# A STUDY ON CONSUMERS PREFERENCE TOWARDS ELECTRIC VEHICLES IN ERNAKULAM CITY

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**ST TERESA'S COLLEGE (Autonomous), ERNAKULAM**

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OF THE DEGREE OF

**BACHELOR OF ARTS IN ECONOMICS**


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# CERTIFICATE

This is to certify that the project titled "A STUDY ON CONSUMERS PREFERENCE TOWARDS ELECTRIC VEHICLES IN ERNAKULAM CITY" submitted in partial fulfilment of the requirement for the award of the degree of Bachelors of Arts in Economics to St. Teresa's College (Autonomous) (Affiliated to Mahatma Gandhi University, Kottayam) is a bonafide record of the work done by the project group under my supervision and guidance.

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# DECLARATION

We hereby declare that the project report titled "A STUDY ON CONSUMERS PREFERENCE TOWARDS ELECTRIC VEHICLES IN ERNAKULAM CITY" submitted by us for the Bachelor of Arts Degree in Economics is our original work.

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# CHAPTER 1

# INTRODUCTION TO ELECTRIC VEHICLES

## 1.1 INTRODUCTION

An Electric Vehicle (EV) is a vehicle that relies on electricity as its main source of power or enhances efficiency through electric technology. It is a vehicle equipped with an electric motor that derives power from a battery and can be recharged through an external source. There are 4 types of EVs available: Battery Electric Vehicle (BEV) which are fully powered by electricity; Hybrid Electric vehicle which uses both internal combustion engine and battery-powered motor; Plug-in Hybrid Electric Vehicle (PHEV) and Fuel Cell Electric Vehicle (FCEV) in which electric energy is produced from chemical energy.

Early electric vehicles first came into existence in the late 19$^{th}$ century, during the Second Industrial Revolution, which introduced electrification. Electricity was a favoured method for powering motor vehicles, offering greater quietness, comfort, and ease of operation compared to the gasoline-powered cars of that era. The first EV to be introduced in India was called the Lovebird, which was launched in 1993 by Eddy Controls in Chalakkudy, Kerala. Even though it was celebrated and won many awards; it took six to eight hours to fully charge and had limited driving on slopes. After only managing to sell 25 cars and stoppage of government subsidy, the production of the Lovebird eventually ended. India has been actively encouraging the adoption of electric vehicles to lower its carbon footprint, reduce pollution, and lessen the reliance on imported oil. Government initiatives, supportive policies, and increased consumer awareness are driving the transition towards electric mobility. Petrol and diesel vehicles are highly polluting and are being quickly replaced. Toxic emissions from these fossil fuels lead to long term, adverse effects on the environment as well as public health. While fully electric vehicles produce zero tailpipe emissions, even when considering electricity generation, petrol and diesel vehicles emit nearly three times more carbon dioxide than the average EV. To reduce the impact of charging electric vehicles, India is ambitious to achieve about 40 percent cumulative electric power installed capacity from non-fossil fuel-based energy resources by the year 2030.

At present, Kerala is recognised as having the highest penetration of e-2Ws and e-cars in FY24. Kerala has been at the forefront of electric car adoption in the past two years. Now, it also leads

in electric two-wheeler penetration (13.5 per cent) as it overtook Karnataka (11.5 per cent) and Delhi (9.4 per cent).[1]

## 1.2 REVIEW OF LITERATURE

**Faizal, M., Feng, S. Y., Zureel, M. F., Sinidol, B. E., Wong, D., & Jian, G. K. (2019)** demonstrates the several obstacles that the expanding business of electric vehicles must overcome, such as their expensive initial cost, short driving range, lack of infrastructure for charging, and lengthy charging times. Price reductions are critical to the commercial marketing of electric vehicles. One of the primary causes of EV's continued high cost is the high expense of batteries. The high cost of EVs acts as a deterrent to their adoption in the current market. When compared to IEC vehicles, EVs are thought to be very expensive. Even a 1% decrease in the retail price would result in a 4% increase in EV sales.[2]

**Raman, G. R., Raman, G. P., & Peng, J. C.-H. (2022)** notes that flooding can cause access to charging infrastructure to be disrupted, particularly in metropolitan areas. Water damage may cause specific charges to stop working. Potential users may be put in danger if chargers are rendered inoperable by water logging at the parking area, even if they were situated at a height that compiles with seating standards or were appropriately weatherized, according to their research, flooding caused a drop in the network's mean charger utilization but an increase in the highest utilization, suggesting that some chargers were under stress. Flooded locations saw a decrease in the number of chargers used, but those close by saw a decrease in the number of chargers used, but those close by saw a rise in stress as users looked for other places to charge.[3]

**Alanazi, F. (2023)** covers the efforts to promote the use of electric vehicles as a sustainable mode of transportation. These activities include financial incentives, minimum EV target sales, investment in charging infrastructure, supportive legislation and regulations, and public education. It emphasises how critical it is to move away from fossil fuels and toward a more sustainable transportation system in order to mitigate climate change. Additionally, it suggests

[1] Kerala charges ahead with highest penetration of e-2Ws and e-cars in FY24. The Hindu Business Line
[2] A review on challenges and opportunities of electric vehicles (EVs). Journal of Cleaner Production.
[3] Resilience of urban public electric vehicle charging infrastructure to flooding. *Nature Communications.*

that AI could be very important to the EV industry. It can enhance the process of producing power and expedite the charging of batteries.[4]

**Chhikara, R., Garg, R., Chhabra, S., Karnatak, U., & Agarwal, G. (2021)** points out that electric vehicles are not a recent addition to the roads. They have been around since the 19th century, but because of their exorbitant costs and inadequate infrastructure, they are neglected. But as Pollution levels rise, more individuals are choosing to use electric cars instead of traditional fossil fuel-powered automobiles. Utilizing electric vehicles lowers tailpipe emissions since they release no toxic chemicals into the atmosphere.[5]

**Chand, K. (2019)** highlights that electric vehicles are a viable substitute for traditional automobiles in a period of rising pollution. By promoting the usage of electric vehicles, the Indian government has taken several steps to lower air pollution. Green transportation has benefited from the 2019-20 budget. In addition to enhancing energy security, reducing greenhouse gas emissions, and improving air quality, EVs will open up new avenues for technological advancement and economic growth in the transportation and electrical industries.[6]

**Nayak, S., & Bohre, A. K. (2022)** states that compared to conventional fuel-fuelled vehicles, the electric vehicle offers more saving in energy usage, decrease in emissions, and improvement in environmental security. As a result, it is becoming most important with more applications in the transportation sector. As Electric vehicles usage is growing from day-to-day Electric vehicles (EVs) will become a reality in the future. The time-consuming problems of charging an EV makes it a big issue to accept the electronic revolution of the automobile industry. But today there are many charging methods for an electric vehicle. It gives a brief overview of the present and methods recommended for EV charging.[7]

**Goswami, R., & Tripathi, G. C. (2020) e**stimated the growth of the adoption of the electric vehicles and the charging infrastructure and the required power to run those charging station.[8]

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[4] Electric Vehicles: Benefits, Challenges, and Potential Solutions for Widespread Adaptation. *Journal of Cleaner Production.*

[5] Factors affecting adoption of Battery Electric Vehicles in India: An exploratory study. *Transportation Research Part D: Transport and Environment***.**

[6] An Initiative of Adopting E-Vehicles to Minimize Air Pollution. *International Journal of Research and Review.*

[7] Status of electric vehicles charging methods. *International Journal of Engineering, Science and Technology*

[8] Augmentation of charging infrastructure for electric vehicles growth in India. *International Journal of Electric and Hybrid Vehicles*

**König, A., Nicoletti, L., Schröder, D., Wolff, S., Waclaw, A., & Lienkamp, M. (2021)** notes that the introduction of both Battery Electric Vehicles (BEVs) and Autonomous Vehicles (AVs) to the international market has recently triggered extensive radical changes within the automotive industry. While new attributes brought by BEV technology, compared with collections following conventional internal combustion engines, led to the emergence of central parameters, such as vehicle range, they also account for crucial selling points. Electric components for BEVs are yet to be optimized, while the sensors needed for autonomous driving are almost prohibitively expensive, which, as a result, modifies the cost equipment structure within the automobile. This transformation is not limited to the vehicle itself but also extends to its mobility and the necessary infrastructure. The former is shaped by new user behaviours and scenarios. The latter is impacted by the BEV powertrain, which requires a charging and energy supply infrastructure. To enable manufacturers and researchers to develop and optimize BEVs and AVs, it is necessary to first identify the relevant parameters and costs. To this end, we have conducted an extensive literature review. The result is a complete overview of the relevant parameters and costs, divided into the categories of vehicle, infrastructure, mobility, and energy.[9]

**Sharma, S., Panwar, A. K., & Tripathi, M. M. (2020)** describes the basic concepts of electric vehicles (EVs) and explains the developments made from ancient times to till date leading to performance improvement of the electric vehicles. It also presents the thorough review of various components and energy storage system (ESS) used in electric vehicles. The main focus of the paper is on batteries as it is the key component in making electric vehicles more environment-friendly, cost-effective and drives the EVs into use in day-to-day life. Various ESS topologies including hybrid combination technologies such as hybrid electric vehicle (HEV), plug-in HEV (PHEV) and many more have been discussed. These technologies are based on different combinations of energy storage systems such as batteries, ultracapacitors and fuel cells. The hybrid combination may be the perspective technologies to support the growth of EVs in modern transportation. The advanced charging systems may also play a major role in the roll-out of electric vehicles in the future. The general strategies of advanced charging systems are explained to highlight the importance of fast charging time with high amount of power and its cost-effectiveness for electric vehicles. Furthermore, the battery pack designing calculation is briefly explained along with all mechanical, electrical and environmental battery

[9] The required power to run those charging stations. *World Electric Vehicle Journal*

tests, which helps in the evaluation of batteries. Moreover, this paper also has a brief summarizing with the help of a flow chart, which clearly demonstrates all the parts of electric vehicles in a much simpler way.[10]

