



A STUDY ON INDIA'S QUEST FOR ELECTRO-MOBILITY

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Abstract

The Indian auto industry is the fifth-largest in the world and is scheduled to be the third-largest by 2030. Riding on this electric vehicle wave, India can groom into an Electric Vehicles (EVs) hub counting on its skilled manpower in technology and by developing an environment-friendly ecosystem for manufacturing industries. EVs have become a topic for discussion across the world with many countries adopting to the new driver of transportation which is being cited as the blue-eyed boy for environment conservation. The major objective of this paper is to investigate the consumer demand and the challenges the country have to face for this visionary target. The aim is to look at the perception of potential consumers towards various aspects of EVs. It was found that potential consumers are looking forward to the switch but they reveal a long transition period as they do not deem EVs much reliable as of now. Affordability has also been identified as a major discouraging factor for potential buyers. Although, EVs have emerged as an alternative to traditional-fuel based vehicles, but such mass transition is bound to face some obstacles in the way. To explore those issues, the study looks at the infrastructural hurdles that surround the charging infrastructure in India. Without developing sustainable charging facilities, the penetration of EVs in India will remain superficial. The paper tries to gather probable solution to such issues. Finally, the study intends to generate insights about the ability of electric vehicles to reduce carbon footprint by looking at China where the adoption of EVs have move faster. Since, China has been running quite ahead of India in the EVs race, India, being in the infancy can try to look at their EV roll-out. A contradictory viewpoint has also been dug out which sheds light on the concept of 'greenwashing'. The electrification of India's transportation sector still seems like a distant dream.

Keywords

Electric Vehicles, transportation, Environment conservation, potential demand, Greenwashing

Introduction

Electric Vehicles are emerging as the one sure-shot solution to all the environmental deterioration-related issues across the world. As more and more fuel is being consumed to satisfy the energy needs of humankind, the search for alternatives is also peaking. EVs not only address the energy crisis but can also act as a solution to the woes of the most polluted countries. Apart from this, EVs have also become the apple of the eye of modern-day entrepreneurs and venture capitalists which is clearly evident from the rising number of EVs based start-ups and huge chunks of funding that they have been attracting. The Indian Government is also recognising the need to promote sustainable means of mobility. By reducing pressure on imported fuels, EVs can also have impact India's finances. If EVs prove their mettle, their usage can create ripple effects in various domains majorly sustainability cutting down the negative impacts of carbon emissions which is being cited as the major threat to planet's biodiversity.

As study conducted by CEEW Centre for Energy Finance (CEEW-CEF), the EV market in India is going to be a whopping INR 14,42,400 crore by 2030 if India keeps up with consistent advancement to fulfil its aggressive 2030 objective. This would require massive investment opportunities for collaboration with several line ministries regulating transport, electronics manufacturing, etc.. The national government is likely to be focusing on the shift towards clean mobility. 140 million people in India breathe air that is 10 times or more

above the WHO acceptable limit, according to a study based on 2016 data. Industrial pollution accounts for 51% of pollution, whereas car emissions account for 27% of pollution.

According to a report based on 2019 statistics, 21 of the 30 most polluted cities in the world are located in India. Over time, the Air Quality Index (AQI) for India has increased. Improvements were observed in 98% of India's cities as a result of a 20% drop in national air pollution from 2018 to 2019. The annual average air quality index for Delhi is 98.6. In 2020, India's yearly AQI was 141.

The National Clean Air Program (NCAP) was inaugurated by the Indian Government at the beginning of 2019. The objective was to address the issue of high AQI. It aims to reduce the air pollution by 20-30% in 2024 in over 102 of the worst affected cities. Niti Aayog published a report "India's Electric Mobility Transformation", according to which, by 2030, India will have an EV sales penetration of 70% for commercial vehicles, 30% for private vehicles, 40% for buses, and 80% for two- and three-wheelers. If achieved, it can reduce our millions of carbon emissions for lifetime.

Despite India's visionary target, India's EVs industry is still in a nascent stage. Undoubtedly, India is one of the world's largest potential and untapped market. But the transition from fuel-based transportation to an electric one is not that simple. Issues surrounding the carbon footprint of production of EVs and their performance have been highlighted from time to time. But the elephant in the room is the issue surrounding the availability of charging infrastructure. The time involved in charging the EVs, the efficiency of it and other practical problems faced by users delve from the same. The cost of electric vehicles in relation to the traditional ones is another point worth pondering over. The study aims to look at some of these issues from the point of view of existing and potential consumers.

Electric vehicle Overview

It is crucial to understand certain fundamental terms used in the topic of EVs before moving on to perception. Electric motors powered by battery energy through a power electronic traction inverter are intended to replace internal combustion engines in electric automobiles. The battery, charger, charging port, regenerative braking, power electronics controller, DC/DC converter, and drive system are some of the important elements of EVs. The electric motor's function is to propel the electric vehicle using the electrical energy contained in the batteries. Electric vehicles (EVs) are environmentally benign since they are recharged with low-emission power sources. The electrical grid supplies power to the cells. The battery's main job is to supply the electric car with the energy it needs to run. Due to their higher efficiency compared to other cells and low maintenance requirements, lithium-ion batteries are used in the majority of electric vehicles. Compared to nickel-metal hydride and lead-acid batteries, Li-ion batteries cost more to produce. Li-ion batteries can live up to 12 years, depending on the environment and maintenance schedule.

Types of electric vehicles

EVs have been created in a number of nations, although China, the United Kingdom, the United States, and Germany account for the majority of the EV market. The electric vehicle market is exploding all over the world. The three major types of electric vehicles are

**HYBRID
ELECTRIC
VEHICLE(S) (HEV)**

- An internal combustion engine and an electric motor combine to form a hybrid electric vehicle. The engine, as well as the energy generated by braking and deceleration, is used to charge the batteries. Hybrid autos are currently referred to as such since they combine a combustion engine with an electric motor as a power converter. The ability to give modern performance without relying on charging infrastructure is one of the numerous advantages of hybrid electric vehicle technology, which is employed all over the world. By electrifying the powertrain, they can also drastically reduce fuel usage. The HEV can be connected in a variety of topologies depending on the type of hybrid system.

