ACCEPTANCE LEVEL OF ELECTRIC VEHICLES IN PAKISTAN: CONSUMER'S PERSPECTIVE

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بسم الله الرحمن الرحيم

In the name of Allah, The Most Affectionate, The Most Merciful

Whatever is the heavens and in the earth glorify Allah; and it is He the Esteemed one the wise.

For Him is the Kingdom of the heavens and the earth He gives life and causes to die, and He can do everything.

He is the First, He is the Last, He is the Manifests, and He is the Hidden and He knows everything.

It is He who created the heavens and the earth in six days, and then seated Himself upon the Throne befitting to His Dignity.

He knows what penetrates the earth and what comes forth from it, and what comes down from heaven and what seconds into it? And He is with you wherever you may be. And Allah is seeing your works. For Him is the Kingdom of the heavens and the earth. And towards Allah is the return of all affairs?

(Al-Quran, Surah Al-Hadeed 1-5)

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Abstract

Recourses scarcity and global warming are some of the biggest challenges face by the world. The major focus of invention has been shifted towards an innovative and alternate solution to these resources. One of the major consumers of fuels is automobiles engines. So, the world has shifted toward electric vehicles. Pakistan is in the top 30 countries of automobiles manufacturers. But still, unfortunately, it has not to gain of the pace in this field. This research was conducted to ascertain the awareness level and the needs of the clients in Pakistan regarding electric vehicles for this epistemological philosophical underpinning were used. A quantitative research method technique was used. It is exploratory research trying to determine the needs of the clients and the areas for the manufacturers to focus upon. For this, a sample of acceptance level of electric vehicles in Pakistan by questionnaire was collected out of which there were be useable. The data was entered into SPSS and XL sheets in combination with STATPRO for further analysis. After going into the detailed analysis of the data it has come out the results have identified that low price electric vehicles with high or medium-level attributes are preferred. Also, what are the preferences of the clients, and what are the needs of the clients on which the manufacturers can focus upon? The significance of this research is that it will give an edge to the new automobile manufacturers to come to Pakistan and start manufacturing electric vehicles and the focus of the local automobile industry will also shift toward electric vehicles. Electric vehicles (EVs) can solve present and impending issues of various divisions including transportation, environment, economy, and power.

Keywords: Electric vehicles, Energy crisis, driving range, charging time, fuel cost, pollution, performance, acceptance level of electric vehicle, hydrocarbon, contamination, emission

Dedication

Oh, Allah Almighty opens our eyes,

To see what is beautiful,

Our minds to know what is true,

Our heart to love what is Allah

Dedicated to

My loving Parents

Whose encouragement and sincere

Prayers initiate me to Achieve High

Academic goals

Acknowledgments

All worships and praises are only for Allah, the most beneficent, merciful, and compassion, whose blessing and exaltation flourished my thoughts and thrived my ambitions to have the cherished fruit of my modest effort in the form of the manuscript. I offer my humblest thanks and countless salutations to the Holy Prophet Mohammad (PBUH), who is forever, a torch of guidance for the entire humanity.

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Lastly, but in no sense the least, I am very grateful to my cherished parents for their constant encouragement in overcoming the difficulties that faced me during my study; and supported me emotionally and financially also. Of course, how can I forget to express my deep gratitude and appreciation to my wife and sisters for their unconditional love and support throughout all my work.

Muhammad Yousuf

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Chapter 1
Introduction

Worries about global warming and vitality crises, alongside innovation in battery technology, have invigorated a renewed enthusiasm in electric vehicles (EVs). Alongside improvement in lithium-ion battery innovation and late examples of overcoming adversity of hybrid vehicles, automobile manufacturers have started a significant push to manufacture fully electric vehicles powered by batteries. Every single significant automotive developer has research and development (R&D) programs for fully electric vehicles (EVs) and has demonstrated its aims to start large scale manufacturing within the next few years.

This Research presents an expressed inclination investigation of electric vehicle acknowledgment utilizing information from a national review. Utilized a decision test was approached to pick between their existing conventional vehicles and two electric variants of the vehicle.

Financial examinations of Electric vehicles (EVs) considering as not ideal, generally because of high-cost battery, short driving range, charging time is long and restricted charging set-up. Though topical development in technologies proposes that the driving range will be increased, charging time reduced, and batteries prices brought down. Correspondingly, upcoming years of manufacturing of Electric Vehicles at large scale, per unit price of electric vehicles, similar other innovations are probably going to drop. The spell appears to be directly for alternative expression at the financial latent for EV.[1]

Automobile manufacturing in Pakistan one of the rapidly increasing trades. Currently around 3200 approximately automobile production and assembly units in Pakistan, with speculation of Rs 92 billion ($870 million) delivering 1.8 million bikes and 200,000 vehicles yearly. Holding 4% of Pakistan's GDP. The division, in total, makes available employs up to 3.5 million persons and plays a major part in sponsoring the development of wholesaler business. Pakistan considers as the minutest automobile market, nevertheless quickest developing in South Asia. More than 180,000 vehicles were sold in the monetary year 2014-15; ascending to 206,777 the unit's financial year 2015-16. Right now, the dominant of automobile producers in Pakistan remains Honda automotive, Indus motors Toyota and Pak Suzuki. But, on March 19, 2016, Pakistan

approved "Auto Policy 2016-2021", this step encourages new automakers to launch production and assembling units in Pakistan and get benefits of the tax incentive.

By this reaction, Renault motors, Nissan motors, Kia motors, SsangYong motors china, Audi Motors, Volkswagen Germany, FAW motors, and Hyundai automobiles have imparted energy aimed at inward-bound the Pakistani marketplace. NLC (National logistic cell) agreed to a course of action with Mercedes Benz for assembling of Mercedes Actros trucks in Pakistan. Yet at the same time has not executed any vehicle protection measures or model bring up-to-date arrangements. That is why outdated automobiles together with Suzuki Mehran, Bolan, and Ravi and so on proceed with the sale.[2]

There are remain numerous benefits of plugin Electric vehicles (EVs) as compared with gasoline vehicles. From a technical perspective, alternative vehicles, for example, hybrid and electric vehicles, technologically very develop and in this manner may fill in as profitable options in contrast to conventional vehicle technology. The capability of Electric vehicles considered in new researches from a methodological, financial, transportation, ecological, and urbanization perspective.[3]

Automobile Development Policy (2016–2021) and China-Pakistan Economic Corridor (CPEC) remain inspiring extraneous funding designed for the other automotive producers to step in the Pakistani marketplace. Many international automotive producers are trying to introduce Electric Vehicles (EVs) in the Pakistani market. International Electric Vehicles (EVs) producers believe Pakistan has a large probable market for Electric Vehicles, and national industries are working together with international Electric Vehicles (EVs) brands to bring Electric vehicles in Pakistan.[2]

The mass acknowledgment of Electric vehicles (EVs) is for the most part dependent on consumer's perception of them. Subsequently, so as to advance Electric vehicle (EV) appropriation, it is important to see how customers see Electric vehicles (EVs) and what the possible drivers for and hindrances against customer Electric vehicles (EVs) adoption are. this research recognizes what factors impact customer expectations to buy EVs.[4]

In the budget 2018-2019, the government of Pakistan has given many incentives for electric vehicles and to take advantage of these incentives, in that scenario, **Rahmat Group** has signed an agreement with the well-known and leading Chinese electric vehicle manufacturing company, **BYD** for the assembling of Electric vehicle (EVs) in Pakistan. The Joint Venture and technical collaboration between the two companies is a

breakthrough in the automotive sector of Pakistan. The Chinese automotive manufacturing companies will be assembling cars, vans, coaches, buses, trucks and batteries, chargers, and other associated products related to automotive. Besides, the government has given exemptions of 16 percent duties on electric vehicles charging stations, duties reduced from 50 percent to 25 percent also freedom of 15 percent regulatory duty. Moreover, the administration has correspondingly diminished duties on implements of electric vehicles charging from 50 percent to 10 percent. On Nov 8, 2016. Dewan Motors' collaboration with BMW started the first electric vehicles charging station in Emporium Mall, Lahore, Pakistan. Dewan Motors had fitted one more electric vehicle charging station at Dolmen Mall in Karachi in February 2017. Also, in May 2017 Dewan Motors inaugurated another charging station in the Capital of Pakistan.

In the Pakistani scenario, consumers are waiting for new technology that replaces the traditional conventional vehicles. Due to the high cost of hydrocarbon fuels and the high consumption of fossil fuels. Peoples are demanding more hybrid technology from the last few years. Now in Pakistan consumers are well known about fully Electric Vehicles. By research, I collect data in terms of an acceptable level. Plugin Hybrid Electric Vehicles (PHEVs) and completely Electric Vehicles demonstration possibilities to decrease greenhouse gas (GHG) discharges, increment eco-friendliness, what's more, recommendation driving reaches that are not restricted by battery limit. Though, these advantages won't remain acknowledged whether customers do not accept this innovative technology.[5]

1.1. Motivation

Pakistan is facing a few multi-sectorial and multifaceted difficulties. In this way, arrangements that positively impact a few segments are critically required. By presenting Electric vehicles (EVs) in Pakistan can solve present and impending issues of various divisions including transportation, environment, economy, and power. The transportation sector has been developing with a double-digit development in Pakistan. Practically most of the transportation division is dependent on oil-based items and the country is spending nearly 13 billion USD on the import of crude oil each year. Pakistan has just been declared as the seventh most helpless nation because of the impacts of environmental change. The power sector in Pakistan has likewise confronted challenges and for as far back as a decade, the power generation could not satisfy the power demand of the country.

However, in the next several years, the circumstance is going to change quickly and Pakistan will have an excess of power generation.[6]

Electric vehicles (EVs) are as of now presented as an answer for the issue of reliance on non-renewable energy sources, increasing carbon dioxide (CO_2) discharges, and additional ecological problems. Transportation adds almost one-fifth of the European unions all out discharges of CO_2, By the core greenhouse gas (European Commission, 2012). Referring to the significance of making a move on environmental transformation, many governments of world countries have started strategies for decreasing CO_2 discharges by motivating the manufacture, introduction, and acceptance of electric vehicles. Despite the indicated positive ecological results of charging the light obligation vehicle armada the portion of electric vehicles in the all-out number of vehicles sold is pretty much nothing. In 2011, the EVs piece of the overall industry was just 0.06 percent of the 51.1 million light obligation vehicles sold in Europe, the United States, and the developed Asian countries.[5], [7]

Nevertheless, this given conventional Automotive makes gap for Hybrid or fully electric vehicles. Pakistan before now has a noteworthy marketplace of Hybrid automobiles. Many models are seen on roads like Honda Vezel, Toyota Prius, Aqua, Fielder, Axio, etc.

There are various focal points of Electric vehicles (EV). It is Engine fewer vehicles, which makes it a considerable green product. So, in that case, no use of Hydrocarbon fuel, no more combustion and burning process, and no harmful emission so that is why it has called environmentally friendly Technology. Electric Vehicles are much better than hybrid cars. Because when hybrids cars running on Hydrocarbon fuel produces harmful gases. By using Electric Vehicles, we all contributing to a healthy and green climate. Electric Vehicles charge by electricity, which means you do not need to buy any Hydrocarbon fuel again.