**Bansal, R. C. (2017)** states that an electric vehicle (EV) is a vehicle powered by an electric motor, instead of an internal combustion engine, and the motor is run using the power stored in the batteries. EVs are known as zero emissions vehicles and are much environment friendly than gasoline- or LPG-powered vehicles. EV has a much longer history than most people realize. The chapter discusses EVs, solar cars, and fuel cell cars. It outlines hybrid vehicles and presents main components, instrumentation, and main auxiliaries of EV. The chapter describes various types of power storage used in EVs. It also presents a bibliographical survey on EVs. The chapter outlines a few of the important terms related with battery technology and various types of batteries in use or under development. The high-current connections in an EV need to be made with 2/0 cable. The cables used in EVs have several thousand copper strands the thickness of hairs.[11]

**Barkenbus, J. N. (2020)** makes the case that there is indeed a transition underway from traditional cars to electric, the timeline of which is still unknown. The contest against climate change is the essential backdrop for this change, prompting governments to spur this transition by way of both consumer incentives for electric automotive purchases, and establishing the required quotas for manufacturers to adopt. Behind this prodding are a set of fundamental forces that both encourage and discourage consumer interest, as set forth in the text. Fortunately, intensive battery research and development is proceeding that should alter market forces and make electric vehicles more attractive to segments of the population not now in the market for an electric vehicle. Hence, despite the uncertainty surrounding the timeline for battery development, continued government support, and upstart automakers, such as Tesla, should ensure that the transformation will proceed over time.[12]

**Poullikkas, A. (2015)** indicates that growing concerns over climate change and energy security are reshaping the transport sector towards alternative fuels and electric vehicle (EV) propulsion systems for sustainability. Three-quarters of transport emissions globally originate from road

[10] Storage technologies for electric vehicles. *Journal of Traffic and Transportation Engineering*
[11] *Handbook of automotive power electronics and motor drives*. CRC Press
[12] Sustainability. *International Journal of Sustainable Development & World Ecology*

transport, making it crucial to reduce emissions and address air quality and noise issues, especially in urban areas. Electric vehicles (EVs) offer a promising solution to cut road transport emissions significantly. However, current EV technologies are still developing and face challenges such as high costs and uncertainties surrounding battery technology, emissions impact, electricity generation interaction, and scalability. This review provides an overview of EV technologies and charging mechanisms. It divides EVs into hybrid electric vehicles (HEVs), plug-in electric vehicles (PHEVs), and full electric vehicles (FEVs). It discusses technical characteristics, fuel efficiency, CO2 emissions, and charging methods, including grid-to-vehicle (G2V) and vehicle-to-grid (V2G) architectures.[13]

**Thomas, C. E. S. (2012)** mentions achieving an 84% reduction in greenhouse gas emissions from 1990 levels by 2050 requires significant cuts in emissions from the light duty vehicle sector. In the United States, LDVs accounted for 17.7% of GHG emissions in 2009, necessitating an ambitious 83.1% reduction below 2009 levels to meet these goals. Similarly, McKinsey & Company estimates that LDVs in Europe must reduce GHG emissions by 95%. To this ,United States has focused its efforts on promoting battery electric vehicles and plug-in hybrid electric vehicles (PHEVs) over fuel cell electric vehicles (FCEVs). This strategic shift was highlighted by President Obama's initiative to deploy one million "electric vehicles" by 2015, steering away from earlier support for FCEVs. The efficacy of Battery Electric Vehicles in reducing Green House Gas emissions depends on two key factors: 1) the carbon intensity of the electricity generation used to charge them, and the market penetration of BEVs among American drivers. Studies, such as those conducted by the Argonne National Laboratory using the GREET model, indicate that the GHG reduction potential of BEVs may be limited by the mix of electricity sources in the grid. Some analysts suggest challenges in achieving widespread adoption of BEVs due to factors like range limitations and cost, McKinsey's research and others anticipate technological advancements that could enhance the competitiveness of hydrogen-powered FCEVs in the future.[14]

**Musardo, C., Rizzoni, G., Guezennec, Y., & Staccia, B. (2006)** points out that the control of an HEV with minimum fuel consumption and emissions is a global problem and the control action taken at each time instant affects the following Thus, dynamic programming (DP) is a

[13] Sustainable options for electric vehicle technologies. *Renewable and Sustainable Energy Reviews*

[14] How green are electric vehicles? *International Journal of Hydrogen Energy*

well-suited technique to find the optimal solution to the control problem. Unfortunately, this approach to solving the optimal control problem requires a priori knowledge of the driving conditions (necessary to implement the DP backward algorithm) and is therefore not suitable for HEV real-time control. In this paper a new control strategy called adaptive ECMS (A-ECMS) is presented. This real-time energy management for HEV is obtained adding to the ECMS framework an on-the-fly algorithm for the estimation of the equivalence factor according to the driving conditions. The main idea - periodically refresh the control parameter according to the current road load, so that the battery state of charge is maintained within the boundaries and the fuel consumption is minimized. The results obtained with A-ECMS show that the fuel economy that can be achieved is only slightly suboptimal and the operations are charge-sustaining.[15]

**Hannan, M. A., Houque, M. M., Mohammed, A., & Ayob, A. (2018)** states that the drive towards technological advancement globally includes improving transportation infrastructure to spur economic growth. However, the surge in vehicle sales has led to challenges such as traffic congestion and escalating carbon dioxide (CO2) emissions. Between 1990 and 2013, CO2 emissions from the transport sector jumped from 22.7 billion to 35.27 billion metric tons. To tackle this, countries are prioritizing decarbonization efforts, notably through electric vehicles (EVs). EVs promise substantial emissions reductions due to their efficient use of electricity and zero tailpipe emissions. They operate using energy stored in batteries, fuel cells, or ultracapacitors, and can tap into renewable sources like solar and wind power for charging. Critical to their success are advancements in energy storage technologies such as batteries, fuel cells, and ultracapacitors. These technologies are pivotal for optimizing EV range, performance, and energy efficiency. Managing these systems effectively requires robust energy storage and distribution management, alongside considerations for safety, efficiency, and sustainability throughout the EV lifecycle. This review goes into the current landscape of EV energy storage systems, their technological innovations, challenges, and future prospects. It also explores hybridization strategies aimed at enhancing ESS efficiency, aiming to pave the way for sustainable development in EV technology and its integration into global mobility solutions.[16]

[15] A-ECMS: An adaptive algorithm for hybrid electric vehicle energy management. *European Journal of Control*.
[16] Review of energy storage systems for electric vehicle applications: Issues and challenges. *Renewable and Sustainable Energy Reviews*

## 1.3 PROBLEM OF THE STUDY

Although there is much interest in EVs due to growing concerns for the environment and technological development, various challenges exist that consumers face, barring large-scale adoption. Knowing the barriers is very important for developing strategies to make the transition smoother and to increase consumer switches from conventional gasoline-powered vehicles.

In this study, we try to study the factors that influence the purchasing decisions of the EVs. We also intend to analyse the challenges and difficulties faced by the consumers.

## 1.4 OBJECTIVES

To analyse the factors influencing purchasing decisions of electric vehicles.

To analyse the threats and challenges faced by the consumers of electric vehicles.

## 1.5 METHODOLOGY

### 1.5.1 Area of study

The area of study taken is Ernakulam City. The city has seen a gradual increase in electric vehicle adoption, influenced by government incentives and growing environmental concerns.

### 1.5.2 Sample size

The sample size of the study is 45 individuals who own an Electric Vehicle. This sample provides insights into the real-world experiences of EV users, highlighting factors that influence satisfaction and adoption rates.

## 1.6 LIMITATIONS

**1.6.1 Limited geographical coverage (only Ernakulam city):** The research is restricted to the consumer's attitude toward electric vehicles (EVs) in the Ernakulam district. Although findings from this study could indeed provide important insights into local market trends, the same cannot be generalized for other districts due to the differences in economic conditions, infrastructure availability, or government incentives to stimulate EV penetration.

**1.6.2 Possible response bias from the respondents:** As the research takes into account the survey responses, there may be instances of response bias whereby participants give socially desirable answers or have least exposure to EVs. Some respondents may be biased toward adopting EVs given the environmental concern and might scale up their concern, while others may downgrade challenges such as price, high initial costs, and absence of charging infrastructure.

# CHAPTER 2

# AN OVERVIEW ON ELECTRIC VEHICLES

## 2.1 ELECTRIC VEHICLES

Electric vehicles are those which run entirely or partially on electricity. An EV is a shortened acronym for an electric vehicle. EVs are propelled by one or more electric motors and can be supplied with electricity via a collector system, fuel cells or batteries. EVs can minimize or completely do away with the need for liquid fuel by running on electricity. Other than road vehicles, there are rail electric vehicles, electric boats, underwater vessels, electric aircraft and electric spacecraft. The current generation of fuel powered automobiles may be replaced by electric vehicles in order to address issues like rising pollution, global warming, depletion of natural resources etc. Although the idea of EVs has been around for a while, in the last decade, due to increased environmental effects of fuel-based vehicles and their growing carbon footprint, it has attracted a lot of attention.

## 2.2 HISTORY OF ELECTRIC VEHICLES

The first practical electric motor was created in 1827 by Hungarian priest Anyos Jedlik, who used it the following year to power a small model car. Sometime between 1832 and 1839, Robert Anderson of Scotland invented the first crude electric carriage. It was powered by non-rechargeable primary cells. In 1835, Professor Sibrandus Stratingh of the University of Groningen, in the Netherlands, built a small-scale electric car and American blacksmith and inventor Thomas Davenport built a toy electric locomotive. The first mass-produced electric vehicles appeared in the American Markets in the early 1900s. However, due to lack of electricity grids, limitations of storage batteries and the advent of cheap assembly line cars by Ford Motor Company, the popularity of electric cars declined significantly.