**PLUG-IN HYBRID
ELECTRIC
VEHICLE(S)
(PHEV).**

- In a plug-in hybrid electric car, an internal combustion engine and an electric motor are integrated (PHEV). These vehicles are powered by gasoline and have a large rechargeable battery that is powered by electricity.

**BATTERY
ELECTRIC
VEHICLE(S) (BEV)**

- A battery electric vehicle, sometimes known as a BEV, is a fully electric vehicle. Instead of a gasoline engine, it is powered by high-capacity rechargeable battery packs that can be charged from an external source. Chemical energy stored in rechargeable batteries powers the electric motor and all internal electronics of a battery-electric vehicle. The BEV has the potential to reduce not only carbon dioxide emissions but also reliance on fossil fuels in the light-duty vehicle fleet. (Mahmoudzadeh Andwari et al., 2017)

Source: (Handbook vehicle charging infrastructure implementation by Nitti Aayog, Ministry of Power.)

	ELECTRIC VEHICLE	HYBRID VEHICLE
CO2 Emission	Low	Medium(50–60% of Internal Combustion Engine)
Price Range	High	Similar to Internal Combustion Engine
Fuel Usage	None	40–60% of Internal Combustion Engine
Charging	Required	Not Required
Powered by	Electric Engine	Internal Combustion Engine and Electric Engine

Source: (Goel et al., 2021)

Table 1. Comparison between Electric & Hybrid Vehicle

Literature Review

"A review on barrier and challenges of electric vehicle in India and vehicle to grid optimisation". (Goel et al., 2021) The paper provides an overview of penetration of different types of vehicles into the market. It also talks about approach of various models and optimisation techniques. It also tells us about the vision for 100% electric vehicles in India by 2030 and recent initiatives and various policies made by the government of India to promote battery technology and give an overview how electronic vehicle can reduce emission of greenhouse gases.

"Quantifying the Societal Benefits of Electric Vehicles" (Malmgren, 2016) This study talks about the advantages that EVs can offer and these benefits are expressed in quantitative terms. The numbers behind benefits offered by Electric Vehicles (EVs) provide insights for policy-makers that can help predict incentive and investment levels that can help ascertain the utility of EVs to society.

"A Study on the Adoption of Electric Vehicles in India: The Mediating Role of Attitude" (Khurana et al., 2020) This paper addresses the agenda that is being pushed aggressively – environment-friendly nature of electric vehicles which is why governments all over the world are pushing for greater absorption of EVs.

Objectives

The main objective of the study is to analyse the consumer perception regarding Electronic Vehicles and identify the associated infrastructural problems and solutions (India Specific) that can be offered for the growing economy of EV in India, which has been further divided into

1. To analyse the acceptance level of E-Vehicles in Delhi-NCR region
2. To identify the infrastructural problems acting as major hurdle in the transition from fuel-based vehicles to EVs.
3. To explore the ability of EVs in reducing the carbon footprint

Methodology

The study makes use of primary as well as secondary data. Primary data has been collected from potential users of electric vehicles to test their perception. The study makes use of questionnaire filled by the respondents. The results of it are analysed using descriptive approach. Secondary Data has been analysed for understanding the infrastructural issues associated with EVs and to understand the utility of EVs in reducing carbon footprint. It has been extracted from credible reports and internet sources. Some auto experts and users of EVs have also been interviewed to fetch first-hand data.