1.2. Advantages of Electric Vehicles

There are various benefits of Electric vehicles (EVs) as compared with conventional gasoline vehicles. From a technical perspective, alternative vehicles, for example, plugin hybrid electric vehicles, technically very develop and in this manner may fill in as profitable options in contrast to conventional vehicle technology. The capability

of electric vehicles considered in previous researches from a methodological, financial, transportation, ecological, and urbanization perspective.[3]
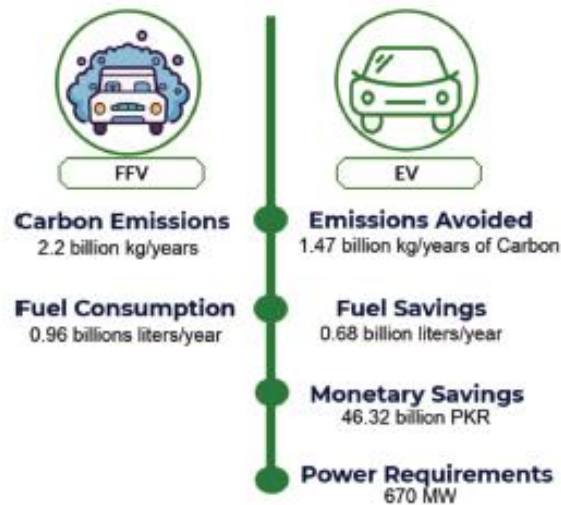
Figure 1.1. Advantages of EV[6]

1.3. Electric Vehicle Target Around the Globe

Electric vehicles are one of the new immerging technologies in the world. Many countries are adopted and, on the way to adopt EVs. There are many reasons for EV's adoption. Due to global warming, many countries are trying to enter the sustainable energy era. Fuel-burning vehicles called conventional gasoline vehicles which the main source of hydrocarbon fuel and harmful gases emission. Norway, Finland, France, Sweden, India, China, and Mexico are setting goals to achieve until 2030. These countries are trying to reduce GHGs (Green House Gases) from 40 % to 70 % by 2030. They also try to provide the incentive to install charging stations. China comes to the world with new technologies. In the electric vehicles sector, China also contributed to its electric vehicle technologies. Chine wants to provide and upgrade its transport sector with the electric truck, buses, and urban logistic trucks. Also trying to develop different models of electric cars which are small passenger, Mid-size passenger, Large size passenger household cars. Pakistan is a newly adopted country that attracted many automobile manufacturers to introduce and enter in Pakistan automobile market with their electric vehicle's technology. By the ministry of science and technology, electric vehicles introduced in the transport sector by 2022.
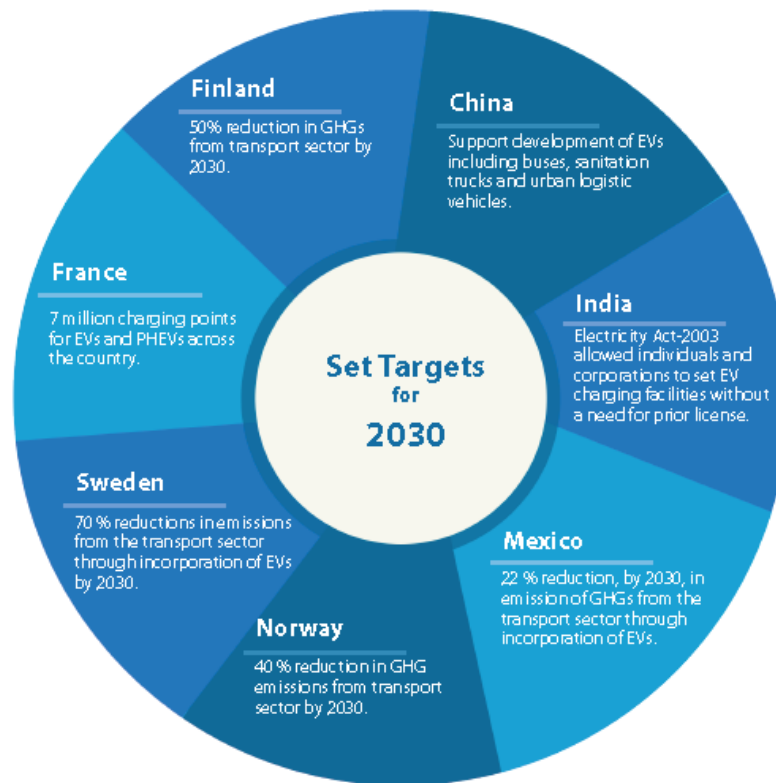
Figure 1.2. EVs target around the globe[8]

1.4. Problem Statement or Research Questions

Pollution is a major threat to the environment and contamination in vehicle emission damage the climate. The rest of the world is in the process of adopting Electric vehicles, but Pakistan manufacturers are only focusing on high price hydrocarbon fuel vehicles.

1.4.1. Research Questions

▶ What is the effect of electric vehicle attributes which are driving range, charging time, fuel cost, performance, pollution, and price comparison on acceptance level?

▶ What are the outcomes of electric vehicle advantages on the acceptance level?

▶ How electric vehicle's disadvantages impact on acceptance level?

▶ How overall information on electric vehicles effect on acceptance level?

1.4.2. Objectives

▶ To determine the influence of electric vehicles attributes on acceptance of electric vehicles

▶ To study the advantages and impact on the acceptance level of electric vehicles

▶ To study the disadvantages and effect on the acceptance level

▶ To determine electric vehicles information impact on acceptance level

1.5. Thesis Organisation

The structure of the thesis is demonstrated in figure 1.3. **Chapter 1** includes a detailed introduction to research. **Chapter 2** discusses the current state of the Electric vehicles in other countries and Pakistan. The effort in chapter 2 replicates the EVs history, current models available in the market. It also clarifies various notions, market, social impact, and outlines associated with acceptance of EVs. The attributes of the selection of EVs is discussed in detail with an overview and critique of existing work.

Chapter 3 focuses on the adopted methodology of the research. It also includes sample size, sampling technique, targeted population, method of data collection, and data analysis. **Chapter 4** discusses the results and evaluation of the collected data and analyzed data. In **chapter 5** conclusion and discusses factors of future work in Pakistan scenario. **Chapter 6** includes references which implemented by Zotero.
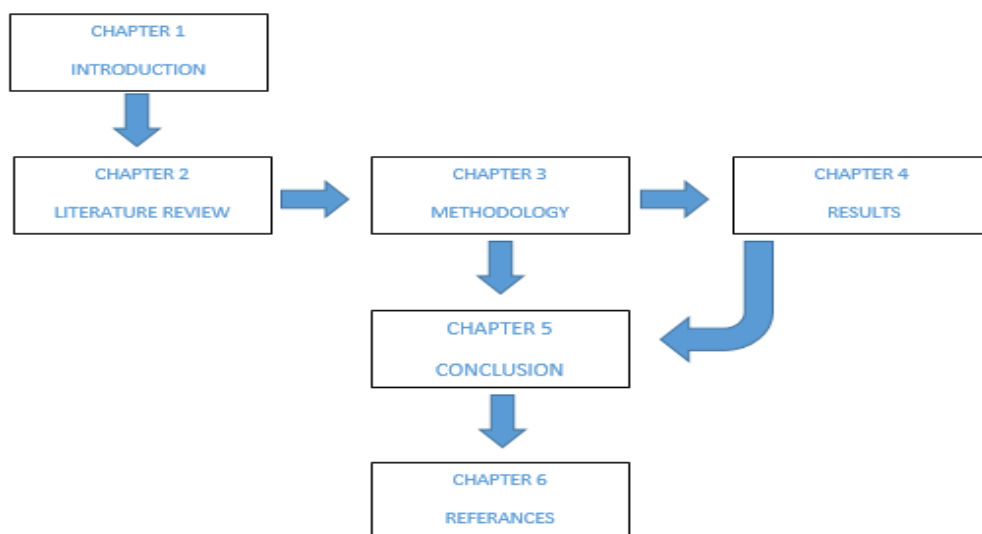
Figure 1.3. Thesis Organization

Chapter 2
Literature Review

2.1. History of Electric Vehicles

The noticeable change in world automobile technology. Gasoline vehicles replaced by hybrid and fully electric vehicles. European countries like Norway, Finland, Germany, and France are seemed full of electric vehicles and charging stations. In America, Tesla motors become more popular in electric vehicle manufacturing. Tesla Motors isn't just an automobile manufacturer. It is an "energy innovation organization," a basic component in its more extensive mission for "zero-emission power generation"[9].

The first electric vehicle innovation technology was used by Robert Anderson in 1832-1839. He invents an electric carriage which motorized by non-rechargeable primary cells. In 1900 approximately 4,192 vehicles produced in the United States of America. In which more than a quarter are powered by electricity. Later that Thomas Edison in 1901 patents rechargeable batteries which were made from nickel-zinc and nickel-iron. But most of the electric vehicles are vanish from U.S. roads and replaced by 10 million of cheap internal combustion engines operated vehicles.
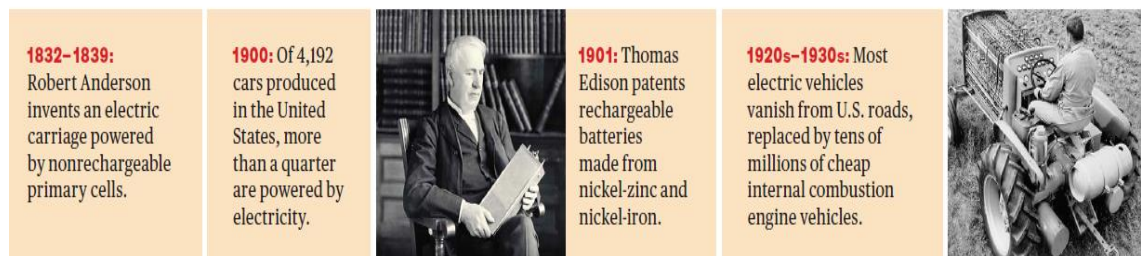
Figure 2.1. History of EVs(a)[9]

In 1959 successfully tests a fuel-cell electric tractor used for gardens was the first vehicle of any kind to employ such a power source by Allis-Chalmers. General Motors first time tested their electrovair which was a battery-electric concept vehicle. Later General Motors tested electrovan fuel-cell concept vehicle. In 1966 Britain's electricity council deployed the Enfield 8000, which was an experimental battery-electric vehicle equipped with lead-acid batteries.

Figure 2.2. History of EVs(b) [9]

In 1979 first time John B.Goodenough and his team invented lithium cobalt oxide cathode cell at the University of Oxford. That was the first step innovation of lithium cells of batteries. After that major development, Stanford R.Ovshinsky developed a nickel-metal hydride (NiMH) battery in 1982 and he was also the founder of the ovonic battery corporation.

Figure 2.3. History of EVs(c)

In 1990 General motors unveils the impact of an all-electric concept car. Zero-emission vehicle (ZEV) implemented in California. Mercedes enter in that electric vehicle race in 1994 when Daimler-Benz introduced their hydrogen fuel-cell electric concept vehicle named NECAR 1. General motors take another step to support the Zero Emission Vehicle (ZEV) by introduced all-electric EV-1 for lease in California and Arizona in 1996.
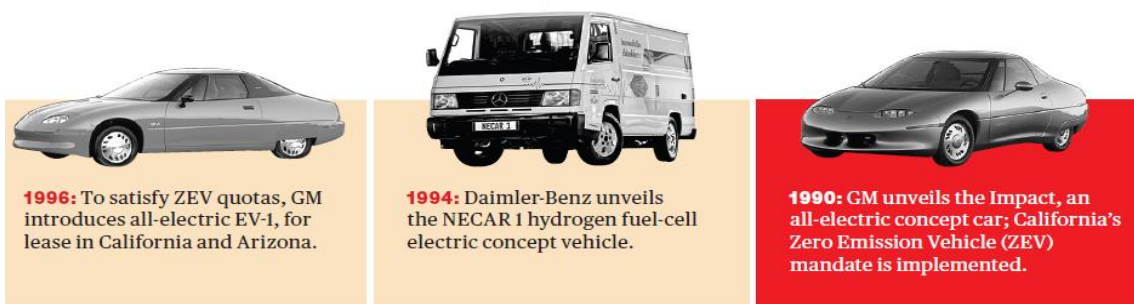
Figure 2.4. History of EVs(d) [9]

Toyota finds a gap in electric vehicle technology and 1997 Toyota Prius was introduced by Toyota Japan. Prius was the first hybrid electric vehicle that uses a NiMH battery and gasoline engine. In 2000s General motors was taken the unaccepted step and

start recalling their EV-1s and destroy approximately all of them. 2003 was the year of fully electric vehicles when Silicon Valley engineers Martin Eberhard and Marc Tarpenning built up Tesla Engines to fabricate very good quality battery electric vehicles. After one year in 2004, Elon Musk invested and becomes chairman of Tesla Motors. Tesla unveils its Roadster with a base price of US $98,000. Roadster armed with a battery pack using repurposed lithium cobalt oxide cells.
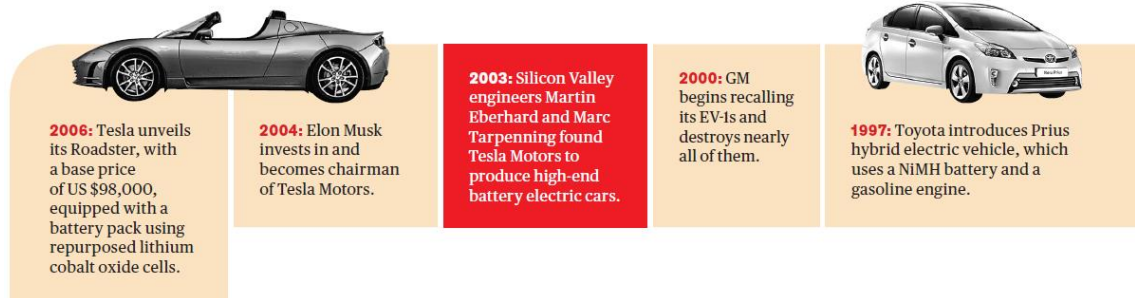
Figure 2.5. History of EVs(e) [9]

BYD Auto Co. China introduced F3DM the world's first marketable plugin hybrid. In 2009 Nissan motors japan unveils all-electric leaf which equipped with a lithium manganese oxide battery pack. Nissan Leaf captured the market of European countries and become the most popular electric car in Europe. Chevrolet introduced the Volt plugin hybrid which equipped with a lithium manganese oxide battery pack from LG Chem in 2010. Parallelly Tesla upgraded its electric car technology and start selling Model S. This is a full-size luxury Electric vehicle with a battery pack using lithium nickel cobalt aluminum cells produced by Panasonic.

