

Project Dissertation Report on

Future of Electric Vehicles

In India

Submitted By

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CERTIFICATE

This is to certify that the work titled '**Future of Electric Vehicles in India**' as part of the final year Major Research Project submitted by Vinayak Babu in the 4th Semester of MBA, Delhi School of Management, Delhi Technological University during January-May 2021 is his original work and has not been submitted anywhere else for the award of any credits/ degree whatsoever.

The project is submitted to Delhi School of Management, Delhi Technological University in partial fulfillment of the requirement for the award of the degree of Master of Business Administration.

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DECLARATION

I hereby declare that the work titled 'Future of Electric Vehicles in India' as part of the final year Major Research Project submitted by me in the 4th Semester of MBA, Delhi School of Management, Delhi Technological University, during January-May 2021 under the guidance of Dr. Saurabh Agarwal is my original work and has not been submitted anywhere else.

The report has been written by me in my own words and not copied from elsewhere. Anything that appears in this report which is not my original work has been duly and appropriately referred cited acknowledged.

Vinayak Babu
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I have put all my efforts to ensure that the project is completed in the best possible manner and also ensured that the project is error-free.

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EXECUTIVE SUMMARY

Electric Vehicles are nothing new and we all have heard about how it is the future in recent past but are all these speculations hold enough weight, is the electric Vehicles infrastructure going to be in the scheme of things of our current governments or future governments. In this particular report, I will try to explain what is Electric Vehicle, how did it arrive and what the future hold for EVs in India.

The objective of this research paper is to gain a better understanding and evaluate the current scenario of Electronic Vehicles manufacturer in adopting future regulatory measures which would be provided by the government, what are the problems that the Electric Vehicles manufacturer will face, how the government would try to help firms in this direction, such as policies that might be beneficial to the average consumer in buying an EV compared to a traditional gas vehicle. And the policies which might encourage new firms in India as well as International firms to try to create manufacturing plants and other investment in Electric Vehicles in Indian Market.

This research paper will also discuss the various problems that the country might face in the transition from traditional vehicles to Electric Vehicles, how the mindset of Indian people is transitioning into becoming more open minded and how it might help them for the adoption of Electric Vehicles in the Future.

I conducted a small survey to better understand the various perceptions and attitudes of the possibilities for new technologies in automobiles, especially electric vehicles. It was difficult to forecast future demand for EVs because it demanded assessing consumer preferences for a product that they had never seen before. As a result, we concentrated on evaluating respondents' familiarity with EV technologies, as well as their views on price, model, choice, fueling, connectivity, and maintenance expenses, as well as the consumer's perceived fit of an Electric vehicle in his or her lifestyle depending on a wide number of demographic parameters.

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Chapter 1

1. INTRODUCTION

Over the past 200 years the world has seen some magnificent transformations and talking about transformation one industry that has revolutionized the modern world is Automobile, in 1901, when Mercedes received the credit of being 1st modern motorcar before that the major mode of transportation was horse.

Later Mr. Henry Ford invented the mass car production technique for car manufacturing, since then the US, Germany and Japan has been the biggest players in the automobile industry. In the last 100 years, the car industry was changed leaps and bounds but that was not the end, there was alternative to gas combustion engines in the form of electric Vehicle.

An Electric Vehicle is a vehicle which includes one or more electronic parts for its movement. In simple words it works on electricity and not on our traditional combustion engines. These vehicles do not use diesel or engine which are non-renewable sources of energy rather they use household electricity which is easily available at every home and is a renewable source of energy.

An EV runs only on electricity and it does not have an exhaust, it also does not contain fuel pump, fuel tank etc. which are essential for running a gas enabled vehicle. These electric vehicles range from an electric bicycle to an electronic car to an electronic aircraft.

Electric Vehicles are said to be a healthy substitute to traditional fuels such as Petrol and Diesel as they are supposed to reduce the emission of greenhouse gases which are harmful to our environment. Electric Vehicles reduce our dependencies on fossil fuels which are limited as they are non-renewable sources of energy, on the other hand Electric Vehicles runs only on Electricity which is a renewable source of energy.

1.1 Background

It was necessary to conduct comprehensive background research in order to gain a thorough understanding of the subject under investigation and to restrict the scope of this analysis by focusing on the most relevant and important aspects while ignoring and omitting non-essential details.

Although there is some debate as to when EVs first originated in history, we could start with 1828, when Anyos Istvan Jedlik created the first electric car, which was then in the form of a model.

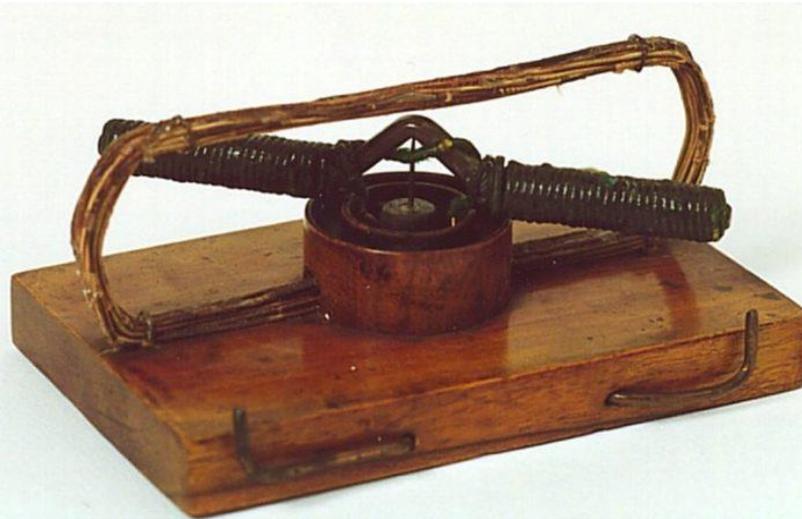


Fig 1.1 - World's 1st known Electric Motor Created by Anyos Jedlik (1)

Maybe that's why many sources overlook the contribution, often citing 1834 or 1835 to be the year when electric vehicles were invented, and crediting an American named Thomas Davenport. He created a small locomotive that operated on a track and was driven by two electromagnets.

The peak of the electric cars is considered at the start of 1900s, at that time horses were still the most preferred transport, but as the income of humans increased and the advancement of technology started, new means of transports were introduced. (1)

At the beginning gas, steam and electricity all were easily accessible and at that time they were fighting for dominating the market at that particular time.



Fig 1.2 - GE's Mercury Arc Rectifier (2)

One of person who standing beside this car is none other than Thomas Edison, you should not be surprised because in the year 1900 electric vehicles had a huge market share of 38% in US market which steam vehicles share was 40% and 22% vehicles used gas. (2)

However, by the 1920s electric cars would stop being commercially viable as gas power became a lot more accessible and people wanted vehicles that could go longer distances and had more horsepower. (2)

Henry Ford used to dominate the car industry at that time beginning in 1908, with his mass production of gas powered cars, the increase of technologies in ICE continued for coming years, till the 60s but in the 60s the pollution level started to increase and as a result another time EVs were considered as an alternative for combustion engines.

Because of various government policies and uncertainty in the market hybrids were introduced in US. But the big change in EV industry came out of Japan when Toyota introduced its Prius domestically in late 1997. It was a huge success and a big milestone when we look back in the history of Electric Vehicle.



Fig 1.3 - An image of Toyota Prius 1997 model (3)

After that new players entered in the field of Electric Vehicle, one of them was Tesla from the visionary Elon Musk. In 2006, Tesla unveiled to the world its Tesla Roadster, it was a battery electric vehicle (BEV) and it was a huge success and showed that EVs are the future of the world, it was in production from 2008 to 2012.



Fig. 1.4 - Tesla Roadster 2006 model (4)

In 2009, another big market player entered in the arena, GM introduced its latest Chevy Volt which marked the first for plug-in hybrids. The technology that was used in this vehicle was interestingly developed by the United States of America's department of energy.

The department of energy was a huge factor as because of the technologies that they produced the price of electric vehicles and their batteries reduced to half in the later decade after the technology was first introduced.



Fig 1.5 - Chevrolet Volt 2009 (5)

1.1.1 Types of Electric Vehicles

Although there can be many types of Electric Vehicles we can consider there are only 4 major types of EVs which are as follows –

1. **Battery Electric Vehicle (BEV)** – These types of Electric Vehicles as the name suggests are powered only on the battery packs that they are provided with, which means that the distance that such vehicles solely depend on the size of Battery that they are being provided. It is also the most common type of Electric Vehicle that is known by most of us.

A normal range of such type of Electric Vehicles is around 105-250 KMs per charge, on the other hand the higher end versions of such Vehicles can travel lot more, ranging somewhere 250-500 KMs on single charge.

Although these ranges are just estimating as it ultimately depends on various factors such as the driving conditions, road conditions, weather etc. Some examples of BEV are Tata Tigor Electric car, Nissan Leaf, Hero Photon Electric scooter to name a few in Indian Market.



Fig 1.6 – An image of Tata Tigor EV (Indian Variant) (6)

2. **Hybrid Electric Vehicle (HEV)** – The second type of electric vehicle that I am going to discuss is Hybrid Electric Vehicle, this type of vehicle is a combination of both IC engine, which mean internal combustion engine and an electric motor.

Here the electric vehicle motor works with both petrol and batteries. In this, the battery gets charged by a mechanism called Regenerative braking system. Recharging the batteries while braking is called regenerative braking system as you can see in the figure below.

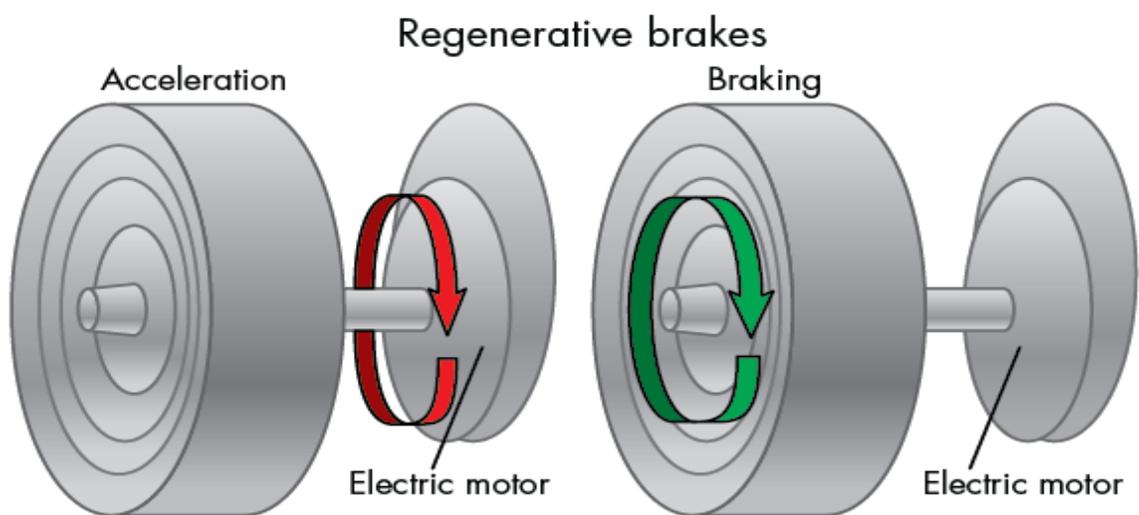


Fig 1.7 – A figure of Regenerative brakes in an HEV (7)

One example of this is, if you are travelling on a vehicle and all of a sudden you press your breaks, at that moment the energy gets converted in the form of electrical energy and gets stored in the batteries of your vehicle. This process is known as Regenerative Braking system. Also, in Hybrid Vehicles there are some inbuild computers, which will decide when to use battery power to the motor and when to use petrol. So, these vehicles having fuel tank to fill with petrol or diesel, whereas there is no requirement for any external electricity as the complete power source depends on the regenerative braking system. Some examples of HEVs are Toyota Camry Hybrid and Honda Civic Hybrid in Indian Market.

