chance to buy EV compared to females. In similar way, customer who has experience of driving an EV or hybrid before has 0.116 times less chance in considering electric vehicle as their buying option. The third variable is monthly expense by the consumer on their conventional vehicle. The consumer with expense of INR 0-2000, INR 2000-5000, INR 5000-10000, INR 10000-20000 has 0.57, 0.55, 0.58, 0.96 times more probability of considering EV compared to those customer who are spending more than INR 20000 in a month on their conventional vehicle.

Environmental factor don't have much influence for consideration of buying of electric vehicle. People who consider environmental factor has only 0.047 times more opportunity to buy EV compared to customer who don't consider environmental factors. But for manufacturer environmental factors can make a big difference due to large population size or high number of sales of EV. Major concern customer will have regarding purchase of electric vehicle or hybrid vehicle is maintenance cost and fuel cost which has 0.51 times more influence compared to low charging range of electric vehicle.

Customer preference for buying an electric vehicle or hybrid vehicle will be in following order:

- 1) Maintenance cost and fuel cost
- 2) Availability of product
- 3) Poor charging infrastructure
- 4) Battery performance
- 5) Low one-charge range
- 6) Higher purchase price
- 7) Vehicle not having pickup and speed

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