Figure 2.6. History of EVs(f) [9]

Tesla take a step to produce its electric car battery packs in 2014. They select a site near Reno, Nev., for Gigafactory 1 where it will produce lithium-ion battery packs with the collaboration of Panasonic. In 2015 Tesla introduced and start selling the world's first electric SUV named Model X crossover. In the first quarter of 2015 major automobile manufacturers purchase $51 million in zero-emission vehicles (ZEV) credits from Tesla. In March 2016 Tesla planned to unveil Model 3 electric car. Later they unveiled model 3 electric car.
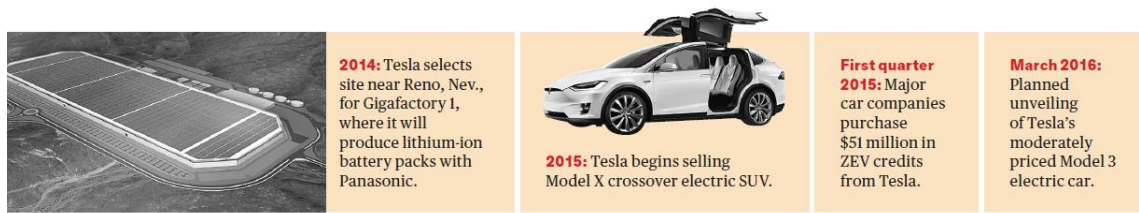
Figure 2.7. History of EVs(g) [9]

From 2005 to 2016 many other automobile manufacturers are developed and enter in electric vehicles market but they are less popular then Nissan, Chevrolet, and Tesla. Recently in 2019, Tesla launched an electric SUV named cyber truck.

2.2. Attributes

Vehicles customers are ready to purchase electric vehicles by these characteristics: Driving range per charge, charging time required for a full charge, extra fuel cost saving, air and noise pollution reduction, and performance of electric vehicles competitivity gasoline vehicles. Driving extent, fuel cost investment funds, and charging time drove in importance to defendants. Individuals were eager to pay from $35 to $75 for a mile of included driving extent, with gradual willingness to pay per mile diminishing at higher distances. In the United States peoples are ready to pay from $425 to $3250 every hour decreases in time of charging (50-mile charge). customers promoted around five years of petrol price saving into the worth tag of Electric vehicles. They reproduced model completed a scope of Electric vehicle setups and find out individuals with the maximum values for Electric vehicles were ready to compensation a first-class over there willing to compensate for the conventional vehicle that available from $6000 to $16,000 for Electric vehicles with the maximum alluring traits. In the meantime, their outcomes recommend that decreasing battery costs altogether before Electric vehicles will discover a mass marketplace without appropriation.[1], [10]

Ordinary gasoline vehicle is considered still to be significantly progressively agreeable and gets a high trustfulness interestingly with Electric vehicles. Also, client assorted variety as far as age and gender orientation was found to fundamentally the evident points of interest and observations[1]. Female drivers yet besides matured people demonstrate a more elevated amount of acceptance, which may be because of their sophisticated realization about the ecosystem as divergent of male drivers and more youthful members. Remarkably, the level of field information self-reported

(fundamentally advanced in males) did not demonstrate an expansive effect on the dimension of acknowledgment.[1], [3].

Automobile manufacturers start production of hybrid electric vehicles for the fuel cost saving and greenhouse effect control. Hybrid electric vehicles work on batteries for an initial 35 km/h speed then after that automatically convert on fuel power engine. When hybrid vehicles run on the engine the invertor also charge the batteries. By this technology, vehicle users save fuel costs and take the maximum driving range. Also, the usage of hybrid vehicles contributes to saving the environment. The electric vehicle is work electricity power and batteries. These batteries charge by external charging stations and provide a different driving range which varies from model to model and manufactures to manufactures.[11]

But electric vehicles still facing many issues related to the attributes. Due to new immerging technology electric vehicles provide a limited driving range, high purchasing cost, and limited overall performance efficiency. But there are some positive benefits of electric vehicles. Fuel cost saving and pollution control are the considerable advantages of electric vehicles.[12]

2.3. Key Concepts

Electric vehicles (EVs) demonstrate possibilities to decrease ozone-depleting substance (GHG) outflows, increment eco-friendliness and offer driving extents that are not restricted by batteries limit. In any case, these preferences won't be acknowledged whether customers don't utilize this innovation [1], [3]. A couple of specialist-based models have been made to show the potential market passage of electric vehicles (EVs), yet holes in the available data limit the estimation of these models. To address this, a few scientists dealt with an investigation to 1000 communicated united states occupants, using Amazon Mechanical Turk, to all the more probable appreciate factors affecting the potential for electric vehicles (EVs) Markets entrance. Customers who felt most emphatically about decreasing United States transportation vitality utilization and cutting ozone-depleting substance outflows had separately and on numerous occasions progressively conspicuous odds of saying they would consider buying a conservative Electric vehicle (EVs) than the people who felt least solidly about these issues. Nonetheless, even the most arranged to consider a limited PHEV were not usually prepared to pay more than a few thousand united state dollars extra at the label cost[1].

In earlier research, they found that economic and battery-related worries continue main hindrances to extensive Electric vehicles marketplace saturation. They talk about in what way their outcomes assist to educate operators about basic models of Electric vehicle marketplace entrance, Governmental strategies, manufactures values, and advertising methodologies to advance customer appropriation of EVs.[5]

Many countries made polices to shift the technology and considering the up-gradation and innovation of technologies. Policymakers also made many beneficial improvements to encouraging vehicle buyers to adopt new technology of electric vehicles in place of conventional gasoline vehicles. The key concept to reduce oil dependency and protect the environment by harmful gases.[13]

The quantity of Electric vehicles (EVs) being used is as yet immaterial. One explanation behind the humble appropriation facts that mass acknowledgment of Electric vehicles to a huge degree was dependent on buyers' impression of Electric vehicles. Researchers show an exhaustive outline of the drivers for and hindrances against purchaser appropriation of module EVs, just as a review of the hypothetical points of view that have been used for understanding customer expectations and selection conduct towards EVs. What's more, recognize holes and constraints in the existing examination and propose regions in which future research would most likely contribute.[7]

An Electric vehicle (EV) model records for spatial and social impacts (counting edge impacts, homophily, and congruity) and media impacts. Considered understanding of the model for gas costs, to precision in the assessment of petrol prices, to operator readiness to embrace EV technology, to EV price label or refunds, to EV battery variety, and experimental qualities identified with gas utilization. The reproductions demonstrate that EV market infiltration could be upgraded altogether by customers with prepared evaluations of predictable lifetime fuel prices related through various automobiles (e.g., on vehicle labels) and that increments of gas costs can nonlinearly amplify the effect on armada effectiveness. Additionally, surmise that a possible collaboration from gas charges continues utilized to finance examination into longer-distance travel with less price EV battery system.[5], [14]

Natural contamination and the extreme utilization of petroleum derivatives, the number of Electric vehicles (EVs) out and about is still low. For what reason is this so? For what reason is the mass reception of EVs so hard to figure it out? One essential reason is that the selection of EVs is, to a huge degree, subject to the acknowledgment of private purchasers, and their eagerness to receive this method of transport is inadequate. [1], [15]

2.4. Social Effects

Adoption of Electric vehicles (EVs) might enhance to controlling the problems, for example, environmental pollution, global warming, and oil reliance[1]. Nonetheless, the current marketplace of Electric vehicles is generally low-slung[3]. A complete audit of focusses on consumer feelings for Electric vehicles, meaning to all the more possible brighten arrangement creators and offer direction to furthermore research. To begin with, look at the financial and psychological approach towards this. An order of amazing components for consumer's tendencies into get-togethers, for instance, money related variables, mental elements, compactness condition, social effect, etc are then made and their possessions are clarified. Finally, an assessment motivation to improve EV customer tendency investigations and give recommendations for further research.[1], [4]

Electric vehicles (EVs) could decrease CO_2 discharges from the vehicle part yet their restricted electric driving range reduces their utility to users. The impact of the constrained driving range can be decreased in multi-vehicle family units where users could pick between an EV and a conventional vehicle for long-distance travel. Nonetheless, to what degree the driving examples of various vehicles in a multi-vehicle family unit's suit the attributes of an EV needs further research.[16], [17]

The part of public character factors for forecasting ecological choices may regularly be under distinguished by mental untrained persons. By applying this to the adoption of Electric vehicles in Germany examined community standards and aggregate adequacy foresee Electric vehicle's acknowledgment and mentally untrained individuals. Moreover, Electric vehicle specialists or non-specialists of Electric vehicles forecast reason for Electric vehicle acknowledgment. An overview ponders, Researcher at that point tried whether or not prices associated preferences or impediments remained prescient of Electric vehicle's acknowledgment and whether or not standards besides aggregate adequacy autonomous impacts notwithstanding while monitoring price associated components besides statistic factors. Consequences recommend equally Electric vehicles specialists and non-specialists measured price associated issues substantially much critical as community character forms[16]. In any case, various leveled relapse examinations of the overview information demonstrated that standards and aggregate viability have equivalent or considerably more grounded consequences for acknowledgment than cost-related variables.[18]

Pakistani north belt blessed with three largest glaciers of the world. Which spread over 15,000 km^2. These large glaciers are the main and important source of water for

rivers. This water use in many sectors like agricultural, Hydro energy production, and water load balancing. Glaciers are stabilizing the global climate alteration. Due to global warming and other anthropogenic activates these glaciers are rapidly melting. By a statement of Intergovernmental Panel on Climate Change (IPCC) approximately half of the mass of the total glacier could disappear by 2100. By project of China-Pakistan Economic Corridor (CPEC), approximately 7000 trucks could travel and pass through northern roads per day. By these trucks emission up to 36.5 million-ton CO_2 produced. That amount of CO_2 directly impacts on glaciers. Which cause of extreme flooding in rivers. These floods mainly damage the agricultural sector and the hydro energy system. This pattern changes not only local biodiversity but also heavily effect on marine biodiversity in the coastal areas of Pakistan. On one side CPEC is supporting the leg of the economy of Pakistan but on the other hand, it will be a tsunami of glaciers, natural environment change, and biodiversity of the Northern area of Pakistan. So, by this issue, both countries need to take a deeper look and urgent base solution to handle this natural biodiversity and environmental change. To reduce the emission of CO_2 both countries need to monitor, plan, and managing this environmental risk. The use of electric vehicle technology instead of gasoline vehicles can help to reduce environmental change.[19]

Mostly Arabs countries are producers and exporter of oils. Fuel available at very low prices in those Arab countries. Arab states like Kingdom Saudi Arabia, United Arab Emirate, Iraq, etc. and main other gulf countries which hold world oil markets. Due to the usage of fuel products especially in the transport sector greenhouse gases are a major threat to the Arab belt. Arab country's governments are focusing on electric vehicle introduction to replace their fuel breathing vehicles. Electric vehicles are mainly known as zero-emission vehicles. Because of some strategies, it will be conceivable to recognize factors affecting the acknowledgment of EVs and to layout changes, for instance in dispositions or conduct, of members amid their investment in test preliminaries. Results from the examination time frame demonstrate that an incredible piece of everyday portability needs are fulfilled even though the scope of EVs is constrained. Frames of mind towards EVs are dominatingly positive. Of course, biological angles, for example, CO^2 emanations assume a critical job in the assessment of EVs.[20], [21], [22]

Confronting the developing CO^2-emission, elective methods for transportation, for example, electric vehicles (EVs) emerge. The point of an investigation is to analyze the consumer acknowledgment and the effect of EVs on the client's day by day portability conduct utilizing mentally established techniques. For this reason, a substantial scale field

thinks about two times of half year of EV use is balanced in the metropolitan territory of Berlin[18]. A technique connected multiple times amid every use period incorporates into profundity interviews, polls, travel, and charging journals just as a conjoint examination.[8]

Worries about environmental transformation, municipal atmosphere contamination besides reliance by precarious and costly materials are remote lubricant have driven strategy producers and analysts to research options in contrast to regular oil-fuelled inward ignition motor vehicles in transportation. Since vehicles that get a few or the majority of their capacity from an Electric vehicle can have short or even nil emanations of ozone-depleting substances (GHG) and municipal atmosphere poisons, and devour practically no oil, here is extensive enthusiasm for creating and assessing propelled Electric vehicles (EVs), as well as unadulterated batteries, operated electric vehicles, module Hybrid Electric vehicles and hydrogen energy component Electric vehicles[18]. By support analysts also arrangement producers evaluate the capability of Electric vehicles to relieve environmental transformation also decrease oil usage, Related study examine the technology of Electric vehicles, The framework required for improvement, effects on discharges of greenhouse gases, oil usage, resources usage, lifetime charges, purchaser acknowledgment, and approach contemplations.[23], [24]

Asian countries also affected by pollution. India, Pakistan, Bangladesh are directly threatened by global warming. Due to the large scale of industrialization, increment in population directly affects traffic increasement. Hydrocarbon fuel operated vehicles exhaust the harmful gases into the air which damages the environment.[25]

2.5. Market of Electric Vehicles (EVs)

The mass entrance of Electric vehicles into the market will have various effects and advantages, including the capacity to considerably diminish ozone harming substance outflows from the transportation part[3] [10]. Subsequently, it is normal that in the coming years this technology will logically infiltrate the market. Examining some results produced by observational discoveries that better advise electric vehicle technology and strategy improvement. Some researches consider inclinations of potential customers and examine how people with building and innovation foundation contrast in electric vehicle appropriation contemplations contrasted with the all-inclusive community.[20]

Electric vehicles (EVs) are hybrid electric vehicle (HEV) which have internal combustion engine for the drive on upper gears and charge the batteries of Hybrid vehicles. Plugin Electric vehicles are fully batteries operated Electric vehicles. But plugin electric vehicles face many problems in the market. Costumers demand easy and less in price charging points in the market and for household use. Peoples have knowledge about the electric vehicle benefits in terms of climate change and fuel consumption but limited range and governments not clear incentive policies on electric vehicles purchase are also discourage customers to buy electric vehicles.[26]

Electric vehicles are as a rule seriously talked about as a conceivable maintainable and vitality proficient methods for transport. All through Europe, expansive projects have been propelled help to Electric vehicle look into, related preliminaries and marketplace dispersion[18]. In any case, for fruitful dissemination of Electric cars, their acknowledgment for buyers will urgent. Consequently, that problem has not broken down adequately including genuine clients of late Electric automobile models. What did Electric vehicle customers aiming to utilize Electric vehicles sooner rather than later truly might be suspected about Electric vehicles? How did recognitions change on the off chance that they utilize an electric vehicle in regular daily existence? The examinations and the correlation between the two pieces of research demonstrate that increasing genuine involvement with electric vehicles impacts a few indicators of the acknowledgment of electric vehicles as per the dissemination of development display by Rogers (2003). This shows the importance of the perceivability and perceptibility of electric vehicles. For instance, giving test drive openings permits shoppers to encounter electric vehicles themselves and might assist with expanding customer acknowledgment.[27], [28]

In the table, some electric vehicle models which are available in the market with specifications are mentioned.

