Issues and Challenges of Public Policy Implementation: A Case Study of National Electric Vehicles Policy (NEVP)

By

MUHAMMAD UMER

Masters of Public Administration from Virtual University of Pakistan, 2018

A THESIS SUBMITTED IN PARTIAL FULFILMENT OF
THE REQUIREMENTS FOR THE DEGREE OF

MASTER OF PHILOSOPHY

In **Governance & Public Policy**

To

FACULTY OF SOCIAL SCIENCES

NATIONAL UNIVERSITY OF MODERN LANGUAGES, ISLAMABAD

THESIS AND DEFENSE APPROVAL FORM

The undersigned certify that they have read the following thesis, examined the defense, are satisfied with the overall exam performance, and recommend the thesis to the Faculty of Social Sciences for acceptance.

Thesis Title: Issues and Challenges of Public Policy Implementation: A Case Study of National Electric Vehicles Policy (NEVP)

Submitted by: Muhammad Umer **Registration #:** 1858 MPhil/GPP/F19

Master of Philosophy
Degree name in full

Governance & Public Policy
Name of Discipline

Dr. Athar Rashid
Name of Research Supervisor

_____
Signature of Research Supervisor

Prof. Dr. Khalid Sultan
Name of Dean (FSS)

_____
Signature of Dean (FSS)

Brig. Syed Nadir Ali
Name of Director General

_____
Signature of Director General

_____
Date

AUTHOR'S DECLARATION

I Muhammad Umer

Son of Nazeer Ahmed Chughtai

Registration # 1858 MPhil/GPP/F19

Discipline Governance & Public Policy

Candidate of **Master of Philosophy** at the National University of Modern Languages do hereby declare that the thesis **Issues and Challenges of Public Policy Implementation: A Case Study of National Electric Vehicles Policy (NEVP)** submitted by me in partial fulfillment of MPhil degree, is my original work, and has not been submitted or published earlier. I also solemnly declare that it shall not, in future, be submitted by me for obtaining any other degree from this or any other university or institution.

I also understand that if evidence of plagiarism is found in my thesis/dissertation at any stage, even after the award of a degree, the work may be cancelled and the degree revoked.

_____
Signature of Candidate

_____
Name of Candidate

_____
Date

ABSTRACT

Issues and Challenges of Public Policy Implementation: A Case Study of National Electric Vehicles Policy (NEVP)

This research is being carried out to identify the issues and challenges in implementation of National Electric Vehicles Policy. Electric Vehicles are new technology vehicles that are being adopted rapidly by the world and becoming popular which have several benefits including less harmful for the environment. Considering the various benefits and the growing trend of EVs, Engineering Development Board in Ministry of Industries and Production prepared the first ever National Electric Vehicles Policy (NEVP) which was approved in December 2020. EV's growth is suffering from various problems in the world. In Pakistan after more than one year of approval of EV policy, EV industry could not start its development and there are only 28 EVs on road.

In this study we have identified issues and challenges in implementation of NEVP using qualitative methods. In depth interviews have been taken from the representatives of all the four major stakeholders i.e. Policy makers, manufacturers, Charging Stations and EV owners. Thematic Analysis has been used to analyze the data.

Several factors have been identified that are acting as barriers in implementation of the policy. These factors have been divided into six categories i.e. social factors, policy factors, energy factors, infrastructure factors, financial factors and technology factors. Top down implementation model along with horizontal input from private sector has been suggested which could be called a "Support Building Approach". A Comprehensive geographical implementation plan has been suggested as well. All of the four major stake holders of the electric vehicles are facing various problems which are turning out to be the barriers, issues and challenges in implementation of the NEVP. Most of the problems faced by one sector can be handled by the other sector if timely communicated in a proper way. Therefore, there is a need to bring together all the stakeholders. This strong and single forum coordination will ease the policy implementation which will result in early adoption of EVs.

Successful implementation of NEVP will lead to the several benefits that include but not limited to the reduction in GHG emissions, improved urban air quality, reduced fuel import bill, promotion of indigenization, employment opportunities and clean and green industrial development in the country.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOMENCLATURE

NEVP	:	National Electric Vehicles Policy
EV	:	Electric Vehicle
CV	:	Conventional Vehicle
ICE	:	Internal Combustion Engine
ZEV	:	Zero Emitting Vehicle
BEV	:	Battery Electric Vehicles
PHEV	:	Plugged-In Hybrid Electric Vehicle
USD	:	United States Dollar
GDP	:	Gross Domestic Production
GHGs	:	Green House Gasses
MOS	:	Metal Oxide Semiconductor
MOSFET	:	MOS Field Effect Transistor
AC	:	Alternate Current
DC	:	Direct Current
CBU	:	Completely Built Unit
NEMMP	:	National Electric Mobility Mission Plan
NCCP	:	National Climate Change Policy
INDC	:	Intended National Determined Contribution
CPUC	:	California Public Utilities Commission
CPEC	:	China Pakistan Economic Corridor
FBR	:	Federal Board of Revenue
PAMA	:	Pakistan Automotive Manufacturers Association
PDBMA	:	Pakistan Dry Battery Manufacturers Association
PEVMA	:	Pakistan Electric Vehicles Manufacturers Association
IESCO	:	Islamabad Electric Supply Company
OEM	:	Original Equipment Manufacturers
FCEV	:	Hydrogen Fuel Cell Electric Vehicle
HEV	:	Hybrid Electric Vehicle
DCFC	:	Direct Current Fast Charging
LTV	:	Light Transport Vehicle
HTV	:	Heavy Transport Vehicle
SUV	:	Sports Utility Vehicle
CARB	:	California Air Resources Board
N^2O	:	Nitrous Oxide
CO^2	:	Carbon Dioxide
PFC	:	Per Fluorocarbon
HFC	:	Hydro Fluorocarbons
SF^6	:	Sulfur Hexafluoride
CNG	:	Compressed Natural Gas
R & D	:	Research and Development
FY	:	Fiscal Year
EAFO	:	European Alternative Fuel Observatory
NGO	:	Non-Governmental Organizations
CEO	:	Chief Executive Officer
EDB	:	Engineering Development Board
NEPRA	:	National Electric Power Regulatory Authority
PBS	:	Pakistan Bureau of Statistics
TDAP	:	Trade Development Authority of Pakistan
PPDA	:	Pakistan Petroleum Dealers Association
PAAPAM	:	Pakistan Association of Automotive Parts and Accessories Manufacturers
WAPDA	:	Water and Power Development Authority

ACKNOWLEDGEMENTS

First of all, I am thankful to Allah, the Almighty who blessed me with courage and strength to successfully complete my thesis. I would like to thank my wife Mrs. Javeria Umer who has extended her full moral and financial support to me throughout my study and my parents whose prayers have surrounded me throughout my life.

I express my most sincere appreciation to my supervisor Dr. Athar Rashid who equipped me with the exceptional tools to not only succeed my M.Phil degree but also in my professional career. Despite a raging pandemic and a demanding schedule, he remained responsive and accommodating. I would like to thank Dr. Zain Rafiqe for their support and guidance at various stages and I would also like to thank all of the interviewees. They took time out of their busy schedules to help us with this study, ask for clarifications, send helpful comments, and answer all of the questions. This research wouldn't have been possible without their help.

The time I spent at NUML Islamabad is a unique experience of my life as I have never attended a large campus of any university in my academic career. I have learnt many things through interaction with my fellows and teacher most of them possess a large practical experiences of various aspects of life and also the field of Governance and Public Policy. Travelling in NUML Student's transport, interacting with students of different fields and from different backgrounds is an amazing experience.

Last but not the least I express my greatest gratitude to my colleagues Dr. Ibrar ul Hassan Akhtar, General Manager (Environmental Scientist), Mr. Madni Shifa Ullah Khan and Mr. Zaigham Saeed Toor, both Managers (Material Engineers) at Government of Pakistan for their step by step guidance and motivation which made it possible to complete my thesis in time.

CHAPTER – 1: INTRODUCTION

1.1 Preamble

Electric Vehicles (EVs) have been initially introduced in 1887 but vanished from roads after failure in adoptions despite of many years of research and development (Kubański, 2020). EVs have been re-introduced in 2008 but still on road EVs are only 8.3 % of globally on-road vehicles (till Dec 2021) (Volumes, 2022). To avoid second failure, this time the researchers have focused on policy developments for successful adoption of EVs. Policy makers are identifying the barriers and challenges in adoption of EVs and addressing the same in their EV policies (Hardman, Kurani, & Chakraborty, 2020) e.g. to tackle the price gap between EVs and CVs the policy makers suggested tax credit for EV buyers. California was the first state to make policy for alternate energy vehicles. The California Public Utilities commission (CPUC) introduced the Policy in 2009 (Kubański, 2020). Pakistan's first ever EV policy has been approved in December 2020 in which the Government has set a target for 2030 to reach 50 % of two and three wheeler EV Sales and 30% of passenger EVs sale of total new vehicles sale in the country. More than 15 months have passed since the approval of policy but EV sales is still under 50 numbers throughout the country (Volumes, 2022); people are not showing interest towards EVs. There is only one manufacturer of passenger cars and one of electric bikes. This study aims to identify the factors due to which people are reluctant to buy, investors are unenthusiastic towards investment in EV manufacturing and charging stations development growth is not up to the mark. Amalgamation of these factors leads towards obstacles in implementation of National Electric Vehicles Policy of Pakistan.

1.2 Background of the Study

The primary purpose of introducing the EVs is to reduce the greenhouse gasses emissions that are polluting the environment and affecting the urban air quality (Ližbetin, Hlatká, & Bartuška, 2018). Nitrous Oxide (N^2O), Methane (CH^4) and Carbon Dioxide (CO^2) are the major greenhouse gasses emitted by human activities. Carbon Dioxide (CO^2) holds the major portion in all GHG emissions (Brinkel, Schram, AlSkaif, Lampropoulos, & van Sark, 2020). Percentage share of all Green House Gasses in global emission have been presented in Figure1. Luxembourg holds the top position in CO^2 emissions per capita. It is emitting 38.18 tons CO^2 per capita annually. Considering upon the impact of GHGs emitted

by transportation sector on the air quality and environment, the California Air Resources Board (CARB) in the early 1990s, started a campaign for more fuel-efficient, lower-emissions vehicles, with the eventual goal to get rid of Green House Gas emitting vehicles to improve urban air quality and shifting of 100 % transport to zero-emissions vehicles like electric vehicles (Collantes & Sperling, 2008). In response, automakers started working on electric vehicles.

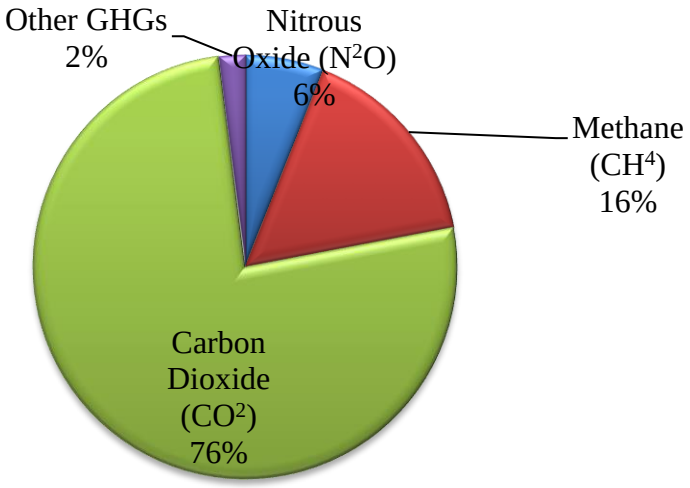

Figure 1: Percentage Share of Different GHGs in Global Emission (Agency, 2014)

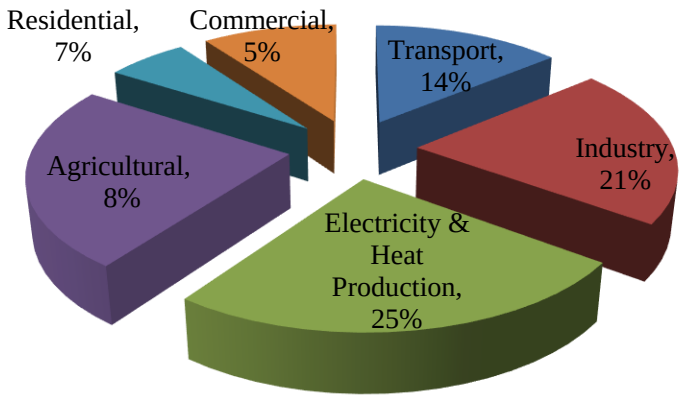

Figure 2: Sector Wise Share in Global GHG Emissions (Agency, 2014)

1.3 Pakistan's Context

Pakistan is not in the top 100 countries in per capita CO^2 emissions ranking and is ranked at 108th in 131 countries in CO^2 emissions. Pakistan is emitting only 1.2 tons per capita CO^2 annually. In 2020 Pakistan has emitted 235 million metric tons of CO^2, but still

several times two major cities of the Pakistan (Karachi and Lahore) have been found in top ten most polluted cities of the world. Other developing countries in neighborhood of Pakistan, India has emitted 2442 million metric tons of CO^2in 2020 and Iran has emitted 745 million metric tons of CO^2in 2020 (Statistica 2020). Considering upon environmental problems, growing trend of electric vehicles in the world, high fuel imports bills and to promote indigenization, Engineering Development Board of Ministry of Industries and Production has prepared first National Electric Vehicles Policy of Pakistan and got it approved in December 2020. As per Ministry of Industries and Production notification no. 2(48)/2018-LED-II, Engineering Development board will function as secretariat of the Electric Vehicles Policy Formulation and Implementation. Engineering Development Board will also provide relevant clarifications and when required by the investors with reference to implementation of the policy. Policy has been approved in 2020 but after passing more than one year there are only less than fifty EVs on road in Pakistan till the end of 2021.

1.4 Research Gap

Several scholars around the world have identified important factors and elements in the consumer intension for the adoption of EV. Lane and Pathak assumed that a pro environmental behavior of user is the key element because electric vehicles are environment friendly (P. J. Lane, Koka, & Pathak, 2006). Many other scholars have identified that the pro-environmental beliefs, values and awareness regarding importance of clean enviornment of user is an important element in buying intentions of consumers (Schuitema, Anable, Skippon, & Kinnear, 2013). Krupa highlighted that knowledge about environmental problems created by the transport sector is the motivating factor for consumers to buy EVs (Krupa et al., 2014). Tarigan and Bayer identified that the pro-environmental behaviour, knowledge about damage of climate due to GHG emissions convince the consumer to buy Hydrogen Fuel Cell Electric Vehicles as these vehicles emit zero GHGs (Graham-Rowe et al., 2012; Tarigan, Bayer, Langhelle, & Thesen, 2012). There are many other studies that concluded the most suitable type of EV for clean enviornment is Fuel Cell Electric Vehicles and these vehicles are Zero Emitting Vehicles (ZEVs).