3. **Plug in Hybrid Electric Vehicle (PHEV)** – These vehicles arrived to extend the reach of all electric range of HEVs. It uses both electric power and petrol.

The batteries of Plug in Hybrid Electric Vehicles can be recharged with “plugging-in” supply as well as the Regenerative Braking System. Examples of Plug in Hybrid Electric Vehicles are Toyota Prius and Hyundai Ioniq Plug-in.



Fig 1.8 – Batteries of a PHEV (Hyundai Ioniq) (8)

4. **Fuel Cell Electric Vehicle (FCEV)** – FCEV is a unique and newer technology of electric vehicle which is not that popular as of now but it is considered as the future, it employs ‘fuel cell technology’ to generate the electricity required to run the vehicle. In FCEVs the chemical energy of the fuel is converted directly into electric energy.

Some examples of FCEVs are Toyota Mirai, Hyundai Tucson FCEV, Riversimple Rasa, Honda Clarity Fuel Cell, Hyundai Nexa.

Table 1.1. Comparison of different vehicle types.

Source – Self created

EV Type	Driving Component	Energy Source	Features	Problems
BEV	<ul style="list-style-type: none"> • Electric motor 	<ul style="list-style-type: none"> • Battery • Ultracapacitor 	<ul style="list-style-type: none"> • No emission • Not dependent on oil • Range depends largely on the type of battery used • Available commercially 	<ul style="list-style-type: none"> • Battery price and capacity • Range • Charging time • Availability of charging stations • High price
HEV	<ul style="list-style-type: none"> • Electric motor • ICE 	<ul style="list-style-type: none"> • Battery • Ultracapacitor • ICE 	<ul style="list-style-type: none"> • Very little emission • Long range • Can get power from both electric supply and fuel • Complex structure having both electrical and mechanical drivetrains • Available commercially 	<ul style="list-style-type: none"> • Management of the energy sources • Battery and engine size optimization
FCEV	<ul style="list-style-type: none"> • Electric motor 	<ul style="list-style-type: none"> • Fuel cell 	<ul style="list-style-type: none"> • Very little or no emission • High efficiency • Not dependent on supply of electricity • High price • Available commercially 	<ul style="list-style-type: none"> • Cost of fuel cell • Feasible way to produce fuel • Availability of fueling facilities

In this particular Table you can see the major types of electric vehicles, their driving components, energy sources, features and problems.

1.1.2 History of EVs in India

If you talk about India Electronic Vehicles were first introduced in 1996 in the form of a three-wheeler named Vikram EV.

This electric Vehicle was created by Scooters India Ltd, and they sold 400 units of this electric vehicle, this vehicle was first of its kind and unique in the market at that time.



Fig 1.9 - Vikram EV 1996 (9)

M&M which is also called Mahindra and Mahindra launched its 1st 3-wheeler which was an electric vehicle in 1999. They also made a company in 2001 as they thought that they would capture the market of EVs in India, the vehicle that they produced was named as Bijlee which was an Electric Vehicle.

Although there were many new opportunities in the market our policies as well as firms were not able to grab them properly and that lead to the downfall of EVs in India.

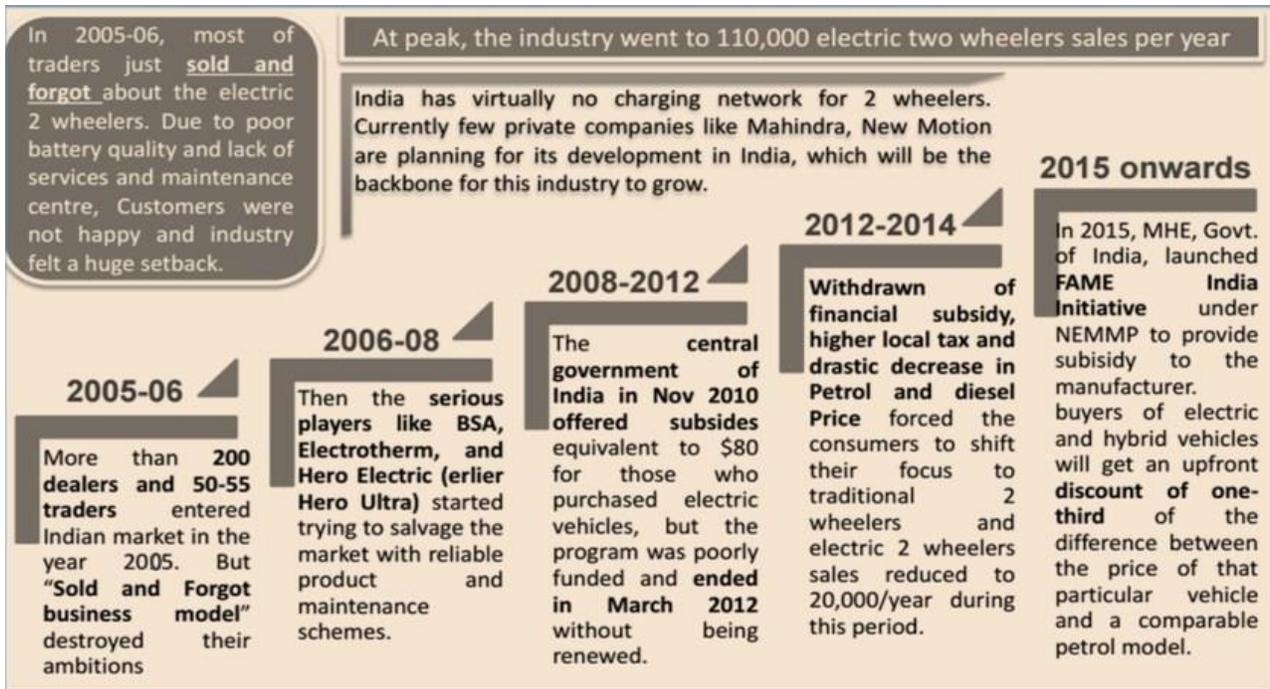


Fig 1.10 - Period of setback for EV in India 2005-15 (9)

In April of 2015 Faster Adoption and Manufacturing of Electric Vehicles were introduced commonly we call it FAME Policy. After this FAME-2 was also introduced because of its success.

FAME policy covers all two wheelers, three-wheelers, and four-wheeler vehicles and tries towards making India a more Electric Vehicle friendly country by its policies.

In FAME-2 our government is giving much more incentive than the previous FAME policy and the incentive is of 20,000.

1.1.3 Automotive Industry in India

India is one of the biggest and largest automobile markets in the world, India is a developing country and a developing market where the growth opportunity for automotive Industry are never ending. This sector contributes 7.1% in the total GDP of India which is a huge number, it also generates around 35 million jobs in the country.

Currently in India 48 automobile company, 12 two-wheeler companies and more than 747 automobile components maker works. The middle class and younger generation of our country is mostly preferring to buy two-wheeler and that is why two-wheelers are the most sold vehicles in India as of 2021.

Also, many big firms are now looking for new customers and for that they are going to the rural areas of India. India also exports a lot of Vehicles to abroad because of which the growth of this sector never fades away.

Infrastructure, government incentives and policies are also very supportive of automotive Industry in our Country.

1.1.4 Major Electric car Manufacturers Worldwide

The global electric vehicle market is dominated by the organizations which are as follows -

- 1) Tesla
- 2) Renault-Nissan-Mitsubishi Alliance
- 3) Volkswagen
- 4) BYD

Tesla alone captured around 28% market share in H1 of FY20, there is high consumer demand for tesla cars due to their innovative technology, modern design and high performance.

1.1.5 Major Electric car manufacturers in India

Electric Vehicles currently represents less than 1% of automobile market in India, it is very small market as of now, but these are some market players in Indian EV sector.

- 1) Ajanta Group
- 2) Hero Electric
- 3) Mahindra
- 4) Tara Motors
- 5) Tata
- 6) Chevrolet

1.2 Problem Statement

There are a lot of problems that Electric Vehicles are facing right now, some are basic like how and till when will the infrastructure for EVs will be made available, what are the government's policies which might affect the future of Electric vehicles negatively.

Administratively cost to regulate prices at every charging stations, there are also problems and concerns regarding setting equal kilowatt per hour price for charging stations. The traveling range of EVs is also a matter of concern in India.

Some external factors such as foreign policies of our government for EV manufacturers which are suitable for the growth of EVs in India are also a matter of concern.

1.3 Objectives of the study

The objectives of my study are –

To determine whether or not consumers are willing to accept electric vehicles as a viable commuting alternative.

To determine the maximum price that customers can pay for an electric vehicle.

To investigate other solutions for range-conscious consumers in terms of current scenarios and batteries currently used in EVs.

To investigate our government's efforts to promote electric vehicles, as well as the subsidies offered on electric vehicle batteries.

To investigate existing customer preferences for electric vehicles, as well as their future potential.

To investigate the current risks that are causing the slow adoption of electric vehicles.

1.4 Scope of Study

The purpose of my study and analysis was to get a better idea of what is the future prospect for Electric Vehicles in India and for this purpose I conducted a small-scale survey with some questions including in it. The sample size of my study is 60 respondents.

I will also try to explain what was the past of Electric Vehicles where it currently stands and what is the future of electric vehicles in India, also I will try to explain what are the various challenges that we are currently facing in this field.

Chapter 2

2. LITERATURE REVIEW

In this literature review we have taken some articles and research paper as a reference.

“A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation” from **Transportation Engineering Volume 4, June 2021, 100057. (10)**

This particular research paper talks about various subjects such as -

- The vision of 100% electric vehicles in India
- The Indian government's recent initiatives and various subsidies which may help to promote battery technology.
- Obstacles can be approached from a variety of angles, including industry, technological policy, and infrastructure.
- Vehicle-to-Grid is a critical component of energy security, clean energy, and addressing global warming concerns.

According to me this research paper talks about some major subject such as how Electric vehicles are a viable choice for reducing greenhouse gas emissions. They diminish dependence on fossil fuels while also reducing the effects of ozone-depleting substances.

For a developing country like India, research on critical barriers and inadequate charging facilities is discussed. When renewable energy sources are unavailable, the implementation of the modern Vehicle-to-Grid model has provided an additional power source.