Table 2.1. Models of EVs Available in Market

Electric Vehicles	Driving Range (km)	Approximately Amount	DC fast charging
Tesla Model SP85	420	18 million	Tesla
Tesla Roadster	390	15 million	Tesla
Mercedes B-Class Electric	140	6 million	J1772 CCS
Chevrolet Spark EV	135	3 million	J1772 CCS
BMW i3	130	6.5 million	J1772 CCS
Ford Focus Electric	120	5.5 million	No
Nissan Leaf	135	3.3 million	CHAdeMO
Smart Electric Drive	110	2 million	No
Toyota RAV4 EV	165	7.5 million	No
Honda Fit EV	130	5.6 million	No
Mitsubishi MiEV	100	3.5 million	CHAdeMO

As representative implications are appeared to be imperative to crossover electric vehicle buy and use, understanding the implications, just as their development and correspondence, is fundamental for strategy producers and others wanting to advance these new kinds of vehicles. Hybrid and electric vehicles typify mixes of implications that were beforehand inaccessible from vehicles. Market eyewitnesses who neglect to perceive this battle to clarify why a few people purchase crossover electric vehicles. They may portray purchasers as naive about figuring compensation on mileage or reject proprietors as picture looking for naturalists. The examination gives a false representation of

such oversimplified clarifications. Through the telling and investigation of purchasers' accounts, this adopts a vigorous strategy to understanding the creation and spread of new emblematic implications in the car advertise. Information was gathered in ethnographic meetings with mixture electric vehicle proprietors in California and investigated utilizing strategies dependent on semiotic hypothesis. Specifically, the examination investigates

how generally perceived social implications (indications) are associated with progressively close to home implications (undertones) and the impact that the two kinds of implications have on a vehicle buying and use.[29], [30]

Electric cars express about advancement with the opportunity to take dejected Ozone-depleting element outflows and support relieve the explanations of ecological transformation. Nonetheless, areas, as well as the appropriable of statistics and pollution reduction, result in societal/financial compensations that not fused in Electric car prices [18], [31]. To discourse approaching from marketplace dissatisfactions, governments used different approaches. Given existing writing, distinguished an insufficient additional economic variable that relied upon to powerful in determining Electric car response charges. Operating various straight deterioration inspection, the study analyzed linking among those features and 30 general Electric vehicle fragments of total manufacturing for the year 2012. The typical found financial motivations, indicting foundation, and region closeness of formation agencies to be serious and emphatically related to the nation's Electric cars section of the overall industry. In any case, enlightening investigation endorses that neither monetary encouraging services nor indicting basis agreement high Electric cars reception charges.[31]

The market for module electric vehicles (EVs) displays circuitous system impacts because of the relationship between EV reception and charging station venture. Through an adapted model, we show that aberrant system impacts on the two sides of the market lead to input circles that could adjust the dispersion procedure of the new technology. An arrangement of equivalent estimated spending however sponsoring charging station organization could have been more than twice as viable in advancing EV appropriation.[32]

The market potential for Electric vehicles in Flanders, Belgium. Utilizing a vast scale study led and applied a decision founded conjoint test, it anticipated that by 2020, Electric cars might have a piece of pie about 5 percent of innovative cars, and module hybrid Electric cars might have an offer of about 7 percent. Through 2030, these statistics might increment 15 percent to 29 percent. The speed of uptake of electric vehicles, in any case, is delicate to buy costs.[33]

Electric vehicles (EVs) are hybrid electric vehicle (HEV) which have internal combustion engine for the drive on upper gears and charge the batteries of hybrid Electric vehicles. Plugin Electric vehicles are completely Electric vehicles. But plugin electric vehicles face many problems in the market. Costumers demand easy and less in price

charging points in the market and for household use. Peoples have knowledge about the electric vehicle benefits in terms of climate change and fuel consumption but limited range and governments not clear incentive policies on electric vehicles purchase are also discourage customers to buy electric vehicles.[10]

2.6. Scope of Electric Vehicles

Like other developing countries Pakistan also facing many issues which are economic, energy, and environmental. To overcome these issues the government needs to build strong policies that are used to spread awareness of sustainable energy resources. The fuel crisis is covering the world rapidly. The fluctuation of fuel prices and unavailability of fuels (Petrol and LNG) many countries and automobile manufacturers are introducing different models of electric vehicles. By electric vehicles, natural fuels are replaced by electricity to charge directly the batteries of the vehicles. Core modification among Electric cars and conventional cars is an internal combustion engine replaced with electric motors to rotates the wheels. Electric vehicles need electricity to charge their batteries. If solar energy use to charge the batteries it's very much considerable and affordable for the daily users. Renewable energy sources are solution of energy, economic, environmental, and transport crisis. To reduce the use of oil developing countries like Pakistan need to shift their energy sector of solar, wind, and hydropower for power production. Same as that electric vehicles can solve the problem of the transport sector and control environmental pollution.[34], [35]

While inquire about has appeared restricted range electric vehicles (EVs) fulfill the range needs of a sizeable offer of the driving populace, vehicle purchasers appear to incline toward vehicles with a highly accessible range. The goal of the present researches was to propel comprehension of the variables that impact the range inclinations of potential EV consumers who had the chance to test an EV. Range inclinations of those consumers were observed to be generously more than their normal choice requirements. Relapse examinations showed higher and normal choice requirements, the higher scope of car owner's well-known conventional vehicle (CV), more noteworthy knowledgeable choice tension stayed identified with higher choice inclinations. At last, markers of normal range needs were all the more emphatically connected with range inclinations as EV experience expanded. Along these lines, just consumers with EV experience appear to depend on precise evaluations of their range needs while building their range

inclinations. Suggestions for systems went for improving consumer's evaluation of restricted range portability and deciding ideal EV go are talked about.[36], [30]

As electric vehicles (EVs) become even more promptly accessible, deals will rely upon buyers' advantage and comprehension. A review of customer frames of mind on electric vehicles was led in Manitoba from 2011 to 2012. It uses two value evaluation techniques. The van Westendorp value affectability technique (PSM) demonstrates the satisfactory value go for Electric vehicles to be 22 thousand dollars to 27 thousand dollars. This variety intently synchronizes standard worth run for proposals of customary automobiles within parallel retro. Excitement to play strategy discovers customers stand reluctant to compensation vast payments for Electric cars. When specified information on upcoming oil reserves. A customer group with participation or introduction to Electric cars is to some degree strange. About 25 percent of these persons agree to compensation top of equal to 10 thousand dollars. Distinctive translations can be drawn from these reactions, calling for further research. A clear arrangement open door includes customer training to upgrade learning and encourage EV buy choices. Study results likewise reinforce the assumption that Electric cars roll out has focussed a lot on modernization and unsatisfactory on buyers.[37]

Another investigation figures out the market capability of electric vehicles by taking a gander at 14 classifications of vehicles. It measures the people's requirements in contradiction of community leanings and a determination technique operated to break down requirements and hindrances to certification public supposed probable Electric vehicle customers designate documented.[28]

The scope of electric vehicles (EVs) has for some time been viewed as a noteworthy obstruction in acknowledgment of electric portability. The idea of how to go is knowledgeable about an EV and whether factors from other adjustment settings, quite stress, have illustrative power for between individual contrasts in what we term agreeable range. Customers assessed extend as an asset to which they could effectively adjust and that fulfilled the majority of their day by day portability needs. In any case, markers were discovered that recommended problematic range use. Stress-buffering identity attributes (control convictions, uncertainty resistance) and adapting aptitudes (emotional range fitness, every day run practice) were found to assume a considerable job in agreeable range. Thus, it might be conceivable to beaten seen extend obstructions with the help of mental intercessions, for example, data, preparing, and interface structure. Giving drivers

a dependable usable range might compare to upgrading maximal range in an electric portability framework.[38], [17]

Utilizing a review to think about buyers' expressed enthusiasm for regular fuel (CV), hybrid Electric vehicles (HEV), plugin hybrid electric vehicle (PHEV), and unadulterated Electric vehicles (EV) of shifting plans also costs. A piece of information stands from 508 families speaking to new vehicle purchasers in San Diego County, California in 2011. Over the higher and lower value situations, a dominant part of customers planned and choose some type of PHEV for their next new vehicle, littler numbers structured an HEV or a traditional vehicle, and just a couple of percent structured an EV. Of the individuals who did not structure an EV, the most successive worries with EVs were constrained range, charger accessibility, and higher vehicle buy costs. Positive enthusiasm for HEVs, PHEVs, and EVs was related to vehicle pictures of insight, obligation, and backing of the earth and country (United States). The appropriation of vehicle plans recommends that less expensive, littler battery PHEVs may accomplish more transient market accomplishment than bigger battery PHEVs or EVs. New vehicle purchasers' present advantages line up with more affordable initial phases in a change to electric-drive vehicles.[39]

Electric vehicles are facing many challenges like batteries cost which is approximately one-third of the electric vehicle's actual price. Due to totally new technology adoption which is a new energy source, energy storage batteries, and energy converter used in electric vehicles facing barriers from serviceability problems. There is a lot of benefits and drawbacks of electric vehicles which encourage and discourage the customers to purchase electric vehicles.[40]

Chapter 3

Proposed Work/Methodology/Model

3.1. Research Design

In this Engineering Management research, aim to analyze the relationship of Electric Vehicle attributes with the acceptance level of electric vehicles (EVs) Pakistan. The research was exploratory in nature, and a quantitative research technique was used. A questionnaire examination technique was used to collect information. Different variables proposed were adopted in this study. It is one of the most commonly used methods for collecting data by using standardized measurement tools. Besides, for cluster making and latent class model XLSTAT software is used. Graphs and tables arrange by excel and word. The questionnaire was provided by hand to the targeted population. The questionnaire was also provided through the internet. Google form was used for collecting data from the internet method.

3.2. Sample Size

The data collected from the selected population along the line of age, education, and buying capability. I considered 205 responses from the population. Respondents were only taken from Pakistan provinces like Punjab, Sindh, KPK, Balochistan.

3.3. Sampling Technique

Cluster sampling methods were used in this study. In cluster sampling population to be separated into smaller groups called 'strata'. Respondents selected randomly from major cities of Pakistan. Also, the latent class model used for the choice of respondents between electric vehicle models and a gasoline/ hybrid vehicle. Descriptive and frequencies were used for charts buildings

3.4. Targeted Population

The targeted population for this study consists of vehicle buyers having minimum education of bachelor's and having a driving license. Those who are driving vehicles for

their daily use and well understand the vehicle attribute. A minimum of 20 years of age was in the targeted population.

3.5. Data Collection

The data was composed of questionnaires from the sample population for this study. Respondents were vehicle buyers having minimum education of bachelor's and having a driving license. The questionnaire has four parts:

1. The first part consists of demographic questions about age, income, education.
2. Second is consists background of vehicle ownership.
3. The third part is the description of conventional and EVs followed by two choices.
4. Forth part is the attributes, advantages, Disadvantages, and information about electric vehicles.

The study incorporates a short cheap talk content, planned to encourage sensible reactions. A large portion of the properties are clear as crystal and catch what probable would stuff to vehicle purchasers contrasting Electric vehicles and Gasoline vehicles – driving extent, charging time, fuel-saving, decrease pollution, performance, and value distinction. Price was characterized as the sum of respondent compensation over the rate of the respondent's chosen Gasoline vehicles. Decrease Pollution was incorporated as a marker of craving to purchase more ecologically valuable things. At long last, acceleration has incorporated an intermediary for act contrasts among EVs and GVs.

The questionnaire was provided by hand to the target population. The questionnaire will also be distributed through the internet to the targeted population. Google Forms will also be used for data collection.