India’s journey towards developing electric vehicles began in 1993 with the launch of its first electric car, the Lovebird. This car was produced by Eddy Current Controls, a company founded by MD Jose and based in Chalakkudy, Kerala. It featured a DC motor powered by a lead-acid battery and had a four-speed gearbox. It could drive 60km on a single charge but could only handle slopes with a maximum incline of 15 degrees. When the government allowed the commercial sales of the car, the company was only able to sell 25 cars and later, with decline in government subsidies, the production was completely shut down. In 2000, the first electric vehicle bus was launched in India which was developed by BHEL with a seating capacity of 18 passengers and powered by the lead-acid battery. The first successful electric car, named REVA, was launched by Chetan Maini’s Reva Electric Car Company. This car

emerged from a joint venture between the Maini Group of Bangalore and Amerigon Electric Vehicle Technologies of USA.

The introduction of electric vehicles in India started with early experimental models and progressed significantly due to major government initiatives such as the National Electric Mobility Mission Plan (NEMMP) 2020 and the FAME schemes. In 2010, General Motors India unveiled its electric hatchback, the E-spark, at the Auto Expo in New Delhi. The battery technology for this vehicle was supplied by Reva. Reva is an acronym for revolutionary electric vehicle alternative. In may 2010, Mahindra & Mahindra acquired a 55.2 per cent majority stake in Reva after which the company was renamed as Mahindra Reva electric Vehicles Pvt Ltd and it was branded as Mahindra Electric Mobility Ltd.

## 2.3 EVs IN KERALA

With the state government's proactive approach and the 2019 Kerala Electric Vehicle Policy, electric vehicles gained traction in Kerala. This policy aimed to encourage the use of electric vehicles by providing financial incentives such as reduced road taxes and vehicle purchase subsidies, in addition to building a network of public charging stations. The high upfront costs and infrastructure difficulties that initially prevented widespread adoption were addressed by these initiatives. Consequently, there has been a steady rise in the availability and acceptance of electric vehicles in Kerala, especially electric scooters and three wheelers that are excellent for commuting in cities. The growth of the EV market has been further supported by the development of public awareness campaigns, local projects, and the expansion of the charging infrastructure. Looking ahead, Kerala is focused on enhancing its EV infrastructure and promoting sustainable transportation as part of its broader environmental goals.

Thirty-one years after the production of India's first electric vehicle in 1993, Kerala has distinguished itself as the leading state in the adoption of two-wheelers and electric cars in 2024. The electric two-wheeler penetration in Kerala stood at 13.5 per cent in FY24 (8.4 per cent in FY23), followed by Karnataka at 11.5 per cent (9.2 per cent in FY23), Maharashtra at 10.1 per cent (8.2 per cent) and Delhi at 9.4 per cent (9.5 per cent). According to latest data with the motor vehicle department (MVD), out of the 7,57,114 vehicles registered in the state in 2023, an impressive 75,650 were electric, with Ernakulam, Thiruvananthapuram, Thrissur, Kozhikode, and Kollam districts leading the away. This growing trend is attributed to soaring

fuel prices and the operational savings that EVs offer, combined with heightened environmental concerns. The government's push for e-vehicles also aims to prevent the cities in Kerala from experiencing a situation similar to New Delhi's.

## 2.4 EVs IN ERNAKULAM

The demand for Electric vehicles in Ernakulam is on the rise. In the initial phase of its popularity, demand for electric vehicles were higher, but now, there is significant increase in electric cars as well. Every month, more than 100 EVs are being sold in the region. This shift is most probably driven by the realisation that EVs are the future of the vehicle industry coupled with the rising fuel prices.[17]

As part of our study, we visited few Electric vehicle shops located in Ernakulam city.

First, we visited Incheon Kia located in Nettoor. They sell Kia EV6 the most that offers a host of impressive features, starting at 60.96 lakh. It offers advanced features like over 10 autonomous driving features through its Advanced Driver Assistance System. It has ultra-fast charging capability via the E-GMP platform. It charges from 0 to 100% in 6 hours for the standard range 2WD and 8 hours for the long-range 2WD and AWD/GT versions. However, it has limited cargo space compared to other electric SUVs, which may be a drawback for some buyers. Despite its impressive technology, the EV6 sees relatively low sales in India, with only 8 to 10 units sold annually.

Then we visited Aban motors located in Palarivattom. They sell Ola, Revolt, Ather, Odysse, TVS, Bajaj and Hero electric scooters the most. In Kerala, 7,500 or more units of all brands are sold annually. The average mileage range for these EVs is 80-120 km per charge. It takes 3-5 hours for charging.

Then we visited Kochin Automotive Distributors llp-Tylos Electric scooter dealers located in the Ernakulam city. They sell only USTROM electric vehicles. There are 3 models of USTROM electric vehicles: -

1.USTROM Affair which is the low-rate electric scooter. It's price range starts from ₹55,500

2.USTROM Selfie price range starts from ₹58,000

[17] *100+ vehicles per month, Ernakulam switching to EV mode, THE TIMES OF INDIA*

3.USTROM Liberty price range starts from ₹61,000.

The average mileage range of these electric scooters is 80-120 km per charge

## 2.5 TYPES OF ELECTRIC VEHICLES

There are four types of electric vehicles available, each with unique features and benefits. Battery Electric Vehicles (BEVs) are fully powered by electricity, making them more efficient than hybrid and plug-in hybrids. Also known as All-Electric Vehicles (AEVs), BEVs run entirely on a battery-powered electric drivetrain, storing electricity in a large battery pack that can be charged by plugging into the electricity grid. This charged battery pack then powers one or more electric motors, resulting in zero tailpipe emissions and typically lower maintenance costs due to fewer moving parts. Examples of BEVs include the Tesla Model S, Nissan Leaf, and Chevrolet Bolt.

**Hybrid Electric Vehicles (HEVs)** use both an internal combustion engine, usually petrol, and a battery-powered motor. The petrol engine drives the vehicle and charges the battery when it is empty. Although not as efficient as fully electric or plug-in hybrid vehicles, HEVs, also known as series or parallel hybrids, have both an engine and an electric motor. The engine derives energy from fuel, while the motor uses electricity from batteries. Both the engine and the electric motor simultaneously rotate the transmission to drive the wheels, providing better fuel efficiency than conventional vehicles. Notable examples include the Toyota Prius and Honda Insight.

**Plug-in Hybrid Electric Vehicles (PHEVs)** combine an internal combustion engine with a battery that can be charged from an external socket. Equipped with a plug for external charging, PHEVs are more efficient than HEVs but less efficient than BEVs. Known as series hybrids, PHEVs have both an engine and a motor, allowing them to use conventional or alternative fuel. The rechargeable battery pack can also be charged externally, providing additional flexibility and improving overall efficiency.

**Fuel Cell Electric Vehicles (FCEVs)** generate electric energy from chemical energy, such as hydrogen. These vehicles, also known as Zero-Emission Vehicles, employ fuel cell technology to produce the electricity needed to run the vehicle. The chemical energy of the fuel is directly converted into electric energy, making FCEVs a clean and efficient option.

They produce only water vapor and heat as byproducts, contributing to their zero-emission status. Examples of FCEVs include the Toyota Mirai and Hyundai Nexo.

## 2.6 TYPES OF BATTERIES

An Electric Vehicle battery is a rechargeable battery used to power the electric motors of a Battery Electric Vehicle (BEV) or Hybrid Electric Vehicle (HEV). They are typically lithium-ion batteries that are designed for high power-to-weight ratio and energy density.

**1.Lithium-Ion Battery (Li-ion)**

This type of battery is the most widely used EV battery. Its benefit includes high energy efficiency, performance efficiency in higher temperatures, i.e., no drop in the performance if the battery gets hot and a good recycling factor. Moreover, it has a better power-to-weight ratio. The discharge level is also low.

**2.Hybrid Nickel-Metal (NiMH) Batteries**

This battery is majorly used in Hybrid Electric Vehicles (HEV). They have longer life cycles also. Also, they have a better safety rating than lead-acid batteries. They perform better even in rugged conditions. Its disadvantages are high self-discharge rate and heat generation at high temperatures. They are considerably expensive.

**3.Lead-Acid Batteries**

This is the oldest rechargeable battery type. Before the discovery of Li-ion, these were the most viable option. Cheaper manufacturing made them popular. However, they are bulky and get discharged very quickly.

**4.Nickel-Cadmium (NiCd) Battery**

They had exceptional energy density and high efficiency. But they had a low life cycle. Invented in 1899, the NiCd battery dominated the market till the early 90s. It is not preferred for modern EVs. Their manufacturing process was also expensive and they got banned very soon because of their toxicity.

**5.Ultracapacitors / Supercapacitor**

They are used as secondary storage devices and help to level the load of lithium-ion battery packs. They basically store polarized liquid between an electrode and an electrolyte. They give EVs an extra boost of power during acceleration.

**6.Sodium Ion**

They completely avoid critical materials. Due to high availability of sodium, cost projections are low.

Future types of batteries

- Solid-State battery
- Lithium-Sulfur battery

LMFP battery – LFP battery that includes manganese as a cathode component

## 2.7 CHARGING SYSTEMS

EV chargers currently come in 3 different models: Level 1, Level 2, and Level 3. In level 1 and 2, the EV is connected to AC power, 120V or 240V, and a battery charger in the EV converts the AC power to the DC needed to charge the battery and controls the charging process. Level 3 is also commonly known as Direct Current Fast Charging (DCFC). In DCFC the DCFC converts the AC power to DC and the DC power is sent directly to the EV battery bypassing the onboard battery charger. This allows the DCFC to charge the EV battery directly.

**Level 1 EV charging**: the standard household charging option that utilizes a 120-volt circuit for charging. Convenient but has a slow charging capacity. Usually provide a charging rate of around 2-3kW.

**Level 2 EV charging**: faster charging as compared to level 1 chargers. Works on 240-volt circuits. Can be installed at homes, workplaces or public charging locations.

**Level 3 EV charging**: fastest form of charging. It uses DC instead of AC to charge the EV battery. Provide rapid charging.