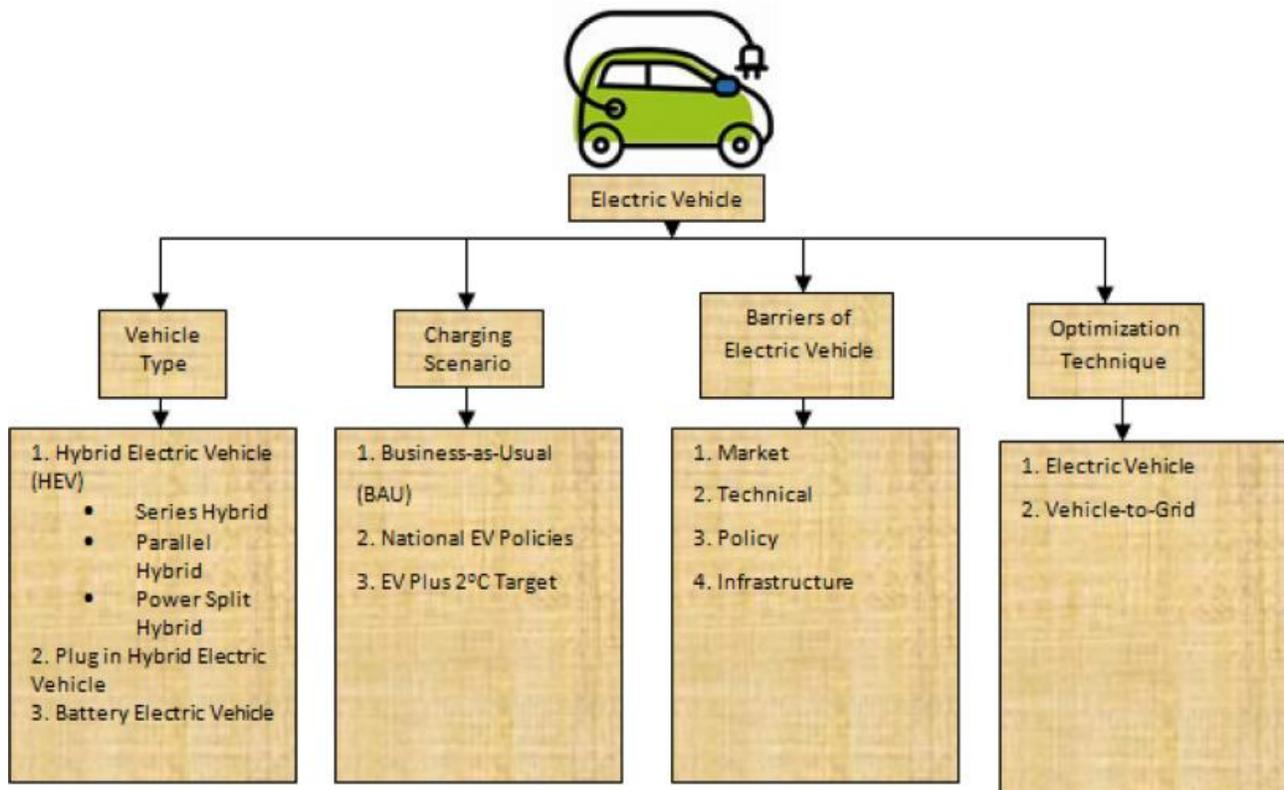


Fig 2.1 A graphical representation of Journey of Electric Vehicles (10)



Getting India ready for the electric mobility revolution



OPINION

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Over the past few weeks, the interest level around EVs (Electric vehicles) has suddenly increased in the country, thanks to the recent budget announcement by the finance minister about promoting electric mobility, by reducing GST for EVs to 5 per cent and allowing income tax benefits for EV buyers.

While these sops must be lauded, there are limited options for electric car buyers, unlike with regular petrol/diesel vehicles or internal combustion engine cars or ICE cars, where the options are aplenty. The automotive industry is reeling under pressure, with ICE car sales at 18-year lows. The industry's woes are compounded with the need for BS VI emission compliance for ICE cars.

Electric car sales cannot revive the struggling industry in the immediate future. But the benefits of electric vehicles are too good to ignore. EVs help in curbing pollution in our cities and towns through reduced carbon dioxide emissions. Also, electric mobility can help reduce India's oil import dependency. Currently India imports 84 per cent of its oil demand. A NITI Aayog report indicates that by 2030 India can save 474 million tonnes of oil if 30 per cent of private cars, 70 per cent of commercial cars, 40 per cent of buses and 80 per cent of two and three-wheelers become electric.

Global EV scenario

Globally, EV prices are at least 50 per cent higher than those of ICE cars, and the price is expected to fall to ICE

car levels over the next 3-5 years. The battery is the most important component of EVs. A Bloomberg report states that the cost per kwh (kilowatt hour) was over \$1,000 in 2010 and it is expected to go below \$100 by 2024. Research reports indicate that EVs will become cheaper compared to ICE cars once the cost per kwh goes below \$125.

The European Union is leading the way in electric mobility adoption with new policies and regulations. Norway is widely seen as a pioneer in the EV market, with over 20 per cent of new cars sold being electric. The government offers subsidies, toll fee waiver and special parking to aid EV adoption. The UK's Road to Zero strategy is aimed at removing ICE vehicles by 2040. The USEV market is expanding rapidly and is expected to add over 4 lakh electric cars this year.

A recent report suggests that the world's EV sector growth is healthy, and by 2025 the global market will be worth \$570 billion, with China leading with a market share of 60 per cent.

India's EV Journey

Electric cars have been around in India since 2001, but only over the past few years have we seen the government's active involvement with policy changes. Since 2017, the government has made a strong pitch for electric vehicle deployment in India through initiatives such as FAME (Faster Adoption and Manufacturing of E-vehicles), FAME-2, Green Mobility Fund and Make in India. In a bold move, the government is pushing for sale of EVs only after 2030.

As per The Society of Manufacturers of Electric Vehicles (SMEV), there are more than 4 lakh electric two-wheelers and a few thousand electric cars on Indian roads. With several new electric cars and two-wheelers planned to be launched in the coming months, adoption should improve. However, there are significant challenges.

Challenges and opportunities

A recent report indicates that 2.1 crore two-wheelers were sold last year, and electric scooters' share was less than one lakh. While over 3 lakh



Standardisation of the charging infrastructure would play a pivotal role. The government and the industry should strive for indigenous technology using solar power for developing a robust charging infrastructure.

cars were sold in FY19, less than 10,000 electric cars were sold. Despite zero road tax in several states and government subsidy to the manufacturers, the high price is a deterrent. But then it is a great opportunity for companies to innovate and bring the prices down. The battery is the costliest component of EVs and India is dependent on China and other countries for both the technology and the supply of lithium for manufacturing batteries.

It is an opportunity for the government to task the premier technical institutes, such as IISc and the IITs, to come up with innovative battery storage/alternative technologies. Innovation in reducing cost and improving charging speed for the mass market are the need of the hour.

The next challenge is about range anxiety, a term used to indicate an electric car driver's worry that the battery will run out of power before a suitable charging point is reached. Newer cars are expected to hit the In-

dian market with a 300-400 km range with a fully charged battery. This is much better than the 100-km range cars currently in the market.

Range anxiety is all the more serious as public charging infrastructure is almost non-existent at present. Even with the infrastructure, it would take 45 minutes to several hours to charge a car, depending on the technology used for charging batteries. While people are used to instant refuelling with ICE vehicles, the time taken for charging will be a dampener. There is a possible opportunity for companies to create innovative replaceable/detachable batteries. This will significantly reduce range anxiety and would make it convenient for the car and two-wheeler users.

Standardisation of the charging infrastructure would play a pivotal role. The government and the industry should strive for indigenous technology using solar power for developing a robust charging infrastructure. India's electricity infrastructure needs significant improvement to cater to increasing demand. Sustainable electricity generation through mini/micro and nano grids can be the way out.

Disruption in the job market can be another big challenge. Sample this: The number of moving parts in a normal ICE car would be over 2,000, while an EV counterpart would just have 20 odd moving parts. The fewer the moving parts, the lesser the need for maintenance. This could affect the established petrol/diesel-based automobile industry ecosystem, which includes service centres, spare parts manufacturers etc. The present automobile ecosystem has provided jobs to over 5 lakh people in the organised sector and several lakhs of unorganised jobs. The government would do well to create a 5-10-year road map that would allow for a gradual move towards creating a strong EV ecosystem. Also, the government and industry should embark on reskilling the existing workforce.

For India to emerge as a global electric mobility leader, a robust ecosystem involving government, industry and academia must be created, with a charter to drive road map implementation and spur innovation.

Fig 2.2 - An Article on how India is getting ready for the electric mobility revolution Sunday, July 21, 2019 by G Krishna Kumar. (11)

2.1 Global Scenario

This particular of G. Krishna Kumar article talks about global EV scenario, how the global markets are continuously adapting and changing themselves according to the new technological developments and other scenarios related to Electric Vehicles. (11)

The current price of Electric Vehicles is almost double of traditional vehicles throughout the globe. However, in the coming years the price will decrease significantly because of the various policies that different countries are going to implement in this sector. (11)

Norway is the market leader in the field of EV sales around the world. In the country around 20% cars sold are Electric which is a huge number when considered to other countries in the world.

The electrical vehicles industry in the United States is expanding rapidly, including over 4 lakh electric vehicles projected to be delivered this year. (11)

2.2 Indian Scenario

EVs are in India for a long time now but the policies and other developments which will affect the market are being introduced recently in India.

Via initiatives like Faster Adoption and Manufacturing of E-vehicles commonly known as FAME and its successor FAME-2, and new governments policies like Make in India, our government is trying it level best to a better adoption of EVs.

Big firms both government and private are also showing interest in this field mainly Indian players like TATA group and foreign players like MG. (11)

2.3 Challenges and opportunities

According to me this article expresses its views on challenges and opportunities very precisely and effectively as it talks about how Last year, 2.1 cr 2 wheelers were being sold in our country, and electric scooters which is supposed to be our future accounted for only 10000 lakh sales. Despite government zero-tolerance policies and government subsidies, less than 10,000 electric vehicles were sold.

It also talks about the battery which is the most expensive component of an electric vehicle, and how India is dependent on foreign countries for this. Range anxiety is compounded by the fact that the charging infrastructure of EVs in India is zero to nothing which is a sign of concern if you think about it.

It also talks about to meet rising demand; India's electricity infrastructure needs to be significantly improved. The use of mini/micro/nano grids to generate sustainable electricity may be the answer. Job industry disruption may also be a significant obstacle. For the development of a robust charging system.

At the end the author concludes with how in the organized sector, the current automotive industry has employed over 5 lakh people. The government will be intelligent if they try to create a road map for future of electric vehicles which, the roadmap should minimum be of 10 years, this will allow us, the average consumer of India a smooth transition to a better and effective electric vehicle ecosystem.