1. DATA ANALYSIS

1.1 Demographic Analysis

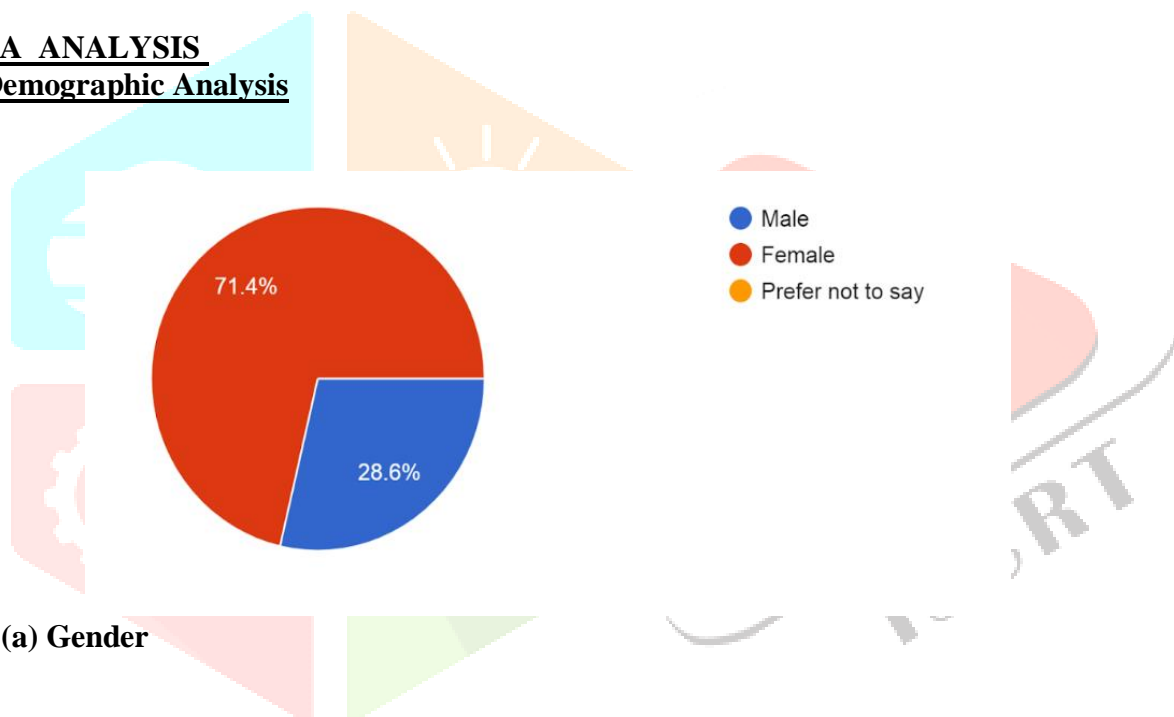


Fig 1(a) Gender

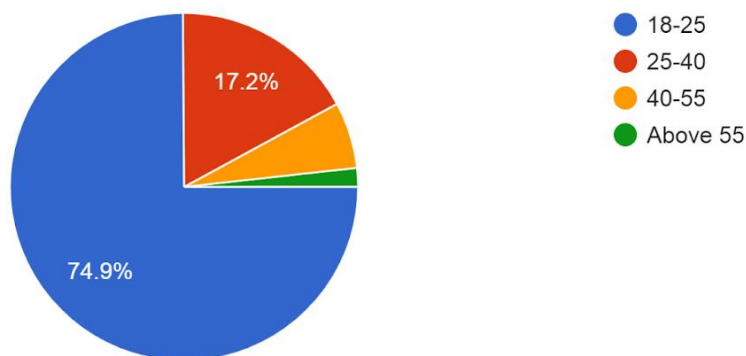


Fig 1 (b) Age Group

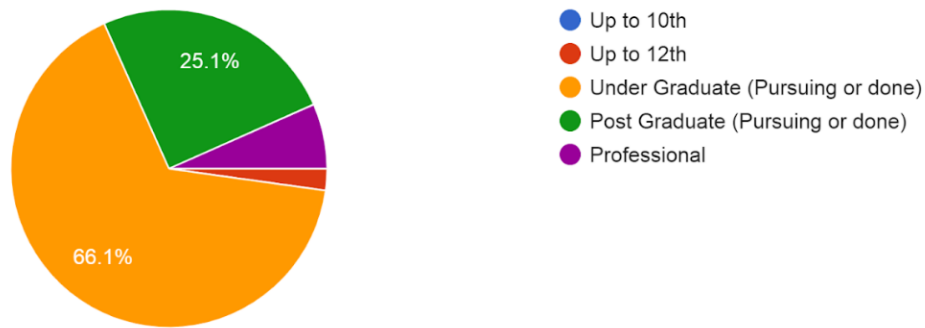


Fig 1 (c) Educational Qualifications

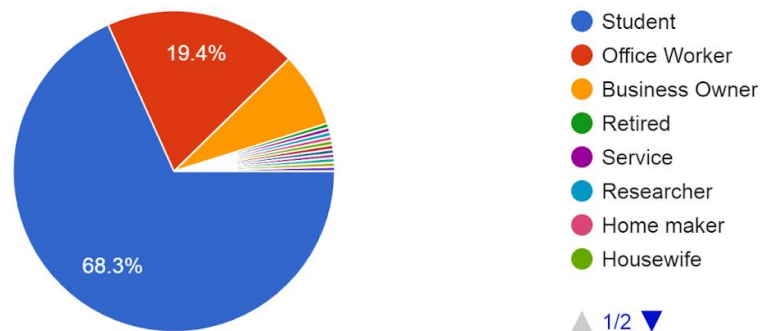


Fig 1 (d) Occupation

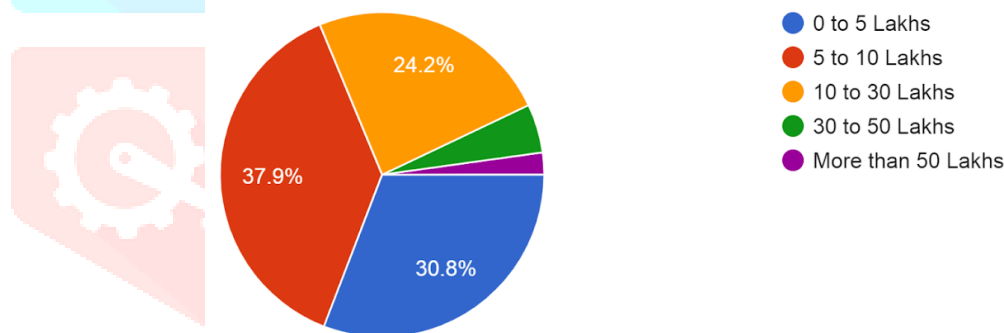


Fig 1 (e) Annual Family Income

The total sample consists of 227 respondents. The above pie charts show that our survey sample consists of 71.4% of Females and 28.6% of males. Major chunk of our sample belongs to the age group 18-25 (74.9%). 17.2% of our sample is between the ages of 25 and 40, 6.52% is between the ages of 40 and 55, and the remainder of the sample is between the ages of 55 and above. Majority of the respondents are pursuing or have done undergraduate (66.1%) followed by the respondents pursuing or have done Post Graduate (25.1%). Majority of the respondents are Students (68.3%) followed by office workers (19.4%). Majority of the sample belongs to the category 5-10 lakhs annual income (37.9%) followed by 0-5 lakhs (30.8%) and 24.2% of the respondents income lies between 10-30 lakhs.