## 2.8 CHARGING INFRASTRUCTURE

EV Infrastructure is defined as structures, machinery, and equipment necessary and integral to support an EV, including battery chargers, rapid chargers, and battery exchange stations. With the vigorous development of the EV market, EV chargers have become the key infrastructure to promote the development of EVs. The emergence of EV charging piles provides convenience and flexibility for EV users, while also having a positive impact on the environment, energy costs, and sustainable development. EV charging piles play an important role in promoting sustainable transportation development. Smart EV chargers are an important innovation in EV charging infrastructure. These advanced chargers can not only provide fast charging but also have intelligent management functions.

India currently has about 6,000 EV charging stations across the country and that too in a very scattered manner. While some of the states in south and north India have good penetration of public EV charging stations, in the eastern region the EV charging penetration is too low. The Bureau of Energy Efficiency (BEE) expects 46,397 public charging stations to be built across 9 cities in India by 2030.

Kerala has emerged the No.1 state in the adoption of electric two- wheelers and electric cars in the country in FY24. The electric two-wheeler penetration in Kerala stood at 13.5% in FY24 (8.4% in FY23). As of October 2023, there are over 300 electric charging stations in Kerala, including both public and private stations. KSEB has setup EV charging stations in Kerala, contributing to the states EV infrastructure. These stations are strategically located to provide convenient charging options for EV owners across the state. Incheon Kia, a prominent player in the automotive industry, has established EV charging stations in Kerala. These stations are part of their commitment to promoting sustainable mobility and supporting the growth of the EV ecosystem in the state.

Cherthala South stations has operational EV charging stations, providing a convenient charging solution for EV owners in the region.In Ernakulam city, numerous charging stations have been set up across the city, enabling the EV owners to conveniently charge their vehicles. The charging infrastructure includes both public as well as private charging stations.

## 2.9 CHARGING STATIONS IN ERNAKULAM

Currently there are 55 EV charging stations in Ernakulam. These cater to various brands such as Audi, BMW, Hyundai, Tata, Mahindra etc. These stations are strategically located to cover various parts of the city, including major residential areas, commercial hubs etc. Almost all of these stations typically operate 24/7, with a few exceptions having specific operating hours.

Some of the key charging stations include

Mahindra - TV Sundaram Iyengar & Sons Charging Station at Maradu, offering CCS-II and Bharat DC-001 charging.

TML - Sree Gokulam Motors Charging Station at Edappally, providing CCS-II charging and operating 24/7.

Tata Power - Sree Gokulam Charging Station at Nettoor, also open 24/7 with CCS-II charging.

Saj Earth Resort Charging Station near Cochin International Airport, which offers CCS-II and AC plug point facilities.

IOCL - SR Adoch Charging Station at Vyttila, offering Bharat DC-001 and CCS-II charging

## 2.10 GOVERNMENT INITIATIVES

The Faster Adoption and Manufacturing of Electric Vehicles (FAME) scheme is a programme in India that promotes electric and hybrid vehicles. FAME has been designed to provide incentives to reduce fuel consumption and vehicular emissions with a focus on sustainable transport. This scheme has two phases:

FAME I: this phase was between 2015-2019 and involved providing incentives for the purchase of electric and hybrid vehicles. It also provided support for the development of charging infrastructure.

FAME II: this phase ran from 2019-2024 and involved supporting the electrification of public and shared transportation. It also aimed to build a robust charging infrastructure.

The Kerala government has also undertaken various policies and implemented incentives to promote electric vehicles. Some of these include:

EV Policy launched in 2019 offers incentives such as free EV registration, road tax exemption, free parking and exemption from toll payments.

The government is building charging infrastructure to improve the connectivity and travel. Servotech Power System LTD. Was contracted to install 12 EV charging stations in Kerala. The Production Linked Incentive (PLI) Scheme provides financial assistance such as subsidies for establishing public charging infrastructure.

## 2.11 DIFFICULTIES AND CHALLENGES

The adoption of electric vehicles is not without its difficulties. The high cost of electric vehicles and the infrastructure are two of the biggest obstacles. Electric vehicles are more expensive than their gasoline-powered counterparts, which limits the number of consumers who can afford them. Furthermore, there is a serious problem with the lack of charging stations that needs to be resolved, particularly in areas with low population densities. Another major barrier to the widespread adoption of electric vehicles is range anxiety, which is caused by the limited range of these vehicles. The problem with the battery: For electric cars, battery performance is still a significant problem. Batteries are less useful for everyday use because they are pricy, heavy, and require frequent charging. To address these issues, scientists are actively working to improve battery technology, which includes reducing weight, cost, charging time, and driving range. In the end, battery technology will determine whether electric vehicles succeed or fail in the marketplace. Including electric cars in smart cities: It is anticipated that electric cars will be essential to smart city transportation networks. Governments, business stakeholders, and residents must work together to integrate them into these cities, though. This entails creating infrastructure for charging, supporting renewable energy sources, and boosting public transportation.

Another major issue is the limited driving range compared to conventional vehicles, which causes "range anxiety" among potential buyers. While improvements in battery technology increasing driving ranges, they still fall short of gasoline-powered cars. Another challenge is the high initial cost of EVs, driven by the expensive battery packs. Even though long-term savings on fuel and maintenance can offset this, the upfront price remains a significant barrier for many consumers. Additionally, the lack of sufficient charging infrastructure is a critical concern. While urban areas are gradually developing more charging stations, rural regions still lag behind, making long-distance travel inconvenient. Charging times also pose a

problem, as even the fastest chargers take significantly longer than refuelling a gas tank. The environmental impact of EVs is another point of debate. Although they produce zero tailpipe emissions, the production and disposal of batteries have significant environmental footprints. Mining for battery materials such as lithium and cobalt can lead to environmental degradation and human rights issues.

Moreover, the electricity used to charge EVs often comes from non-renewable sources, which can diminish their overall environmental benefits. Public perception and awareness also play a crucial role. Many consumers still lack adequate knowledge about EVs, their benefits, and their limitations, which slows down adoption rates. Governments and manufacturers need to invest in education and marketing to shift consumer perceptions. Lastly, the automotive industry is undergoing a slow transition, as traditional manufacturers face high costs and logistical challenges in shifting from internal combustion engines to electric drivetrains. This slow transition impacts the availability and variety of EV models on the market. Overall, while EVs present a promising solution to reduce greenhouse gas emissions and reliance on fossil fuels, overcoming these challenges is essential for their mainstream adoption.

## 2.12 FUTURE OF EVs

The future of electric vehicles (EVs) in India looks exceptionally promising due to groundbreaking EV technologies and the willingness to share these advancements globally, resulting in lower manufacturing and driving costs. EVs are not only cleaner alternatives to fossil-fuel-powered vehicles but also more cost-effective, which is crucial given India's rising fuel prices. The Indian government's strong initiatives, including tax subsidies and stricter regulations, encourage potential vehicle owners to choose EVs over traditional cars. Moreover, various lending institutions are providing easy car loans to support EV purchases, as a result, consumers enjoy substantial tax rebates, lower driving costs, and minimal maintenance expenses, making EVs a compelling choice. These benefits contribute to a promising future for electric vehicles.

First, reduced CO2 emissions and sustainability are significant benefits. By switching to EVs, India could curb its CO2 emissions by one Giga tonne by 2030, leading to less air pollution in metros and mini metros and promoting healthier lives for present and future generations. Second, EVs are becoming cheaper to buy and drive. Initially a novel concept with scalability issues, EVs are now more accessible thanks to government tax rebates and the efforts of

automotive giants like Tata, Mahindra, Hyundai, and Toyota. Third, charging infrastructure is rapidly improving. Previously, the lack of charging stations was a major hurdle for EV adoption. However, the Indian government is now issuing tenders for private players to establish permanent, pop-up, and mobile EV charging stations. Additionally, all EVs come with fast chargers that can be easily installed at home, allowing you to charge your vehicle within a few hours. Fourth, EVs offer an enjoyable driving experience. Driving an electric vehicle offers a distinct experience, as these vehicles are quiet and free from vibrations, ensuring a smoother and more comfortable ride than traditional fuel-powered cars. With no conventional engine or gears, EVs feature simple controls, making them easy to operate. Their silent operation not only cuts down on air pollution but also helps reduce noise pollution, a major concern in India.

## 2.13 CONCLUSION

Electric vehicles are the leading change in global travel, empowered by technological advances and environmental issues. In the past, the evolution of EVs has ranged from the basic 19$^{th}$-century experiments to modern, highly-efficient designs. EV adoption has been there in India, especially in Kerala, thanks to the support of the government and infrastructure development coverage, the environment for its widespread usage has been provisioned. Different types of EVs such as Battery Electric Vehicles BEVs, Hybrid Electric Vehicles HEVs, Plug-in Hybrid Electric Vehicles PHEVs, and Fuel Cell Electric Vehicles FCEVs, each have their own advantages, and are powered by different battery technologies and better charging infrastructure. Although challenges include high upfront costs and lack of charging infrastructure, the growth of EVs in India is attractive with the gains in carbon dioxide reduction, and improvements in the driving experience driving the adoption of an environmentally sustainable and practical means of transportation.

# CHAPTER 3

# ANALYSIS OF CONSUMER PREFERENCE TOWARDS ELECTRIC VEHICLES IN ERNAKULAM CITY

## 3.1 AGE DISTRIBUTION

Age plays a crucial role in shaping the preferences for electric vehicles. People belonging to different age groups show different levels of technological adaptability and environmental concern.

Table 3.1: Age Distribution of Survey Respondents

| AGE | PERCENTAGE |
|---|---|
| 16-20 years | 13.3 |
| 21-30 years | 26.7 |
| 31-40 years | 15.6 |
| 41-50 years | 15.6 |
| 51 years and above | 28.9 |

Source: Primary data

## 3.2 EDUCATION LEVEL

The education level can significantly influence consumer awareness and understanding of the sustainable technology of electric vehicles.