The first portion of the survey includes demographic questions. It includes gender, education, living area, driving license, concerned about pollution. Also includes some interests in vehicles fixing, like new products that enter the market and thinking about the kind of car a person owns says about the person.

The second part of the survey questionnaire covered the respondent's current driving habits, ownership of the vehicles, and facts of the maximum buying the next vehicle. This portion includes the number of vehicles already in use, size of the vehicle, average travel per year, and next purchase. The third part of the survey questionnaire includes a description of conventional vehicles and Electric vehicles by two choices. In conjoint format, respondents asked for choices between GVs and EVs. Farther in these

two choices peoples are questioned to consider 3 cars: 2 electric vehicles and 1 gasoline vehicles in response they provide in previous questions on the next purchase type of vehicle. Preferred gasoline and the money the peoples spend was stated in the overture to the questions. This inquiry of choices is the following.

Vehicle Attributes	Electric Vehicle 1	Electric Vehicle 2	
Driving Range on Full Battery	150 kms	200 kms	You Preferred Hybrid/ Gasoline Vehicle?
Time it Takes to Charge Battery for 50 kms of Driving Range	5 hours	10 hours	
Fuel Cost	Like PKR 60/Liter Gas	Like PKR 120/Liter Gas	
Acceleration Compared to Your Preferred Hybrid Gasoline	5% faster	5% slower	
Pollution Compared to Your Preferred Hybrid Gasoline	75% lower	25% lower	
Price Compared to Your Preferred Hybrid Gasoline	PKR 5,00,000 higher	PKR 10,00,000 higher	

13. **I would most likely purchase......**
   a) The Electric Vehicle 1
   b) The Electric Vehicle 2
   c) My Preference Hybrid/Gasoline Vehicle
   d) My Preference Hybrid/Gasoline Vehicle - Although I like the idea of electric vehicles and some of the features here are OK, I could/would not buy these electric vehicles at these prices.

Figure 3.1. Choice Question of EVs and Hybrid/Gasoline Vehicles

The last part includes the benefits of Electric vehicles as related to the gasoline cars in contents of pollutions, fuel cost, trips to gas stations, interest in new technology, and lower dependence on foreign oil. Also disadvantages of the electric vehicle versus gasoline vehicles as buyer potential like higher purchase price, lower driving range per fill-up, longer fill-up time to charge batteries, unfamiliar technology. This also allows us in opinion to control other structures of vehicles like interior, exterior, size, look, safety, reliability, and so into view. Most characteristics are understandable and what probable

would matter to car consumers in associating electric vehicles and gasoline vehicles-driving range, pollution reduction, fuel-saving, charging time, price difference, and overall performance.

Information about electric vehicles is also included in that part of the questionnaire. Which are evaluate the vehicle buyers in the context of having and knowledge about electric vehicles, easy to understand the features of the electric vehicle, understanding about electric vehicles advantages and Disadvantages, how much electric vehicles seem too realistic to the respondents, and how much respondents consider an electric vehicle for their next purchase.

3.6. Data Analysis

At this stage, the composed statistics examined by software. Statistical Package for Social Sciences (SPSS) software was used for descriptive and frequency tables generation. The reliability of the outputs was also checked by SPSS. Cron-batch Alpha, two-step clustering also done by SPSS. Graphs and other related tables were made by Microsoft offices (word and excel). These graphs are Age, Education, Selection of vehicles, and type of vehicles. Other descriptive and frequency tables of independent variables like Attributes (Driving Range, Fuel Cost, Pollution, Performance, and Price compare to the Hybrid/Gasoline vehicles), Advantages, Disadvantages, and Information about electric vehicles are calculated by SPSS.

3.6.1. Descriptive

In descriptive tables variables, counts were shown. The total number of responses was in descriptive statistics. By the selection during the generation of descriptive statistics of different variables minimum, maximum, and mean of the responses was also calculated in the tables. The standard deviation of the total responses of selected variables was also mentioned in the descriptive statistics.

3.6.2. Frequencies

In frequencies tables, respondents were separated into the groups. And calculated the percentages between those groups. Like age group in which 20 to 30 years of ages were included are set into one group and others are set into other groups respectively. Valid percentages and cumulative percentages columns were also mentioned in variables

frequencies tables. By generating frequency tables of required variables its make it easy to build to generate different types of graphs and charts.

3.6.3. Graphs and Charts

Data collected from frequencies tables of different required variables and converted into charts and graphs. In this research data like Age clusters, education level, selection of vehicle types for their next purchase, and selection of vehicles condition for next purchase were calculated by frequency tables and put their percentages of respondents into chart or graph builder to generate charts and graphs. Mostly pie charts, histograms, bar charts, and dot graphs are used.

3.6.4. Validity

Validity states to the capacity of a research gadget to quantify what it should measure. When choosing the research design, we carefully considered the hypothetical framework to guarantee that the data got are significant to the subject of research. An issue that may have restricted the validity is the inconsistent conveyance of nationalities in our research.

3.6.5. Reliability

Reliability is related to the steadiness of results. Reliable instruments are hearty and give a similar outcome each time led. Unwavering quality frequently needs when the reviews are assumed to control after some time, are led by various methods and individuals, or are evaluated subjectively. Monitoring the way that our understanding of information may be one-sided, we talked about our information investigation altogether to fuse alternate points of view and guarantee objectivity. Moreover, by pre-testing our poll, potential blunders or mistaken assumptions were uncovered and improved to expand reliability quality.

3.6.6. Latent Class Analysis

Latent Class Analysis (LCA) is a factual system for perceiving unmeasured class participation among subjects using unmitigated just as steady watched factors. For instance, you may wish to arrange people reliant on their driving habits (perceptions) into different kinds of consumers (latent classes). This could provoke finding characterizations, for example, driving range, pollution, fuel cost, performance, and price compared to hybrid/gasoline vehicles. You could endeavor to make models to anticipate

why one falls into explicit class interests (for what reason do people become to buy electric vehicles), and you can moreover hope to examine the results of such class memberships. You can even combine such a class examination with various frameworks. LCA can be used in various controls, for instance, Prosperity Sciences, Cerebrum science, Guidance, and the Sociologies.

Chapter 4
Results and Evaluation

In this research independent variable was mentioned as a factor of acceptance of the electric vehicle. Which includes characteristics (Driving range, Charging time, Pollution, Fuel cost, Performance, and Price compared to the Hybrid/Gasoline vehicles), Advantages (Lower pollution, Lower fuelling cost compared to the gasoline vehicles, fewer trips to the gas stations, interest in new technology, and lower dependency on foreign oils), Disadvantages (Higher purchasing cost, lower driving range per fill-up, longer fill-up time required for batteries, and unfamiliar technology), and information provided about electric vehicles.

In the first part of the questionnaire (Question 1 to 4) includes demographic survey questions. These questions fulfill the research criteria of the required population. These questions are Age, Gender, Education, and Province. Age requirements were above 20 years of age. Individuals who have a driving license and having vehicles for their daily use are included in the targeted population. The minimum requirements of education level were bachelor's degrees. Those who understand the importance and also have knowledge of electric vehicle aspects. Respondents are openly encouraging from all over Pakistan. Data collected on the provincial level and from both genders (Male and Female). Questions 5 to 7 contained information about the respondent's contribution to protecting environmental pollution.

The second portion of the questionnaire contains background information on vehicle ownership. In which questions 11 to 18 are about respondents number of owned vehicles, type of vehicles they drive, selection of vehicles between conventional and hybrid, selection of vehicles for next purchase between new and second-hand vehicles, how much they spend on next vehicles purchase, how many kilometers per year they drive, petrol prices variation within five years.

In the third part of the questionnaire, dependent variables are contained questions 28 to 29. Which is selection by different attributes selection between electric vehicle 1, electric vehicle 2, preferred hybrid/gasoline vehicles, and preferred hybrid/gasoline vehicles due to the high price of electric vehicles?

The fourth portion of the questionnaire includes independent variables which are Advantages and Disadvantages from questions 19 to 27. In the advantages of lower pollution, lower fuel costs, avoid trips to gas stations, interesting new technology, and

lower dependency on foreign oil. In Disadvantages higher price as compared to the hybrid/gasoline vehicles, lower driving range per battery charge, longer charging time, and unfamiliar technology are included. Characteristics (Driving Range, Charging Time, Fuel Cost, Performance, Pollution, and Price compared to the Hybrid/Gasoline vehicles) are in question 30 to 35. Another independent variable question 36 to 40 is information about electric vehicles which includes having enough information about electric vehicles, easy to understand the electric vehicle technology, easy to understand the advantages and disadvantages of electric vehicles, how much electric vehicles seem too realistic, and how much you felt to purchase the electric vehicle for your next purchase.

4.1. Evaluation

4.1.1. Descriptive Statistics

In descriptive statistics, the age converted into small groups like 20 years to 30 years into group 1st and above 50 years into 4th groups. The same as educational level groups was 1 to 5. Which represented no high school degree, high school degree, bachelor's degree, master's degree, and doctorate respectively. All values are shown in table 4.1. In the following table numbers of responses, minimum value, maximum value, mean and standard deviation also mentioned.

Table 4.1. Descriptive Statistics (Age, Education)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Age by clusters	205	1	4	1.73	.858
Education Level	205	3	5	3.42	.551
Valid N (listwise)	205				

Descriptive statistics of independent variables attributes which are Driving Range, Charging Time, Fuel cost, Performance, Pollution, and Price compared to the Hybrid/Gasoline vehicles are mentioned in table 4.2. In table 4.2 total numbers of responses, minimum value, maximum value, mean, and standard deviation also mentioned.

Table 4.2. Descriptive Statistics Attributes (Independent variables)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Driving Range attribute mattered	205	0	2	1.77	.468
Charging Time attribute mattered	205	0	2	1.56	.527
Fuel Cost attribute mattered	205	0	2	1.62	.612
Performance attribute mattered	205	0	2	1.28	.663
Pollution attribute mattered	205	0	2	1.60	.530
Price compared to Hybrid/Gasoline attribute mattered	205	0	2	1.61	.605
Valid N (listwise)	205				

Descriptive statistics of independent variables of electric vehicle's advantages and disadvantages are shown in table 4.3. The advantages of electric vehicles include pollution, lower fuel costs, avoid trips to the gas station, interesting new technology, and lower dependence on foreign oil characteristics. In disadvantages includes the higher price of an electric vehicle compared to the hybrid/gasoline vehicles, lower driving range available on per full charge battery, longer charging time needed to charge the full battery, and unfamiliar to the electric vehicle technology. Also, the total number of responses, minimum and maximum value, mean, and standard deviation shown in table 4.3.

Table 4.3. Descriptive Statistics Advantages and Disadvantages (Independent variable)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
EV lower pollution Adventage	205	0	2	1.67	.590
EV lower fuel cost Advantage	205	0	2	1.66	.505
EV avoid trips to gas station Advantage	205	0	2	1.28	.731
EV intersting new technology Advantage	205	0	2	1.63	.618
EV lower dependance on foreign oil Advantage	205	0	2	1.45	.667
EV higher price Disadvantage	205	0	2	1.75	.499
EV lower driving range Disadvantage	205	0	2	1.47	.590
EV longer charging time Disadvantage	205	0	2	1.50	.583
EV unfimiliar Technology Disadvantage	205	0	2	1.04	.747
Valid N (listwise)	205				

In table 4.4 descriptive statistics of independent variables of electric vehicle information. This information on electric vehicles further includes information provided by the survey and already knowledge of electric vehicles of respondents. Information like knowledge of electric vehicles, electric vehicle technology understanding, advantages and disadvantages of electric vehicles understanding, electric vehicles seem realistic to respondents, and how much respondents felt to select the electric vehicle for their next purchase. Same as other descriptive statistics tables in this table number of responses, minimum and maximum values of the variables, mean, and standard deviation of information of electric vehicles also mentioned.

Table 4.4. Descriptive Statistics Information (Independent variable)

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Enough information of EV	205	0	4	2.75	.972
Easy to understand Technology	205	0	4	2.79	.946
Easy to understand Advantages and Disadvantages	205	0	4	2.92	1.018
EV seem realistic to you	205	0	4	2.52	.889
Felt to purchase EV	205	0	4	2.28	1.078
Valid N (listwise)	205				

4.1.2. Frequencies Tables and Charts

All frequencies were calculated in percentages from the total number of responses. Data collected from the Pakistani nationals and 205 responses were collected. This chapter includes frequency tables and graphs.

Age divided into small groups in which 4 groups were made. The minimum age required for the response of that survey is 20 years. Group 1 formed 20 years to 30 years of age. By which 99 persons out of 205 was lying in group 1. Which was 48.3 percent of the total data. Group 2 formed 30 years to 40 years of age. Which was 35.6 percent of the total data. 40 years to 50 years of age respondents were 22 out of 205 which is 10.5 percent of the total data. The above 50 years of age were in group 4. Which are only 5 percent of the total respondents. From this frequency calculation, young people age between 20 years to 30 years was responded this questionnaire in a large number. And middle-age persons were on the second largest number of responses.