Incentives on offer under phase II of FAME

- ▶ ₹10,000 per kW
Planned incentive on the basis of battery size
- ▶ ₹20,000 per kW
Planned incentive for electric buses
- ▶ ₹8,596 crore
Total incentive sanctioned
- ▶ ₹1,000 crore
Incentive for setting up charging stations



Source: Heavy industries ministry

Stiff Riders

Minimum localised content of **50%** required to receive incentives, **40%** for buses
Incentive of ₹10,000 per kWh of battery capacity, ₹20,000 for buses

Import duty on electric powertrain and batteries to be raised to 15% in a year to promote local manufacturing

Maximum incentive for electric buses capped at ₹50 lakh against ₹1 crore in FAME I

Only fleet operators to get incentives on electric four-wheelers



E-vehicles to see more PE, VC money

TE NARASIMHAN & GIREESH BABU
Chennai, 28 April

The country's electric vehicle (EV) industry is expected to see higher interest from private equity and venture capital (PE, VC) investors.

Venture Intelligence, that tracks these things, says PE, VC investment in the EV space was \$23 million (₹160 crore) in 2018, in two deals, compared to \$3 million (₹21 crore) from three deals in 2017. The 2018 money was led by Alpha Capital and others investing around \$22 million in Hero Electric last December.

There were other notable investments. Twenty Two Motors raised \$65 million from Kwang Yang Motor in October 2018; Hero MotoCorp invested \$19 million into Ather Energy in July. Also, in 2016, Hero invested \$31 million in Ather Energy, says Venture Intelligence.

In March 2015, around \$12 million was infused by Tiger Global into Ather Energy. S Gopalakrishnan and others invested around \$1 million in Ampere Vehicles, which later saw a major share acquired by Greaves Cotton.

In 2019 till date, PE, VC investment in the sector has been \$300,000 (₹2.1 crore), in one deal. Tarun Mehta, co-founder at Ather Energy, said when they started, it was difficult for product-led start-ups to raise investments. The requirement of a lot of upfront capital expenditure in the initial stages, products' long journey from conception to market readiness, and absence of immediate return on investment proved detrimental.

However, in the recent past, the government's support and incumbents' active interest in the EV ecosystem has bolstered consumer interest. Firm business plans, the long-term outlook for electrification of mobility and increased investment in the industry has reinforced PE, VC



TOP DEALS FROM 2015

Company	Investors	Date	Amount (\$ mn)
Hero Electric	Alpha Capital, others	Dec '18	22
Ather Energy	Tiger Global	Mar '15	12
Ampere Vehicles	Kris Gopalakrishnan, others	Sep '17	1

Source: Venture Intelligence

faith in the growth potential.

"We believe there is mass awareness about opportunities in the EV industry and that has primarily contributed to simplification of the fund-raising process," said Mehta. Ather is investing in improving its products and Ather Grid, its charging eco-system, is working on expanding to 30 cities in a couple of years, he said.

Initially, the investments would be more towards usage in shared services and logistics, rather than private vehicles, as it would make business sense to investors, say both investors and consultants. Original equipment makers (OEMs) might be looking at investing in end-to-end solution providers such as Ather Energy or Ampere Vehicles. However, VC investments might need

time to pick up here, since identifying a solution and the start of manufacturing could need larger investment. A second round of funding would be critical.

"It is too early for the investment community to make large bets on that, though there are exceptions. There could be a lot of smaller investment in a larger number of sub-system kind of companies. The larger bet seems to be from existing OEMs and such players into end-to-end players. VC money will follow that," said Anand Ganapathy Chennira, chief operating officer of Micello Fund. This is a seed fund focused solely on clean mobility, led by Shreyas Shibulal, son of Infosys co-founder SD Shibulal.

Micello, with a corpus of ₹140 crore, also has a discovery studio along with

HOLDING SEATS

PE, VC investments in e-vehicle companies

Year	No. of deals	Amount (\$ mn)
2015	3	13.0
2016	1	1.0
2017	3	3.0
2018	2	23.0
2019 (YTD)	1	0.3

works on a last-mile logistics business. It is interested in investing in sub-systems as part of larger solutions, such as motor technology, powertrain and electric parts or firms that have a lot of intellectual property on a particular area. It is more focused on the impact the investment can create; return on investment is not the most important thing, he said.

Electric two-wheelers would be a particular attraction for investors, said Aswin Kumar, programme manager for the mobility practice at Frost & Sullivan. "Shared e-scooter service providers across the world got \$4 billion funding during 2017-18. The entire PE focus will shift towards India and they will cast their nets as widely as possible and invest in start-ups that have promising technology, to see if we can have a Tesla for two-wheelers in India, another unicorn for the market. The only thing they would look at is whether they have a scalable model to reach at least 10-15 per cent of the potential," he said.

An earlier report by Asian Venture Philanthropy Network India and IIM-Ahmedabad's Centre for Innovation Incubation and Entrepreneurship, in collaboration with Shell Foundation, detailed the challenge in attracting investment. Such as the lack of policy support, a weak eco-system and charging infra for EVs, lack of synergy with the

power sector, possible backlash from the auto sector and competition from the international market. According to the Automotive Component Manufacturers Association, the ICE powertrain contributes to 60 per cent of employment generation in their sector. A full switch to EVs could impact up to 5.6 million jobs by 2025-26, it said. However, the potential is huge in the segment, it said.

NTI Aayog predicts India's vision

of mass conversion to EVs can create a \$300 billion potential domestic market for EV batteries by 2030. This could be around two-fifth of global battery demand and 25-40 per cent of this market can be captured through 'Make in India', aimed at encouraging manufacturing and attracting foreign investment to India. Apart from government and corporate funding, VC funding hasn't got any successes in this space," says the report.

The government's recent announcement of Faster Adoption and Manufacturing of Electric (FAME-II), to take effect from this April has lack of clarity but once the business model and government policies are in place, there will be more PE activity in the sector, said Kumar. "Regulatory uncertainty is probably to come to an end soon but we do not see that as a big challenge because the OEMs themselves will fill the space," he added.

Last week, TVS Motor announced it had acquired a minority stake in a US-based industrial Internet of Things (IoT) firm, Altizon and Altizon Systems. It invested \$2.5 million. Altizon helps enterprises use machine data to drive business decisions, beside helping on digital transformation and new models for service delivery. "We will," said TVS Motor, "utilise the strong roster of global industrial majors who are customers of Altizon and gain from enhanced technology offerings."

These are some other articles forecasting the future of Electric Vehicles by their own estimates and calculations. These are from various newspaper articles showing the various policies of our government such as FAME and FAME-2 to increasing the awareness and sales of electric Vehicles in India.

Chapter 3

3. RESEARCH METHODOLOGY

3.1 Introduction

This part of my research contains the dissertation's research methodology, as mentioned in the title above. In this section, I will go through the research strategy, research method, research methodology, data collection techniques, sample selection, research process, data analysis type, and limitations of the study in greater detail.

3.2 Data Collection

For the purpose of my study I have conducted a Quantitative research, this type of research helps us to collect data in the form of numbers and graphs the research that I have conducted was a survey.

Data –The Data for this was collected by me from different sources, such as my friends, family and fellow classmates.

Sample Size – 60 respondents were selected as the sample size of my survey.

Sampling Technique – The sampling technique that I used for this survey is simple random sampling technique.

Tools and Techniques - The tool and technique that I used for collecting my primary data is interview method.

3.2.1 Interview Method

For my purposes I created a questionnaire which contained 15 questions for which suitable options were given to the participants. The questionnaire was an electronic Survey and I created it with Google docs.

The form was then sent out to the participants through their E-Mails or respective mobile number, after which the respondents found it convenient to answer the questionnaire and share their viewpoints.

The format and the questions that were asked in this particular online survey are given on the next page of this research.

3.2.2 Questionnaire Format

Please put a (✓) mark against each option where ever required.

Your Profession: - Student House wife Retired

Self Employed Job Other (please specify) _____

Gender: - M F

1) Do you have any vehicle? Yes No If yes total no. of vehicles ____

2) Is it a

Two Wheeler Three Wheeler Hatch Back Sedan SUV
 MUV Pickup Truck Other (please specify) _____

3) Is most of your daily travelling in city, on the highway or mixed?

City Highway Mixed

4) Also let us know the mode of transportation you prefer and approx. distance travelled.

Own Vehicle Taxi/Auto Rickshaw Public Bus Train
 <100km <150km >200km Other (please specify) _____

5) Have you heard about Electric/Hybrid vehicle? Yes No

6) Would you be interested in owning/converting your vehicle into Electric/Hybrid Vehicle?

Yes No Can't say

7) If yes then how much would you expect to be the price of an Electric Vehicle/ Hybrid Vehicle?

Two wheeler _____ Three wheeler _____ Hatchback _____
 Sedan _____ SUV _____ MUV _____
 Pickup Truck _____ Other (please specify) _____

8) What is preventing you from purchasing an Electric Vehicle?

- Nothing, I plan to buy an electric vehicle soon
- The present cost of electric vehicles is too high
- The vehicles available at the moment don't have enough range on a single charge to meet my needs
- I need more information about the technology before I would make a purchase
- It would be difficult to set up charging in my building/home
- Other (please specify) _____

9) Would you like to know more about Electric/Hybrid vehicle? Yes No

10) If yes from which source? Television Ads Auto Expo Magazines

Live Demo Internet Websites Blogs Newspaper Ads

11) Where would you prefer to charge your Electric Vehicle if you were to buy one in the future?

At home At work Using public charging facilities

12) What should be the range of an Electric Vehicle when fully charged? (In approx.)

Less than 100 km 100-150 km 150-200 km Other (please specify) _____

13) What should be the expected maximum speed of an Electric Vehicle? (In approx.)

Up to 80kmph 150kmph Other (please specify) _____

14) How much would you spend on changing the batteries once it gets exhausted? (In INR approx.)