Some scholars like Collins and Chambers have identified many other factors that influence the buyer towards EVs. Some of these factors are social norms, environmental regualtions and economic aspects (Collins & Chambers, 2005). Pschological factors, personal

beliefs, attitudes, and personal mindset of buyer are important element in influencing the buyer towards EV (Van Acker, Mokhtarian, & Witlox, 2014).

Table 1: Summary of Earlier Studies with identified important factors

Author and Year	Method Used	Identified Factors
(Agrawal, Kumar, Narang, & Singh, 2020)	Qualitative	Change in the fueling process, charging infrastructure, initial cost, travel distance per recharge, Income Demographics and policy changes
(Fang et al., 2020)	Qualitative	Taxation policy, dynamic subsidy system and charging infrastructure
(Noel, de Rubens, Kester, & Sovacool, 2020)	Qualitative	Price and range of vehicles, charging infrastructure, consumer awareness and knowledge about enviornmental aspects
(Rezvani, Jansson, & Bodin, 2015)	Qualitative	Battery material and electricity source, environmental impacts, performance, safety, being a work in progress
(Burgess, King, Harris, & Lewis, 2013)	Qualitative	Speed andperformance of vehicle, environmental characteristics, initial purchase cost, running cost, and experience
(Kester, Sovacool, Noel, & de Rubens, 2020)	Qualitative	Sociology of Expectation and Critical Security Studies(as these fields share a focus on the political use of the 'future' as deployed in the 'present' in order to guide, shape and prioritize certain sustainable technologies and practices over others)
(B. Lane & Potter, 2007)	Qualitative	Ease of usage and performance of vehicle as well as its energy efficiencyand reliability, initial purchase price, government policies,environmental regulations, economic

		benefits, moral and social norms,and pro-environmental identity and lifestyle
(Skippon & Garwood, 2011)	Qualitative and Quantitaive	Performance and range of vehicle, initial purchase cost, environmental impact,availability of charging stations
(Ahmad, Alam, Alsaidan, & Shariff, 2020)	Qualitative	Power system infrastructure, business models and charging strategies,
(Feng, Lin, Xian, & Chester, 2020)	Qualitative	Charging strategies, improved battery technology and power prices

There is a very limited literature found that focuses on the electric vehicles context of Pakistan. In Pakistan's scenario, there is still a lot of research work to be done. Several aspects of electric vehicles have not been addressed in context of Pakistan including "user intention to buy EVs and to shift from CVs to EVs", "intention of the people to adopt new technology vehices", "type of EVs most suitable for Pakistan's scenario and most liked by the people", "impact of EVs on environment conditions in Pakistan", "issues and Challenges faced by the major stake holders which could act as barriers in implementation of the Electric Vehicles Policy of Pakistan" and there may be many other as well. Due to research limitations, we are focusing only one aspect that is "*Issues and Challenges faced by the major stake holders which could act as barriers in implementation of the Electric Vehicles Policy of Pakistan*". The factors that act as a barrier in adoption of EVs and thus affecting the successful implementation of Electric Vehicles Policies has been identified in this study.

1.5 Problem Definition

First highway electric car was in market for sale in 2008 and first ever alternate energy vehicles policy was formulated by California Public Utilities commission (CPUC) in 2009 and a target of 1.5 million EVs on road till 2025 was set but till 2020 there are only 145,099 EVs on road in California. In eleven years, California could achieve only 9.67 % of its own set target in 62.5 % of time. Global EV sales along with percentage of on road EVs in ten years have been presented in Table 2, Figure 3 and Figure 4.

Table 2: Global sales of EVs and their percentage of total vehicles on road (Volumes, 2022)

Year	Global Number of EVs on Road (Millions)	Percentage Share of EVs of Total Vehicles on Road
2012	0.12	0.20%
2013	0.21	0.30%
2014	0.32	0.40%
2015	0.54	0.60%
2016	0.79	0.90%
2017	1.26	1.30%
2018	2.08	2.20%
2019	2.27	2.50%
2020	3.24	4.2 %
2021	6.75	8.3 %

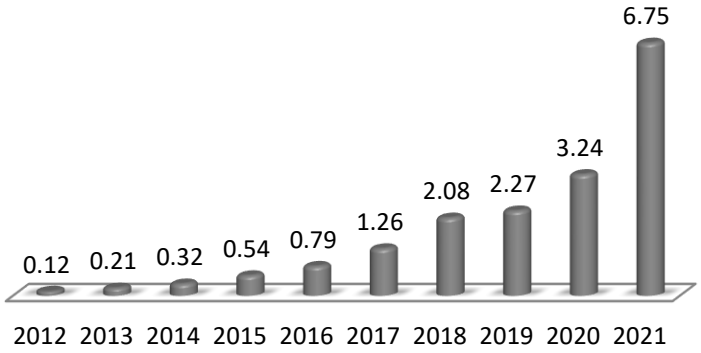

Figure 3: Last Ten Years Global Sales of Electric Vehicles (Millions) (Volumes, 2022)

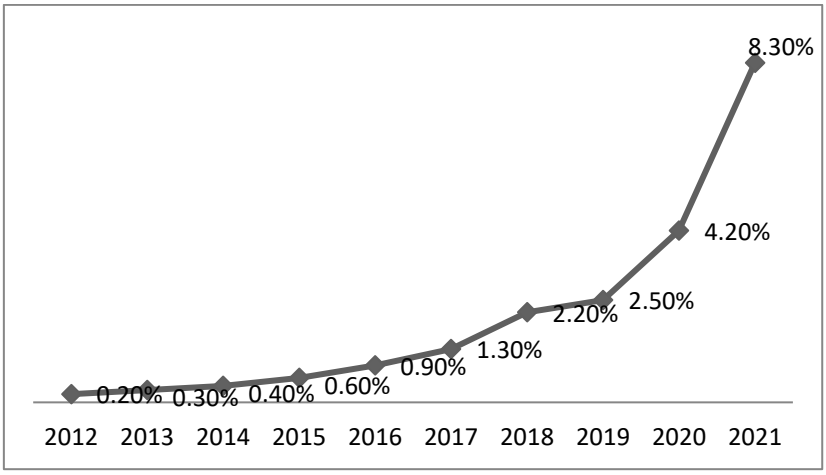

Figure 4: Percentage share of EVs of Total on Road Vehicles (Volumes, 2022)

China holds the maximum i.e. 44.89 % share of total EVs in the world but still it is only 1.75 % of total on road vehicles in China. Number of EVs sold till 2020, percentage share in global EV sales and percentage share of on road vehicles of top ten countries have been presented in table 3.

Table 3: Number of EVs sold till 2020, Percentage Share in global EV Sales and Percentage Share of on Road Vehicles in Top Ten Countries (Volumes, 2022)

Country	Number of EVs sold till 2020 (Millions)	Percentage Share of Global on road EVs	Percentage of Total on Road Vehicles in the Country
China	4.51	44.89%	1.75%
USA	1.79	17.77%	0.7%
Germany	0.63	6.31%	2.27%
Norway	0.48	4.82%	1.2%
UK	0.44	4.33%	17.2%
France	0.42	4.14%	1.29%
Japan	0.30	2.96%	1.38%
Netherlands	0.29	2.90%	3%
Canada	0.21	2.08%	4%
Sweden	0.18	1.78%	0.73%

Data shows that despite of several attractive incentives by many countries and billions of dollars' investments, still no country could have 20% of on road vehicles as electric vehicles. China owns maximum of EVs i.e.4.51 million but it is still just 1.75 % of on road vehicles in China. Pakistan's first ever EV policy was approved in 2020 but after passing more than 18 months there are only less than fifty electric vehicles on road.

1.6 Problem Statement

Electric Vehicles have been introduced in 2008 to save the environment from Green House Gasses Emissions but still on road EVs are only 8.3 % of total on road vehicles in the world (Volumes, 2022). National Electric Vehicles Policy of Pakistan was approved in December 2020 but there are less than fifty EVs on road (Volumes, 2022). There are several factors due to which EV's growth is not up to the mark and this new technology vehicle is not attracting customers, hence, Pakistan's first ever EV policy is not moving towards successful

implementation. This study will try to find out these issues and challenges due to which adoption of Electric Vehicles is slow and people are not showing their interest in EVs, consequently, NEVP is not being implemented successfully.

1.7 Research Objective

Purpose of the research is to analyze issues and challenges in implementation of National Electric Vehicles Policy in Pakistan and give suggestions for the better implementation of the policy.

1.8 Research Questions

1.8.1 Primary Research Question:

What are the issues and challenges in implementing National Electric Vehicles Policy in Pakistan?

1.8.2 Secondary Research Questions:

(1) What are the problems faced by the major stakeholders (i.e. EV Policy Makers, EV Manufacturers, EV Owners and Charging Station Owners) that act as a barrier in implementation of NEVP?

(2) How these problems can be addressed to avoid delay and obstacles in implementation of NEVP?

1.9 Significance of the Study

Electric Vehicles are new technology vehicles and despite of having various benefits, still have many disadvantages and issues. Major issues are less mileage, more recharging time, high initial price of the vehicle and less reliability (Patyal, Kumar, & Kushwah, 2021). Due to this people around the world are hesitating in shifting from conventional vehicles to EV. To encourage and attract people towards EVs and to avoid second failure of EV industry, various countries have formulated EVs policy through which they are offering various types of incentives to the customers as well as to the manufacturers (Harvey, 2020). Pakistan has its first National Electric Vehicles Policy (NEVP) got approved in December 2020. In the policy various incentives have been offered to the customers as well as to the manufacturers. This study will evaluate the issues and challenges in implementation of the policy by highlighting the problems faced by of all major stakeholders. It is important to address the issues at initial stage of EVs adoption in the country as this will help winning the trust of the buyers. And

thus, people will encourage adopting electric vehicle instead of conventional vehicle. Increased percentage of electric vehicles in total number of vehicles on road will help reducing the GHG emissions which will increase the quality of urban air reducing pollution.

1.10 Scope of Research

This study is focusing primarily on the factors that are acting as barriers in successful implementation of the National Electric Vehicles Policy of Pakistan only. Issues have been identified and suggestions have been given to address those issues, which will help the government in better implementation of the policy.

1.11 Organization of the Study

This study consists of five chapters.

1.11.1. First chapter gives a brief overview of the study which includes introduction to the problem with its background and discusses it specifically in Pakistan's context. Identify's research gap, defines problem, highlights significance and scope of the study.

1.11.2. Second chapter reviews the previous literature published on similar issues and problems. It introduces the electric vehicles and illustrates role of public policy in adoption of EVs. It gives an overview of EV policies of several major countries around the world and underlines important factors in implementation of EV policy.

1.11.3. Third chapter is about the methodology used to conduct the study. Starting from the conceptual framework, it moves forward by describing paradigm, design and strategy of the research. After discussing the qualitative approach, chapter is summarized after ethical considerations.

1.11.4. Fourth chapter starts with analyzing the data that was collected through in-depth interviews. By passing through various steps of thematic analysis, it ends up with discussions.

1.11.5. Final chapter provides recommendations and concludes the study.

CHAPTER – 2: LITERATURE REVIEW

The knowledge of the researcher is based upon the literature review. In this study published articles, books and reports have been reviewed that are relevant to the both parts of the title i.e. Public Policy and Electric Vehicles. Total 207 published articles have been reviewed. Due consideration has been given to the recent publications but historically important and most cited relevant articles of previous times have not been ignored. This chapter is divided into four major parts, first part is about Electric Vehicles, second part is about public policy, if we combine the both topics i.e. electric vehicles and public policy, it becomes electric vehicles policy and that is the third part of this chapter, outcome of the electric vehicles policy can be evaluated by observing adoption of electric vehicles and that is the fourth part of this chapter.

2.1 Prologue of Electric Vehicles

The vehicle that has no engine and a substitute fuel vehicle that uses electric motors and their controllers for moving the vehicle, instead of the common force methods such as the Internal Combustion Engine are called Electric Vehicles (Severengiz, Finke, Schelte, & Forrister, 2020). Electricity, stored in the batteries, is used as a fuel to power the electric motors of the Electric Vehicles. The electricity stored in batteries powers the vehicle's wheels through those motor (Klee, 2021). Figure 5 show how an electric vehicle works and Figure 6 is a platform of an Electric Vehicle.

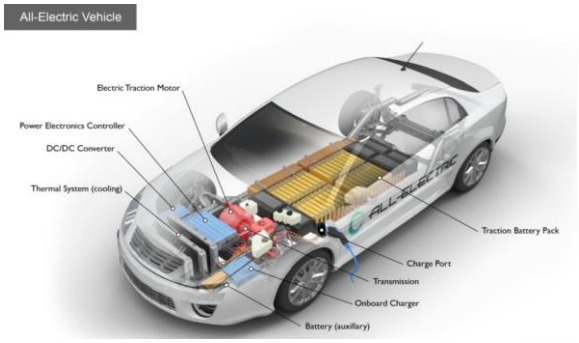

Figure 5: Working of an Electric Vehicle

Figure 6: Platform of an Electric Vehicle

Electric vehicles can be in the form of Electric Trains, Electric Cars, Electric Boats, Electric Trucks, Electric Motorcycles and Electric Tractors. This study focuses on Electric cars, Jeeps and vans (often called passenger cars).

Electric cars are quieter as compare to internal combustion engine cars, and produce less emission (Pietrzak & Pietrzak, 2020). The car contains battery packs to store the energy and that pack has limited energy storage capacity. Batteries are recharged by using a plug in charger from power source i.e. electricity. The chargers can be made available by establishing charging stations (like gasoline stations) (Funke, Jochem, Ried, & Gnann, 2020), Installing charging points at car parking (Wolbertus & van den Hoed, 2020), Charging point can be installed at car porch inside houses as well.

Electric cars contain packs of lithium-ion batteries that are expensive, so the cost of car is multiple times higher than equivalent ICE car. More batteries mean more mileage per single charge and hence higher price (Noel et al., 2020). Due to comparatively higher prices customer was not attracted towards buying electric car, so the governments announced some incentives for electric car buyers to promote electric cars (Wu et al., 2021)and at the same time the governments have set target to get rid of ICE vehicles to reduce GHG emission to improve urban air quality. Different countries offer different types of incentives to the electric vehicle buyer to promote electric vehicles for example waiver in vehicle tax while purchasing the vehicle, purchase subsidy (Lu, Yao, Jin, & Pan, 2020), waiver in registration charges, waiver in duty fee on import of electric vehicles, waiver in import and other taxes on import of electric vehicles, tax credit for electric vehicle owner (Li, Long, Chen, Dou, et al., 2020)

Promoting electric vehicles, setting target for adoption of electric vehicles and initiating programs to meet that target, all these subjects are of policy makers. So the policy makers play vital role in promoting the electric vehicles to save the environment and hence the world from pollution and to improve the urban air quality which directly impacts the citizens' health. Good policy initiatives can make it easy to buy and keep electric vehicles for the customer. Supportive policy measures, attractive incentives can attract customers towards electric vehicles.