Table 4.5. Frequency table of Age

Age by clusters

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	20-30	99	48.3	48.3	48.3
	30-40	73	35.6	35.6	83.9
	40-50	22	10.7	10.7	94.6
	above 50	11	5.4	5.4	100.0
	Total	205	100.0	100.0	

Data required for this research need a minimum education level of bachelor's degree. Most respondents were in a group of bachelor's degree criteria. 125 out of 205 respondents were holding a bachelor's degree. Which was 61 percent of the total. The Master's degree holders were 74 respondents. Which was 36.1 percent of the total targeted population. The Ph.D. degree holders are very few responses to this survey. Only 6 Ph.D.'s out of 205 targeted population was responded. Which is 2.9 percent of the total.
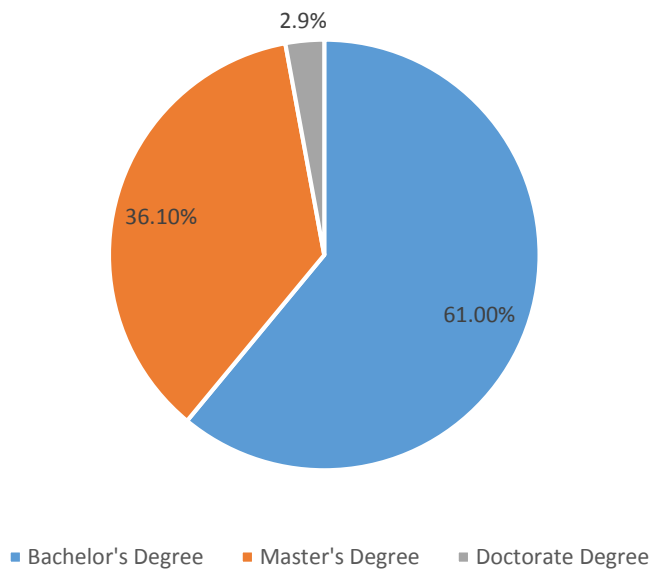
Figure 4.1. Education Frequency Chart

Question about the next purchase vehicle by condition respondents was selected new vehicles for their next purchase. There was a very large percentage difference between new and used vehicle selection. 155 Peoples from the total population was selected new vehicles for their next purchase. In percentage its 75.6 percent of the total.

Somehow 24.4 percent of responses select used vehicles for their next purchase. In number, they are 55 out of 205 responses.
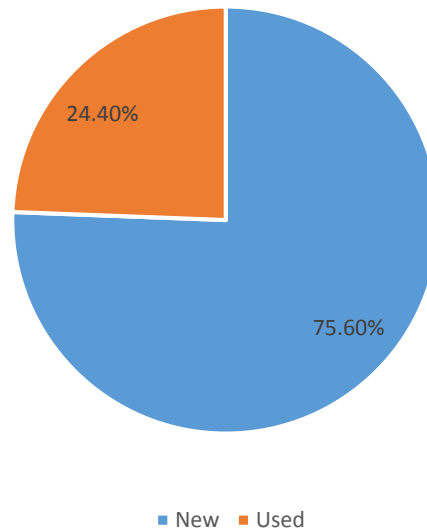
Figure 4.2. Next Purchase Chart (New or Used)

Another question related to the next purchase in which peoples giving two options which were choice between conventional or hybrid vehicles. Respondents were select hybrid vehicles for their next purchase. 61.5 percent of peoples of the targeted population selected the hybrid vehicles. Which clearly show the interest of peoples toward fuel cost saving and concern about pollution. 38.5 percent of people's choose the option of exiting conventional fuel operating vehicles. In number 126 persons out of 205 samples are choices hybrid vehicles and 79 responses were in record of conventional fuel operated vehicles. The chart is shown in figure 4.3.
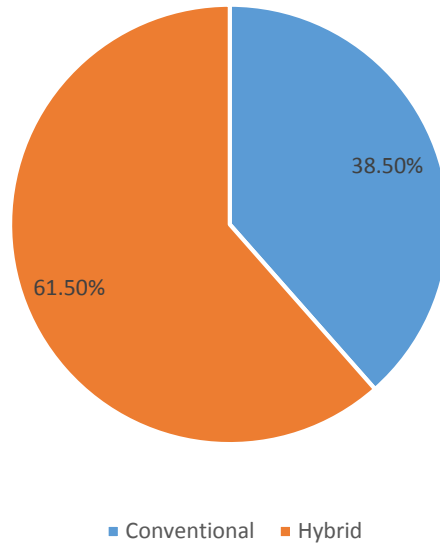
Figure 4.3. Next Purchase (Conventional or Hybrid)

4.2. Cluster Analysis

4.2.1. Two-Step Cluster

In a two-step cluster study classifying the sets of statistics by pre-clustering. By this method, we can handle the large data set. By two-step cluster analysis large data converted into an easy cluster algorithm. It converted data into small groups which used for important predictor evaluation.

All attributes created sperate clusters by calculation of "matter a lot" selection from all cases of the collected data. By the two-step cluster analysis, peoples were response price compared to the hybrid and gasoline vehicles as a very important factor to adopt or select electric vehicles for the next purchase. Cluster 4 represented the price comparison attribute. 48 responses out of 205 marked their choice as matters a lot for the price comparison attribute. Which was 23.3 percent of the total. After that cluster 5 represented the charging time required for full charging the batteries of electric vehicles. It was the second most important attribute of the selection of electric vehicles. 40 positive responses out of 205 are in the count of charging time attributes of electric vehicles. By percentage, it's 19.5 and which shows the minimum difference between price comparison and charging time requirements. By this cluster analysis, respondents are select fuel cost saving by 19 percent of the total. Fuel cost saving attribute is less important than price comparison and charging time attributes. 39 responses were selected "matters a lot" for

fuel cost-saving attributes. Pollution related attribute is less important than fuel cost saving. People's responses were calculated 14.6 percent of the total. 30 peoples out of 205 cases selected "matters a lot" option for the pollution attribute in the selection of electric vehicles. Peoples are less demanding of performance attribute to the pollution attribute of electric vehicles. 12.2 percent of the total was calculated which was 25 cases out of 205. In the last 11.2 percent cases shows the driving range important by the respondents. Only 23 cases have represented the importance of driving range attributes in the selection of electric vehicles. Shown in table 4.6.

By this analysis results peoples are more concerned about the prices of the vehicles and they also want less charging time requirements for their electric vehicles. They compared electric vehicle prices with their existing hybrid and gasoline vehicles.

In the two-step cluster analysis importance predictors also show the importance level of all attributes separately. Importance level values are 0.0 to 1.0. The attribute to which value is 1.0 is the most important attribute and its direct impact on electric vehicle acceptance. From pollution attributes to driving range attributes importance gradually decreases. The driving range is between 0.2 to 0.3 importance levels. Shown in figure 4.4.

Table 4.6. Attributes Cluster Analysis

Clusters

Input (Predictor) Importance
■ 1.0 ■ 0.8 ■ 0.6 ■ 0.4 □ 0.2 □ 0.0

Cluster	4	5	6	2	1	3
Label	Price Comparision	Charging Time	Fuel Cost	Pollution	Performance	Driving Range
Description	Price compared to the hybrid and gasoline vehicles importance 1.00 level which is first priority of the customers	charging time requried to electric vehicles is second most importent attribute with 0.71 importance level	Reduction in fuel cost imortance level 0.61 which is third most importent attribute	Pollution reduction is fourth important attribute with value of 0.54	with the value of 0.45 performance of EV is fifth place in importance chart	Least importance attribute is driving range with value of 0.25
Size	23.4% (48)	19.5% (40)	19.0% (39)	14.6% (30)	12.2% (25)	11.2% (23)
Inputs	Price compared to Hybrid/Gasoline attribute mattered Matters a Lot (100.0%)	Price compared to Hybrid/Gasoline attribute mattered Matters a Lot (95.0%)	Price compared to Hybrid/Gasoline attribute mattered Matters a Lot (100.0%)	Price compared to Hybrid/Gasoline attribute mattered Matters Some (76.7%)	Price compared to Hybrid/Gasoline attribute mattered Matters Some (88.0%)	Price compared to Hybrid/Gasoline attribute mattered Matters a Lot (60.9%)
	Charging Time attribute mattered Matters a Lot (87.5%)	Charging Time attribute mattered Matters Some (100.0%)	Charging Time attribute mattered Matters a Lot (64.1%)	Charging Time attribute mattered Matters Some (73.3%)	Charging Time attribute mattered Matters a Lot (76.0%)	Charging Time attribute mattered Matters a Lot (100.0%)
	Fuel Cost attribute mattered Matters a Lot (97.9%)	Fuel Cost attribute mattered Matters a Lot (72.5%)	Fuel Cost attribute mattered Matters a Lot (74.4%)	Fuel Cost attribute mattered Matters Some (66.7%)	Fuel Cost attribute mattered Matters a Lot (56.0%)	Fuel Cost attribute mattered Matters a Lot (56.5%)
	Pollution attribute mattered Matters a Lot (100.0%)	Pollution attribute mattered Matters a Lot (65.0%)	Pollution attribute mattered Matters Some (87.2%)	Pollution attribute mattered Matters a Lot (60.0%)	Pollution attribute mattered Matters a Lot (96.0%)	Pollution attribute mattered Matters Some (69.6%)
	Performance attribute mattered Matters Some (47.9%)	Performance attribute mattered Matters a Lot (67.5%)	Performance attribute mattered Matters Some (92.3%)	Performance attribute mattered Matters a Lot (36.7%)	Performance attribute mattered Matters Some (60.0%)	Performance attribute mattered Matters a Lot (47.8%)
	Driving Range attribute mattered Matters a Lot (68.8%)	Driving Range attribute mattered Matters a Lot (100.0%)	Driving Range attribute mattered Matters a Lot (84.6%)	Driving Range attribute mattered Matters a Lot (43.3%)	Driving Range attribute mattered Matters a Lot (76.0%)	Driving Range attribute mattered Matters a Lot (100.0%)

In two-step cluster analysis importance predictors shows the importance level of all attributes separately by the respondent's selections. Importance level values are 0.0 to 1.0 which varies from attributes to attributes. The attribute to which value was 1.0 is the most important attribute and its direct impact on electric vehicle acceptance. By the analysis, the most important attribute which was selected by the population was the prices of electric vehicles as compared to the hybrid and gasoline vehicles by the value of 1.0. charging time required to electric vehicles was the second most important attribute with a value of 0.71. The reduction in fuel cost importance level is 0.61. pollution reduction was the fourth important attribute with a value of 0.54. With an importance level of 0.45 performance attribute in fifth place. The least important attribute for peoples was the driving range with a value of 0.25. Shown in figure 4.4.

Predictor Importance
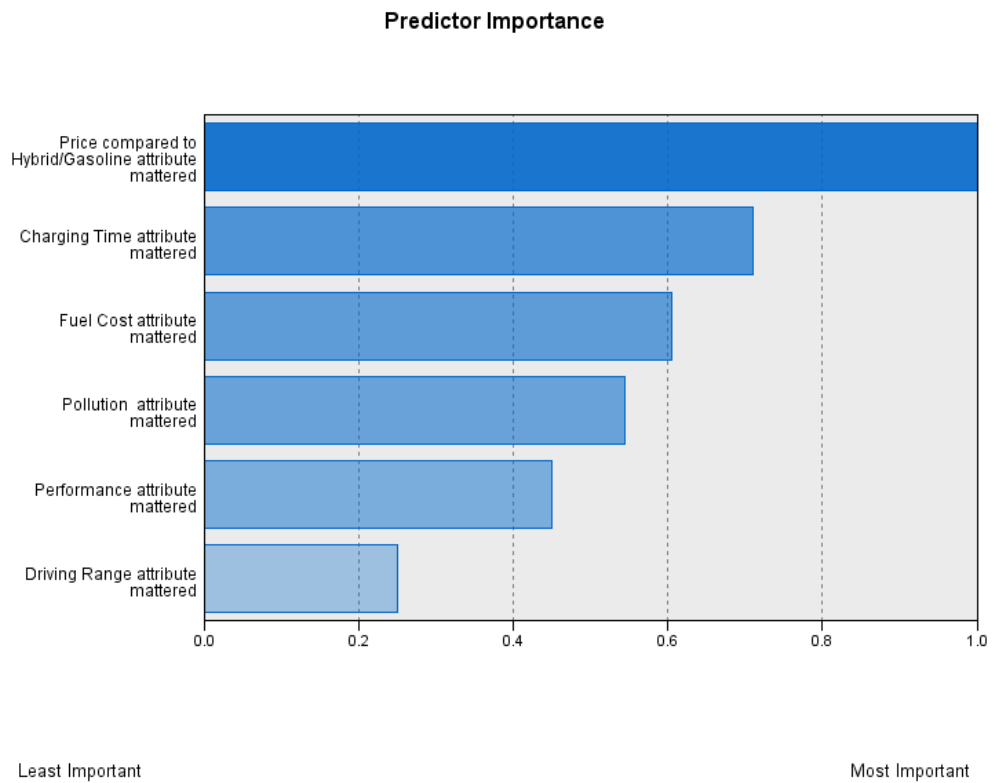
Figure 4.4. Attributes Predictor importance

4.2.2. Latent Class Cluster Analysis

By latent class cluster analysis dependent variable which choice of electric vehicles. In these choices, two electric vehicles with different attributes specifications and prices of electric vehicles and a hybrid/gasoline vehicle are mentioned. Another option which was price related in which peoples were like many features of the electric vehicle, but they didn't purchase electric vehicles at high prices. These choices made by different attributes comparison. Which was shown previously in figure 5.