1.2 Exposure Analysis

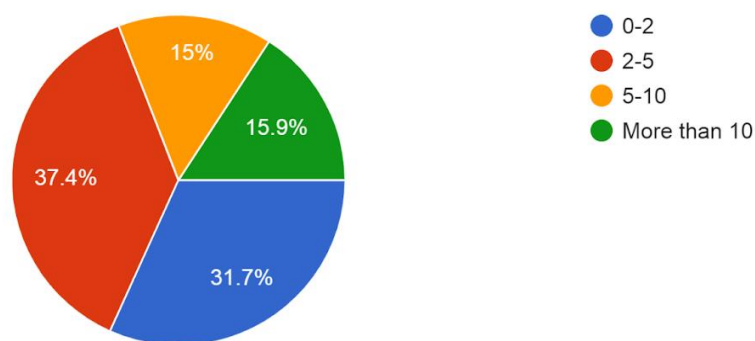


Fig 2 (a) Number of electric vehicles spotted by respondents on road in 1 hour

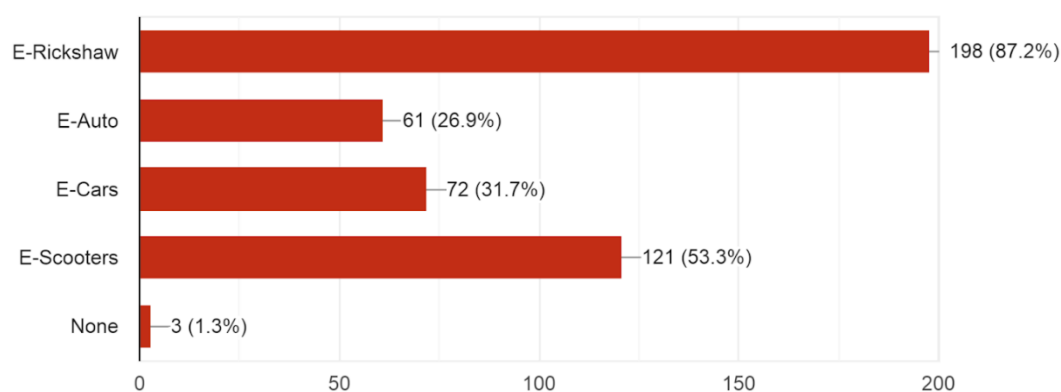


Fig 2 (b) Types of electric vehicles spotted by respondents on road in 1 hour

Before moving to perception of potential buyers towards EVs, it was imperative to understand the frequency and types of electric vehicles to which the respondents were exposed. To understand the exposure of respondents towards electric vehicles, they were asked questions about the frequency and types of vehicles they spot on road in 1 hour. If the respondent spends 1 hour in the traffic, then he/she usually spots 2-5 electric vehicles (37.4%). E-rickshaw is the most spotted electric vehicle (87.2%) followed by E-scooters (53.3%). E-scooters are majorly being used for making deliveries by delivery partners employed by food and grocery delivery companies.

1.3 Potential Demand Analysis

To analyse the perception of potential buyers towards electric vehicles, the respondents were asked a series of questions to get insights about their expectations from an electric vehicle.

Willingness : Out of our total sample, 52.4% respondents said that they would prefer to buy an EV. 12.3% responded negatively and rest are unsure.

Expected Transition Time : On being asked about the transition time, 42.7% of the respondents might take 2-5 years to switch to EV while 33.5% of the respondents might take 0-2 years, 17.6% of the respondents might take 5-8 years and the rest might take 8 or more years to switch to EV. This shows that it is a possibility that an influx of EV buyers can be witnessed in the next 2-5 years. Most of the consumers are not willing to take the risk of experimenting with a new product. They would rather wait for someone in their social circle to buy EVs so that they can decide based on first-hand feedback.

Willingness to Pay: It was found that 48.9% of the respondents would be willing to pay 1-5 lakhs for an EV whereas 33.9% would be willing to pay 5-10 lakhs. 11.9% of the respondents would be willing to pay 10-15 Lakhs for an EV and only around 5% are willing to pay 15 lakhs or more for buying an EV. This highlights the price sensitivity of the potential buyer as they are concerned about the cost of the vehicle and want more options in the relatively cheaper categories.

Types: 38.3% of the respondents would prefer PHEV, 31.7% of the respondents would prefer BEV, 30% of the respondents would prefer HEV. The preference for three different types of EV is almost equal.

Brand Preference: The most popular EV company among our sample is 'TATA Motors' (71.8%) followed by 'Hyundai Kona Electric' (31.7%) followed by 'Mahindra Electric' (30%) followed by 'Hero Electric' (26.9%). Tata Nexon has also been suggested by auto experts as a budget-friendly EV for masses.

In order to get a peek into psyche of the potential consumer and their take on EVs, respondents were asked about the factors which discourage and encourage them from buying electric vehicles.

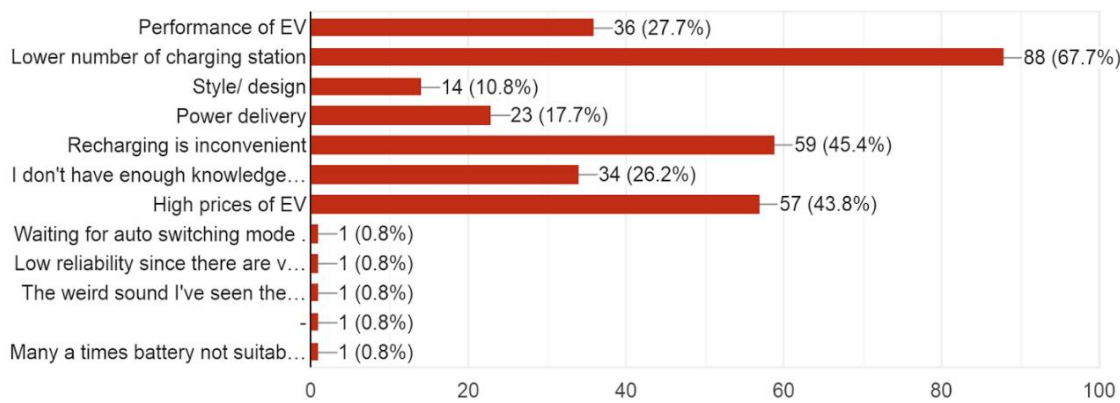


Fig 3 (a) Factors that discourage the preference towards EVs

The majority of the respondents (67.7%) voted lower number of charging station as the major discouraging factor followed by inconvenient recharging. The major hurdle is the issue of charging the EVs and the inconvenience it causes due to underdeveloped infrastructure and technology. Apart from that, the prices of EVs are relatively high. Lack of knowledge and awareness about EVs also plays a role in discouraging people from buying EVs.