2.1.1 History of Electric Vehicles

Practical electric car of the world for the first time was introduced by Thomas Parker in 1884 in Wolver Hampton. He himself has designed high-capacity batteries that were rechargeable and used the same in that electric car (Wakefield, 1993).

Figure 7: Thomas Parker's first ever electric car (1884)

Next electric car was designed and developed by Andreas Flocken (a German inventor) in 1888. Name of the car was Flocken Elektrowagen. This car is recognized as first practical electric car (Guarnieri, 2012). In the earlier years of 20th century a total of 2000 electric vehicles were produced by a New York based company "Electric Vehicle Company". Electric Cars were preferential in the late 19th and initial 20th century because of electric starting, easy operating and the level of comfort which was not offered by internal combustion engine vehicles of that time. Globally on road electric vehicles reached the number up to 30000 units in early 20th century. Electric cars were first used commercially as cab in New York in 1987. At the time when cabs were horse-driven Walter Bersey's electric taxi was the first ever electric taxi company of the world. But with the invention of electric start and increase in comfort level of gasoline vehicles, electric vehicles started becoming less priority of the consumer (Thiel, Tsakalidis, & Jäger-Waldau, 2020)as the major issue in that time of electric vehicles was of charging the batteries, speed and range of the vehicle (Noel et al., 2020). Bersey's electric taxi could be driven up to 30 miles only after it is fully charged. It has the maximum speed of 9 mph. The charging infrastructure could not be developed, speed and range could not be increased enough to meet these issues. The gasoline vehicles became more popular and the electric vehicles started vanishing from roads (Kubański, 2020)

2.1.2 2nd Phase of Electric Vehicles

The development of Metal Oxide Semiconductor (Javadi & Zarea) equipment enabled the development of second generation electric vehicles. In 1969 the MOSFET (MOS field-effect transistor, or MOS Transistor), made-up in Bell Labs by Mohamed M.

Atalla and Dawon Kahng in 1959, made it possible for Hitachi to develop the power MOSFET (Oxner, 2020). The power MOSFET and the microcontroller (developed by Intel), brought novelty in electric vehicles technology. MOSFET power converters made it possible the operation at higher switching frequencies, driving became easy, power losses reduced, and the prices considerably reduced, while single-chip microcontrollers were able to run all features of the drive control and could manage battery administration as well (Gosden, 1990).

2.1.3 Modern Electric Vehicles

In 1980s Rachid Yazami, John Good enough, and Akira Yoshino invented lithium-ion batteries. This technology increased the mileage of electric vehicles and made the electric vehicles highway capable long distance travelling vehicles. A California based electric automobile company "Tesla" started working on electric vehicles using lithium-ion batteries in 2004. In 2008 Tesla launched the first ever highway electric car named as Roadster; this car was the first fully electric car that could travel more than 300 kilometers on single charge by using lithium-ion batteries.

Figure 8: A Lithium-ion Battery

Figure 9: Tesla Roadster, the first ever highway electric car

2.1.4 Types of Electric Vehicle

Electric vehicle are of different types, some vehicles solely rely on batteries and the batteries have to be recharged before fully discharging, while some vehicles have alternate energy source like hybrid vehicles. There are following four popular types of electric vehicles: -

(1) Battery Electric Vehicles (BEV or EV). This type of vehicle is called fully electric vehicles as it contains no alternate energy source. This type of vehicle has no engine instead electric motors are used to move the vehicle. These

motors use power stored in installed packs of batteries. These batteries can be recharged by plugging into an electric power source. These vehicles are also known as Battery Electric Vehicles (BEVs) (Khurana, Kumar, & Sidhpuria, 2020). There is no alternate energy source in this type of vehicles which means if the batteries run out of charge, the vehicle cannot move until it is recharged (Shetty et al., 2020). Tesla Model S is the world's most selling battery electric vehicle. Tesla model S has become "the entire time best-selling electric car". AUS based motor trend magazine has awarded the title of "ultimate car of the year" to the Tesla Model S. Tesla model S has achieved the mark of 500,000 units sold in March 2020. The second best-selling electric car in the world is Nissan Leaf which has achieved 500,000 sale targets in December 2020.

Figure 10: Tesla Model S, a Battery Electric Vehicle

Figure 11: Nissan Leaf, a Battery Electric Vehicle

(2) Hybrid Electric Vehicles (Sotnyk et al.). A vehicle that contains both gasoline engine and electric batteries as a power source is called hybrid electric vehicle. This type of vehicle gets its energy simultaneously from a fuel (e.g. petrol) engine and an electric motor. The gasoline engine and the electric motor both works together to move the car, this helps to increase the fuel economy of the vehicle (mileage per litter). The engine also uses fuel to help recharge the car's battery which powers the electric motor (ROBINSON & RAJAVIGNESH, 2020). HEV is of two types, Series Hybrid Electric Vehicle (Series HEV) and Parallel Hybrid Electric Vehicle (Parallel HEV). In Series HEV, the electric motor is powered by engine through generator. Vehicle starting and stopping is managed by engine with less fuel consumption. While in Parallel HEV vehicle gets its energy simultaneously from petrol and electric motor, which reduces fuel consumption (Naseem, Uddin, Rashid, Chishti, & Naseem, 2019). Toyota Prius, Toyota Aqua, Honda Vezel are the best-

selling hybrid electric vehicles in Pakistan. These cars are not being manufactured/ assembled in Pakistan. People in Pakistan import these cars as reconditioned cars and are available in price ranging from two million PKR to four million PKR in used condition.

Figure 12: Toyota Prius XW50 fourth Generation, an HEV

(3) Plug-in Hybrid Electric Vehicles (PHEV). Plug-in Hybrid Electric Vehicles (PHEVs) have a minor difference from Hybrid Electric Vehicles. This type of vehicles contains small engine and larger batteries. The vehicle uses electric power from batteries primarily to move. The vehicle only switches on the engine when the batteries are out of charge. PHEVs use engine as a back-up power source only. The batteries can only be recharged by plugging into an electric charging point. The engine does not recharge the batteries unlike Hybrid Electric Vehicles (ROBINSON & RAJAVIGNESH, 2020). The Mitsubishi Outlander PHEV is the best-selling PHEV in the world. (Press release, Tokyo: Mitsubishi Motors Corporation. 04-11-19)

Figure 13: Mitsubishi Outlander, a PHEV

(4) Hydrogen Fuel Cell Electric Vehicles (FCEV). FCEV is a vehicle that uses fuel cell. The fuel cell used by FCEVs is called “Hydrogen fuel cell stack”. This stack includes enough cells to move the vehicle. The stack constantly provides

power until the fuel cells are available. The vehicle can easily be refilled with compressed hydrogen from hydrogen stations like Compressed Natural Gas (CNG) vehicles. FCEVs use oxygen from air and compressed hydrogen from hydrogen fuel cell stack to generate electricity to power the vehicle. This process only produces water hence provides zero emission (Li, Long, Chen, Chen, et al., 2020). Toyota Mirai is an example of FCEV. It has the range of 502 kilometers. It is one of the first FCEV to be sold commercially. Hyundai Xcient is the first mass produced fuel cell commercial truck. It is a hydrogen fuel cell-powered 34-ton cargo truck. Its range is 400 kilometers on a full tank and tank takes from eight to twenty minutes to fill up.

Figure 14: Toyota Mirai, an FCEV

Figure 15: Hyundai Trago Xcient, an FCEV Truck

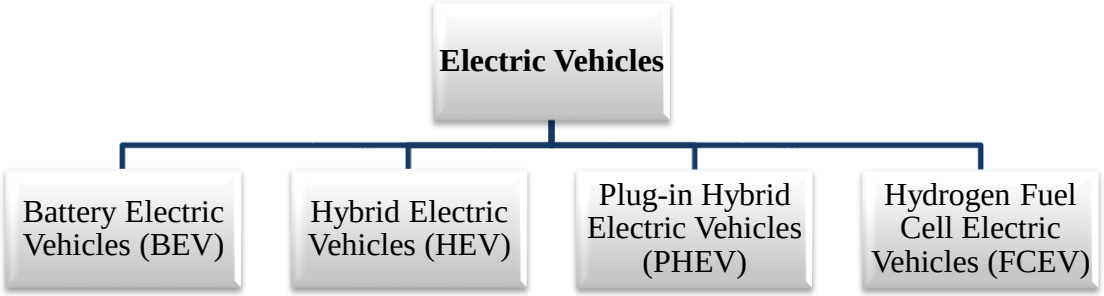

Figure 16: Types of electric vehicles

2.1.5 Price of Electric Vehicle

Electric vehicles contain packs of lithium-ion batteries which are major component of the vehicle. The batteries contribute in with maximum share in the total cost of the vehicle. Electric Vehicles are much expensive as compare to their equivalent Internal Combustion Engine vehicles. Following table shows the top six electric vehicles of the world with the prices of their highest variant:

Table 4: Top six most selling electric vehicles, their price and number of units sold till December 2020 (Statistica 2021)

Car Make and Model	Units sold till End of 2020 (Globally)	Variant	Showroom Price (in USD)
1. Tesla Model S	645,000	Plaid +	139,990
2. Nissan LEAF	490,000	SL Plus	44,845
3. Tesla Model 3	305,000	Performance	54,990
4. Renault ZOE	231,000	Zoe-s	27,250
5. BAIC EU	203,000	EU-5	19,713
6. BMW i3	191,000	i3-S	47,650

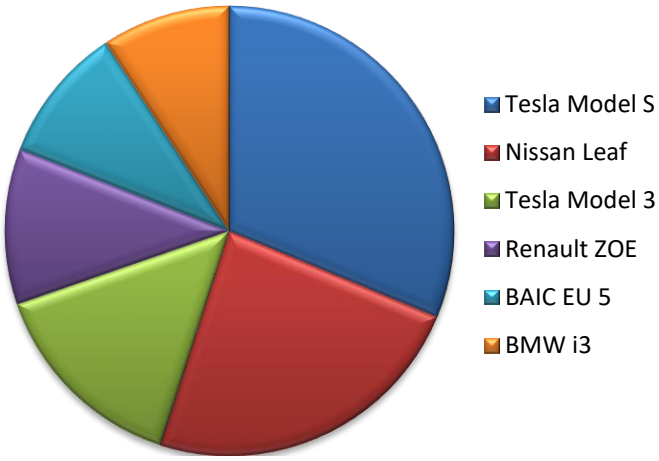

Figure 17: Top six electric vehicles global sales till December 2020 (Statistica 2021)

The lowest price highway electric car is a China made BAIC EU-5 in this list, which costs only $19,713 (3.15 million PKR) only at showroom.

Figure 18: BAIC EU-5 Sedan Car, Made in China

2.1.6 Battery Power and Range of Popular Electric Vehicles

Table 5: Top six most selling electric vehicles, their battery capacity and mileage per single charge (Statistica 2021)

Car Make and Model	Variant	Battery (kilowatt)	Mileage per single charge
1. Tesla Model S	Plaid +	100 kW	837 Kilometers
2. Nissan LEAF	SL Plus	62 kW	362 Kilometers
3. Tesla Model 3	Performance	78 kW	507 Kilometers
4. Renault ZOE	Zoe-s	52 kW	392 Kilometers
5. BAIC EU	EU-5	53.6 kW	458 Kilometers
6. BMW i3	i3-S	42.2 kW	246 Kilometers

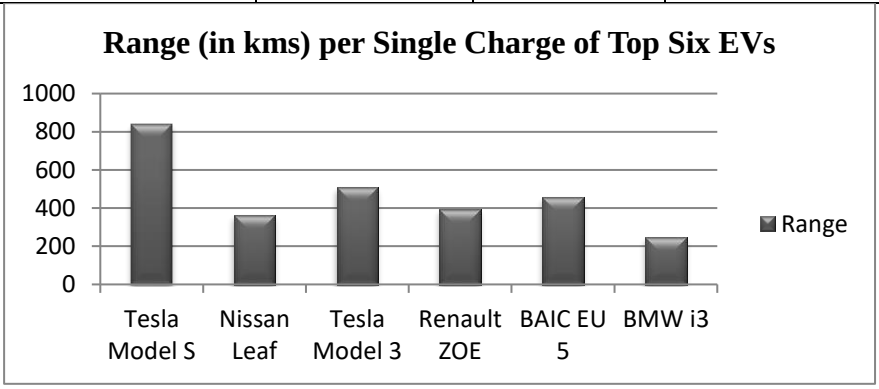

Figure 19: Range (in kilometers) per single charge of Top six EVs (Statistica 2021)

2.1.7 Charging Time

Charging times depend upon the size of battery pack's type of charge, its capacity, charger type, connection type and voltage available (Fang et al., 2020). A house hold charger connected with 120 voltages/ 15-amp connection charges a car for a range of six km for every single hour of charging. While a ten kilowatt charger connected with 240 Voltage / 50-amp connection increases the range of vehicle at the rate of forty six kilometers per hour of charging. This means a Tesla Model S, Plaid+ having battery pack which has capacity of 837 km will be fully charged with such a charger in eighteen hours. Latest electric cars have dual charging capacity i.e. twenty kilowatts. Such a vehicle can be charged with High Power ten kilowatt Charger connected with 240 Voltage connections charges the battery of the vehicle and increased its range at the rate of 92 kilometers per hour of charging. This can charge the above mentioned vehicle in around nine hours. Direct Current Fast Charging (DCFC) is the fastest charging way to charge an EV. This can charge a vehicle of 85 KWh within an hour.