Table 3.2: Educational Qualifications of Respondents

| EDUCATION LEVEL | PERCENTAGE |
|---|---|
| High School | 11.1 |
| Bachelor's Degree | 48.9 |
| Master's Degree | 33.3 |
| Doctorate | 0 |
| Other | 6.6 |

Source: Primary data

The above data shows that younger individuals (21-31 years) with Bachelor's and Master's Degrees plays a significant role in the adoption of electric vehicles. This might be because they are more informed about the models, benefits, environmental and technological advancements in the field of EVs. Middle-aged individuals between 31 and 50 years old, tend to be well-educated and financially stable, making them strong candidates for buying electric vehicles. For older individuals aged 51 years and above, interest in electric vehicles may stem from their financial stability and the potential for long-term savings, regardless of their educational background. Beyond this, older individuals also prioritize sustainability, lower maintenance and fuel savings that leads to the adoption of electric vehicle.

## 3.3 GENDER REPRESENTATION

The analysis of the gender of respondents can be used to study the variations in preferences for electric vehicles across the genders.

Table 3.3: Gender Representation in the Sample.

| GENDER | PERCENTAGE |
|---|---|
| Male | 64.4 |
| Female | 35.6 |

Source: Primary data

The result reveals that males form a larger proportion of the survey participants, which reflects that men are more likely to engage in discussions or decisions regarding electric vehicles, potentially because they have a higher interest in automobiles or technology. Compared to men, women might have less knowledge about the up-and-coming electric vehicles and their characteristics. The current marketing of EVs emphasize the newness of innovation rather than practicality, safety and environmental benefits that are more appealing to women.

## 3.4 INCOME RANGE

The income of respondents is a fundamental determinant of the purchasing power of consumers and can be analysed to understand the economic feasibility and market potential of EVs.

Table 3.4: Income Range Distribution of respondents

| INCOME RANGE | PERCENTAGE |
|---|---|
| Less than ₹3,00,000 | 37.8 |
| ₹3,00,000 - ₹6,00,000 | 15.6 |
| ₹6,00,000 - ₹10,00,000 | 17.8 |
| ₹10,00,000 - ₹15,00,000 | 8.9 |
| Above ₹15,00,000 | 20 |

Source: Primary data

The above data shows that a significant proportion of respondents belong to the group who earns less than ₹3,00,000 annually, because they prioritize affordability and also the lower running cost of electric vehicles. Various Government schemes and subsidies like tax deductions on EV loans are now there that prompt lower-income individuals to purchase electric vehicles. However, individuals with higher income constitute only 20%, because they prioritize advanced features, luxury and environmental benefits when choosing an electric vehicle.

## 3.5 SOURCE OF AWARENESS ABOUT EVs

By understanding the primary sources through which the consumers learn about EVs, it can be used for effective market penetration. These sources play a key role in shaping consumer perceptions and influence purchase decisions.

Table 3.5: Sources of Awareness Among Respondents

| SOURCE | PERCENTAGE |
|---|---|
| Media (TV, newspapers, etc) | 33.3 |
| Internet | 33.3 |
| Friends/Family | 24.4 |
| Advertisement | 8.9 |

Source: Primary data

The data indicates that 33.3% respondents gained awareness about electric vehicles from internet and media including TV, newspapers etc. The media and internet play a crucial role in raising awareness about electric vehicles by informing the public about their benefits, dispelling misconceptions and influencing consumer perception, ultimately leading to the adoption of EVs as a sustainable transportation option. EV manufacturers can make better use of media platforms to advertise their vehicles, to connect with people and spread awareness.

## 3.6 DURATION OF USAGE OF EVs

How long respondents have been using EVs can strongly influence their satisfaction and experience. It can be used to understand the evolving perception of the early users of EVs.

Table 3.6: Duration of EV Usage Among Respondents

| DURATION | PERCENTAGE |
|---|---|
| Less than 1 year | 51.1 |
| 1 - 3 years | 46.7 |
| 3 - 6 years | 2.2 |
| 6 - 10 years | 0 |
| More than 10 years | 0 |

Source: Primary data

The data suggests that electric vehicle adoption in Ernakulam is still at an early stage, with most respondents having used their EVs for less than a year or between one and three years. There is significant interest and uptake in EVs, but the number of long-term users remains quite low. The lack of respondents in the 3-6 years, 6-10 years and over 10 years categories suggests that the EV market is still developing and the long-term reliability and maintenance of electric vehicles have not yet been thoroughly evaluated by most users in the area.

## 3.7 OVERALL RATING OF EVs

The ratings provided by users of EVs can help draw a holistic perspective on its performance, satisfaction, and potential market acceptance.

Table 3.7: Overall Rating of Electric Vehicles

| RATING | PERCENTAGE |
|---|---|
| Very positive | 31.1 |
| Positive | 51.1 |
| Neutral | 15.6 |
| Negative | 2.2 |
| Very bad | 0 |

Source: Primary data

## 3.8 FACTORS INFLUENCING ELECTRIC VEHICLE PREFERENCES

By analysing the factors influencing people to purchase EVs, a concrete image can be built on how preferences for EVs emerge.

Table 3.8: Factors Influencing Electric Vehicle Preferences

| FACTORS | PERCENTAGE |
|---|---|
| Save fuel cost | 84.4 |
| Reduce environmental problems | 57.8 |
| Government incentives | 22.2 |
| Ease of use of technology | 26.7 |
| Brand name | 6.7 |
| Easy availability of charging station | 8.9 |
| Others | 2.2 |

Source: Primary data

A significant proportion of respondents rate electric vehicles positively, probably due to factors like fuel cost saving and environmental concerns. This indicates that they value not just the affordability, but also the sustainability aspect of EVs. However, those who gave neutral or negative rating seems to be concerned by factor like charging infrastructure and perceived lack of government subsidies. Factors like brand reputation and other minor considerations appear to have minimal influence. Moreover, the increasing concern that the environmental problems are causing motivates people to be keen on EVs because of the fact that they help to reduce the environmental problem both in terms of carbon pollution and air pollution. Although the government provides subsidies, it is still perceived to be a smaller factor than the environmental issue and cost savings. Things like the brand name and the presence of charging stations have the least effect. This means that even if the infrastructure and the brand are important, they are not the most significant reasons for the acceptance of EVs.

## 3.9 BUDGET PREFERENCES

Budget decisions directly impact the purchasing decisions of respondents. It can be used to understand the price sensitivity in the market.

Table 3.9: Budget Preferences Among Respondents

| BUDGET | PERCENTAGE |
|---|---|
| Less than Rs 500,000 | 51.1 |
| Rs.500,000-Rs.10,00,000 | 20 |
| Rs10,00,000-Rs.15,00,000 | 15.6 |
| Abv Rs.15,00,000 | 13.3 |

Source: Primary data

The majority of consumers in Ernakulam are opting for electric vehicles within a budget of less than Rs. 500,000, thus the affordable vehicle segment shows a significant market demand. This could be because that the major part of the population is on a tight budget and they look for less expensive transportation options. This shows that most people prefer low initial investment while choosing EVs. A smaller part of people is also ready to pay between Rs. 500,000 and Rs. 1,000,000 for medium-range EV models that have some extra features or a higher performance level. Even fewer people could be the ones who are the most comfortable with budgets that fall in the range of Rs. 1,000,000 to the Rs. 1,500,000, making us realize that the luxury segment is less attractive to the general population. Only a few people have a budget of more than Rs. 1,500,000. Thus, the demand for high-end EVs is still very low in this area.

## 3.10 VEHICLE PREFERENCE

Vehicle type preference shows consumer expectations, preferences for vehicle design, usage patterns etc. it can be used to understand the trends in market and potential areas of development.

Table 3.10: Appealing Vehicle of Respondents

| APPEALING VEHICLE | PERCENTAGE |
|---|---|
| Electric Car | 53.3 |
| Electric Bike | 8.9 |
| Electric Scooter | 37.8 |

Source: Primary data

The respondents seem to find electric cars the most attractive option. This could be because of the fact that electric cars offer higher functionality, comfort, and capacity, which makes them perfect for families and for travel on a regular basis. Unlike the other two, cars have many attracting features such as air conditioning, better seating and entertainment systems and also is better at safety features such as air bags and seatbelts. The ease of use and low cost of electric scooters have made them highly popular; therefore, many consumers find them convenient and affordable for short-distance travel, particularly in urban areas with heavy traffic. Contrarily, electric bikes are not so appealing compared to the other two, which might be because of the rare awareness issue or the fact that fewer people use them as the first way of transport. The Indian market also seem to have fewer electric bike options and they are not as widely promoted as electric cars and scooters.

## 3.11 BRAND PREFERENCE

Brand preference and loyalty can reflect consumer trust, perception of quality and the effectiveness of marketing**.**

Table 3.11: Preferred Electric Vehicle Brands

| PREFERRED BRAND | PERCENTAGE |
|---|---|
| Tata Motors | 35.6 |
| Mahindra Electric | 11.1 |
| Ola Electric | 17.8 |
| Hyundai | 8.9 |
| TVS | 4.4 |
| Bajaj | 4.4 |
| Ather | 6.7 |
| MG | 4.4 |
| TVS iQube | 2.2 |
| Roma | 2.2 |
| Others | 2.2 |

Source: Primary data

Tata Motors is the most preferred brand, with a significant share of people opting for their models. It might be because it is a well-established Indian brand, having a reputation for producing reliable products, and budget friendly EV options. The preference for Ola electric vehicles follows closely behind. It is already gaining attention as a smart and fresh enterprise with a clear focus on electric scooters, which are very popular for urban transportation. Although their demands are steady, Mahindra Electric is somewhere at the rear of the two. This could be because it has limited EV options as compared to Tata and mostly deal with expensive EVs. Smaller demand exists for Hyundai and even less for TVS and Ather. TVS and Bajaj mainly focus on two-wheelers which are not the first choice for most respondents.

## 3.12 CHARGING STATION CONCERNS

Charging infrastructure concern remains a main deterrent in the consumption of EVs. Analyzing this can help identify infrastructure priority areas to be developed.