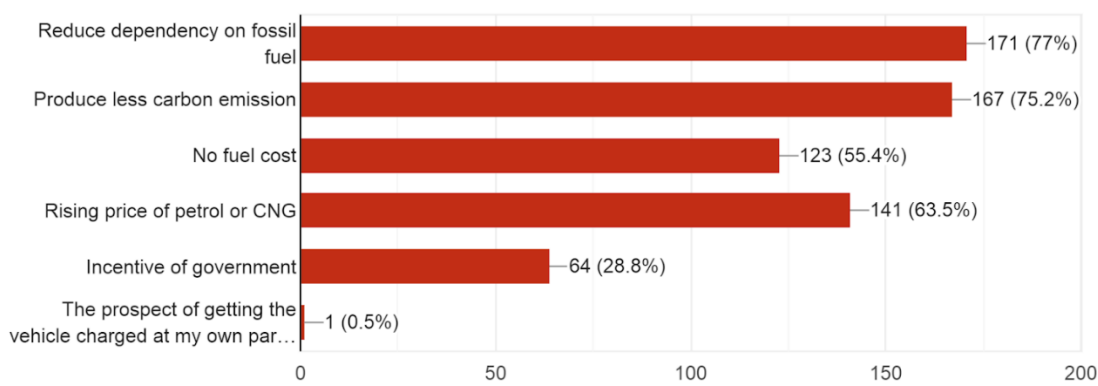


Fig 3 (b) Factors that encourage the preference towards EVs

77% of the respondents chose 'reduced dependency on fossil fuel' as the major factor which drives them towards e-vehicles. The next preferred factor came out to be 'produce less carbon emission' (75.2%). This shows that a very large percentage of our population is concerned about the environment and would like to be a part of environment conservation. A large percentage of our sample (63.5%) reveal that they consider EVs to be better as cost effectiveness than petrol or CNG vehicles. The rising cost of petrol or CNG is being highlighted as a major concern for potential buyers. Other encouraging factors include government initiatives which are increasing public awareness regarding EVs and making common man aware of their presence. The respondents were asked to rate the features of Electric Vehicles on a scale of 1-5 (1 being the lowest and 5 being the highest). The following features were rated by our respondents.

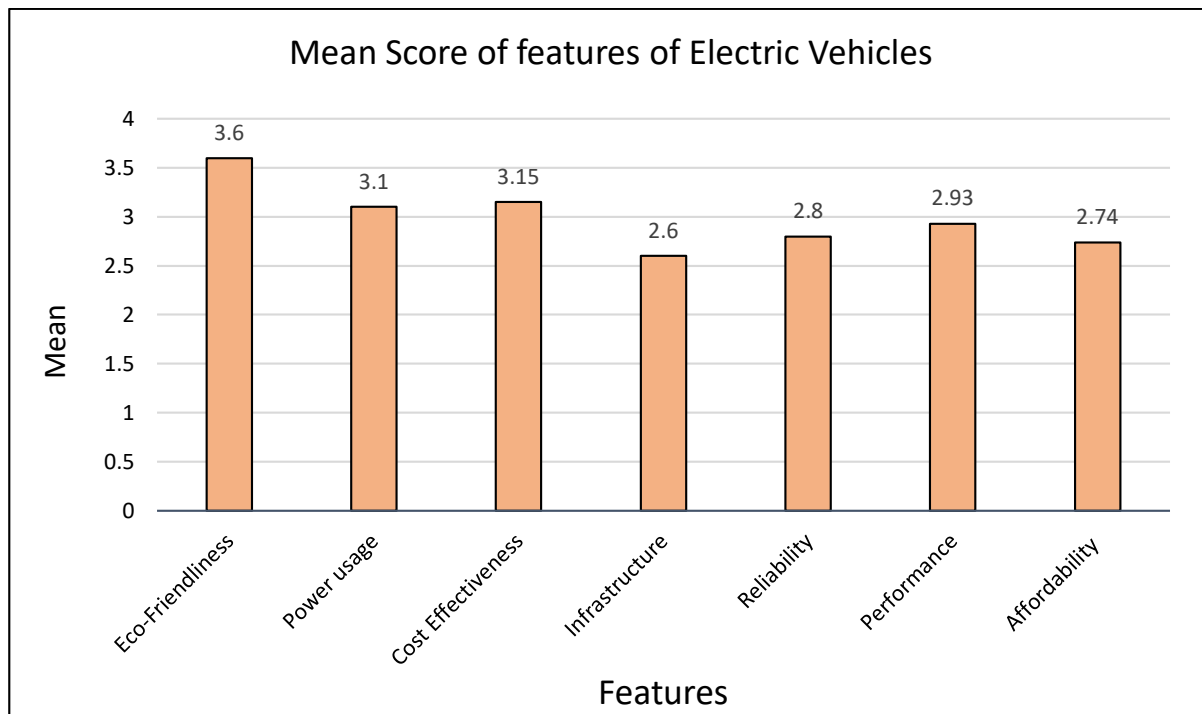


Fig 3 (c) Mean Score given by respondents to various features of EVs

The highest mean score has been given to eco-friendliness (3.6). Hence, it can be concluded that the most desired feature of an electric vehicles is the perception that they aid in environment conservation. Cost-effectiveness (3.15) has also been highlighted as second most desired feature which shows that the respondents think that once purchased, the cost of maintenance of an electric vehicle is not very high. Although, a contrast can be witnessed as affordability (2.74) has not been given high score by them which implies that EVs might be cost-effective but respondents do not deem them affordable right now despite their maintenance being deemed as cost-effective. Apart from that, reliability (2.8) has also not received high score, which shows consumers are facing trust issues and they would like to wait and look at other's experience before they switch to EVs. The lowest score has been given to Infrastructure (2.6) making it the biggest hurdle in the way of absorption of EVs into Indian Market.