Figure 20: An image of DCFC (Direct Current Fast Charging)

2.2 Pakistan Auto Industry Analysis

National Electric Vehicles Policy is directly linked with the transport industry in Pakistan. Transport industry plays a fundamental role in the development of the country. It provides employment to 3.5 million people in the country. Pakistan holds 22nd largest roads network in the world with 270,971 km lengths of roads and 7791 km lengths of railway lines. Roads include 13000 km national highways and motorways; 93000 kilometers of provincial highways and rest are district and rural roads. The ranking may be improved with development of China Pakistan Economic Corridor (CPEC) (Division, 2019-20)

2.2.1 Transport Statistics

Pakistan is a country with low motorization rate. Total number of registered vehicles in the country is29.05 million out of which 22.843 million are two and three wheelers, 2.337 million are commercial vehicles / busses / trucks etc and only 3.87million are passenger cars, jeeps and cabs which is just 13.32 % of total vehicles. Details data has been presented in Table 6

Table 6: Number of Registered Vehicle in Pakistan (June 2019) (Statistics, 2020)

Type of Vehicle	**Number of Registered Vehicles (Million)**	**Percentage of Total Registered Vehicles**
Cars / Jeeps	3.87	13.32%
Trucks / Busses	0.54	1.86%
Motor Cycles	21.927	75.48%
Auto Rickshaws	0.916	3.15%
Other/ Commercial Vehicles	1.797	6.19%
Total	**29.05**	

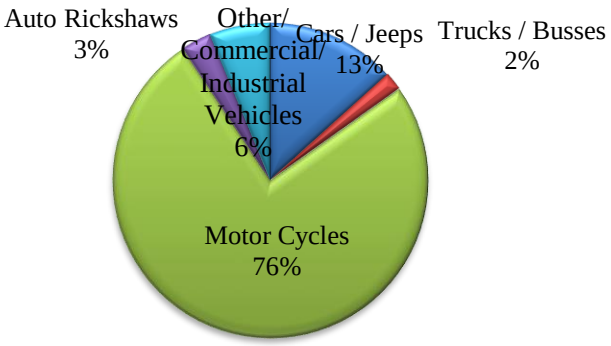

Figure 21: Percentage share of type of vehicles in Pakistan (Statistics, 2020)

2.2.2 Motorization Rate

Motorization rate means passenger vehicles per 1000 people. Motorization rate in Pakistan is only 15.4 which mean only fifteen in every 1000 people own passenger cars. While the lowest price passenger car in Pakistan is United Bravo 800 cc which is available at 6017 USD. It means this ratio can be increased by spending just 6017 USD per person. Comparison of Motorization rate of Pakistan with the neighbor countries along with comparison of their Gross Domestic Production, Per Capita Income and lowest price passenger car are mentioned in table 7.

Table 7: Motorization Rate, Gross Domestic Production and Per Capita Income

Country	Motorization Rate	Gross Domestic Production (USD in millions)	Per Capita Income (in USD)	Lowest Price Passenger Car (Show Room Price in USD)
Pakistan	15.4	304.567	1400	6017 USD (United Bravo, 800 cc)
Bangladesh	2.63	249.711	1520	10107 USD (Suzuki Alto 800 cc)
Sri-Lanka	33.4	87,422	3870	3772 USD (Renault Kwid, 800 cc)
India	19.7	2,651,000	1820	5038 USD (Suzuki S-Presso, 1000 cc)

(Library, 2021) (Bank, 2021) (CCP, 2021) (Wheels, 2021) (Bangla, 2021)

To idenify the relationship of car prices with motorization ratio and to make it more precise, let's have a look on car prices of similar models in all above countries.

Table 8: Similar Car prices in neighbor countries (lowest variant price in USD)

Country	Suzuki Swift 1200/ 1300 cc	Suzuki Cultus 1000 cc	Toyota Corolla 1800 cc	Honda City 1500 cc
Pakistan	11519	9667	20905	17634
Bangladesh	16065	N/A	49072	38556
Sri-Lanka	12167	11187	20858	22670
India	7796	6197	19990	14873

(CCP, 2021) (Bangla, 2021) (Wheels, 2021)

If we throughly observe the both tables we will come to know that per capita income and car prices both are linked with motorization rate. Bangladesh has lowest motorization rate due to 2nd lowest per capita income and highest vehicles prices. While India has 2nd highest motorization rate due to 2nd highest per capita income and lowest car prices. Pakistan has a high car prices market and low per capita income thus has a low motorization rate.

2.2.3 Automobile Industry in Pakistan

Automobile industry is one of rapidly growing industries in Pakistan. It contributes 2.8 % of the Country's Gross Domestic Production (GDP) and pays Rs.30 billion in the form of taxes and duties. Investment in Automobile industry is estimated to Rs.92 billion. The industry is manufacturing / assembling around 200,000 vehicles and 1.8 million motorcycles per annum. It is fastest growing automobile industry in Asia. Due to the attractive Auto Policy of 2016 it has grown 171 % from 2014 to 2018. The Auto policy 2016 offered various attractive incentives to the investors like duty free import of plant and machinery for establishing the assembly/ manufacturing facility, import of 100 Completely Built Units (CBUs) of the model/variant before starting its manufacturing for testing the market at 50 % of duty, 10 % waiver on custom duty on non-localized parts for manufacturing of small vehicles (LTVs), 25 % waiver on custom duty on localized parts for manufacturing of small vehicles (LTVs) and less duty on import of parts for manufacturing of trucks and heavy transport vehicles.

These attractive incentives in Auto Policy 2016 opened up gateway to many new auto manufacturers including Hyndai, Kia, Faw, MG, Changan, United, Proton and Prince. These new entries in automobile industry have created a competitive environment for

three big companies i.e. Toyota, Suzuki and Honda. Total vehicles (less two and three wheelers) sales in Pakistan remained around 200,000 vehicles per annum less 2018 in which a record 339,772 vehicles sales have been observed in the country. Vehicles sales from 2011-12 till 2020-21 have been presented in Table 9.

Table 9: Number of Vehicles Sold in Last Ten Financial Years ((PAMA)), 2021 #214)

Fiscal Year	Number of Passenger Cars Sold	Other Vehicles Sold (HTV, Jeeps, Vans, Pick-Ups Tractors)	Four (and more) Wheeler Vehicles Sold	Two /Three Wheelers Sold	Percentage Change in Vehicles Sales	Percentage Change in Two / Three Wheelers Sales
2011-12	157325	74,562	231,887	829,893		
2012-13	118830	69,531	188,361	820,217	-18.77%	-0.01
2013-14	118102	55,610	173,712	772,046	-7.78%	-0.06
2014-15	151134	80,299	231,433	766,733	33.23%	-0.01
2015-16	181145	77,087	258,232	1,358,643	11.58%	0.77
2016-17	185781	90,959	276,740	1,630,735	7.17%	0.20
2017-18	**216786**	**122,986**	**339,772**	**1,931,340**	**22.78%**	**0.18**
2018-19	207630	90,184	297,814	1,781,959	-12.35%	-0.08
2019-20	96455	51,881	148,336	1,370,005	-50.19%	-0.23
2020-21	151182	85,482	236,664	1,903,932	59.55%	0.39

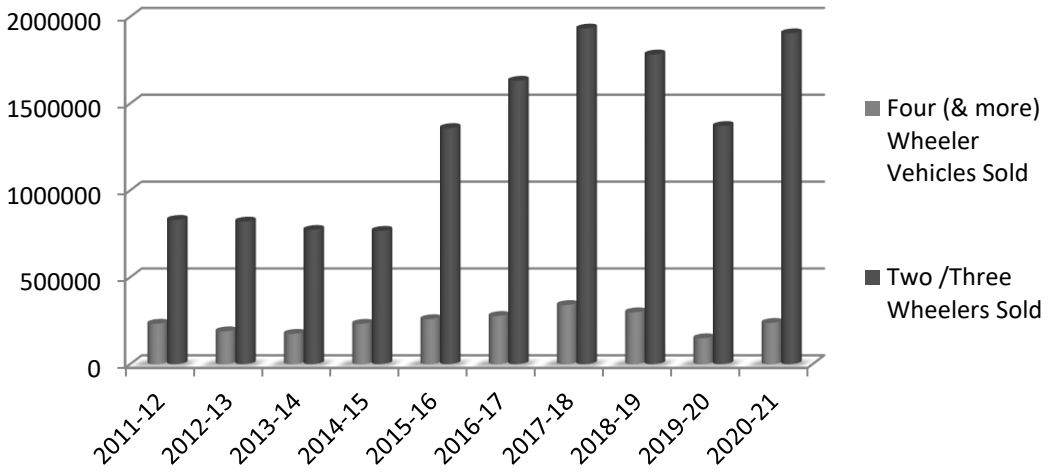

Figure 22: Sales of Vehicles in Pakistan 2011 to 2021 ((PAMA)), 2021 #214)

If we observe the percentage change in sales of vehicles we will realize that vehicles sales have been increased dramatically in the period from 2014 to 2018. In 2014-15 a record 33.23 % change has been monitored in vehicles sales. From FY 2018-19 vehicles sales started decreasing may be due to political situation created in connection with shift of government after general elections 2018 of the country as we have observed the similar decrease during 2012-13 after general elections 2013. A major decrease in the vehicles sales has been observed in year 2019-20 due to worldwide restrictions amid COVID-19 pandemic. Vehicles sales have been decreased in year 2019-20 by more than 50 %. But in the very next year i.e. FY 2020-21 when the COVID-19 restrictions were removed / relaxed, a dramatic increase 59.9 % has been observed in vehicle sales in Pakistan. Figure6 describes percentage change in sales of vehicles from 2012 to 2021.

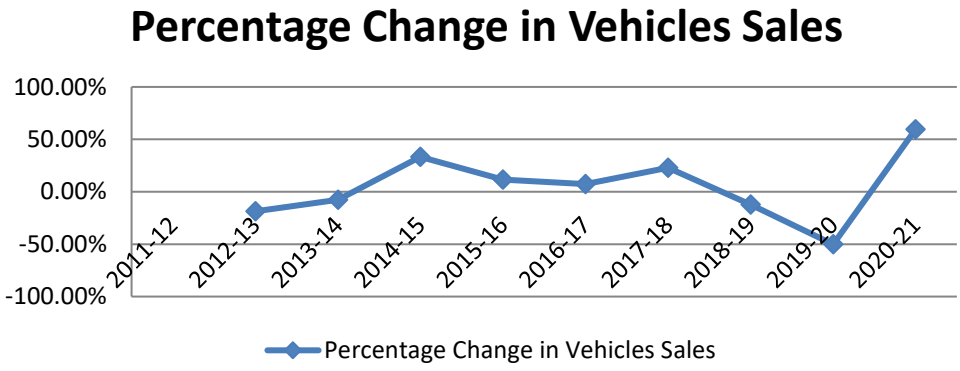

Figure 23: Annual Percentage Change in Vehicles Sales in Pakistan

2.2.4 Impact of Transport Sector on Environment

Transportation plays vital role in the development of the country, quality roads, upgraded railway tracks, and national and provincial highways are primary requirement for economic development. However, the transport in urban areas and on national highways is threat to the environment. The air pollution due to transport in big cities of almost all countries has remarkably increased during the last few years. The GHG emission by transportation is dangerous as it is increasing the overall temperature of the earth. GHGs include Methane (CH^4), Carbon Dioxide (CO^2), Nitrous Oxide (N^2O), per fluorocarbons (PFCs), Hydro fluorocarbons (HFCs), Sulfur hexafluoride (SF^6) and Nitrogen trifluoride (NF^3). Transport sector emits

Carbon Dioxide (CO^2) as principle gas and Methane (CH^4) and Nitrous Oxide (N^2O) as secondary gasses.

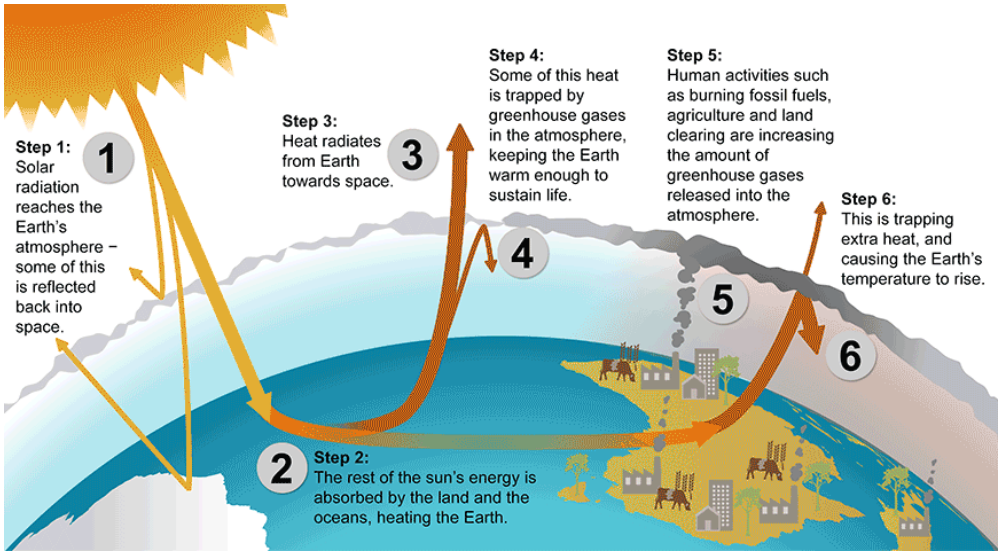

Figure 24: How do GHGs are affecting the earth

2.2.5 Impact of Transport Sector on Environment in Pakistan

Transport sector in Pakistan use petroleum products and gasses to fuels the vehicles. In 2019 transport sector consumed 15,549,796 tons of petroleum products (Petrol / Diesel etc) and 1,523,315 million cubic feet Compressed Natural Gas (CNG). Total energy consumed by transport sector in 2019 is 1707311 Tons of Oil Equivalent (Statistics, 2020). Percentage of share of GHG emission by sector has been presented in Figure. 25.

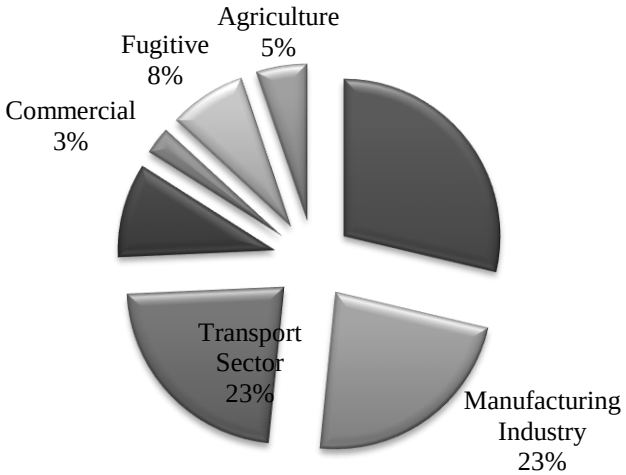

Figure 25: Percentage share of GHG emissions by sector in Pakistan (Mir, Purohit, & Mehmood, 2017)

It is important to highlight here that Pakistan is emitting only 1.2 tons CO^2 per capita per annum in total in which transport share is only 23 %. Pakistan is ranked at number 108 from 131 countries in CO^2 emissions. If we divide all 131 countries into eight groups, Pakistan is in the 2nd lowest group. In addition to that as per Pakistan Updated Nationally Determined Contributions 2021 Pakistan has achieved a target of 8.7 % reduction in GHG emissions in 2018 and after lockdowns, industrial shut downs and transport closure due to COVID-19 restrictions, the GHG emissions may have been reduced further in Pakistan. It means that the GHG emissions in Pakistan are not at alarming level.