Table 3.12: Concerns Regarding Charging Stations for EVs

| CHARGING STATIONS CONCERNS | PERCENTAGE |
|---|---|
| Very worried | 8.9 |
| Concerned | 42.2 |
| Neutral | 28.9 |
| Unconcerned | 11.1 |
| Not at all concerned | 8.9 |

Source: Primary data

The study shows that most of participants have concerns about charging stations; this makes it the biggest concern regarding electric vehicles. This may pose a bigger challenge to people who want to travel longer distances and for emergency purposes. Even if there are charging stations available, the slow rate of charging is also another concern for users of EVs. A percentage of 28.9% of the respondents is neutral, denoting indifference or a balance of opinion on the issue. These respondents may have access to home or workplace charging stations, and might not be relying on public charging stations. These may also be people who commute short distances daily or travel within well- connected localities. Thus, the inadequate charging infrastructure is unlikely to affect them. All in all, more respondents are of the opinion that there is some concern being expressed for charging points, reflecting the urgent nature in addressing infrastructural issues on charging to build confidence on electric vehicles.

## 3.13 DRIVING RANGE CONCERN

Driving range anxiety is a significant barrier to adoption of EVs. This can be analysed to understand consumer hesitations in purchasing EVs.

Table 3.13: Concerns About Driving Range of EVs

| DRIVING RANGE CONCERNS | PERCENTAGE |
|---|---|
| Very worried | 2.2 |
| Concerned | 40 |
| Neutral | 33.3 |
| Unconcerned | 22.2 |
| Not at all concerned | 2.2 |

Source: Primary data

Driving range concerns play a noticeable role in shaping consumer perception in Ernakulam. A huge percentage of the population seems concerned about the driving range. This might be because the drivers worry about being stranded if the battery runs out before reaching a charging station. The public charging stations are not as widely available as petrol pumps. This can be a cause of concern regarding the driving range. Very few respondents seem not concerned or at all concerned with driving range issues. This maybe because they only drive short distances or their locality provides numerous charging stations. Another reason for less concern maybe because these respondents have access to home or workplace charging systems.

## 3.14 IMPORTANCE OF GOVERNMENT INITIATIVES

Government policies and initiatives can play a significant role in shaping the consumers' attitudes towards electric vehicles.

Table 3.14 Respondents' Views on the Importance of Government Initiatives

| GOVERNMENT INCENTIVES | PERCENTAGE |
|---|---|
| Very Important | 44.4 |
| Important | 28.9 |
| Neutral | 20 |
| Not Important | 6.7 |
| Certainly Not | 0 |

Source: Primary data

The majority of the consumers in Electric City find incentives offered by the government a significant factor in making purchases of electric vehicles. Because electric vehicles are pricier than conventional vehicles, the incentives provided by governments in the form of direct purchase subsidies, tax credits, or rebates help offset this cost barrier. This makes EVs more accessible to a broader range of buyers. By offering financial incentives, governments can stimulate demand for electric vehicles, encouraging manufacturers to invest more in EV development and production, leading to increased availability and potentially lower prices over time. By promoting EV adoption through incentives, governments can contribute to reduced greenhouse gas emissions and improved air quality. Some government incentives are also directed towards building out charging infrastructure, which is essential for widespread EV adoption and addresses concerns about range anxiety.

## 3.15 SATISFACTION LEVEL OF EV USERS

By analyzing the satisfaction level of EV users, indications on the overall feedback can be attained, relating real-world performance and user experience.

Table 3.15 Satisfaction Levels of Electric Vehicle Users

| SATISFACTION | PERCENTAGE |
|---|---|
| Highly Satisfied | 22.2 |
| Satisfied | 60 |
| Neutral | 15.6 |
| Dissatisfied | 2.2 |
| Strongly Dissatisfied | 0 |

Source: Primary data

## 3.16 FACTORS MOST APPRECIATED BY EV USERS

The satisfaction of users of EVs can be analysed in relation with the factors of EVs that the users are most satisfied with.

Table 3.16 Factors Most Appreciated by Electric Vehicle Users

| FACTORS | PERCENTAGE |
|---|---|
| Cost-saving | 71.1 |
| Environmental impact | 62.2 |
| Performance | 53.3 |
| Comfort | 53.3 |
| Technology features | 42.2 |

Source: Primary data

## 3.17 AREAS OF DISSATISFACTION WITH EVs

Areas of dissatisfaction can also be related to the satisfaction level, highlighting areas for improvement.

Table 3.17 Areas of Dissatisfaction with Electric Vehicles

| FACTORS | PERCENTAGE |
|---|---|
| Initial cost | 28.9 |
| Driving range | 31.1 |
| Charging time | 53.3 |
| Maintenance | 28.9 |
| Resale value | 37.8 |
| Others | 4.4 |

Source: Primary data

The level of satisfaction with electric vehicles is increasing due to several factors. Cost savings are the most important satisfaction factor for electric vehicles (EVs). Because there is no need for petrol or diesel, users only pay for electricity, which is generally cheaper per mile driven than fuel. EVs have a simpler design with fewer moving components compared to gasoline cars, resulting in lower maintenance costs associated with oil changes, spark plugs, and other engine-related repairs. Many governments offer tax credits and rebates for purchasing EVs, further lowering the overall cost of ownership. Charging an EV at home, especially during off-peak hours when electricity rates are lower, can significantly reduce charging costs. Consumers are increasingly drawn to the eco-friendly aspect of EVs which contributes to reduction in air and sound pollution and can have a positive impact on climate change in the long run.

Many users are least satisfied with the charging time aspect of electric vehicles because it often takes significantly longer to fully charge an EV as opposed to filling a fuel car. This can also lead to concern on "range anxiety" as drivers worrying that they may run out of power before reaching their destination, especially if they rely on public charging stations with slower speeds. The current charging infrastructure is not yet widespread to handle a large number of EVs, leading to wait times at public charging stations. Even though long-term

savings can be achieved on fuel and maintenance, high initial cost is a major factor of dissatisfaction among the consumers. Many people still find EVs expensive compared to fuel powered vehicles. Resale value is also another area where the consumers are not satisfied. This can indicate that they are concerned about the depreciation of EVs. Since these vehicles are vastly improving, old models might lose value quickly. Maintenance seems to be of the least concern to the respondents. This might be because they perceive the maintenance of EVs easier compared to fuel powered vehicles. The dissatisfaction may be caused due to lack of skilled technicians, limited-service centres etc.

## 3.18 FACTORS THAT COULD ENCOURAGE OTHERS TO PURCHASE

Understanding factors that could encourage EV adoption can help to identify key drivers for market growth and guides marketing strategies.

Table 3.18 Factors That Could Encourage Others to Purchase Electric Vehicles

| FACTORS | PERCENTAGE |
|---|---|
| Lower cost | 53.3 |
| Greater range | 51.1 |
| More refuelling stations | 42.2 |
| Less time to charge | 46.7 |
| More government incentives | 35.6 |
| Better models of vehicles | 44.4 |
| More information and awareness | 24.4 |
| Other | 4.4 |

Source: Primary data

Lower cost is the most influential factor showing that affordability is a main factor that influences the purchasing decisions of EVs. Many consumers might be hesitant to buy EVs because of worries about depleting the battery and inadequacy of charging stations. If EVs with better driving range are introduced, the demand for them may increase rapidly. The availability of more charging stations an expanding charging networks across cities, highways, and rural areas can significantly boost confidence in EVs and eliminate one of the biggest adoption barriers. If the time taken to charge EVs can be reduced, it might induce more demand for them. Faster charging batteries and fast public chargers would make EVs more convenient. New and innovative models of EVs can also influence more people to purchase them because many potential buyers might not be satisfied with the current options in terms of design, features, or performance. Government incentives also play a key role in influencing the purchase of EVs. Tax benefits, subsidies, reduced registration fees etc can make EVs more attractive. Providing more public awareness can improve clarity about the benefits, maintenance and usage of EVs and can increase their demand.

## 3.19 CHALLENGES FACED BY EV USERS

Studying the challenges and problems faced by users of EV owners provides critical practical insights into areas requiring attention from manufacturers and policymakers.

Table 3.19 Challenges Faced by Electric Vehicle Users

| CHALLENGES FACED | PERCENTAGE |
|---|---|
| Limited driving range | 40 |
| Lack of charging | 48.9 |
| Long charging time | 51.1 |
| High prices | 42.2 |
| Maintenance issues | 22.2 |
| Performance issues | 0 |
| Others | 4.4 |

Source: Primary data

Electric vehicles take long to charge mainly because of battery technology, which limits the rate at which electricity can be transferred to avoid overheating, and other factors such as the size of the battery, the power of the charger, and the ambient temperature. It takes a long time to fully charge a battery compared to filling a gas tank. This is perceived as the biggest challenge faced by the users of EVs. Lack of widespread charging stations are also one of the biggest problems faced by the consumers of EV. This can have negative impacts on long distance drives or emergency travels. The high initial prices can also make people hesitant to purchase electric vehicles. These are higher than that of the traditional vehicles, making EVs unattractive to a wider audience. Maintenance issues are a lesser concern of users of EVs as most of them might feel this to better than the maintenance of traditional vehicles. Performance issues are not seen as a significant problem, suggesting that consumers are generally satisfied with the driving experience of EVs, likely because of their smoother and quieter operation

## 3.20 MAINTENANCE OF EVs IN RELATION TO FUEL POWERED VEHICLES

By comparing the maintenance difficulty of electric vehicles to fuel powered vehicles, insights into the operational expenses across vehicle types can be studied.

Table 3.20 Maintenance of EVs in relation to fuel-powered vehicles

| MAINTENANCE | PERCENTAGE |
|---|---|
| Somewhat harder | 15.6 |
| All about same | 24.4 |
| Somewhat easier | 60 |

Source: Primary data

## 3.21 MAINTENANCE COST RANGE OF ELECTRIC VEHICLES

The average range of maintenance cost of EVs can be analyzed to understand the latter expenses incurred after purchasing EVs. This can be used to assess the economic feasibility of electric vehicle ownership.