5000 15000 250000 50000 Other (please specify) _____

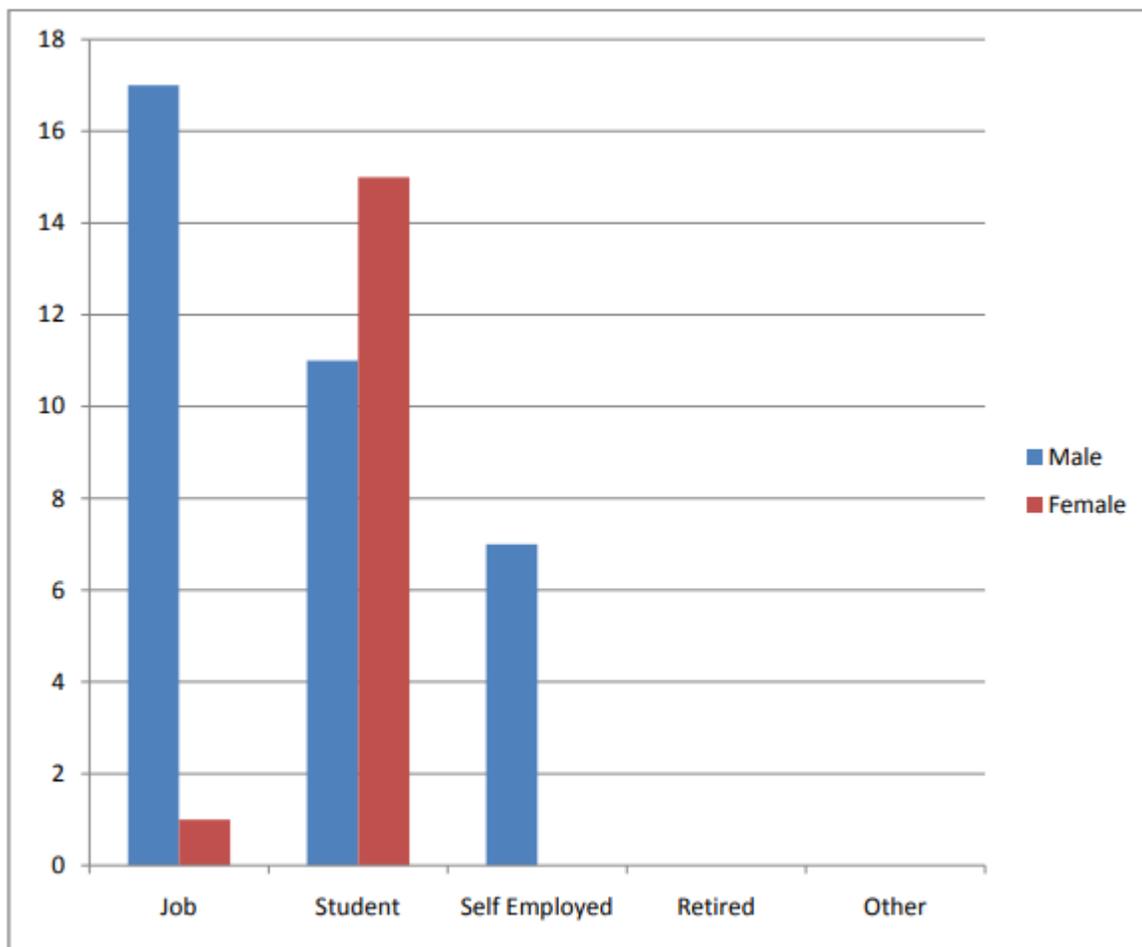
15) How much subsidies you expect from Government on the price of batteries of Electric/Hybrid Vehicles? (In approx.)

10% 20 % Other (please specify) _____

16) How much premium would you pay for additional development or manufacturing cost of infrastructure? (In INR approx.)

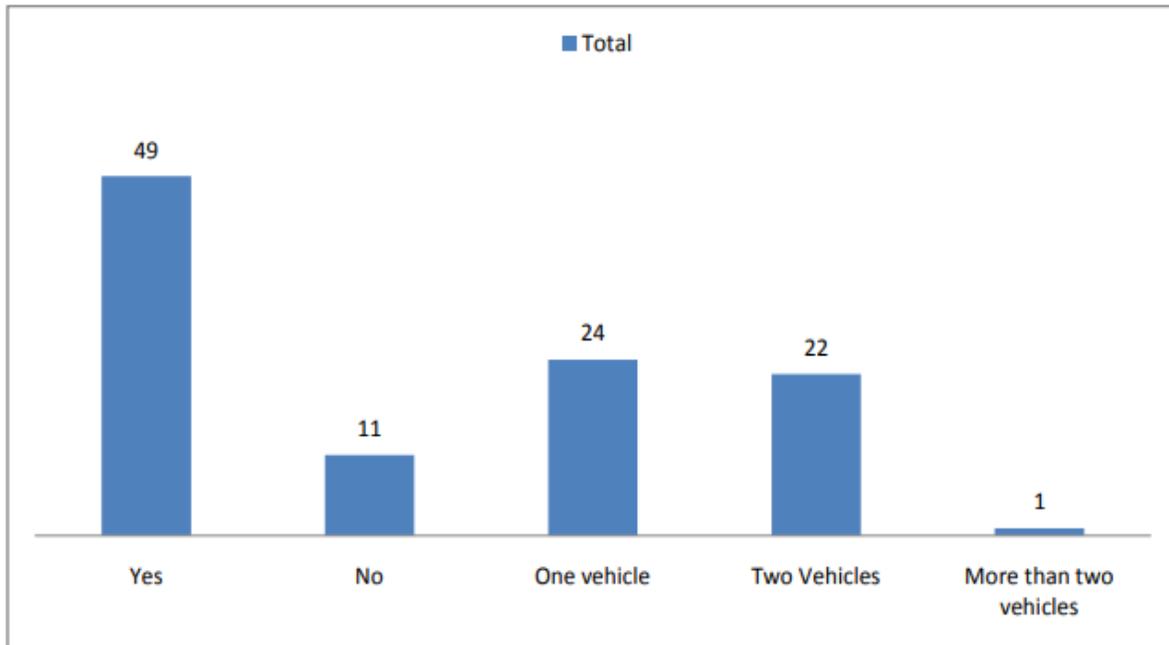
25000 50000 75000 100000 Other (please specify) _____

3.2.3 Results of the questionnaire

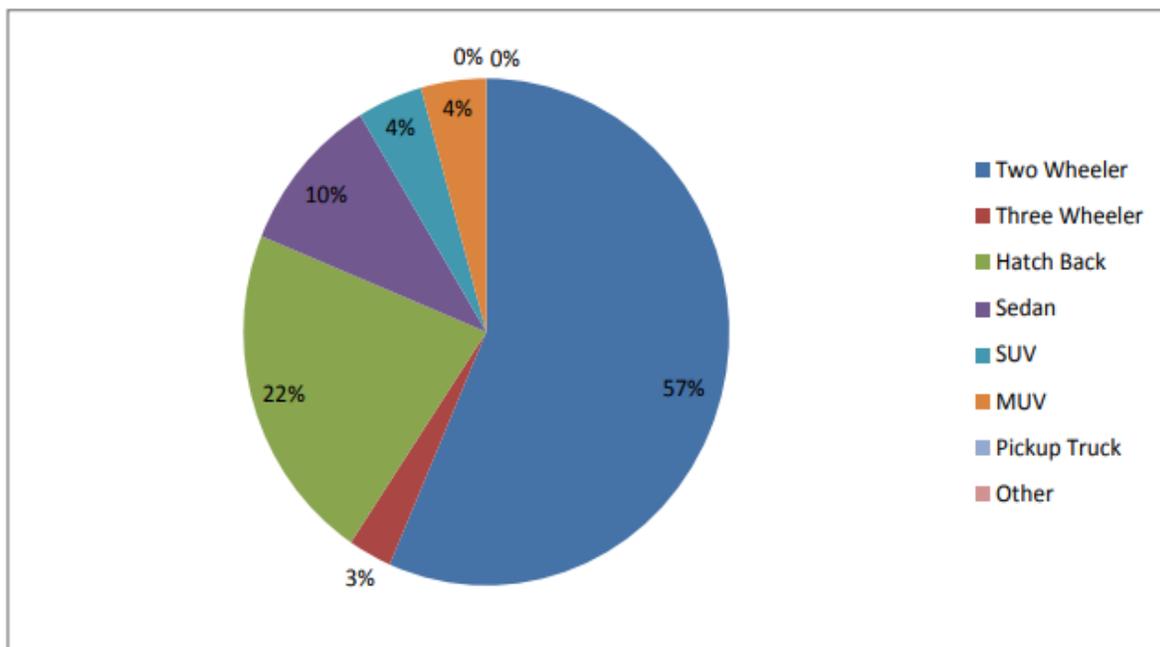


In this graph you can see the total 60 participants who took part in this survey. Most of the respondents are students or people who are working.

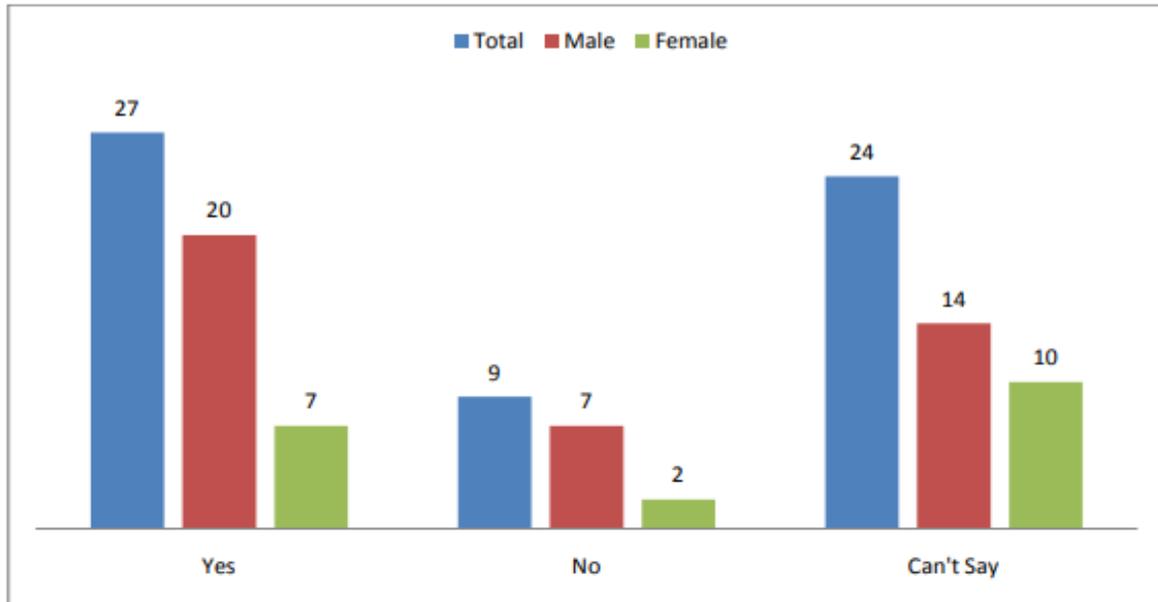
Q.1. Do you have any vehicle? If yes, total no. of vehicles?