2.3 Public Policy and its Role in Adoption of Electric Vehicles

Government bodies make law and policies, and distribute resources to the different parts of the society as per their requirements (Peters & Pierre, 2006). Public policy can be defined as regulatory actions, laws, rules and funding priorities concerning a given topic disseminated by a governmental body or its representatives or purposive course of actions or inactions undertaken by an actor or set of actors (Bernier & Clavier, 2011). Role of public policy started with initiation of the step to reduce the emission of GHGs. Introducing electric vehicles again and their widespread adoption was to save the earth using environment protection policy by contributing in reduction of the GHG emissions. Different countries announced their Electric Vehicles Policies with different features but the major purpose of the policy was to encourage widespread adoption of electric vehicles (Joshi, Malhotra, & Singh, 2022). For this purpose, different incentives are being offered by almost all countries having EV policy. Automobile industry is able to only develop the vehicle and trying its best to reduce the cost and increase the range as much as possible but this sector is unable to encourage people for adopting a new type of vehicle having less reliability and high price. Here comes the role of policy scientist. By introducing incentives through announcing electric vehicles policy, they are encouraging people to purchase a new type of car and increasing rate of adoption creating attraction in the electric vehicles (Lopez-Arboleda, Sarmiento, & Cardenas, 2021).

2.4 Electric Vehicles Policy

In 1990, California was the first state to introduce the regulations for Zero Emitting Vehicles (ZEVs) which require from auto manufacturers to produce at least two % ZEVs (Kubański, 2020). This was the first ever policy for electric vehicles.

2.4.1 Electric Vehicles Policies in the World

Various countries now have worked on electric vehicles policy and have set targets for adoption of electric vehicles. Some of them are being discussed as under:

Electric Vehicles in California. In 2009 the California Public Utilities commission (CPUC) introduced the first Policy for Alternate Energy Source for Vehicles (R.09-08-009). In March 2012 the Governor of California Mr. Jerry Brown set a goal of 1.5 million vehicles in California by 2025 that emit zero % by issuing an executive order. In January 2018 the Governor set a new goal of five million Zero Emitting Vehicles on the roads by 2030 and 250,000 electric vehicle charging stations by 2025 (Kubański, 2020).

Electric Vehicles in USA. The Electric Vehicle Research, Development, and Demonstration Act, enacted in 1976 after the Congress overrode the President's veto in USA. The percentage share of Electric Vehicles as compare to Conventional Vehicles is quite low. Electric Vehicles sale is only one % of all 146 million new light duty vehicles sales from 2011 to 2019. Total sale is 245,000 in year 2019 with Tesla selling 80 % of this Figure (Klee, 2021).

Electric Vehicles in China. China took initial start of electric two wheelers in 1960 but failed. In the first decade of 21st century China witnessed an extra-ordinary growth in electric motorcycles. The sale of electric motorcycles increased from 56000 in 1998 to 21 million in 2008 as compare to 9.4 million four wheelers. In 2001 China started a project for electric vehicles named as "863 EV Project". The National Development and Reforms Commission China introduced Auto Industry Development Policy in 2004 and 16 Chinese state owned companies formed the Chinese Electric Vehicles Association Chinese increased spending more money on manufacturing of electric vehicles (Lu et al., 2020). In 2007 300 million dollars were invested in EVs. In 2018 China witnessed the record sales of PHEVs i.e. 1.2 million vehicles which is more than three times than the sale in US and more than 50 % of the

sales of electric vehicles in entire world. China is currently making 99 % electric buses of the world. This all happened more due to policy development and less due to technological development (Wu et al., 2021).

Electric Vehicles in Europe. European Union issued Air Quality Directives in 2008. According to the European Alternative Fuel Observatory (EAFO) till 2010 there were less than 1500 electric cars registered in Europe. The policies of different European countries offered several incentives to encourage the sale of electric vehicles due to which the sale increased up to 0.3 million till 2017 and passed one million in 2020 (Konečný et al., 2020).

Electric Vehicles in UK. The British Government after signing 2015 Paris agreement has set a target of net zero Green House Gas emission by 2050 as part of the global effort to undertake climate change. Despite sale of more than 0.2 million electric vehicles till the end of 2019, still they are only 0.8 % of total vehicles sales (Logan, Nelson, & Hastings, 2020).

Electric Vehicles in India. India is fourth largest Green House Gas emitter and third largest vehicle market in the world. Out of 40 most populated cities of the world, 20 cities are located in India and out of 20 top polluted cities of the world, 14 are situated in India (Kumar & Bharj, 2020). National Electric Mobility Mission Plan (NEMMP) 2013 was the first ever EV plan in India. The government has set target to sale 30% EVs of total vehicles sale. Total Electric Vehicles (including two and three wheelers) sale in India till June 2020 is recorded as 136000 units out of which only 3400 are four wheelers (Ram, 2020).

Electric Vehicles in Sri-Lanka. The Federal Finance Minister of Sri-Lanka has expounded a tactical plan for converting CVs to EVs gradually. They have set a target of replacement of 100% vehicles to non-fossil fuels by 2040. In the gradual process of implementing the policy, they have estimated that 2 to 3 % of on road vehicles in Sri-Lanka will be electric by 2030 (Bandara, AN, Perera, & SWGK). Therefore, Government of Sri-Lanka has reduced taxes on import of HEVs and BEVs up to 50 % of the price of vehicle while the rate of tax on other vehicles in 200% to 300 % of price of vehicle. The government has provided tax exemptions to EVs in the form of waiver in custom duty by 62.5 % for EVs up to 100 kW. In spite of attractive

incentives being offered by the Government of Sri-Lanka, still the demand for EVs is not increasing and till 2021, from total on road vehicles, there are only 0.11 % EVs (DE SILVA & KUMARAGE).

Electric Vehicles in Nepal. First Electric Vehicle in on roads of Nepal was found in December 1975 when China provided assistance to Nepal in construction of a 13 KM distance covering Electric Trolley Bus in Kathmandu. Nepalese government started working on Electric three wheelers and in early 1990s they were able to convert six conventional three wheelers into electric three wheelers with the help of USAID. However in spite of early action in the EV sector, Nepal could not continue her efforts in developing the EV industry (Mali et al., 2022) (Ghimire, 2019). Till this time there was no policy development and no target was set for adoption of EVs so Nepalese government initiated NAMA Support Program NSP and set target that 20 % will be EVs in all public transport vehicles and among all new mini buses, there will 85% Electric till 2030. Due to a big pause in the development of EV sector in spite of early initial start, there are only less than 1000 electric vehicles on road in Nepal (Karki et al., 2019).

Electric Vehicles in Thailand. Thai government's first EV policy was launched in 2015. Later on another policy named as Energy Efficiency Plan EEP 2015 was launched, through which first target was set to have 1.2 million EVs on road by 2036. Then the National Science % Technology Development Agency (NSTDA) prepared and issued its plan for manufacturing at least 1000 electric busses every year (Kongklaew et al., 2021). To support this plan, the finance ministry provided assistance by waving taxes and custom duties in import of electric vehicles and their parts. Board of investment approved investment in EV industry (Chinda, 2022). After putting in so many efforts, the roads in Thailand can only witness less than 8000 EVs till the end of 2021. Major challenges to EV industry in Thailand are less developed charging infrastructure, range of EV, battery life and the reliability of vehicle (Wattana & Wattana, 2022).

Electric Bikes. Electric bikes / motorcycles are becoming first priority of many developing countries as they are comparatively easy to adopt due to less initial price and easy conversion. Small attention towards electric motorcycles can lead

towards big impact in context with adoption of EVs. India has focused on electric two and three wheelers and could be able to sale 132600 e-bikes and e-rickshaws till June 2020 (Ram, 2020). People in China prefer bikes on cars for daily use, so they preferred e-bikes upon EVs. China has reached 21 million on-road e-bikes in 2008 (Xiao, Chen, Wang, & Nie, 2020). Indonesian Government has set a target of 2.1 million e-bikes (Utami, Yuniaristanto, & Sutopo, 2020). Bikes emit less than vehicles and they consume less parking space as well (Severengiz et al., 2020). So the developing countries with less efforts on electric motorbikes can gain big impact.

2.4.2 National Electric Vehicles Policy (NEVP) of Pakistan

Pakistan has always remained concerned about the environmental protection issues and it is continuously struggling in the area of climate justice for over two decades. Pakistan has ratified United Nations Framework convention on climate change first time in 1994 and later also ratified different conventions on the climate justice, signed Kyoto protocol in 1997 and Paris agreement in 2015. Coming to the national legislation, Pakistan endorses the goals in the provisions of Kyoto protocol and Paris Agreement by formulating a National Climate Change Policy (NCCP) in 2012 (Khan & Deeba, 2020).

According to the World Bank, Pakistan has emitted 342 million metric tons of GHG in 2012. Transport sector is a major contributor in emitting GHG. Major energy sources used by transportation sector are gas and oil and both are 64 % of total energy mix. After development of China Pakistan Economic Corridor (CPEC) with conventional vehicles the Green House Gas emission and air pollution will become a major challenge in addition to the heavy cost of fuels. Ample opportunity exists for environment friendly and efficient transport system for Pakistan to implement electric transportation on CPEC, which could help the country to attain its INDC (Intended National Determined Contribution) goal of a 20% reduction in GHG emissions (Ul-Haq et al., 2020).

As per the statement of Federal Minister of Industries and Production, federal cabinet in Pakistan has approved the National Electric Vehicles Policy 2019 for two and three wheelers on 5th November 2019 and for commercial vehicles on 22nd December 2020. Salient features of the policy are: -

Tax Incentives. It includes removal of Additional Customs duty on imports of EVs only one % tax for Manufacturers on import of the Electric Vehicles spare parts, waiver in registration charges and annual token fee for Electric Vehicles in Islamabad, for locally manufactured EVs, only one % sales tax up to 50kwh, only one % duty on charging equipment's import, no duty on importing plant and machinery equipment for manufacturing of Electric Vehicles.

Goals for Vehicles Sales. Different goals have been set in the policy i.e. Passenger EV sales to constitute 30 % of new vehicles sales by 2030 and 90 % of new vehicles sales by 2040, two and three wheelers EV sales to constitute 50 % of new two and three wheeler vehicles sales by 2030 and 90 % of new two and three wheeler vehicles sales by 2040, electric busses sales to constitute 50 % of new busses sales by 2030 and 90 % of new busses sales by 2040, electric trucks sales to constitute 30 % of new trucks sales by 2030 and 90 % of new trucks sales by 2040.

Goals for Developing Charging Infrastructure. To develop charging infrastructure, goals have been set that include one Direct Current Fast Charging (DCFC) station to be installed at every three kilometers distance in all major cities, one Direct Current Fast Charging (DCFC) station to be installed at every fifteen to thirty kilometers distance at all motorways, uninterrupted power supply to be ensured to all charging stations.

Policy has been approved but it has not become a part of the Auto Policy of the country. No special programs still initiated to start implementing the National Electric Vehicles Policy. No awareness campaigns have been launched for public awareness regarding EVs and NEVP.

2.5 Adoption of Electric Vehicles

Outcomes of electric vehicles policy can be depicted by evaluating adoption of electric vehicles. If the adoption is in good pace, it means the policy is working well but people are not adopting the EVs, it means the policy should be re-considered.

2.5.1 Key Factors Persuading the Adoption of Electric Vehicles

Key factors persuading the adoption of EVs are enlisted below

Developing Charging Infrastructure. Charging infrastructure plays major role in adoption of EV for consumers. Availability of public charging stations

nationwide especially on highways, motorways and roads leading towards tourism destinations (Brinkel et al., 2020). Availability of charging stations on less distance will increase reliability of the EVs and consumer will prefer EV in long distance travelling. Availability of charging stations on the way to tourism destinations will make tourists prefer EVs and families will feel comfortable using EVs while going on vacations. Availability of fast charging stations like DCFC countrywide will boost adoption of EVs. Because long charging time acts like a barrier in adoption of EVs (Bhattacharyya & Thakre, 2020).

Emerging Business Models and Public Policy Support: Adoption of EVs is being encouraged throughout the world by attracting buyers towards EVs instead of ICE vehicles. Governments offer incentives for EV buyers like tax credit, low taxation rates etc. Such incentives attract customer towards EV (Wu et al., 2021). More incentives and more attractive offers play the role of boosters in adoption of EVs. On the other hand, various governments attract manufacturers by providing them incentives and similarly incentives are being provided to the charging stations owners.

Switching Intention of Consumers. Widespread EV adoption is possible when customer will start preferring to own EV as compare to ICE vehicles and customers will start switching from ICE vehicles to electric vehicles (Asadi et al., 2021). When the prices of EVs will be dropped as compare to ICE vehicles and maintaining EV will be easier and cheaper than ICE vehicles, taxation will be lesser; the customers will starts switching from ICE vehicles to electric vehicles.

Retail Price of EV. Initial retail price of EV is major barrier in adoption of EVs in current era because the initial price of EV is multiple times higher than the parallel ICE vehicle (Dong, Zhang, Wang, & Wang, 2020). So the retail price is one of the most important key factors in influencing the adoption of EVs.

Range and Life of Batteries. Range of the vehicle on one single full charge is quite low currently. Therefore, people are still hesitating in adoption of the vehicles (Noel et al., 2020) (Lim, Mak, & Rong, 2015), because these vehicles are not suitable for long drives etc. Therefore, range of the vehicle must have to be increased in order to satisfy the customers.

Electricity Prices. Electricity prices in a specific region have a direct link with the adoption of EVs (C. Zhang, Greenblatt, MacDougall, Saxena, & Prabhakar, 2020). People compare the EV with CV by calculating per km cost. If the electricity prices are high and per km running cost of the EV is greater than that of a conventional vehicle, then the adoption of EVs could not be expedited.

2.5.2 Issues and Challenges in the Adoption of Electric Vehicles

Various scholars around the globe have identified several factors that are acting as barriers, issues and challenges in adoption of EVs. These factors have been enlisted as following:-

Comparison of EVs with CVs. Whenever new product / new technology is presented for sale, people compare it with existing one in price, features, ease of use, value for money and various other scales (Kwon, Son, & Jang, 2020). If the new product is comparatively better more beneficial than the existing one, it is adopted widely and vice versa (Hasan & Simsekoglu, 2020).

Social Norms. Social norms play important role in consumer's intention of witching from existing to new technology vehicles (W. Zhang, Wang, Wan, Zhang, & Zhao, 2022) (Utami et al., 2020). Society that is overall supportive towards government's actions adopt procedures and rules early as compare to the others. (W. Zhang et al., 2022)

Environmental Beliefs. People who are well aware of impact of environment on the human life and lives of other living things on the planet belives that the environment should be protected and it must receive less damage by human activities as much as possible (Collins & Chambers, 2005). Less or zero emitting vehicles are always preferred by such people. So environmental beleifs play major role in adoption of EVs. (Jain, Bhaskar, & Jain, 2022)

Resale Anxiety. Specifically, in vehicles context, resale value of vehicle plays major role in a specific vehicles market. If a specific model vehicle has no market for its used vehicles, then this clearly affects its market of new vehicles. (Patyal et al., 2021) (Lim et al., 2015)

Standards for Manufacturers. A good quality vehicle values for money and is accepted by the customer. EVs being expensive must have to be better in quality

than the CVs to receive preference by the customers. Therefore, there must be some set standards for manufacturers of EVs. (Gao, Leng, Zhang, & Liang, 2022)

Incentives through Policy. EVs have high initial costs so people are reluctant in spending so many funds on personal transport, so the governments offer various financial incentives that attract customers towards EVs (Gao et al., 2022) (Fang et al., 2020) (Lu et al., 2020). Similarly, incentives have been provided to the manufacturers as well. (Khurana et al., 2020; B. Lane & Potter, 2007)

Consistency in the Policy. New technology is any sector, especially where heavy funds are involved, takes time in widespread adoption, therefore if the policy to promote new technology is continuously changing, the customer will be reluctant to adopt (Hardman et al., 2020) so Consistent policy plays important role in adoption of new technology.