1.4 Government Initiative Awareness

To check awareness of respondents regarding the government schemes and initiatives surrounding EVs ecosystem, respondents were asked a few questions regarding them. Respondents were asked whether they are aware of nine government initiatives. Out of 9, in case of 7 initiatives, the proportion of unaware respondents came to be significantly higher than those who were aware of the initiative. In only 2 cases (1. If you buy an electric vehicles in Delhi, you don't have to pay road tax and registration fees & 2. Railways in India are said to be 100% electrified, which will help in cutting fuel bill and pollution), the number of aware respondents was found to be higher than the number of unaware ones. It can be concluded from the discussion that potential consumers are not aware about the steps taken by government for enhancing EV acceptance. Steps should be taken to market these initiatives in a more efficient way.

To check awareness regarding various government schemes, respondents were asked to mark the ones they know about.

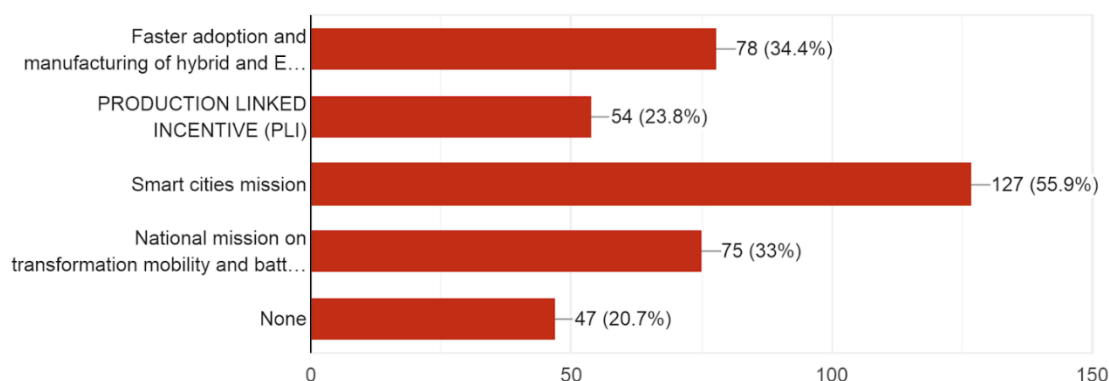


Fig 4 (a) Awareness level regarding government schemes

Majority of the respondents (55.9%) were found to be aware about 'Smart Cities Mission', followed by 'FAME – Faster Adoption & Manufacturing of Hybrid & Electric Vehicles' (34.4%). 33% of the respondents were found to be familiar with 'National Mission on transformation mobility and battery storage'. The awareness around the rest of the schemes were found to be less than 25%.

2. **INFRASTRUCTURAL ISSUES DURING TRANSITION PERIOD**

An effective global strategy for decarbonizing the transportation industry is electrification. India is one of the few nations that promotes the switch to electric mobility and supports the EV30@30 campaign, which aims for at least 30% of new vehicle sales to be electric by 2030 but discussion about electric mode of transportation is incomplete without discussing the charging infrastructure available in the country.

An extensive network of EV charging infrastructure that is both accessible and dependable is essential to completing this ambitious transition. The Indian government has put in place a variety of supportive policies to promote the expansion of the infrastructure network for charging. Given the unique characteristics of this new infrastructure type, it must be fitted to the unique Indian transport ecosystem in order to support its on-the-ground expansion. Stakeholders must also be strengthened. A contextual strategy is needed to enable the timely and effective deployment of EV charging infrastructure that complies with local standards and is optimally integrated into the transportation and electrical supply networks.

Depending on the situation and need, electric vehicles (EV) can be charged in a variety of methods. As a result, there are several types of charging infrastructure for EVs that are created for various applications. Electric vehicle supply equipment (EVSE), also known as EV charger specifications and standards, differ from one country to the next depending on the types of EVs that are sold there and the power grid's features. Whenever an electric vehicle gets charged, the voltage at which power should be supplied to it, depends upon the type of vehicle. The following table shows the battery capacity and associated voltage of EV batteries depending upon the types of electric vehicles.

VEHICLE SEGMENT	BATTERY CAPACITY	BATTERY VOLTAGE
E-2 Wheelers	1.2-3.3 kWh	48-72V
E-3 Wheelers (Passengers/Goods)	3.6-8 kWh	48-60V
E-Cars (First Generation)	21 kWh	72V
E-Cars (Second Generation)	30-80 kWh	350-500V

Source: (Handbook vehicle charging infrastructure implementation by Nitti Aayog, Ministry of Power.)

Table 2. Battery Voltage required by various types of EVs according to their battery capacity

2.1 A Solution - Battery Swapping

Global attention is being paid to battery swapping, in which a depleted EV battery is removed and replaced with a fully charged one. The technology is being tested for a range of EV segments, including e-2Ws, e-3Ws, etc. There are majorly two types of battery swapping -

- **Manual** - Battery placement and removal must be done manually, typically by hand, in the battery changing station, a standalone equipment. Manual changing stations are modular and take up very little room. These are utilised in applications requiring 2W and 3W batteries since they have smaller battery packs and can be lifted by one or two people.
- **Autonomous** - In these kinds of battery switching stations, a robotic arm is used, and the battery swapping procedure is partially or entirely automated. For 4W and e-bus applications, robotic swapping is used since the larger and heavier battery packs there need mechanical help. Additionally more expensive and requiring more area are these exchanging stations.

For business EV fleets, particularly in the e-2W and e-3W segments, battery swapping is now seen as a workable alternative. In order to encourage battery swapping among commercial EV fleets, especially for e-2W and e-3W models, the Ministry of Road Transport and Highways (MoRTH) has permitted the sale and registration of EVs without batteries.