Option 1 was represented by electric vehicle 1. Which was better in attributes specification and at a reasonable price. In choice 1 maximum respondents selected electric vehicle 1. Due to the low price of electric vehicles with good attributes. Very few respondents select option 4 which was price related. In which peoples like many features of electric vehicles but they did not purchase high price electric vehicles. Some peoples need high-performance vehicles, so they ignore the prices of electric vehicles and select option 2. But 15 percent of the total cases preferred their existing hybrid or conventional gasoline vehicles.

Table 4.7. Choice 1 of Electric Vehicles

Vehicles Attributes	Electric Vehicle 1	Electric Vehicle 2
Driving Range on a full battery	150 km	200 km
Charing Time Required	5 hrs	10 hrs
Fuel Cost Saving	PKR 60/ Liter	PKR 120/ Liter
Performance	5 % faster	5 % slower
Pollution Reduction	75 % lower	25 % lower
Price Compared to hybrid/gasoline vehicles	0.5 million higher	1 million higher

In choice 2 there are also 4 options like choice 1. But approximately equal responses are recorded. In choice 2 electric vehicle prices are mentioned high on the values of the same attribute. Peoples was select option 2 which represents the electric vehicle 2. Which is 31 percent of the total. But other options are also very close values of selection to option 2. Which shows peoples are demanding batter attributes electric vehicles but in reasonable prices.

Table 4.8. Choice 2 of Electric Vehicles

Vehicles Attributes	Electric Vehicle 1	Electric Vehicle 2
Driving Range on a full battery	75 km	200 km
Charing Time Required	1 hr	10 hrs
Fuel Cost Saving	PKR 120/ Liter	PKR 60/ Liter
Performance	20 % faster	5 % faster
Pollution Reduction	25 % lower	95 % lower
Price Compared to hybrid/gasoline vehicles	0.5 million higher	2.5 million higher

In both choice respondents mainly considered the price of electric vehicles. they selected electric vehicles 1 in choice 1. Because electric vehicle 1 was the high value of attributes compared to the electric vehicle 2 but 50 percent less in price. In choice 2 peoples equally responded to all options. Because of the very low attribute values of electric vehicle 1 and highly valued in some attributes electric vehicle 2 but at a very high price. The noticeable thing was peoples are spending a maximum of 2.5 million on electric vehicles.

Table 4.9. Summary statistics

Variable	Categories	Frequencies	%
Choice 1 I would most likely purchase.....			
.	1	115	56.1
	2	33	16.1
	3	31	15.1
	4	26	12.7
Choice 2 I would most likely purchase.....	1	49	23.9
	2	67	32.7
	3	45	22.0
	4	44	21.5

1. Electric Vehicle 1
2. Electric Vehicle 2
3. Preferred Hybrid/ Gasoline
4. Not Purchase electric vehicle at this price

In table 4.10 latent class cluster analysis values are shown. The number of clusters was made 2 in which calculate 13 parameters of 2 different choices. P-value was highly significant. Which is <0.0001. Bayesian Information Criterion (BIC) value was 999.379

and Akaike's Information Criterion (AIC) value was 956.501. L^2 represents the likelihood ratio chi-square value which was 51.563.

Table 4.10. Summary statistics for each model

Nbr Clusters	LL	BIC(LL)	AIC(LL)	AIC3(LL)	Number of parameters	L^2	DF	p-value	Class.Err.
2	-465.250	999.379	956.501	969.501	13	51.563	2	< 0.0001	0.085

In the latent class profile plot, two clusters are mentioned. Choice 1 dependent variable associated with cluster 1 and choice 2 dependent variable is associated with cluster 2. The X-axis represents the options of both choices which are Electric vehicle1, Electric vehicle 2, Preferred hybrid and gasoline vehicles, and like electric vehicle features but not purchase at mentioned prices. Y-axis shows the importance values of the selection. 0 to 1 importance gradually increases.
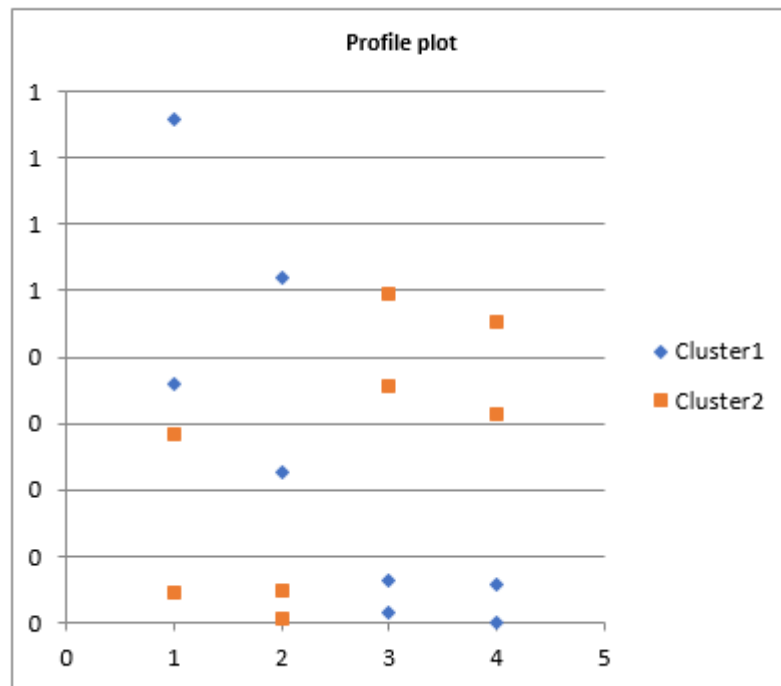

Figure 4.5. Latent Class Profile Plot

4.3. Research Gap

The automobile sector of Pakistan is far behind the rest of the world. Vehicles assemblers like Toyota, Honda, and Suzuki deliver outdated models that do not fulfill safety, fuel cost-saving, and price requirements of the individuals. Pakistan among those countries which are on the list of global warming. Vehicle emissions damaging the environment very rapidly. Electric vehicles have the opportunity to fill up this gap. And overcome many crises which are economic, energy, and environmental. The results of this research show many gaps in technological adoptions. Many developing countries including Pakistan difficult to adopt new technologies and innovations due to some reasons. The economic conditions of countries can boost up or sometimes reduce the capabilities to implementation of new technologies. Individuals of any country are keys to innovation development. But in the case of Pakistan due to less amount of resources and expensive household items can make limits around the developments.

Toyota Prius launched in 1997 and this hybrid vehicle entered Pakistan in 2010. Which is an example of the late adoption of new technology. Pakistan is approximately 10 years behind the technological development in the automobile industries. The demands of hybrid cars are increasing day by day. Some factors which are increasing the demands of hybrid is low fuel consumption provides fuel cost saving, during low-speed batteries, provides power to wheels, contribution to controlling the pollution. Fluctuation in fuel prices consumers are looking for battery operated vehicles. Electric vehicles provide some positive conditions to overcome the market of hybrid and conventional gasoline vehicles.

4.4. Findings

By generating the results and analyzing the data in the hypothesis scenario. Find a positive impression of the independent variable on dependent variables. But by demands and peoples selections, some hypothesis has different importance levels and values from others.

Attributes of electric vehicles like Driving range, Charing time required to charge the batteries, Pollution control by the electric vehicles, Performance compared to the hybrid and existing gasoline vehicles, Fuel cost-saving, and Price comparison of electric vehicles and hybrid/gasoline vehicles. By the two-step clustering analysis, peoples select different attributes by the value of importance. By which prices of electric vehicles were

the most important attribute in the factor of acceptance and driving range attribute least important factor of acceptance. Advantages are also put on the impact on acceptance level as well as disadvantages like limited driving range, longer charging time, the high price of electric vehicles discouraging peoples to acceptance of electric vehicles. Information about electric vehicles also impacts on acceptance level.

Chapter 5

Conclusion and future work

Electric vehicles are a solution to many problems which are social, economic, and pollution-related. Many countries of the world already adopted electric vehicles to replace limited the use of conventional gasoline vehicles. Peoples of Pakistan have well educated and very much concerned about these issues. Peoples have knowledge about electric vehicle benefits.

The transportation sector has been developing very rapidly and most of this division is depending on oil-based items. Pakistan spending nearly 13 billion USD per year on the import of oil. Pakistan has been declared the seventh most helpless country because of the impact of environmental change. The energy crisis concerning fuel is alarming. Alternate of fuel-burning vehicles are fully Electric vehicles. Electric vehicles are considered as environmentally friendly. Contamination in the emission of hydrocarbon operated vehicle produces harmful gases like HC, CO^2, and NO^x which damages the environment. By using the Electric Vehicles (EVs) fuel prices are cut-off. Fully Electric Vehicle provides 100 km to 200 km per charge of full batteries. By many advantages like emission avoided, fuel-saving, monetary saving, and avoid trips to fuel stations which makes electric vehicles superior. Pakistan manufacturers are still focusing on high price hydrocarbon fuel vehicles. Analyzing the acceptance level of Electric vehicles in Pakistan by different attributes like Driving range, charging time, fuel cost saving, pollution reduction, performance, and price compared to the hybrid vehicles available in the market already. Instead of hybrid vehicles how many vehicles users and buyers are ready to pay some extra money for purchasing fully electric vehicles.

By this research developing countries have to adopt those technologies which overcome their issues. Peoples are worried about environmental pollution and want to reduce the use of harmful gases. Vehicles emission is a large and common source of greenhouse gases that damaging the climate directly.

On the other hand, buyers and consumers of vehicles also want less expansive vehicles. By this research calculated the data collected through questionnaires. The most important factor that effects on acceptance level of the electric vehicle is the prices of electric vehicles compared to the exiting hybrid and fuel operating gasoline vehicles. Another aspect of electric vehicles which ignored or not an important factor for peoples of Pakistan is pollution reduction. In the choice of electric vehicles, a noticeable point is

peoples have rejected electric vehicles on high price electric vehicles. Respondents are not going to spend more than 2.5 million for electric vehicles. Which directly impacts on acceptance level and also on the dependency of foreign oils.

Peoples was interested in new technologies. But they also calculate the prices. Imported electric vehicles are very expensive and customs duties are making it double of its original price. Mostly customers of automobiles shifted on small size passenger cars due to fluctuation and high-cost fuels. In the Pakistani automobile market, the minimum engine capacity is 1000cc. Japanese 650cc engine capacity vehicles entered in this fuel crisis gap and near about 70 percent captured the Pakistani automobile market. Peoples are responded positively purchase hybrid vehicles for their next purchase. But they spend a minimum of 0.5 million to 2.5 million maximum. A simple electric vehicle like Nissan leaf was available in 3 million. Prices of electric vehicles matters and effect on the selection of respondents.

Pakistan's government is already working on the green revolution. Electric vehicle adoption is one of the parts of this revolution. But without clear and proper automobile policy it's difficult for electric vehicles to enter Pakistan. The government should compile auto policy and provide tax incentives for those who want to introduce electric vehicles in Pakistan. The government should focus on low price electric vehicles. Because of this research peoples are rejecting electric vehicles due to high prices. Charging facilities are not enough to attract electric vehicle purchasers. By reduction of customs duties on imports of electric vehicles and charging unites peoples are responding well to purchase electric vehicles. The publicity of new technologies and protect the environment are also provided information about electric vehicles.

This research covers many aspects of electric vehicle technology, but many other gaps still need some more work to do. Due to limited time frame data collected from limited areas of Pakistan. Large data collection can change the evaluations. Economical areas related to the adoption of the electric vehicle are provided the platform for more research work. Sustainable energy sources for charging infrastructure and charging system technology need some work in the case of Pakistan.

Electric vehicle research is somehow difficult to analyze the data. But by calculating frequencies and descriptive statistics generating the results are easy. Some limitations are required to collecting data which are:

1. Data not collected from below 18 years of age
2. Data collected from minimum bachelor's degree holders

3. Respondents are nationals of Pakistan

4. Respondents have a valid driving license

5. Respondents know electric vehicles attributes

6. Respondents are understanding the straight and weaknesses of electric vehicles

7. Electric vehicle technology information also mattered

For better understanding, the results graphs and tables are generated by computer software. Also, two-step cluster analysis use for cluster making of collected data. The latent class cluster analysis technique uses for dependent variables choices. In which generating the results of electric vehicles acceptance by four different choices.

Innovative researches always need regular developments. By calculating the gaps of innovation development from different areas of technological implementation many other doors will open. In this research data collected from a small population size. By collecting large data results will be better calculated. Pakistan's economic effects on innovation development like electric vehicles case also need some work to analyze the economic effects on technological innovation developments. On one side electric vehicles can solve many problems but on other side energy crisis directly hit the questions of charging infrastructure for electric vehicles. Charging facilities will need some analysis and researches to calculate the demands and availability of electricity for electric vehicles. local manufacturer's interest related to electric vehicle productions also provides a platform for further researches.