Support by all actors. Support from all government departments like taxation, vehicle registration and customs etc. is mandatory because if their policies are contrary to the EV policy then the EV policy would not be implemented successfully. (Khurana et al., 2020)

Electricity Prices. Electricity prices matter a lot for EVs just like oil prices matter for conventional vehicles. If the prices of electricity in any country are high or increasing rapidly, this will have a negative effect on the demand of EVs.(Ahmed & Karmaker, 2019)

Electricity Load Management / Supply. In addition to the prices, electricity generation and supply also matter. Non-availability of enough electricity in the country will lead to the rejection of EVs by the customers. (Vidhi & Shrivastava, 2018)

Charging Infrastructure. Charging stations are pre-conditions for widespread adoption of EVs. Charging infrastructure has to be developed prior to the focusing on promotion of EVs. (Goel, Sharma, Mathiyazhagan, & Vimal, 2021) Fast charging facility at homes can be meet the issue in a comparatively easy way. (Rastogi, Thomas, & Digalwar, 2021)

Battery Swapping Stations. As it takes some time to charge the vehicle, the alternate option especially for emergency vehicles is battery swapping stations. (Patyal et al., 2021)

Price of Vehicle. Vehicle price plays primary role in auto industry. High initial price is the principal disadvantage for EVs. Although engineers are working on introduction of low cost batteries but still due to high number of batteries EVs prices are remarkably high. (Patyal et al., 2021)

Running Cost of the Vehicle. If the customer is paying high initial price for a vehicle then he / she should enjoy less running cost for the same vehicle and if running cost is high as well, then how it would attract customers. (Agrawal et al., 2020)

Battery replacement / other Scheduled Maintenance Costs. Although scheduled maintenance cost is low as compare to CVs because there is no engine but battery life matters in this context. Battery pack replacement is a major expenditure after purchasing the vehicle. More battery life can decrease this expenditure and that will be another advantage of EVs (Rastogi et al., 2021).

Purchasing Power of the Buyer/ Per Capita Income. Per capita income of the county matters a lot for auto market. Motorization rate is always low in low income countries as their buying power is low so the vehicles go out of the affordability of the customer and EVs are expensive as compare to CVs (Shashank, Sairam, Reddy, Afreed, & Sridharan, 2020).

Speed, Range and Power of the Vehicle. All these aspects are related to the specifications of the vehicle. In comparison with CVs, if the speed of EV is less than CVs then this will act as a barrier in EVs adoption because in first era of EVs the low speed was one of the reasons in failure of EVs. Range means mileage of vehicle on full charge and it matters a lot especially for long driving. Powerful electric motor can compete well with internal combustion engine. (Karlsson, 2020; Panwar, Kumar, & Chakrabarti, 2019)

Reliability and Safety of the Vehicle. Reliability and safety are as important in EVs as they are in CVs. (Jena, 2020; Tiwari, Aditjandra, & Dissanayake, 2020)

Charging Time. One of the biggest barriers in adoption of EVs today is charging time (Wolbertus & van den Hoed, 2020). In today's world everyone is busy and have no or less free time. In this rapidly moving world, waiting for hours to charge the vehicle acts as one of the major barriers in adoption of EVs. (Rastogi et al., 2021)

These factors can be divided into following six categories*:* -

Social Factors. Social Norms, Environmental Beliefs (Verma, Verma, & Khan, 2020), Comparison of the EV with equivalent CV (Bansal, Kumar, Raj, Dubey, & Graham, 2021), Resale Anxiety (Lim et al., 2015)

Policy Factors. Incentives Offered to the buyers (Khurana et al., 2020), Incentives offered to the charging stations, Incentives offered to the manufacturers, Standards for Manufacturers, Consistency in the policy, Policy Implementation by all relevant stake holders

Infrastructural Factors. Battery swapping stations (especially for emergency vehicles), Charging stations on Highways and Motorways, Charging infrastructure at homes (Goel et al., 2021), Charging facility at work places (Rastogi et al., 2021)

Financial Factors. Purchasing power of the buyer / Per capita income, Purchase cost of the vehicle (Shashank et al., 2020), Running cost of the vehicle, Battery replacement cost, Scheduled maintenance cost (Rastogi et al., 2021)

Energy Factors. Electricity Prices (Ahmed & Karmaker, 2019), Electricity Supply (Vidhi & Shrivastava, 2018)

Auto Technology Factors. Range of the Vehicle (Panwar et al., 2019), Reliability of the vehicle, Charging Time , Safety of the vehicle (Jena, 2020), Top speed and power of the vehicle, Maximum battery life (Rastogi et al., 2021)

In Pakistan's context, the primary factors are financial factors. Pakistan is low income country. Per capita income is just 1190 USD per annum which is forty percent less than India (World Bank). Car prices in Pakistan are more than 200 % high as compare to India hence; it is very difficult for a middle class person to afford a new car. Currently the cheapest EV available in the country costs more than five million rupees so it is out of range of upper middle class even. This directly affects the infrastructural development, as there is less demand of EVs so there is less

requirement of charging infrastructure as well. Energy sector in Pakistan is also less developed. Despite of having enough electricity in national grid, still public is facing several hours of load shedding, which means the supply of power is not accurate due to whatever reason and government is unable to manage the existing demand of electricity, then how will the increased demand be managed if EVs are adopted in the country? Policies are constantly changing in almost every sector in Pakistan, even taxation policy of EVs have been changed several times since December 2020. So most of these factors can directly affect EV industry in Pakistan.

CHAPTER – 3: FRAMEWORK AND METHODOLOGY

3.1 Conceptual Framework

Electric Vehicles is a new phenomenon for the country and one theory is unable to fully address phenomenon therefore conceptual framework is used to show the relationship among ideas and to relate them with the study. Several factors have been identified by researchers (as mentioned in previous chapter) that can play important role in adoption of the EVs for successful implementation of the National Electric Vehicles Policy of Pakistan. Main factors are *Social Factors, Policy Factors, Energy Factors, Infrastructural Factors, Financial Factors, and Technology Factors*.

Each of the above factors has several sub factors and these sub factors directly affect the factors that are affecting the adoption of EVs, hence playing the role of barriers in implementation of EV Policy. Based upon those factors, following conceptual framework has been prepared.

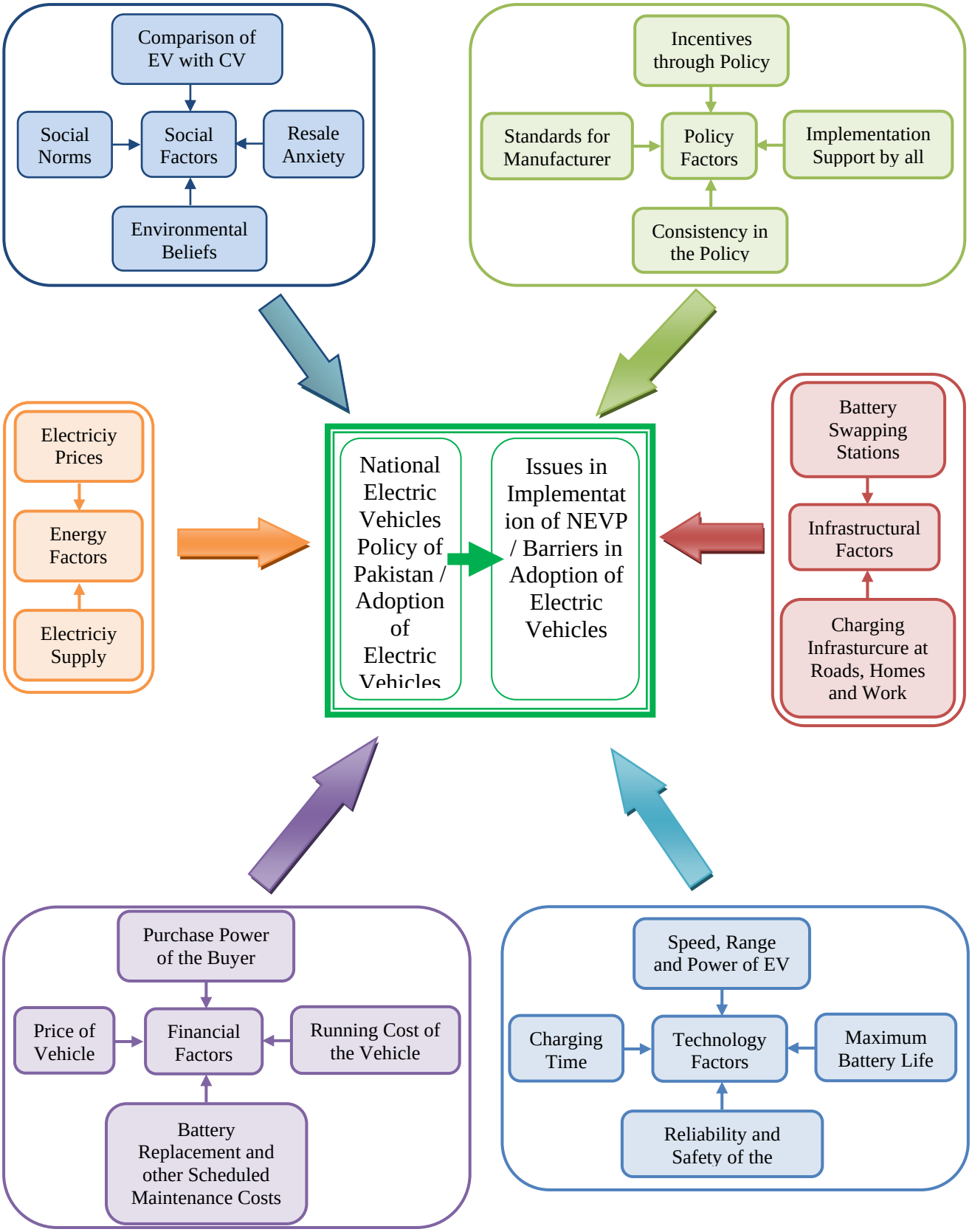

Figure 26: Conceptual Framework

3.2 Research Paradigm

3.2.1 Philosophy / Approach

Electric Vehicles adoption is a social and new phenomenon which is directly linked with the health of human being through the environment. This phenomenon is interpretative and constructed socially, and is subjective and there may be multiple beliefs regarding this reality and there is no single truth. Thus, the research paradigm of this study is *Interpretativism and Constructivism.* As per the interpretativism approach, it is impossible to separate facts from values and belief of the people. (Kincheloe, McLaren, & Steinberg, 2011). From the interpretativist point of view, fundamental relationships construct or explain certain aspects of the society for which the research is being carried out. Instead of finding an exact match between the reality and the research findings, this approach constructs the reality through the findings. (Bowen, 2009; Kincheloe et al., 2011). As per the Constructivist believe that there is no single truth and there are multiple veracities (Guba & Lincoln, 1994). This interpretative / constructive paradigm believes that people using their society / social gatherings construct knowledge. (Gregg, Kulkarni, & Vinzé, 2001). Consequently both constructivism and interpretativism are being used to study the customs and mores of the society and thus, will help attaining an extensive view of people's beliefs. This paradigm allows the researcher to build new notions on the basis of observations and experiences of others (Gregg et al., 2001). Constructivism and interpretativism paradigm in this study will help us to determine the factors that are acting as barriers in implementation of NEVP.

3.2.2 Ontology

It is about the nature of reality. Ontology is a system of facts and beliefs that reflect the understanding of an individual about the composition of the reality. In simple terms, ontology is associated with what we consider as reality. In this case the ontology is subjective.

3.2.3 Epistemology

Epistemology deals with the sources of knowledge and is concerned with nature of the study, its sources and possibilities. In simple terms the researcher describes the composition of the knowledge through epistemology.

EVs adoption is a new phenomenon and there are various aspects that directly or indirectly affect EV adoption including behavior and norms of the people, future of EVs, reliability and other financial and technological factors etc. So it is a social phenomenon and is subjective.

3.2.4 Methodology

Being a new concept of study and several factors to be identified that influence adoption of EVs, qualitative method is adopted. Only a few samples are available in the country. Non-probability, snow ball sampling is used.

3.3 Research Design

Research design is the track of the whole research process in an organized mode (Creswell, 2014). It describes the precise route for the entire research process and it must be espoused according to the nature of the research questions (Creswell, 2014; Creswell & Clark, 2011; Leech & Onwuegbuzie, 2009). In this study, as the title depicts, it is a case study research where qualitative methods is used. Detailed research design in explained in following table:

Table 10: Research Design

Objective of the Research	Objective of the research is to analyze issues and challenges in implementation of National Electric Vehicles Policy in Pakistan and give suggestions for the better implementation of the policy
Research Question	What are the issues and challenges in implementation of the National Electric Vehicles Policy in Pakistan?
Sampling Technique	Non-Probability, Snowball sampling is used.
Data Collection	Data is collected through In-Depth Interviews.
Data Analysis	Data is analyzed through Thematic Analysis.

3.4 Justification of the Case Study Research

Case study has been chosen due to the nature of objectives of the research and its proceedings. Case study approach is flexible in context of data collection like questionnaires and in depth interviews etc. (Punch, 2013).

3.5 Research Approach and Strategy

Electric Vehicles adoption is a social and new phenomenon for the world. It is directly linked with the health of living things especially human beings through the climate change issues. This phenomenon is constructed socially, and is subjective and there may be multiple beliefs regarding this. So interpretative and constructive approach is adopted.

3.6 Research Methodology

Qualitative method is adopted. Data has been collected through in-depth interviews and has been analyzed through Thematic Analysis. Details are being described in 3.7.