2.2 Current Scenario of EV Charging Infrastructure in Delhi-NCR

Niti Aayog, who represented India in the fourth ministerial dialogue of the Zero-Emission Vehicle Transition Council (ZEVTC), at the recently concluded Conference of the Parties (CoP) in Glasgow, emphasised the necessity of replacing the nation's sizable fleet of two- and three-wheelers with zero-emission vehicles.

The decision to concentrate the country's transition to electric vehicles (EVs) on these two segments is timely and appropriate given that two- and three-wheeled vehicles make up more than 80% of the automobile market in India. Delhi can shed light on potential driving forces towards a widespread roll-out of EV charging stations. In order to reach the target of 25% EV registrations by 2024, the Delhi Electric Vehicle Policy specifies two and three wheelers as priority categories.

Delhi's EV policy, which was introduced in August 2020, has clauses that show how the city would distribute charging stations to its priority demographics. In accordance with one such requirement, the DISCOMs are required to permit online purchases of private charging points at a cost less the GNCTD subsidy and to request charger installations at their locations. The subsidy given to 30,000 charging stations for the two and three wheeler segments is another.

2.3 Existing Barriers that impede deployment of EV Charging points in Delhi

Consumers must first locate reliable, compatible chargers on the market that work with a variety of automobiles before installing EV charging points. Additionally, little is known about the procedures for building charging stations, which likewise involve a lot of back and forth with DISCOMs, or for obtaining EV tariffs (Delhi offers some of the lowest prices in India). Owners of private or semi-public locations are not currently offered incentives to install charging stations.

Another obstacle is the price of the chargers and the electrical connection needed to establish these charging points. The lack of understanding, the need to negotiate with several stakeholders, the price of chargers and electrical connections, and the lack of incentives make it difficult to build EV charging points in Delhi. E-rickshaws in particular are frequently and unsafely charged as a result of these obstacles.

Interviews with some EV users substantiated these infrastructural issues. A 2 – wheeler EV user mentioned that the performance of EVs leaves user with a good impression (mentioning that riding it feels like a 'sportsbike') and they have not been facing any such issues but the bone of contention is the process of charging. Those who were using it for commercial purposes such as making deliveries faced problems when they were not able to find operational charging points. Before beginning their travel, they have estimate for how long they could continue their travel and would they be able to find charging station if the battery got discharged. Many users also mentioned issues like EVs not being suitable for long journeys, weird sounds, and lack of auto switching mode.

2.4 A Probable Solution - Single-Window Selling Process

The installation of chargers and EV tariff metres will be combined as part of the single window process, and at the same time, the Delhi EV policy subsidy will be accessed. An EV charging station can be established for as cheap as Rs 2,500. The cost of the charger (net of subsidies and including GST) is included in this pricing, as well as the cost of installation (including wiring up to 5 metres) and three years of yearly maintenance. (Abhishek Ranjan & Shijoy Varughese)

Thanks to the single window facility, authorised merchants are able to provide three different sorts of fees. The first one is an AC charger for Light Electric Vehicles (LEVs), which complies with the most recent charging standard released by the Bureau of India Standards (BIS) in September 2021. Within two months of its official announcement, Delhi became the first city to implement this billing strategy. The charger will mostly be used for light electric vehicles, while it might be utilised for electric cars as well (2 and 3 wheelers). Another AC charging standard called AC 001 is the most widely used for 2 and 3 wheelers. Finally, the DC 001 charging standard is compatible with the majority of electric vehicles used by fleet operators.

Both online and over the phone, you can use the single window process. The DISCOMs will be used by the Delhi government to install two- and three-wheeler chargers as well as chargers for fleet cars. Searching for dependable EV chargers on the websites created by all three Delhi DISCOMs, where users may compare charger prices, is the first step in the single window process.

Additionally, the customer has two options: they can keep their current connection and arrange for installation at their convenience, or they can get a new electrical connection (with a pre-paid metre) in order to receive a reduced EV tariff. The mechanism makes sure that users can receive a subsidy for light EV chargers of up to Rs 6000 and pay without the subsidy. It is important to note that since the subsidy will be paid directly to the vendor and will be included in the cost of the charger, the consumer does not need to file a separate subsidy claim. The buyer can also choose to pay the full amount upfront or on a monthly subscription basis.

Emerging Business Model

An electric vehicle's benefit is that it can be charged even while it is not being driven. The single window process will utilise currently existing private and semi-public spaces with parking and long dwell times for vehicles, such as hospitals, theatres, group housing societies, workspaces, kirana stores, malls and so on. This is true even though finding land for public EV charging stations is frequently difficult in Delhi.

The incentives can lower the price of chargers by up to 70% and give these retailers new streams of income. By offering fleet owners and delivery service provider's overnight EV charging facilities, it also gives owners of commercial venues like malls and theatres the chance to monetize their parking space. The one window procedure will offer an Enabling way to install charging stations in both residential and commercial facilities because most charging occurs at home and at the office. The process will also offer a means of legalising the risky and unauthorised charging of e-rickshaws.

3. ARE EVs CAPABLE OF REDUCING INDIA'S CARBON FOOTPRINT

Indian automotive industry is the world's fourth-largest industry. As the industry is growing rapidly, the growing demand for an internal combustion engine is doubled in a decade. Simultaneously, carbon emission is increasing giving raise to air pollution and public health problems. According to "Climate Action Tracker-Decarbonising the Indian transport sector pathways and policies", the transport industry alone contributes 13.5% of the country's carbon emission with road transport accounting for 90% of the total emission.

Delhi has been ranked as one of the world's most polluted cities, and the toxic air it produces poses serious risks to people's health and wellness. Major sources causing pollution in the city are light and heavy-duty trucks. Every third child in Delhi is said to suffer from a respiratory condition as a result of the high levels of pollution in the air. This industry also has a significant carbon footprint. In 2019, registered delivery cars alone in Delhi produced 700,000 tonnes of CO₂, directly causing climate change.