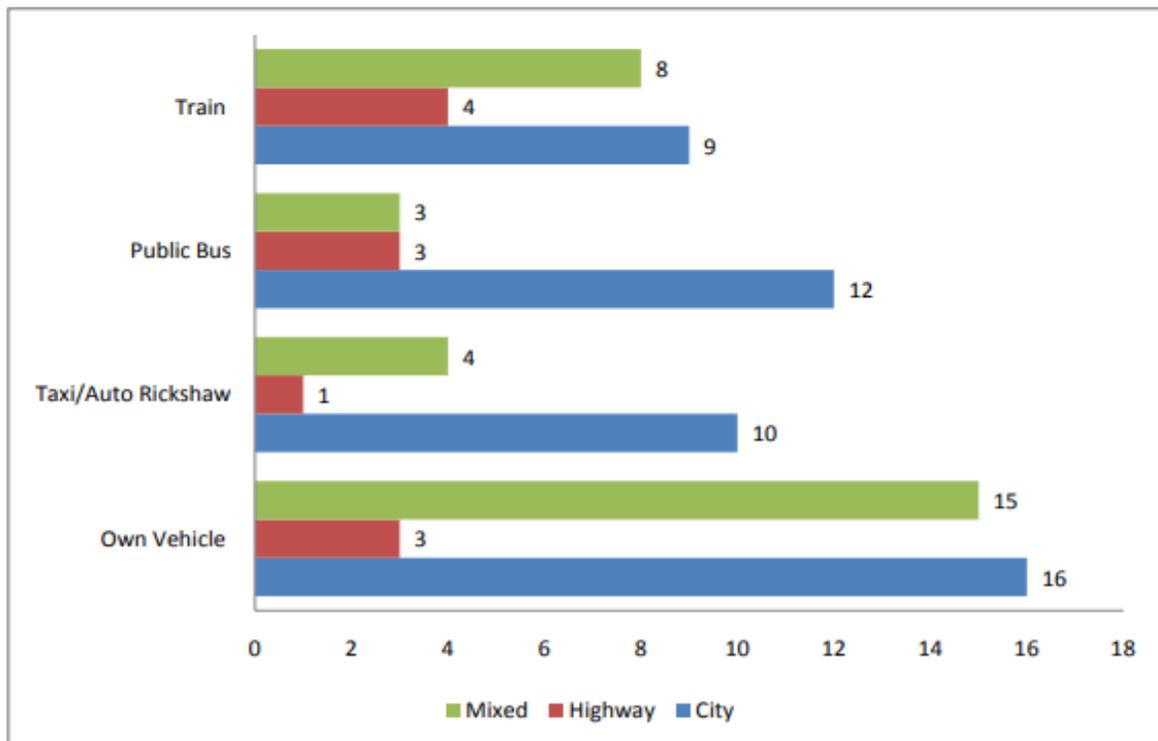
Q.2. If yes, what is the Vehicle-type?



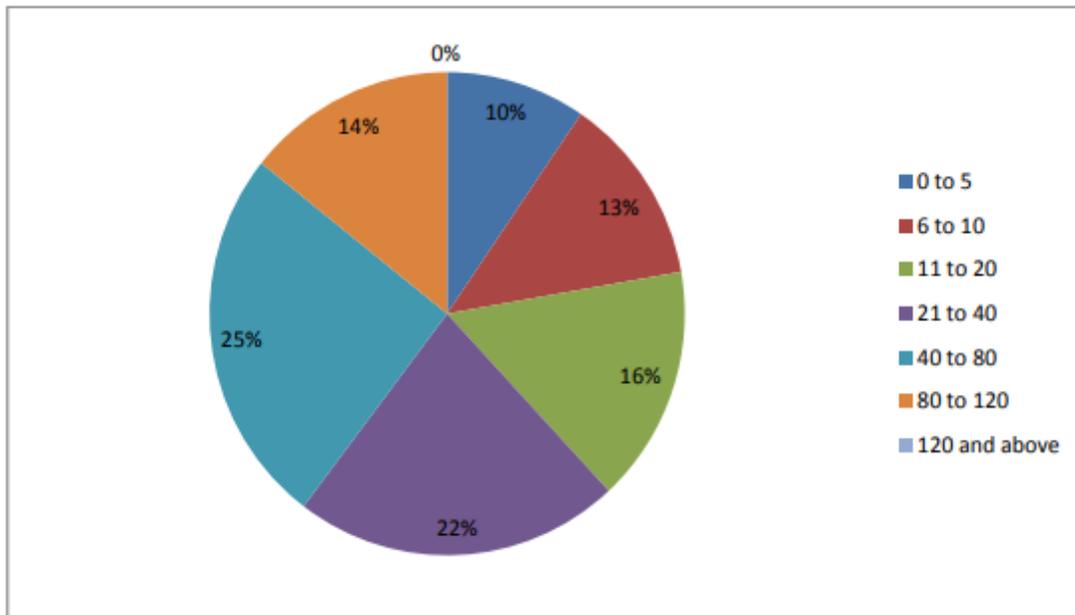
Q.3. Would you be interested in owning/converting your vehicle into Electric/Hybrid Vehicle?



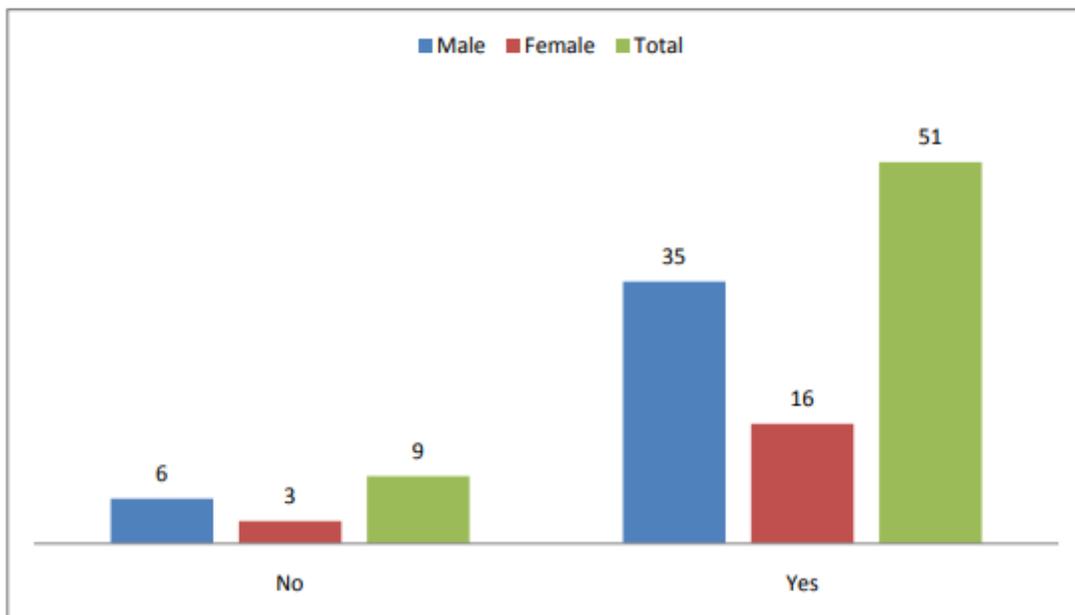
Q.4. Is most of your daily travelling in city, on the highway or mixed? Also let us know the mode of transportation you prefer and approx. distance travelled.



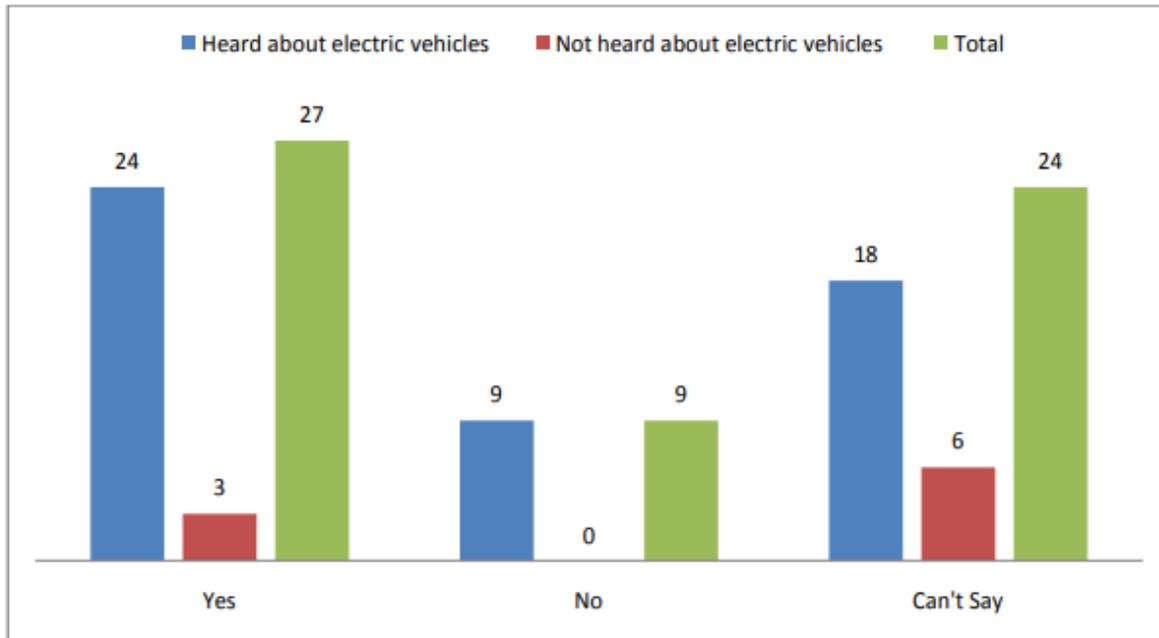
Q.5. What is the total approx. distance travelled by you daily?



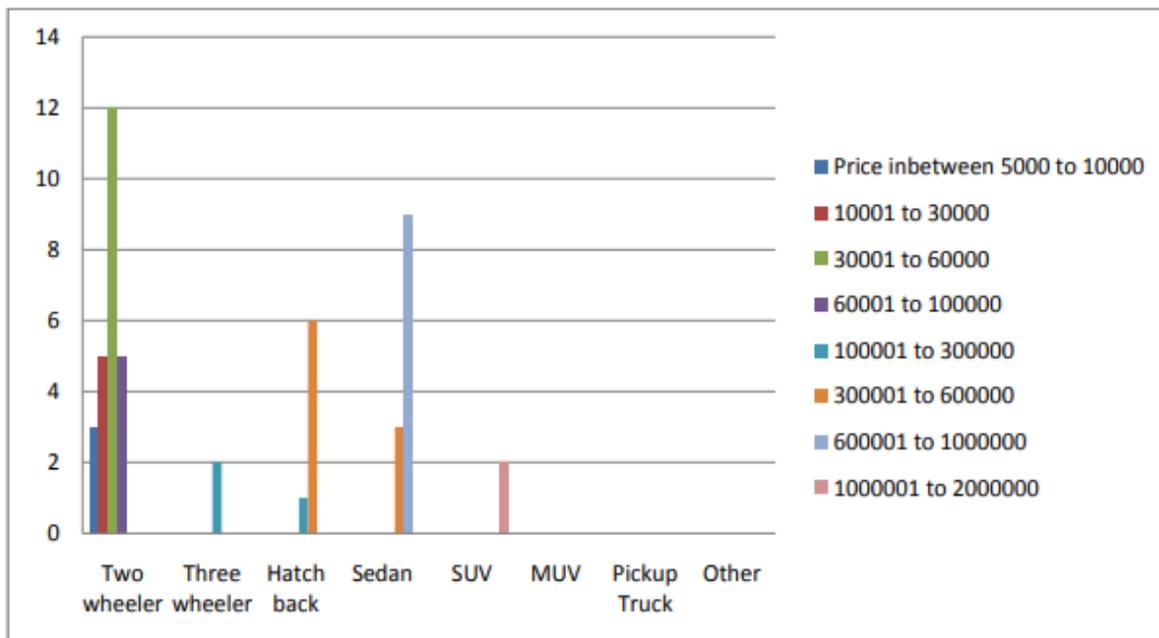
Q.6. Have you heard about Electric/Hybrid vehicle?