3.7 Qualitative Approach

Qualitative research is carried out to gain understanding of underlying reasons and motivations. Sample size is usually small. Data is collected through one-on-one interviews / focused group discussions etc and is analyzed non-statistically. Qualitative research is poor in number but good in quality. It consumes more time but gains more information. Qualitative approach has been adopted like (Noel et al., 2020), (Rezvani et al., 2015) and (Burgess et al., 2013) have adopted in their studies on EVs. Details of methodology used in this study are as under: -

3.7.1 Sampling Technique

Apart from the question that what exactly is being studied, "who will form the units of the study" also matters a lot. It is never possible to include all units of study in research, so a certain selection has to be made. In this case, elements in the population under study have no known chances of selection so this is Non-Probability sampling. Stake holders of the EVs i.e. owners, manufacturers and changing station owners / operators are very limited in the country and there is no data set that contains their information. So it is difficult to find the sample. One sample could know the other one e.g. charging station operators can provide information regarding EV owners. So there is an un-structured network among the samples through which samples can be identified and contacted. So this "Snow ball sampling" has been used in this study. It is called snow ball because a snow ball when it starts rolling down from top is small but with every moving down roll it becomes bigger and bigger. In qualitative research sample is less in number but rich in information. Sample size in this case is fifteen.

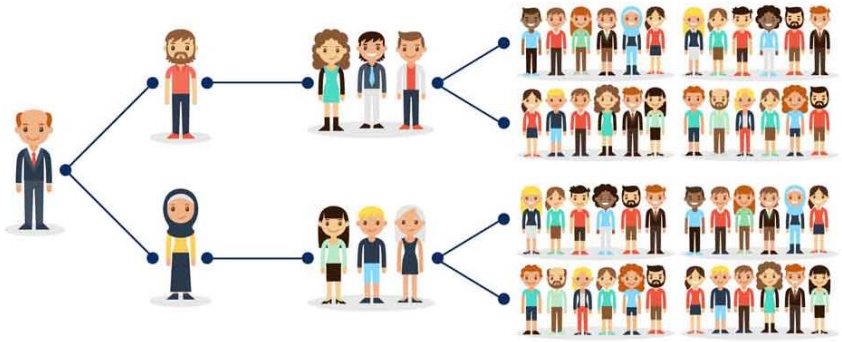

Figure 27: Snow Ball Sampling

3.7.2 Data Collection

There are following types of data collections that have used in this study:

Preliminary data collection. 207 published articles have been reviewed to build concepts regarding EVs. Focus has been made on recently published articles but important articles of all the times have not been ignored. Articles regarding issues in adoption of EVs in the sub-continent have been given due importance as the scenario of EVs has several similarities in these countries.

Principal data collection. One-on-One in-depth interviews have been taken. There are four major stake holders of EVs in Pakistan:

Policy Maker. Engineering Development Board of the Ministry of Industries and Production has formulated the National Electric Vehicle Policy of Pakistan. Two senior officers of EDB have been interviewed very thoroughly.

EV Manufacturers. There are three companies that are manufacturing EVs in Pakistan i.e. Tesla Industries, Jolta Electric and MG Motors and one importers / distributors of EVs in Pakistan i.e. Audi Motors. Five officials (in total) from these companies have been approached and interviewed in detail.

EV Owners. This is the most difficult sample to find as there are very few. Six people who are using EVs have been interviewed. Three of them own four wheelers while three of them own two wheelers.

Charging Station Owners. There are only three to four charging stations in the city. Two charging station managers have been interviewed in detail.

Total fifteen interviews have been taken.

3.7.3 Data Analysis

Thematic analysis has been used to analyze the data. It is sometimes also called framework analysis. According to (Braun & Clarke, 2006) "thematic analysis is a method for identifying, analyzing, and reporting patterns (themes) within data". It helps to understand those aspects of the phenomenon about which the participants have talked the most and in details and connection among them (Javadi & Zarea, 2016).Thematic analysis is about analyzing the themes within your data set to identify meaning, based on your research question. It is useful when the study aims to discover new aspects, unidentified concepts / themes entrenched throughout the qualitative data when data is in large amount. Thematic analysis allows dividing and categorizing a large amount of data in such a way that makes it easier to analyze. It is useful when subject information is required based upon participants' experiences, opinions and point of views. Following are the steps that have been followed to analyze this qualitative data:

Steps of Thematic Analysis. Developing familiarity with the data→ organizing and preparing raw data for analysis → generating initial codes→ defining themes→ reviewing themes→ write-Ups / discussions→ final analysis

Approach of Thematic Analysis. In this study we have adopted deductive and latent approaches for thematic analysis because the researcher has developed idea regarding themes on the basis of profound literature review.

Type of Thematic Analysis. In this study we have adopted Reflexive Thematic Analysis type to keep the analysis flexible and elastic. This type has been adopted because this research is a part of postgraduate studies i.e. thesis so the researcher is working solo and already generated codes have not been found.

3.8 Ethical Considerations

Ethics in research are fundamental part that continues throughout the research process, from the selection and approval of a research topic, to data collection and final data

analysis and diffusion of results in the last stage (Resnik & Elliott, 2016). Ethical considerations include viewpoint of subject protection and conducting research built on ethical standards (Pietilä, Nurmi, Halkoaho, & Kyngäs, 2020). Ethical considerations in research are based upon two foundations. One is ethical principles that protect the study participant and the second focuses on professional standards of the research to ensure good standard and scientifically acceptable research (Launis, 2015; Mustajoki & Mustajoki, 2017). Qualitative research that involves human participants must be conducted in line with the ethical code of conducts and institutional rules and regulations (Beauchamp, 2009) and such study must follow ethics that protect the participants. But these ethics are research based code of ethics and not legally binding laws (Heale & Shorten, 2017). There are following common research ethics that should be given due consideration by the researchers:

3.8.1 Autonomy:

In this study all the participants were provided right to decide whether to participate in the study through interview response or not and were given freedom of expression. Their consent was taken by their wish to use the data provided by them in this study and publish. They were provided satisfactory answers regarding confidentiality of the data by stating that their data would only be used for research purpose and is not to be provided to anyone else for any purpose.

3.8.2 Non-malfeasance:

No person has been harmed physically, psychologically or emotionally. Neither any equipment nor any vehicle or any other installments have been affected during conduct of the research.

3.8.3 Beneficence:

The study is being carried out for the wellbeing of the society in context with the adoption of Electric vehicles. And all the efforts have been put up by the researcher to produce best possible output which can bring positive change in the field.

3.8.4 Justice:

Selection of sample has been made using snow ball sampling technique. Selection of sample is neither gender biased nor social status biased. The composition of sample is mixed with male and female respondents and people belonging to elite class and middle class as well.

CHAPTER – 4: DATA ANALYSIS AND FINDINGS

4.1 Thematic Analysis

Concept of thematic analysis has been discussed in details in chapter three. Deductive and Latent approaches of thematic analysis have been used to analyze the data. Reflexive thematic analysis is being carried out.

4.1.1 Developing Familiarity with the Data

One-on-One in-depth interviews have been taken from major stakeholders of electric vehicles i.e. National EV Policy makers, EV owners, EV manufacturers / distributors and EV charging stations owners / managers. The interviews have been recorded on the papers and have been converted into Microsoft Word format on the same day to avoid skipping any information provided by the participants. Interviews have been taken from following officials:

National EV Policy Makers.

(1) Ministry of Industries and Production – GM Business Development Group, Engineering Development Board, D-Chowk, Islamabad

(2) Ministry of Industries and Production –GM Policy Development Group, Engineering Development Board, D-Chowk, Islamabad

EV Manufacturers/ Importers / Distributors.

(3) Jolta Electric –General Manager North Zone, I-10/3, Islamabad

(4) Audi Pakistan – Marketing and Sales Manager, Audi Center, Islamabad

(5) MG JW Automobile – Marketing Manager MG Capital Motors F-7, Islamabad

(6) MG JW Automobile – Marketing Manager, Main Office Gulberg, Lahore

(7) Tesla-PV Industries – Manager Operations, I-10/3, Islamabad

EV Charging Station Managers.

(8) Attock Petroleum, Jinnah Avenue, F-7/4, Islamabad

(9) R and I Electrical Appliances, I-10/3, Islamabad

EV Owners (Two and Four Wheeler).

(10) Owner – 1 from Islamabad, Executive Director Shaoor Foundation for Education and Awareness – Owner of Audi e-Tron

(11) Owner – 2 from Islamabad, a Software Engineer and businessman, Owner of Audi e-Tron, a Battery Electric Vehicle

(12) Owner – 3 from Rawalpindi, a businessman – Owner of MG ZS EV

(13) Owner – 4 from Attock, a Shopkeeper, Owner of JE-Scooty

(14) Owner – 5 from Attock, a Shopkeeper, Owner of JE-Scooty

(15) Owner – 4 from Kamra, a Shopkeeper, Owner of Jolta JE-70D Electric Bike

4.1.2 Organizing and Preparing Data

Responses have been organized in following ways:

Respondents have been divided into six categories i.e. EV Policy Makers, Two Wheeler EVs Manufacturers, Four Wheeler EVs Manufacturers, Two Wheeler EV Owners, Four Wheeler EV Owners, Charging Stations Operators / Owners. Important points to be addressed have been extracted from the data provided by the respondents. Nearly matching issues have been written in combined form to avoid unnecessary length of the study. Only unique and important points have been mentioned

Important points highlighted by interview participants are as under: -

EV Policy Makers. Following important points have been highlighted during interview with EV Policy Makers:-

***Comprehensive Policy*.** Policy should be comprehensive and it should cover all aspects of all types of EVs. Currently there is no proper definition is mentioned in the policy because the policy makers in Pakistan are still learning from the world's experiences with BEVs as they mentioned in their statement during interview.

***Initiative of EVs in Pakistan*.** Prime Minister Imran Khan has taken initiative of Clean and Green Pakistan. Following this vision of the PM, KPK government is planting one billion trees under Billion Tree Afforestation Project and similarly Punjab government is working to reduce smog and its harmful effects on human body. In continuation of the same the Engineering Development Board under Ministry of Industries and Production started working on Electric Vehicles Policy. Policy for 2-3 wheelers (domestic and commercial) and heavy commercial vehicles has been approved while policy for passenger cars and light commercial vehicles (four wheelers) is under review.

***Objectives of EV Policy in Pakistan*.** There are four objectives of this policy.

The primary objective of EVs is to tackle the climate change problem in Pakistan and to keep the environment clean and green. Second major reason for National Electric Vehicles Policy is the growing trend of electric vehicles in the world. Being a new technology in auto sector which is being adopted widely around the globe, some people who can afford were found interested in EVs and some have imported EVs as well. So there was a need of policy for such vehicle. Third important reason behind this policy is to reduce import fuel bill which is in trillions, this will relax the economy by reducing imports. Fourth and one of the major reasons is to grow and promote indigenous technology. Engines required complex and highly technical Research and Development and investment. There are no engine designers and manufacturers in Pakistan. So the fuel vehicles being assembled in Pakistan have many imported components. While in case of EVs, there is no engine, the major component is the structure which is already being manufactured in Pakistan and secondly the batteries and the motors. Batteries and the motors both can be manufactured in Pakistan with a little R and D and technical investment. So the EVs can be indigenously developed. This will reduce the imports and our indigenous industry will be promoted as well.

Basis of the various recommendations made in the policy. As per the officials of EDB, current auto manufacturers have been taken onboard before finalizing the policy, recommendation have been sought from board members and their industries and other industries that were found interested in investment in EVs. On the basis of these inputs and recommendations and various incentives offer by other neighbor countries, they have made these recommendations in the policy for users and manufacturers.

Climate Change Problems of Pakistan. Pakistan is being affected badly by climate change. Especially the two big cities Karachi and Lahore are in world's top ten polluted cities of the world. No doubt there are many others reasons for these cities to lie in the top ten, but reducing GHG emissions from transport sector we can somehow tackle the climate change issue. Many other steps are being taken as well and Ministry of Climate Change has brought New Climate Change Policy 2021 and now EVs have been mentioned in this policy as well.

Government Initiatives for Promoting EVs. Despite being in tight financial conditions, Government through policy is still providing various attractive incentives to the manufactures of EVs and their spare parts. Comfortable environment is being created for the new investors in EVs sector. Attractive benefits, including waiver on registration charges, token tax and toll tax, are being offered to the EV users as well.

Electricity Supply. Various newly installed power stations have started working including hydro power stations, coal power stations and Nuclear Power stations. Foreign investors are interested in installing more power stations as well. So the electricity supply will not be interrupted and there will be no load shedding in near future.

Electricity Prices. Unfortunately, many power plants have been installed by taken loan from various international financial institutions, so to return the loan and interest on it, the prices have to go high. And the prices are affected by the increasing inflation as well. So this impact is beyond Government's control.

Programs for Implementing NEVP. Government has approved the policy and has welcomed local and foreign investors. For this purpose, many attractive incentives are being offered. So there are no special programs going to be initiated for implementation of the policy.

Targets set in NEVP. Major targets in NEVP are: 50 % sales of EVs in total two and three wheeler vehicles new sales by 2030**,** 50 % sales of EVs in total new busses sales by 2030**,** 30 % sales of EVs in total new passenger vehicles sales by 2030**,** 30 % sales of EVs in total new trucks sales by 2030**,** One DCFC station at every 3 km in all major cities**,** DCFC stations on all motorways at every 15 to 30 kilometers

Incentives for Charging Infrastructure Developers. There are no incentives for developers of charging infrastructure. Government is already offering incentives to the manufacturers and users beyond our affordability. So it is not possible for the government to offer incentives to the charging infrastructure developers as well.

Standards for EV Manufacturers. Vehicle standards are not defined in Auto Policy so could not be defined in EV Policy.

Barriers / Challenges in Implementation of this Policy. Factors that can play as a barrier in implementation in the policy are: Hesitation in shifting of Auto

Manufacturers from conventional vehicles to electric vehicles because they have to invest a huge amount of money to establish EV manufacturing plants, Less investment in developing charging infrastructure by private sector, Delay in indigenous manufacturing of Auto parts, components and accessories for EVs, Long lasting battery manufacturing e.g. Lithium-Ion batteries manufacturing by local manufacturers. All these point play a very important role in the adoption of EVs and implementation of NEVP because all of them are directly linked with private sector investment and government can never force any private sector to invest in a specific industry. Government can only encourage investment in the EV industry and the same has already been done by offering various attractive incentives for the manufactures through NEVP 2020.

Other Important Points. Various actors have to play their role and only with the support of all these actors, NEVP could be implemented as government alone is not able to implement this policy. Industries / organizations / institutions / association / sector that hold very important position and can play big role in the development of EV industry and only then widespread adoption of EV is possible in Pakistan are: Engineering Development Board, Ministry of Industries and Production, it holds role of EV policy making, National Electric Power Regulatory Authority (NEPRA),it holds role of electricity pricing, All Electricity Supply companies e.g. IESCO, LESCO, K-Electric, PESCO etc, they hold role of supply of electricity, Pakistan Petroleum Dealers Association (PPDA),it holds role of charging infrastructure development, Pakistan Association of Automotive Parts and Accessories Manufacturers (PAAPAM),it holds role of establishing plants for manufacturing of EV parts and components, Pakistan Automotive Manufacturers Association ((PAMA)),it holds role of manufacturing EVs, Pakistan Dry Battery Manufacturers Association (PDBMA),it holds role of manufacturing long lasting and long range batteries like Lithium-Ion and their uninterrupted supply to the Auto manufacturers, Pakistan Electric Vehicles Manufacturers Association (PEVMA),it holds role of manufacturing EVs and their promotion, Pakistan Electric Vehicles and Parts Manufacturers and Traders Association (PEVPMTA),it holds role of manufacturing EV specific spare parts and components, and a strong professional relationship and

coordination between Original Equipment Manufacturers (OEMs) and Vendors, academia and industry, manufacturers and distributors, policy makers and policy implementers is very much important.