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APPENDIX A

Vehicles ownership details

Type of vehicles you Drive?

Types	Frequency	Percentage
Small Passenger Car	91	44.4
Mid-Size Passenger Car	62	30.2
Large Size Passenger Car	39	19.0
SUV	2	1.0
Pickup Track	6	2.9
VAN	5	2.4
Total	205	100.0

Next Purchase (New or Old)?

Types	Frequency	Percentage
New	155	75.6
Old	50	24.4
Total	205	100.0

Next Purchase (Conventional or Hybrid)?

Types	Frequency	Percentage
Conventional Gasoline	79	38.5
Hybrid	126	61.5
Total	205	100.0

How much spend on the next purchase?

Money in PKR	Frequency	Percentage
200000 PKR	2	1.0
500000 PKR	59	28.8
1000000 PKR	62	30.2
1500000 PKR	36	17.6
2000000 PKR	19	9.3
2500000 PKR	27	13.2
Total	205	100.0

How many vehicles did you own?

Numbers of Vehicles	Frequency	Percentage
1	126	61.5
2	51	24.9
3	16	7.8
4	8	3.9
5	1	0.5
6	1	0.5
7	2	1.0
Total	205	100.0

APPENDIX B

Independent Variables

Attributes:

Driving Range		Frequency	Percentages
Does Not Matter		24	11.7
Matter Some		99	48.3
Matters a Lot		82	40.0
	Total	205	100.0

Charging Time		Frequency	Percentages
Does Not Matter		14	6.8
Matter Some		50	24.4
Matters a Lot		141	68.8
	Total	205	100.0

Fuel Cost Saving		Frequency	Percentages
Does Not Matter		13	6.3
Matter Some		53	25.9
Matters a Lot		139	67.8
	Total	205	100.0

Performance	Frequency	Percentages
Does Not Matter	3	1.5
Matter Some	85	41.5
Matters a Lot	117	57.1
Total	205	100.0

Pollution	Frequency	Percentages
Does Not Matter	4	2.0
Matter Some	75	36.6
Matters a Lot	126	61.5
Total	205	100.0

Price Compared to Hybrid and Gasoline Vehicles	Frequency	Percentages
Does Not Matter	4	2.0
Matter Some	40	19.5
Matters a Lot	161	78.5
Total	205	100.0

APPENDIX C

Independent Variables

Advantages:

Electric Vehicles Lower Pollution	Frequency	Percentages
Does Not Matter	13	6.3
Matter Some	41	20.0
Matters a Lot	151	73.7
Total	205	100.0

Electric Vehicles Lower Fuel Cost	Frequency	Percentages
Does Not Matter	3	1.5
Matter Some	64	31.2
Matters a Lot	138	67.3
Total	205	100.0

Electric Vehicles Lower Fuel Cost	Frequency	Percentages
Does Not Matter	3	1.5
Matter Some	64	31.2
Matters a Lot	138	67.3
Total	205	100.0

Avoid Trips to Gas Stations		Frequency	Percentages
Does Not Matter		34	16.6
Matter Some		80	39.0
Matters a Lot		91	44.4
	Total	205	100.0

Interesting New Technology		Frequency	Percentages
Does Not Matter		15	7.3
Matter Some		46	22.4
Matters a Lot		144	70.2
	Total	205	100.0

Disadvantages:

Lower Dependency on foreign oil	Frequency	Percentages
Does Not Matter	29	9.8
Matter Some	72	35.1
Matters a Lot	113	55.1
Total	205	100.0

Electric Vehicles Lower Driving Range	Frequency	Percentages
Does Not Matter	10	4.9
Matter Some	88	42.9
Matters a Lot	107	52.2
Total	205	100.0

Electric Vehicles Longer Charging Time	Frequency	Percentages
Does Not Matter	9	4.4
Matter Some	84	41.0
Matters a Lot	112	52.6
Total	205	100.0

Electric Vehicles Unfamiliar Technology	Frequency	Percentages
Does Not Matter	53	25.9
Matter Some	91	44.4
Matters a Lot	61	29.8
Total	205	100.0

APPENDIX D

Independent Variables

Information about Electric Vehicles:

Enough Information of Electric Vehicles	Frequency	Percentages
Strongly Disagree	6	2.9
Disagree	11	5.4
Neutral	60	29.3
Agree	80	39.0
Strongly Agree	48	23.4
Total	205	100.0

Easy to Understand Electric Vehicles Technology	Frequency	Percentages
Strongly Disagree	8	3.9
Disagree	5	2.4
Neutral	55	26.8
Agree	92	44.9
Strongly Agree	45	22.0
Total	205	100.0

Easy to Understand Electric Vehicles Advantages and Disadvantages	Frequency	Percentages
Strongly Disagree	4	2.0
Disagree	16	7.8
Neutral	43	21.0
Agree	72	35.1
Strongly Agree	70	34.1
Total	205	100.0

Electric Vehicles Seem Realistic	Frequency	Percentages
Strongly Disagree	5	2.4
Disagree	15	7.3
Neutral	79	38.5
Agree	81	39.5
Strongly Agree	25	12.2
Total	205	100.0

Felt to Purchase Electric Vehicles	Frequency	Percentages
Strongly Disagree	13	6.3
Disagree	29	14.1
Neutral	81	39.5
Agree	52	25.4
Strongly Agree	30	14.6
Total	205	100.0

APPENDIX E

Questionnaire

Part I: Information about You

We have a few questions about you and your household on the upcoming slides. The information in this section will help us identify vehicle preference by households. The data will be used only at aggregate level for statistical analysis.

1. **What is your age?**
   a) 20-30
   b) 30-40
   c) 40-50
   d) Above 50

2. **What is your gender?**
   a) Male
   b) Female

3. **What is your highest level of education?**
   a) No high school degree
   b) High school degree
   c) Bachelor's degree
   d) Master's degree
   e) Doctorate degree

4. **Where do you live? (Your Province)**
   _____

5. **How many people in your household have a driver license?**
   _____

6. **How concerned are you about air pollution in your city?**
   a) Very concerned
   b) Somewhat concerned
   c) Not concerned at all

7. **Do you believe climate change is a major threat, a minor threat, or no real threat?**
   a) Major threat
   b) Minor threat
   c) No real threat

8. Thinking about your own shopping and living habits over the last five years, would you say you have made major changes, minor changes or no changes to help protect the environment?
   a) Major change
   b) Minor change
   c) No change

9. This is the last question. Please tell us to what extent you agree with each of the following statements.

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
I like to fix cars					
I like new products that enter the market					
I think the kind of car a person owns says some about the person					

Part II: Background of Owned Vehicles

10. How many vehicles (cars and trucks) does your household own or lease? A household here refers to all individuals who share a common budget with you and make up your Current immediate family. Please exclude employer owned vehicles.

   _____

11. What type of vehicle do you currently drive most often?

   a) Small Passenger Car
   b) Mid-Size Passenger Car
   c) Large Passenger Car
   d) SUV
   e) Pickup Truck
   f) VAN

12. On average, how many km per year do you drive?

   _____

13. Will your next purchase or lease most likely be new or used? Again, if you are uncertain, make your best guess.
   a) NEW
   b) UESD

14. Are you most likely to purchase a conventional gasoline or a hybrid gasoline vehicle on your next purchase? Hybrid here includes plug-in hybrid (like the new Chevy Volt) and non-plug-in hybrid (like the Toyota Prius). Again, if you are uncertain make your best guess. (If you think you are likely to purchase or lease something other than a gasoline or hybrid gasoline vehicle (such as a 100% electric vesicle or alternative fuel vehicle), please choose here between gasoline and hybrid gasoline anyway. Later in the survey we will be offering you some hypothetical electric vehicles and we will ask you to compare these to your preferred gasoline or hybrid gasoline vehicle.)
   a) Conventional Gasoline
   b) Hybrid Gasoline

15. Thinking about the vehicle you will purchase or lease next, how many days per month do you expect it will be driven more than 100 km per day? If your number of trips changes a lot from one month to the next, try to report an average. Again, if you are uncertain make your best guess.

   _____

16. Approximately how much do you expect to spend on your next vehicle? If you plan on leasing please report the purchase price for the same vehicle. Again, if you are uncertain, make your best guess.

   _____

17. What is your best guess at what Petrol prices will be for regular gas THIS TIME NEXT YEAR?

   _____

18. What is your best guess at what Petrol prices will be for regular gas IN 5 YEARS?

   _____

Part III: Electric Vehicles Choices

Choice 1 of 2 Choices

You indicated earlier that your next purchase. Suppose on your next purchase you were offered this vehicle plus two electric versions of this vehicle with the features shown below. Assume the three vehicles are otherwise identical.

Your preferred Hybrid/Gasoline Vehicle?

Vehicle Attributes	Electric Vehicle 1	Electric Vehicle 2	
Driving Range on Full Battery	150 kms	200 kms	
Time it Takes to Charge Battery for 50 kms of Driving Range	5 hours	10 hours	You Preferred Hybrid/ Gasoline Vehicle?
Fuel Cost	Like PKR 60/Liter Gas	Like PKR 120/Liter Gas	
Acceleration Compared to Your Preferred Hybrid Gasoline	5% faster	5% slower	
Pollution Compared to Your Preferred Hybrid Gasoline	75% lower	25% lower	
Price Compared to Your Preferred Hybrid Gasoline	PKR 5,00,000 higher	PKR 10,00,000 higher	

19. **I would most likely purchase......**

   a) The Electric Vehicle 1

   b) The Electric Vehicle 2

   c) My Preference Hybrid/Gasoline Vehicle

   d) My Preference Hybrid/Gasoline Vehicle - Although I like the idea of electric vehicles and some of the features here are OK, I could/would not buy these electric vehicles at these prices

Choice 2 of 2 Choices

Now, consider a different set of vehicles. Using the buttons below the table, please indicate which one of the three vehicles you would most likely purchase.

Vehicle Attributes	Electric Vehicle 1	Electric Vehicle 2	You Preferred Hybrid/ Gasoline Vehicle?
Driving Range on Full Battery	75 kms	200 kms	
Time it Takes to Charge Battery for 50 kms of Driving Range	1 hour	10 hours	
Fuel Cost	Like PKR 120/Liter Gas	Like PKR 60/Liter Gas	
Acceleration Compared to Your Preferred Hybrid Gasoline	20% faster	5% faster	
Pollution Compared to Your Preferred Hybrid Gasoline	25% lower	95% lower	
Price Compared to Your Preferred Hybrid Gasoline	PKR 5,00,000 higher	PKR 25,00,000 higher	

20. I would most likely purchase.....
   a) The Electric Vehicle 1
   b) The Electric Vehicle 2
   c) My Preference Hybrid/Gasoline Vehicle
   d) My Preference Hybrid/Gasoline Vehicle - Although I like the idea of electric vehicles and some of the features here are OK, I could/would not buy these electric vehicles at these prices.

21. Thinking about the two choices you just made, indicate how much each of the following attributes mattered in your choice.

	Does Not Matter	Matters Some	Matters a Lot
Driving range on full battery			
Time it takes to charge battery for 50 Kms of driving range			
Fuel cost			
Acceleration compared to your preferred Hybrid gasoline vehicle			
Pollution compared to your preferred Hybrid Gasoline Vehicle			
Price compared to your preferred Hybrid gasoline Vehicle			

22. **Thinking about the two choices you just made, indicate how much you agree with each of the following statements.**

	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
You have enough information of Electric vehicles					
Easy to understand Electric vehicles					
Easy to understand advantages and disadvantages					
The electric vehicle described so far seem realistic					
I felt pushed to say I would buy an electric vehicle					

Part IV: Electric Vehicles

Now we are going to describe what modern electric vehicles will be like and then ask you if you might buy one at the time of your next purchase if such vehicles were available.

Since most people are just learning about electric vehicles, we will begin by telling you how they will be different from gasoline vehicles and then tell you how they will be like gasoline vehicles.

Please keep in mind that we are not promoting electric vehicles, we are simply interested in knowing how well they might sell in a market.

Please give honest and realistic answers to the upcoming questions. It will make our research more accurate.

23. **Here are some of the advantages of electric versus gasoline vehicles. Please indicate which matter to you as a potential buyer.**

	Does Not Matter	Matters Some	Matters a Lot
Lower Pollution			
Lower Fueling cost compared to Gasoline			
Avoid Trips to Gas station			
Interesting New Technology			
Lower Dependence on Foreign Oil			

24. **Here are some disadvantages of electric versus gasoline vehicles. Please indicate which matter to you as a potential buyer.**

	Does Not Matter	Matters Some	Matters a Lot
Higher Purchase Price			
Lower Driving Range per Fill-up			
Longer Fill-up Time (Charging Battery)			
Unfamiliar Technology			

25. **If you were to purchase an electric vehicle, a special outlet for charging it would be installed at your home --- in your garage, by your driveway, or near another designated parking space. How likely is it that there would be a space for installing such an outlet at your home at the time you make your next vehicle purchase?**
    a) Very Likely
    b) Somewhat Likely
    c) May be/ Not Sure
    d) Somewhat Unlikely
    e) Very Unlikely

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