As a result, we need to decarbonise the transport sector in India, which will impact significantly reduce pollution, improve public health in cities, reduce noise pollution, and improve quality of life.

India is already leading in the renewal industry for attaining its own goal of achieving net-zero carbon emission by 2050. Electrification of transport plays a key role in reducing our country's carbon. Two-three wheeler vehicles are the major transport mode in India, for faster adoption government is already started initiatives to promote them like FAME II. The sales of EVs are nearly doubled in 2021 by 244% on a yearly basis. The registration of EV has crossed 50000 for the very first time according to the Union Ministry of Road Transport and Highways.

The China Model

With the increasing demand, China-model can be one approach to look at. China's approach to faster adoption of EVs, led them to become the world's biggest EV market.

China started making EVs in 2007, and government support and their policies added to the increase in sales. Therefore, China was able to reduce carbon emissions by 43% lower than a normal internal combustion engine.

Major policies adopted by China:

- **Tax Cut** - China provided a major tax cut to ensure the increase in the demand for EVs. Until 2020, consumers were allowed not to pay the sales tax.
- **Increased the investment in the charging infrastructure** - Government set goals to increase the charging station. They divided the region into 3 tiers
 - the first tier includes major big cities which have high populations and high demand (Beijing, and Shanghai), and they installed about 7,400 charging stations (fast charging) and 2.5 million charging units (slow charging)
 - For the second tier, they installed 4,300 charging stations
 - Lastly for the third tier, they installed 400 charging stations and 100,000 charging piles will be built to meet the needs of 110,000 EVs.
- **Cap & Trade** - China introduced the new policy called "cap" and "trade". In this scheme, the total amount of greenhouse gases that can be emitted by sectors covered by the scheme is limited. Within this cap, companies get free allowances and can buy or sell emission allowances as necessary with other participants.

EVs or Greenwashing?

However, interviews with automobile experts also present a contrasting views regarding EVs which shed light on case of 'greenwashing' in the automobile industry. Greenwashing refer to the process of creating an illusion of being ecologically responsible by corporates to ride on the Environmental, Social & Governance (ESG) wave. It was mentioned by auto experts that the EVs might look eco-friendly but the carbon emission generated during the manufacturing process of EVs is quite high. Also, the demand for electricity for charging EVs will disturb the ecological balance as electricity generation in India majorly depends on traditional sources of energy. Hence, unless and until more eco-friendly method of electricity generation are set up in the country, reduction in carbon footprint seems like a distant dream even if electric vehicles become more popular.

Conclusion

The discussion around Electric Vehicles is a heated debate. Potential buyers are intrigued by the new proposition but they want to wait for EVs to become more common before they can experiment with it a sonly 52.4% of the respondents would like to switch to them. Respondents are of the opinion that the EVs look cost-effective in long-run but they don't seem affordable currently. It can be implied that if EVs manufacturers want more buyers, they will have to work on the pricing of electric vehicles to make them lucrative for masses as there is a need for developing EV cars under 10 lakhs. The 'eco-friendly' appeal of EVs is definitely reaching out to consumers but they have not been successful in generating trust and reliability among consumers as of now. Lack of charging infrastructure has been identified as the major discouraging factor. Unless, charging facilities are made more accessible to masses, EVs will not be able to gain market share. Such infrastructural issues and probable solutions such as battery swapping are being discussed across the globe. The expert opinion also does see EVs adoption going at a faster pace in near future as they are still deemed as a luxury product which make their users feel proud of contributing to environment conservation but not a product for masses.

Limitations

1. The major limitation of the study is smaller sample size which is skewed towards young female population.
2. The study highlight the issue of Greenwashing but does not delve deeper into it. It can be explored in by future researchers from the point of view of marketing.
3. The carbon footprint generated by Electric Vehicles before they come on roads has emerged as a major issue during the interviews with the auto experts. But due to paucity of time, the scientific component of it could not be discussed in greater depth which provides an opportunity for budding researchers to probe this area.

Recommendations

1. The major hurdle for current users of EVs is the availability of charging infrastructure. There is need for enhanced government participation in developing more efficient charging points which are easily accessible to the users. New-age EVs start-ups are raising a lot of funding in the current times but private investment also needs to flow into companies who are working on developing the pre-requisite charging infrastructure for EV penetration. The flow of government investment into such companies can also help them attract private investment.

2. Lack of awareness regarding government initiatives has also been witnessed during the study. More efforts are required to market such government initiatives and schemes so that information about such incentives becomes wide-spread.
3. An issue which got highlighted from the analysis of responses is affordability factor of electric vehicles which poses as a major concern for potential consumers. For reaching the masses, the manufacturers of EVs would have to focus more on making them affordable for consumers of a price-sensitive market such as India.
4. Interviews with automobile reviewers have also generated insights about the electricity generation aspect of electric vehicles. Undoubtedly, EVs can help to reduce carbon emissions but their running is dependent upon electricity, which again requires the usage of fossil fuels. There is a need to develop alternate sources of electricity generation. Research in this area should be promoted by government to expand the spread of renewable sources of electricity generation.
5. Automobile companies and EV manufacturers should look into the carbon emission generated during the manufacturing of electric vehicles. Research & Development departments of such companies should work towards making the production process of EVs cleaner.

Abbreviations

EV(Electric Vehicle)

EVSE(Electric Vehicle Supply Equipment)

kWh(kilowatt hours)

V(volts)

e-2Ws(electric 2 wheelers), e-3Ws(electric 3 wheelers)

OEMs(original Equipment manufacturer)

GNCTD (Government of National Capital Territory of Delhi),

NO_x-Nitrogen oxide ; PM- Particulate matter ; CO₂- Carbon dioxide

FAME- Faster adoption and manufacturing of hybrid and electric vehicles

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