Table 3.21 Maintenance cost range of EVs

| MAINTENANCE COST | PERCENTAGE |
|---|---|
| ₹1000-₹5000 | 64.4 |
| ₹5000-₹10000 | 26.7 |
| ₹10000-₹15000 | 8.9 |

Source: Primary data

A majority of respondents feel that maintaining an EV is somewhat easier when compared to fuel powered vehicles. For majority of these people, the maintenance cost incurred is under ₹5000. The people who incur more than ₹5000 for maintenance could be the ones who own older EVs that might require more frequent repairs or might own expensive EVs having expensive service charges. Higher maintenance costs are likely to be incurred for services such as replacement of the brake pads and battery packs. On an average, the maintenance costs of EVs are relatively less and easier compared to the fuel powered vehicles.

## 3.22 ESTIMATED COST SAVINGS

By estimating the cost savings experienced by the owners of EVs, the economic benefits of switching to electric vehicles can be studied.

Table 3.22 Estimated Cost Savings from Switching to Electric Vehicles

| COST SAVINGS | PERCENTAGE |
|---|---|
| Significant cost savings | 44.4 |
| Moderate cost savings | 44.2 |
| Slight cost savings | 11.1 |
| No cost savings | 2.3 |

Source: Primary data

A large majority of the respondents believe switching to electric vehicles results in significant and moderate cost savings. The cost saving might be evident in case of long-term savings on fuel cost as electricity is much cheaper than petrol and diesel. The maintenance cost can also lead to savings in case of EVs. The slight cost savings as perceived by 11% of the respondents might be due to the higher initial purchase price they incurred or due to the additional costs of installing charging stations or replacing batteries.

## 3.23 IMPORTANCE OF AIR POLLUTION AS A FACTOR INFLUENCING EV PREFERENCE

Environmental consciousness, particularly regarding air pollution plays a significant role in shaping consumer preferences for sustainable transportation options.

Table 3.23 Importance of Air Pollution in Shaping Electric Vehicle Preferences

| IMPORTANCE | PERCENTAGE |
|---|---|
| Very important | 48.9 |
| Important | 24.4 |
| Neutral | 24.4 |
| Not at all important | 2.2 |

Source: Primary data

An essential factor influencing the purchase of electric vehicles is the problem of air pollution. Electric cars have been depicted as cleaner and more sustainable than fuel-powered vehicles. Majority of the respondents believe air pollution is quite important, showing high concern of growing environmental consciousness in consumers. It can be inferred that most people purchase electric vehicles, keeping in mind the positive impacts that it can have on the environment. More than a cleaner environment, pollution related health risks such as respiratory diseases might also be a concern for the consumers and can influence them to purchase EVs.

## 3.24 LIKELIHOOD OF RECOMMENDING EVs TO OTHERS

Recommendations from existing users can significantly influence potential buyers, making it a crucial indicator of market growth potential.

Table 3.24 Likelihood of Recommending Electric Vehicles to Others

| LIKELIHOOD OF RECOMMENDATION | PERCENTAGE |
|---|---|
| Very likely | 37.8 |
| Likely | 48.9 |
| Neutral | 11.1 |
| Unlikely | 2.2 |

Source: Primary data

Recommendations play a significant role in determining the purchase of electric vehicles as they represent consumer satisfaction, trust, and confidence in the product. The majority of respondents are likely or very likely to recommend EVs to others. This indicates that there is an overall positive attitude towards EVs. This might be due to savings on fuel, positive impacts on the environment, government incentives and an overall smoother driving experience as compared to the fuel powered vehicles. There is a portion of respondents who remains neutral on further recommending EVs to others. They may need more convincing maybe through improved charging infrastructure and better awareness to improve their views on EVs.

## 3.25 CORRELATION

Correlation refers to the degree to which a pair of variables are linearly related. It can be used to indicate a predictive relationship. Here, the correlation between the level of satisfaction of the users of electric vehicles and the likelihood of them recommending electric vehicles to others is analysed.

### 3.25.1 PEARSON CORRELATION

Table 3.25.1 Pearson's Correlation Coefficient

| | | Satisfaction level | Likelihood of Recommending |
|---|---|---|---|
| Satisfaction level | Pearson Correlation | 1 | -.476** |
| | Sig. (2-tailed) | | <.001 |
| | N | 45 | 45 |
| Likelihood of Recommending | Pearson Correlation | -.476** | 1 |
| | Sig. (2-tailed) | <.001 | |
| | N | 45 | 45 |

**. Correlation is significant at the 0.01 level (2-tailed).

Developed by Karl Pearson, the Pearson Correlation Coefficient measures the linear relationship between two sets of data. It is a normalized measurement of the covariance, such that the result always has a value between -1 and 1.

The Pearson correlation coefficient of -0.476 indicates a moderate negative correlation between the two variables: Satisfaction Level and Likelihood of Recommending EVs. Negative correlation means that as the satisfaction level decreases, i.e. moving from highly satisfied to dissatisfied, the likelihood of recommending EVs also decreases. People who are dissatisfied are less likely to recommend EVs.

The p-value of <0.001 means that this relationship is statistically significant at the 0.01 level. This means that there is strong evidence to reject the null hypothesis – there is no correlation between satisfaction level and likelihood of recommendation, and to accept the alternate hypothesis – there is significant relationship between satisfaction level and likelihood of recommendation.

## 3.25.2 SPEARMAN'S RANK CORRELATION

Table 3.25.2 Spearman's rank correlation

| | | | Satisfaction level | Likelihood of Recommending |
|---|---|---|---|---|
| Spearman's rho | Satisfaction Level | Correlation Coefficient | 1.000 | -.410** |
| | | Sig. (2-tailed) | . | .005 |
| | | N | 45 | 45 |
| | Likelihood of Recommending | Correlation Coefficient | -.410** | 1.000 |
| | | Sig. (2-tailed) | .005 | . |
| | | N | 45 | 45 |

**. Correlation is significant at the 0.01 level (2-tailed).

Spearman's rank correlation, named after Charles Spearman measures the strength and direction of a monotonic relationship between two ordinal variables.

A Spearman's rho of -0.410 indicates a moderate negative correlation. It suggests that, generally, respondents who report lower levels of satisfaction with electric vehicles are less likely to recommend them to others, and those who express higher satisfaction with EVs are more likely to recommend them.

# CHAPTER 4

# FINDINGS, SUGGESTIONS AND RECOMMENDATIONS FOR ACCELERATING ELECTRIC VEHICLES DEMAND IN ERNAKULAM CITY

## 4.1 INTRODUCTION

Driven by an escalating trend towards sustainability and affordability, the number of electric vehicles purchased in Ernakulam city are increasing year by year. This chapter focuses on the findings regarding the primary factors influencing consumer decisions and the challenges faced by the owners of EVs.

Based on these findings, this chapter also provides recommendations and practical suggestions to identify the drawbacks and address the challenges faced by EV adoption in Ernakulam. These can help provide valuable insights to guide policymakers, automobile manufacturers and other stakeholders to develop strategies that can be used to improve consumer confidence and accelerate the sale of EVs.

## 4.2 FINDINGS

4.2.1

**Objective 1: To analyse the factors influencing purchasing decisions of Electric Vehicles**

From our study on Consumer Preference Towards Electric Vehicles in Ernakulam City, "cost savings" of EVs can be established as the most prominent factor driving the demand for EVs. Out of all responses, 84.4 per cent identified "Saves Fuel Cost" as the most influencing factor of an electric vehicle. More and more consumers now are focusing on the financial benefits when choosing vehicles and EVs provide various economic advantages over traditional fuel-powered vehicles. While the initial purchase of an EV may still be higher than some fuel-powered vehicles, the long-term cost savings are comparatively much better. Cost savings on EVs are contributed by lower fuel costs, lower maintenance costs and government incentives and subsidies. As a result of these factors, the total cost of ownership decreases.

Another factor influencing people to purchase electric vehicles is the increasing concern towards environment. The majority of respondents, around 73 per cent agrees that mitigating air pollution is an important or very important factor that influences them to purchase EVs. With an aim to reduce air pollution, carbon emissions, and climate change, many consumers are seeking sustainable alternatives to traditional vehicles. With zero tailpipe emissions contributing to reduction in greenhouse gases, EVs can play a major role in improving the air quality in an urban city like Ernakulam.

Technological advancements and ease (26.7%) of use are also taken into account by consumers while purchasing EVS. Regenerative breaking, AI-powered driving assistance, smoother and quieter driving experience, connectivity and integration with smart devices, ease of charging and home-charging convenience are some of the main attractions for consumers. This combination of smart features and comfort makes EVs a compelling choice for a growing number of consumers.

Government policies, initiatives and subsidies lay a key role in increasing the demand for electric vehicles in Ernakulam as recorded by 22 per cent of respondents. These not only promote sustainable transportation, but also reduces the overall cost burden, making EVs more attractive and viable option. The government, through the Faster Adoption and Manufacturing of Hybrid and Electric Vehicles (FAME-II) provides direct subsidies to EV buyers, reducing the upfront cost. Tax benefits including lower GST rate on EVs and exemption from road tax and lower registration fees further reduces the overall cost.

4.2.2

**Objective 2: To analyse the threats and challenges faced by the consumers of Electric Vehicles**

While EVs offer significant benefits, consumers also face several challenges that can act as hindrances to widespread adoption. A major challenge faced by EV consumers is the lack of adequate charging infrastructure. Almost half of the respondents (48.9%) identified this as the main challenge they face. Despite the initiatives taken by government, charging stations appear to be few and far between, especially in residential areas and highways. EVs need a longer time to charge, making long distance travel complicated. Not every consumer has dedicated parking and electrical arrangements required to install home charging stations.

The high initial cost while purchasing EVs is a cause of hesitance in consumers towards adoption of EVs as identified by 29 per cent of the respondents. Even with subsidies, EVs are still more expensive compared to some fuel-powered vehicles. This high pricing is caused due to importing of batteries and advanced technologies. Consumers might not be entirely sure as to whether amount spent on an EV will bring long-term savings.