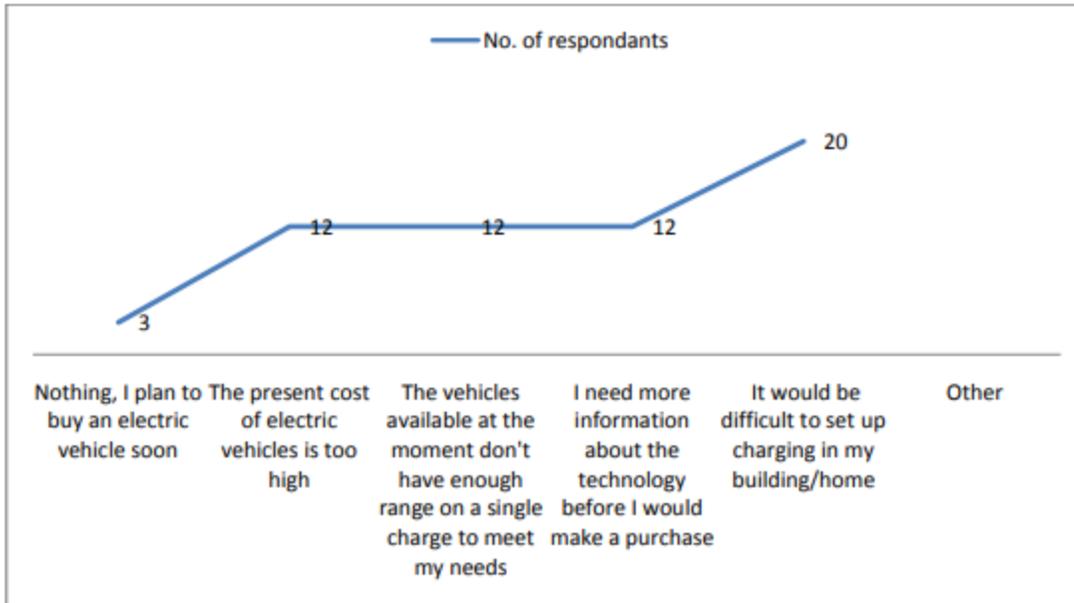
Q.7. Would you be interested in owning/converting your vehicle into Electric/Hybrid Vehicle?



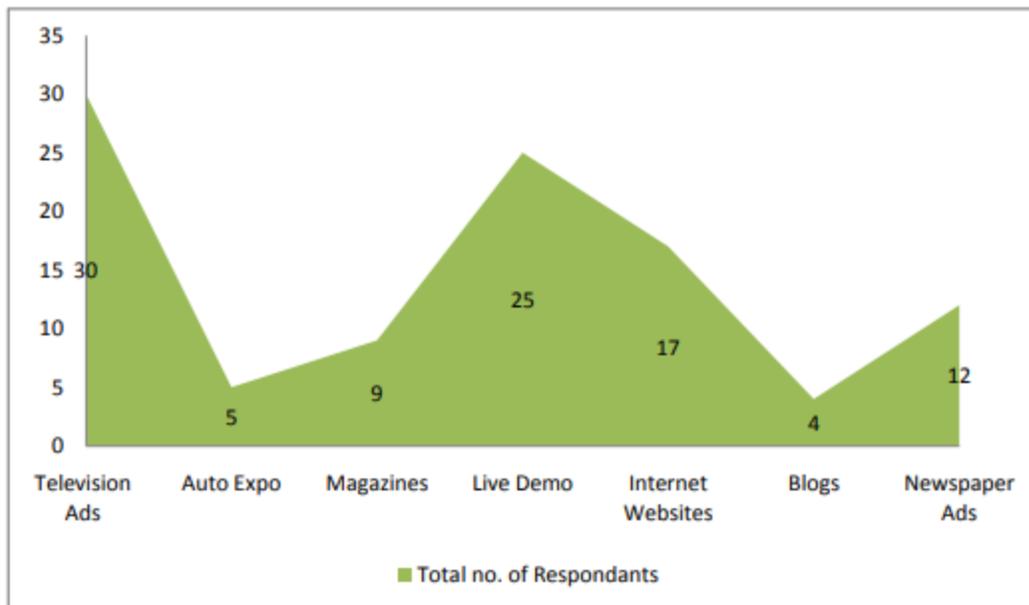
If yes, then how much would you expect to be the price of an Electric Vehicle/ Hybrid Vehicle?



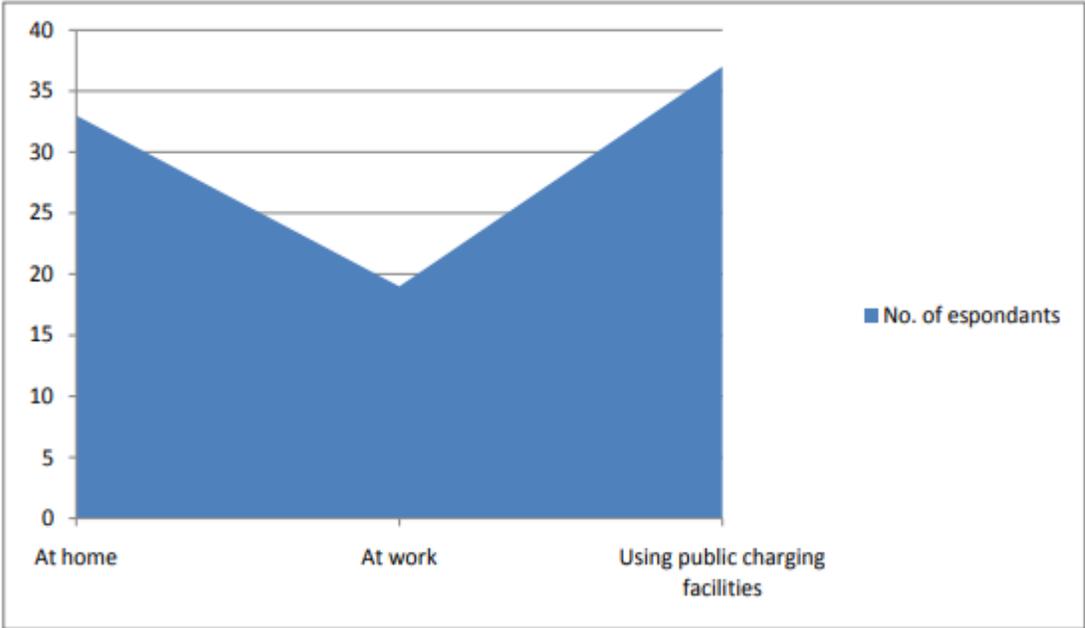
Q.8. What is preventing you from purchasing an Electric Vehicle?



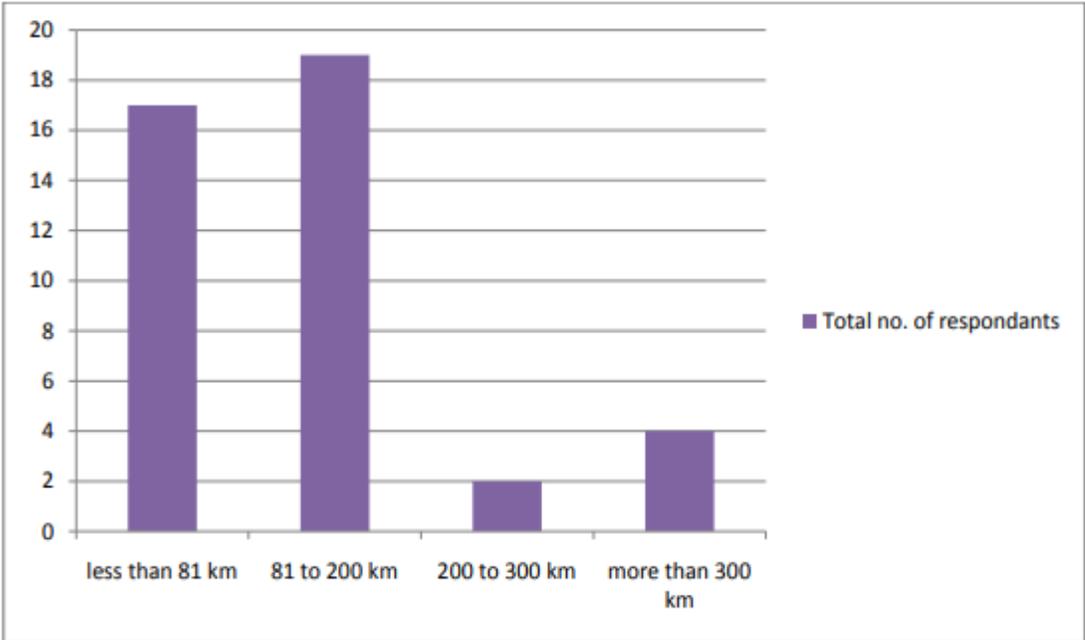
Q.9. Would you like to know more about Electric/Hybrid vehicle? If yes, from which source?



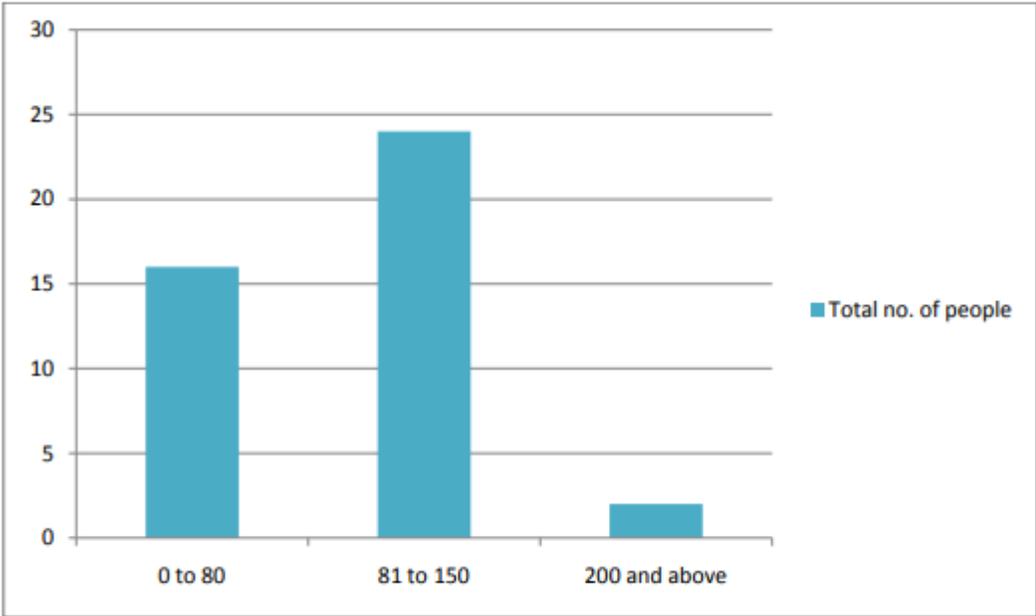
Q.10. Where would you prefer to charge your Electric Vehicle if you were to buy one in the future?