Even-though the overall maintenance cost of EVs is relatively less, they have an entirely different approach and challenge related to their maintenance. Over a long period, the output

of the battery declines and it becomes less efficient. Replacement of a battery for an electric vehicle may be pricey in the long term. In Kerala, the technology of EVs is still fresh. Local mechanics are untrained to perform repairs for EVs and the consumers need to depend on authorized service centres.

The unpredictable resale value of EVs is another major challenge faced by around 38 per cent owners of EVs. There is uncertainty about how well EVs will do in keeping their value against gasoline or diesel engines. The rapid advancement of battery technology indicated the introduction of newer, more developed models. This can diminish the prospects of older EV models in the second-hand market. The value is also affected by a decline in battery life and replacement costs since the buyers may be concerned about buying an EV second-hand with a compromised battery.

4.2.3

**CORRELATION**

From the data acquired, a correlation analysis was conducted between the two variables: Level of Satisfaction and Likelihood of Recommending to Others. The findings indicate that moderate negative correlation exists between the two variables, as indicated by Spearman's rho correlation coefficient of -0.410 with a p-value of 0.005. The observed difference was statistically significant at the 0.01 level. This shows that the higher the satisfaction of EVs, the more likely one would recommend EVs to others; while the lower the satisfaction level, the less likely one would recommend it.

This negative association reflects the importance of consumer satisfaction in the process of word-to-mouth recommendations, suggesting that manufacturers and policymakers should prioritize the determinants of customer satisfaction with a view to attain positive recommendations for fostering further EV uptake.

4.2.4

**FEEDBACKS**

The feedbacks from the respondents points to a generally positive record of perception about electric vehicles in regard to environmental benefits, cost efficiency, and comfort. The respondents acknowledged the overall savings on fuel cost by stating that “Cost savings - running cost less than Rs.1”. there were also comments appreciating the environmental contributions of the vehicles including “reduction of air and noise pollution”.

Concerns were raised regarding the lack of charging infrastructure, suggesting the need for more charging stations and faster charging technology. Respondents were also concerned about the battery performance, resale value and delays in after-sales service, indication areas in need of improvement.

The overall feedback indicates an increasing acceptance of EVs as a sustainable and cost-effective option for transportation indicated by comments such as “Best in current scenario.... expecting the best ones in near future with long range in affordable price”.

## 4.3 SUGGESTIONS AND RECOMMENDATIONS

4.3.1 Build and Improve Charging Facilities

Establish and install charging stations, especially in areas of residence, commercial strategic positions, and highways. Stimulate and motivate private investments in setting up charging networks as a complement to government efforts. Encourage charging stations to utilize renewable sources of energy for sustainability

4.3.2 Bring Down the High Initial Purchase Cost of EVs

Make consumers aware of government subsidies and incentives that provide consumers with a good understanding of their purchasing decisions. Urge local manufacturing of batteries and components of EVs to cut import expenditures and vehicle prices. Provide affordable financing options-a gracious low-interest EV loan-helping them to relax easily on ownership.

4.3.3 Better Maintenance and After-Sales Support

Position numerous service centres for servicing EVs and corresponding battery replacements. Cultivate training programs for mechanics and technicians towards the enlargement of the

broad spectrum of proficiency in EV servicing. Advocate for longer battery warranties with lower replacements from manufacturers.

#### 4.3.4 Addressing the Resale Value Concerns

Set up an EV certified pre-owned market, wherein used EVs are checked for quality prior to buyers. Establish a battery repurposing or recycling system to extend battery life and the maintain resale value. Advocate for leasing options that allow consumers to use and enjoy EVs without worrying about long-term resale value.

#### 4.3.5 More Efficient EV and Consumer Confidence

Motivate automakers to make longer-range EV vehicles fit for Indian roads. Equip vehicles with a real-time range monitoring system, allowing efficient trip planning. Enrol candidates for test drives and employ promotional campaigns to get them acquainted with the merits of EVs, and dispel any apprehension they have.

#### 4.3.6 Government-level recommendations

Strengthen and amend the existing Kerala EV policy to add a wider range of subsidies and tax incentives for both personal and commercial EVs. Make EV charging a requirement for all new residential and commercial buildings. Formulate the EV battery recycling policy on waste management for long-term sustainability. Expand the FAME II scheme to include more types of vehicles and grant greater subsidies.

#### 4.3.7 Industry recommendations

Automobile manufacturers should invest in research and development to reduce production and maintenance costs, along with the developed technologies on battery and energy sources. Market affordable EV models that are currently absent in the Indian market. Energy companies should be encouraged to install more fast-charging stations.

#### 4.3.8 Consumer Awareness and Adoption Strategies

Build campaigns to create awareness about the advantages of EVs in terms of cost savings and lesser environmental effects. Exchange programs should be initiated with incentives that allow existing petrol/diesel vehicles to be traded for EVs at discounted rates. Encourage shared mobility and corporate fleets to promote the visibility and acceptability of EVs.

## 4.4 CONCLUSION

This chapter's focus has been to provide a more significant understanding on the drivers of, challenges of, and recommendations for adopting consumer preferences toward EVs in Ernakulam. In particular, good savings from cost acted as a key pull factor for adopting EVs further influenced by environmental concerns, technological advancement, ease of use, and government incentives. Nonetheless, substantial barrier factors such as limitations of charging infrastructure, high initial cost, maintenance issues, resale value, and performance-related challenges continue to dampen mainstream adoption.

To mitigate these, several suggestions and recommendations are proposed, including a wide range of suggestions to expanding the charging network, encouraging the development of new technologies for battery packs, augmenting the selling market, and enhancing consumer awareness programs indicating that as we advance, governmental policy measures, combined with industry initiatives and consumer education, are expected to drive the future of EV adoption in Ernakulam.

The above shows that although EVs can be a growing cost-effective alternative to internal combustion vehicles, considerable challenges will require a collaborative effort of policymakers, manufacturers, infrastructure developers, and consumers. Continual improvements and properly targeted interventions would fast-track the journey of Ernakulam into electric mobility with the least negative repercussions on the environment and society.

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**QUESTIONNAIRE**

1. Age

- 16 - 20 years
- 21 - 30 years
- 31 - 40 years
- 41 - 50 years
- 51 years and above

2. Gender

- Male
- Female
- Prefer not to say

3. Highest level of education

- High school
- Bachelor's Degree
- Master's Degree
- Doctorate
- Other

4. Annual income

- Less than ₹ 3,00,000
- ₹ 300000 - ₹ 6,00,000
- ₹ 6,00,000 - ₹ 10,00,000
- ₹ 10,00,000 - ₹ 15,00,000
- Above ₹ 15,00,000

5. How did you first hear about an Electric Vehicle?

- Media (TV, newspapers, etc.)
- Internet
- Friends/Family
- Advertisement
- Other

6. How long have you been using EVs?

- Less than 1 year
- 1 - 3 years
- 3 - 6 years
- 6 - 10 years
- More than 10 years

7. How do you view electric vehicles

- Very positive
- Positive
- Neutral
- Negative
- Very bad

8. What were the factors that lead you to buy an electric vehicle? (Select all that apply)

- Save fuel cost
- Reduce environmental problems
- Government incentives
- Ease of use of technology
- Brand name
- Easy availability of charging station
- Other

9. What is your approximate budget for an electric vehicle?

- Less than ₹ 5,00,000
- ₹ 5,00,000 - ₹ 10,00,000
- ₹ 10,00,000 - ₹ 15,00,000
- Above ₹ 15,00,000

10. What kind of electric vehicle appeals to you most?

- Electric Car
- Electric Bike
- Electric Scooter

11. Which brand do you prefer for an electric vehicle?

- Tata Motors
- Mahindra Electric
- Ola Electric
- Hyundai
- Other

12. How concerned are you that in your area the charging stations for electric vehicles are well distributed?

- Very worried
- Concerned
- Neutral
- Unconcerned
- Not at all concerned

13. How concerned are you with the driving range of electric vehicles?

- Very worried
- Concerned
- Neutral
- Unconcerned
- Not at all concerned

14. How important is the presence of governmental incentives a factor when it comes to you buying an electric vehicle?

- Very important
- Important
- Neutral
- Not important
- Certainly not

15. Your level of satisfaction with Electric Vehicles is

- Highly satisfied
- Satisfied
- Neutral
- Dissatisfied
- Strongly dissatisfied

16. What aspects of your electric vehicle are you satisfied with? (Select all that apply)

- In terms of cost-saving
- Environmental impact
- Performance
- Comfort
- Technology features
- Other

17. Which of the following is the characteristic of your electric vehicle which you are least satisfied with? (Select all that apply)

- Initial cost
- Driving range
- Charging time
- Maintenance
- Resale value
- Other

18. What do you think will influence others to buy EVs? (Select all that apply)

- Lower cost
- Greater range
- More refuelling stations
- Less time to charge
- More government incentives
- Better models of vehicles
- More information and awareness
- Other

19. What problems have you encountered with EVs? (Select all that apply)

- Limited driving range
- Lack of charging infrastructure
- Long charging times
- High purchase price
- Maintenance issues
- Performance issues
- Other

20. How do you perceive the maintenance of electric vehicles compared to traditional vehicles?

- Somewhat easier
- About the same
- Somewhat harder
- Much harder

21. How much cost do you incur for maintenance of your vehicle?

- ₹ 1000 - ₹ 5000
- ₹ 5000 - ₹ 10000
- ₹ 10000 - ₹ 15000
- ₹ 15000 - ₹ 20000
- Above ₹ 20000

22. How much cost saving do you experience with an electric vehicle compared to a normal vehicle?

- Significant cost savings
- Moderate cost savings
- Slight cost savings
- No cost savings
- Higher costs with EV

23. How important do you feel it is to inculcate electric vehicles to address the problem of air pollution?

- Very important
- Important
- Neutral
- Not important
- Not at all important

24. As far as electric vehicles are concerned, do you find yourself recommending them to others?

- Very Likely
- Likely
- Neutral
- Unlikely
- Very Unlikely

25. What is your feedback regarding Electric Vehicles?