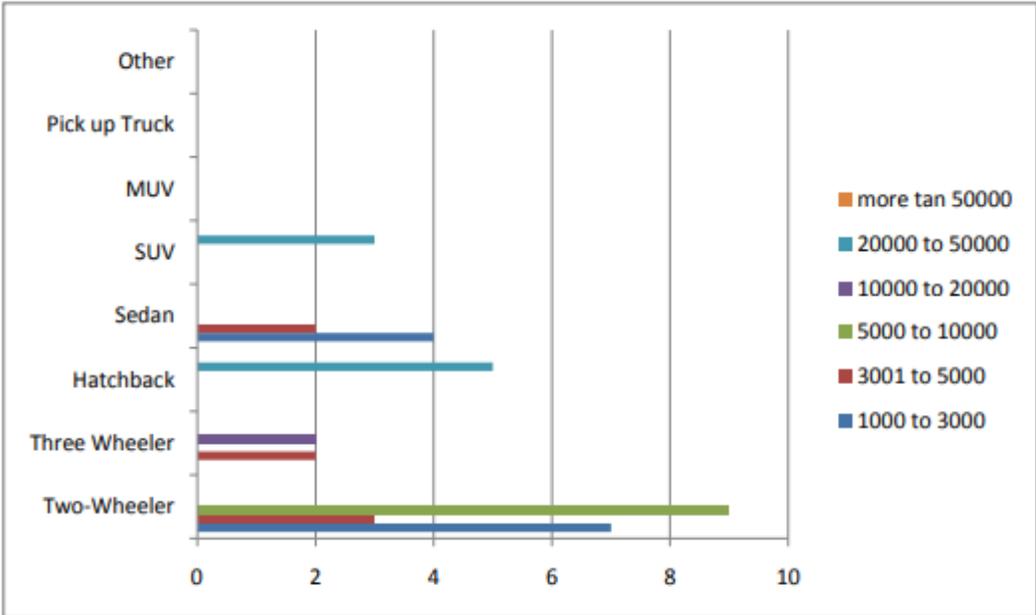
Q.11. What should be the range of an Electric Vehicle when fully charged?



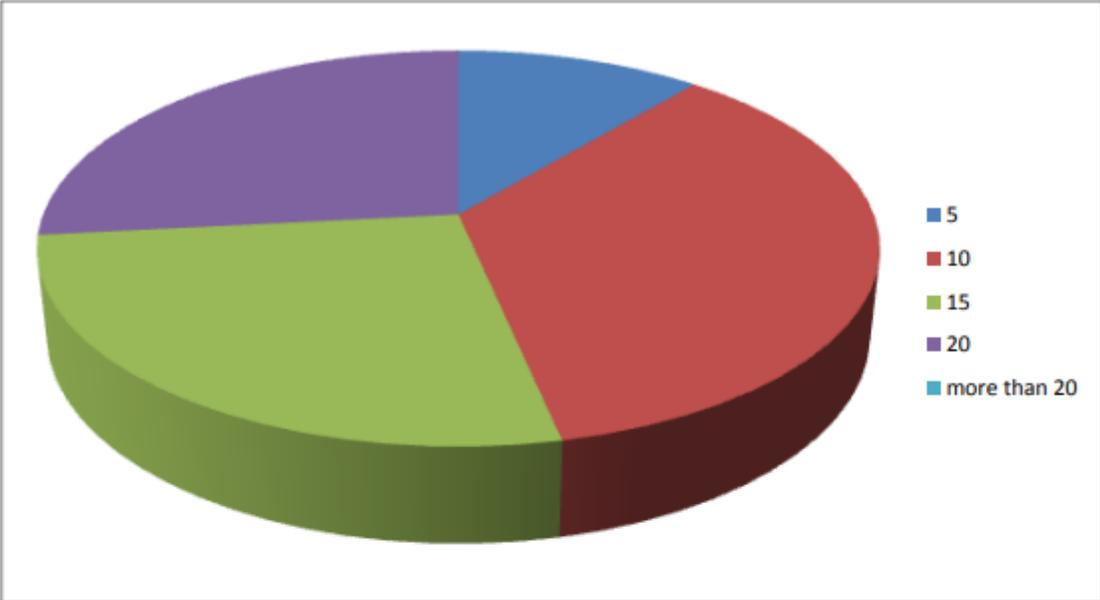
Q.12.What should be the expected maximum speed of an Electric Vehicle?



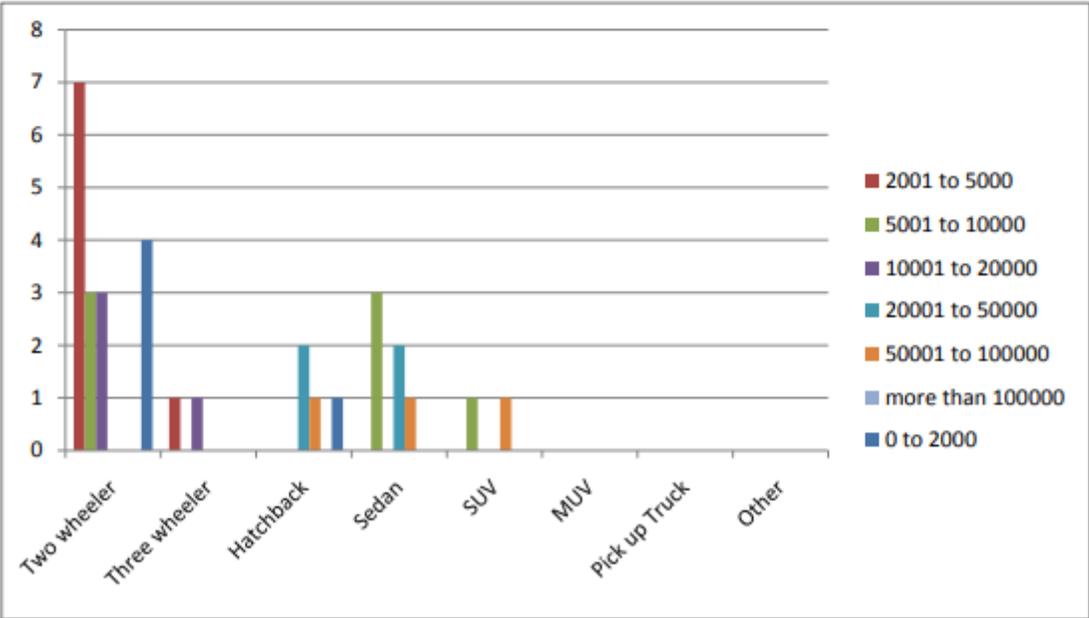
Q.13. How much would you spend on changing the batteries once it gets exhausted?



Q.14 How much subsidies you expect from Government on the price of batteries of Electric/Hybrid Vehicles?



Q.15. How much premium would you pay for additional development or manufacturing cost of infrastructure?



3.3 Data Analysis

According to the survey that I have conducted below are my results and analysis.

- Males have taken the survey in greater numbers than females.
- A significant number of people consider their work to be their occupation.
- A greater number of two-wheeler owners expressed interest in purchasing or upgrading their vehicles to electric or hybrid vehicles.
- The majority of people (males) tend to drive in their very own cars on a routine basis, spread over an area of 40-80 kilometers.
- The majority of the people in our survey drives their vehicles in the city environment as well as on the highway or they drive only in the city most of the time.
- A large number of female students have shown a strong desire to learn more about electric and hybrid vehicle technologies.
- The majority of Sedan Vehicle owners particularly expects that their EVs should cost somewhere between 60,000 and 100,000 INR.
- With this price, it's safe to say they're interested in converting their current vehicle to a hybrid.

- It was discovered that
 - The current cost of EV is very high and average consumer is not willing to buy it at the current price.
 - One other problem is that EVs as of now doesn't give desirable mileage to the consumer.
 - Many people don't even properly know what is an EV and they need more information about the technology before they will invest.

- The majority of the people are interested in learning more about electric vehicles from newspaper advertisements and live exhibition vehicles.

- According to my survey majority will prefer to charge their cars at home rather than on a public charging station. This is concerning as the infrastructure is far from being completed in the near future.

- It was examined that most the people in our survey usually travel approximately 80 kilometers but they will be open to the idea of EV if it is providing a mileage of 80 to 150Kilometers. One of the newer models is Reva which can travel up to 100 kilometers when it completely charged.

- Most of the 2 wheeler's owners and it cars hatchback owners are willing to pay around 5000 to 10000 and 20000 to 50000 INR respectively for the replacement of batteries once exhausted.

- EVs batteries are generally changed between 4 to 5 years approximately which is necessary for the working of the EVs and it costs around 20000 to 50000.

- People who are considering purchasing an electric vehicle are unworried about the vehicle's speed. People are indifferent about government subsidies when it comes to purchasing an electric vehicle.

- The large bulk of everyone who contributed to my questionnaire is prepared to pay a one-time premium as a one-time manufacturing cost.
- Depending on the type of vehicle, people may probably pay a premium of 2000 to 5000INR. Two-wheeler owners, for instance, should expect to pay a premium of 2000 to 5000 INR.

3.4 Finding and Recommendations

Throughout this survey there are some findings that I have seen such as people are admittedly more open towards electric vehicles than I had anticipated, people are even willing to pay premiums.

People know what are electric vehicles and they are willing to gain more knowledge about them particularly I found that students are much more eager towards knowing what Electric Vehicles have to offer them in the future.

It was also seen through these surveys that majority of the people will be willing to adopt the new technologies such as hybrid vehicle which will modify the engine of their cars but they will adopt it only if the price is not high otherwise they are not willing to adopt new Technologies.

After analyzing the survey, I have gained some insights regarding future of electric vehicles in India, some recommendations from my side will be that –

- Our government have to focus on providing more infrastructure for the growth of electric vehicles.
- Government should understand that for better adoption of new technologies such as EVs it is necessary to reduce taxes and encourage people for buying them.
- Government should also try to educate people about why EVs are important and what are their benefits through various platforms such as TVs, Internet and Newspapers.

3.5 Limitation of the Study

- Due to practical constraints, this paper cannot provide a comprehensive review of all vehicles in the market; only present and future of electric vehicle scenario is considered for study; hence other automobiles are excluded from the study.
- Another potential problem is that scope of the study may be too broad. A full discussion of other aspects of electric vehicle lies beyond the scope of this study.
- The sample size was very small and it might have been better if I could have about 1000 responses for my survey on this research. Nonetheless, this leaves option for further research and analysis for the future.

Chapter 4

4. CONCLUSION

The results of my survey proved to be critical for the conclusion of my study because the results were largely positive and provided important insights to the mind of an average buyer of our country.

People's perceptions of EVs remain unsatisfactory, as a large segment of our population is still ignorant of the numerous Alternative Technologies used in automobiles.

Market standards are not being met to a large extent in current Electric Vehicles.

The government's measures to promote electric vehicles are still in the planning stages and are still on paper. Although numerous departments have been established and various proposals have been presented, their execution has yet to be completed.

An average consumer in India is not that much concerned about green environment and clean energies, our government should try to initiate and tell the benefits of green energies for our future, awareness campaigns regarding this can be introduced by our government.

The marketing of new EVs would play a critical role in moving us closer to a Sustainable Future.

As part of their corporate social responsibility, various corporations should also take steps to support electric vehicles.

Chapter 5

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