Two Wheeler EV Manufacturers

Important points have been highlighted by e-bikes manufacturers are:

Reasons for Manufacturing of Electric bikes. Following the Prime Minister's "Clean Green Pakistan" initiative, Research and Development was started on electric bikes to make the environment clean and green. After the R and D we came to know that from on road transport there are more than 70 % bikes, and people can afford electric bikes easily as compare to electric vehicles due to very high cost of electric vehicles.

Environmental Impacts of Electric Bikes. One e-bike in a year emits 90 % less CO^2 as compare to conventional motorbike. It means if we are able to convert 100 % bikes into electric bikes, the overall emission will be reduced by more than 50 % of current emissions.

Benefits of Electric Bikes. Besides environmental benefits of e-bikes, there are several other benefits. People in Pakistan usually use bikes for one of the many reasons like: For going on jobs / small businesses: Some people work within twenty to thirty kilometers from their residence while some work beyond that. For the people living between twenty to thirty kilometers, e-bike is a good option, as this will reduce their routine expense of fuel. Electricity cost is much lesser than that of monthly fuel. For school / colleges / university going: For students travelling to schools, colleges / universities within the distance of fifteen to twenty kilometers, e-cycle is the best option. It is safe, secure, easy to operate, economical and has alternate option of manual operation i.e. paddles. For mail / courier delivery purpose: Courier / mail delivery boys usually have to travel long and throughout the day so this bike is not feasible for them at the moment as it can't go beyond eighty kilometers on single charge. After the arrival of Super Capacitor Fast Charger, they can also enjoy economical ride on this bike. For Food delivery purpose: Food delivery is usually within twenty kilometers so this bike is very feasible for food delivery riders. Many of food delivery riders have already purchased this bike. Some of the food chains who

provide free delivery prefer this bike because this will reduce their cost of delivery. For general purpose: For moving within city this bike is proven good and even e-cycle is a good option. E-cycle has an alternative option of manually driven by using paddles. Other benefits of e-bikes are: These bikes are best for students going to schools and colleges and parents remain relax when their children are out on these bikes as they can't go beyond 40 kilometers , they can't misuse the bike as there is no chance of one-wheeling. These bikes are easy to operate. Speed limit remains under control. No hassle of changing gears. No problem of scheduled maintenance like oil change, tuning etc. No worries of fuel re-filling. Easy to charge from home by using any 220v electric point. (Charger is provided by the company). Batteries life comes down gradually after two years of using. Batteries can be replaced after three years. Charging cost is minimal as one full charge consumes only 2 to 2.5 units of domestic electricity.

Creating Awareness Regarding Electric Bikes. It is very important to create awareness regarding e-bikes because only then people will be aware of the benefits of e-bikes. Techniques that can be used for this purpose are: Social media has become the next big platform for any social campaign and due to this; marketing departments of almost all large firms are focusing much on social media marketing campaigns. So social media can be used for creating awareness among public regarding benefits of e-bikes. Secondly existing customers play a vital role in marketing of e-bikes and creating awareness regarding benefits of e-bikes. One customer brings another one with him / her and a chain is being established and thus people are becoming more aware of the economic and environmental benefits of the e-bikes. But the major reason of attraction towards of e-bikes is the economic benefits rather not environmental. In addition to that content marketing is being done to meet the specific requirements of the customers e.g. convincing food delivery boys to use e-bikes etc. JE-Scooty is becoming popular in ladies especially students, it has an additional benefit of having no requirement of registration as registration is not required for any vehicle which is under 50 cc or equivalent.

Challenges to E-Bikes market in Pakistan. Challenges faced by e-bikes in Pakistan are: Conventional motorcycle manufacturers are becoming a big challenge

for EVs. Many conventional motorcycle manufacturers have starting offering incentives to the distributors for selling more conventional motorcycles instead of electric motorcycles. Thus the distributors / showroom sales managers discourage people for buying e-bikes by telling them several de-merits of e-bikes. Low mileage of the e-bikes is a major problem till date and most of the people are unable to buy it only because of less mileage. Although working has been started on using Lithium-Ion batteries but there are some safety concerns in using lithium-ion batteries, R and D departments are working to resolve the same. More charging time: Currently there is only AC / Domestic charging facility available to e-bikes due to which charging time is 4 to 6 hours. Companies are working on reducing charging time and introducing *Super Capacitor Fast Charger* which will charge the bike in just 30 minutes. Electricity supply (especially in summer season): Electricity load shedding in summer seasons can play as a barrier in adoption of e-bikes because if the bikes could not be charged fully, their mileage will decrease this can affect the battery as well. Super capacitor fast charger can tackle with this issue as well. High electricity tariffs and day by day increasing rates of electricity are creating a situation of uncertainty regarding electricity prices. This is leading towards a delay in adoption of electric bikes as people are hesitating in buying e-bikes. Two and three wheeler EVs are exempted from registration charges but still the same is not implemented by any excise and taxation department due to which e-bike owners have to pay Rs.4000/- in ICT and Rs.5000/- in Punjab as registration charges.

Four Wheeler EV Manufacturers. Following important points have been highlighted by four wheeler EV manufacturers.

***Reasons for Manufacturing of Electric Vehicles*.** There are a lot of reasons to bring EVs, some of them are: Primarily following Prime Minister's initiative of "Clean and Green Pakistan", we started working on Electric Vehicles and secondly to introduce a new technology vehicle in the country. It is environment friendly; it has less emission of Carbon Dioxide and Carbon Monoxide so it is less harmful for the environment and has less impact on climate, secondly it a new technology and becoming popular worldwide. People are shifting rapidly from conventional vehicles to electric vehicles. So it should be available for people in Pakistan as well. Another

major reason is that it is cost effective. Fuel prices are increasing twice a month almost so running cost of fuel vehicles are increasing day by day. This vehicle is being charged on electricity, although prices of electricity are also very high in Pakistan but even then it is less costly then petrol.

Marketing of Electric Vehicles. Techniques for marketing of the electric vehicles that are being used are: Social media pages twitter accounts and advertisements. Political as well as social links of our high management, satisfied customers refer EVs to others as well. They are offering quick, easy and comfortable after sales services so that customer could feel relax while purchasing electric vehicle.

Benefits of EV. Major benefits of the electric vehicle are: It has a lot of user friendly features, a new technology vehicle which is being adopted by the world very rapidly, environment friendly, cost effectiveness, almost no maintenance, various charging options, Comfortable and quiet.

Challenges to EVs market in Pakistan. The major challenge is always changing Government policies. Sometimes they reduce taxes and after few months they again impose or increase the taxes. Policies of the government are not stable and are not for long time. Due to this Auto industry is suffering a lot. People are having problems in registration of the vehicle as well. As per policy there are no registration charges for electric vehicles but excise and taxation departments are still charging. Charging infrastructure is not developed because Government is not giving any incentives to the charging stations. Less mileage and more charging time is a big barrier for EVs market in Pakistan. We are working on increasing mileage of the vehicle, in fact the new models of same vehicles have more mileage but to reduce charging time, there is still a lot of R and D is required. High and continuously increasing electricity prices are acting as a barrier in installation of charging stations and also in adoption of EVs. Brand consciousness of the people of Pakistan is another factor. People prefer three major brands of Pakistan Auto market i.e. Toyota, Honda and Suzuki. Although with the entry of several other international brands in the Auto market of Pakistan, trends are changing now, but still it will take some time. Network of spare parts and repairing workshops: Most of the mechanics know the repairing of popular vehicles and don't understand the system of less popular vehicles. Similarly,

availability of spare parts nationwide is another challenge. The most important thing is the non-availability of OEMs; there are no OEMs of the components being used in the EVs. Secondly people are reluctant for entry into fully electric vehicles market due to less developed charging infrastructure. High investment is another issue in this type of vehicles. It's a totally new thing so people are reluctant to invest their funds into EVs manufacturing in Pakistan. Country's political conditions are very unpredictable; policy shift is not a big deal. Economic conditions are not best and attractive for the investors, people have low incomes, electricity prices are going higher and higher day by day so there may be not very good response from the customers for fully electric vehicles.

***EV Charging Station Owners / Managers*.** Following important points have been highlighted by EV charging station owners:-

***Reason for Installing Charging Station*.** Reasons to install charging stations are: due to ongoing demand of the public, to facilitate the people having electric cars and to promote EVs.

***Tariff of IESCO for charging station & Effect of Electricity Prices*.** Default commercial tariff applies on charging stations, there is no special tariff. We receive electricity as Alternate Current (AC) that has 220 voltages and charging stations converts it into Direct Current (DC) which has 12 voltages. There is no special tariff for this charging station. Due to high IESCO tariffs and always increasing per unit rate, unfortunately the charging points are neither in profit nor in loss. Per unit cost is around Rs.25 for commercial consumers excluding all sorts of taxes, Fuel price adjustments, duties, FC surcharge, NJ surcharge etc. Including all these types of taxes, electricity bill to electricity cost ratio increases. This ratio is sometimes 60: 40 even.

***Charging Cost*:** An amount of Rs. 45 to Rs.50 per unit is being charged from customers. If we consider per unit charging cost as Rs. 45, a vehicle connected with DCFC consumes one unit in about 75 to 80 seconds. In one minute 0.76 unit is consumed which means a vehicle plugged in for one hour will consume about 45 to 47 units and the bill will be Rs. 2000/- to Rs. 2200/- and in case per unit price is Rs.50 than after one hours charging, the bill will be Rs. 2300/- to Rs.2500/-

***Variety of Charging Ports*:** There are following two types of charging ports: -

Alternate Current (AC) charger – It's a slow charger and takes seven to eight hours to charge one vehicle, Direct Current Fast Charger (DCFC) – It is a fast charger and charges a vehicle within 60 to 70 minutes. It has two types of connectors; one is CHAdeMO – For Japanese Electric Vehicles and second is CCS – For European Electric Vehicles.

Two Wheeler EV Owners. E-Bikes available in the market are JE-Scooty is equipped with 20 Ah dry battery, 1000 Watt electric motor. Its range is 80 kilometers on full charge and maximum speed is 60 km per hour. It takes 8 to 10 hours to charge at domestic connection and consumes 2 units of electricity on one full charge. Price is Rs. 110,000/- and Jolta JE-70 D is equipped with 20 Ah dry battery, 1000 Watt electric motor. Its range is 80 kilometers on full charge and maximum speed is 60 km per hour on plain roads. It takes 8 to 10 hours to charge at domestic connection and consumes 2 units of electricity on one full charge. Price is Rs. 89,500/-

Following important points have been highlighted by two wheeler EV owners.

***Reason for Buying*.** Reasons to buy e-bikes are: To promote locally manufactured new technology bike, to encourage people who believe in indigenization, design of bike, cost effectiveness, and easy to Operate for new users.

***Non-Reliability of e-Bikes*.** Bikes are currently not reliable as no single customer has purchased this bike as his only bike. People are not willing to take this bike when moving in night and re-sale market is low as well so existing customers are not using this bike as the first option. The mileage of bike is just seventy to eighty kilometers so it cannot be taken for medium range driving. It takes whole night to charge the batteries and batteries life is just six months.

***Problems faced by e-bike owners*.** Major problems highlighted by e-bike owners are: Major problem is less mileage, more charging time, no charging options available in public as there are some charging stations available for cars but there is no option for charging bikes, Battery life is very much less. Life of batteries in electric cars is more than eight years but batteries in bike have life less than one year, in fact only two to three months.

Four Wheeler EV Owners. Vehicles available in the country are: Audi E-tron is a 50 Quattro Vehicle, 71 KWh battery, range up to 300 kilometers maximum,

charging time: 70 minutes at DCFC and 10 hours at domestic. Full charge costs up to Rs.3000/- while in USA the same specs EV costs $8.50 for full charging at DCFC, Its price is Rs.17 million and MG ZS EV is equipped with 44.5 KWh battery; Range is up to 320 kilometers maximum, charging time: 70 to 90 minutes at DCFC and 12 hours at domestic. Full charge costs up to Rs.2200/-. Its price is Rs.6.3 million)

Following important points have been highlighted by two wheeler EV owners.

Reliability of EV. All EV owners in Pakistan currently own conventional vehicle as well because they do not consider EV as reliable. They use it only when they are assuring that they don't have to travel long. So for long drive people are trusting EV. They are not using it during emergencies. The EVs cannot be driven to hilly areas because the vehicle consumes more batteries and the batteries discharge too quickly.

Mileage. Mileage depends upon various things. The type of driving, the type of road and the weather conditions, use of Air conditioner or Heater etc. Maximum mileage of the vehicle is around 300 kilometers if you are driving on a straight road and not using AC or heater and not accelerating too much. I have driven it for more than 250 kilometers on a single charge.

Charging Time. At DCFC it takes around 60 to 70 minutes if the batteries are less than ten % and it costs around Rs.3000/-. At home it takes around 10 hours to fully charge the batteries and it depends upon the total number of units consumed that how much the charging will cost at home because the rate of unit is not constant, it changes after every 100 units.

Running Cost. If you charge the vehicle fully and drive it on straight road with no AC the vehicle will move 300 kilometers on a cost of around Rs.3000/- to Rs.3200/-. For 1000 kilometers it may cost you around Rs.30000 to Rs.32000/- and reduction in battery life and wastage of time on charging as well. So the *per km driving cost is around Rs.30* while electricity costs Rs.45 per unit constantly. Same specifications petrol vehicle like Toyota Prado 4000 cc consumes around 125 liters of petrol to travel 1000 kilometers. If the fuel price is Rs. 145 per liter then *per km driving cost will be Rs.18 approximately*.

Life of Batteries. Maximum life of the batteries is eight years as claimed by the company. I think after that the mileage will be decreased gradually and I may have to change the batteries after nine or ten years may be. It is important to highlight that life of e-bike batteries is less than one year; this is one of the major differences.

Problems faced by EV Owners. Problems faced by EV owners are: The major problem being faced is the lack of charging infrastructure. One owner tried to go to Murree on EV but before entering the city he came to know that with the remaining battery of the vehicle he can only reach back home and if he enters the city he wouldn't be able to reach back home or he has to stay in Murree for more than 10 hours to charge his vehicle only if someone allows him to charge the vehicle from his hotel and he doesn't know how much will he charge for the same. There are only two to three charging stations in Islamabad that are never enough. Just imagine if there are only three petrol pumps in the entire city, who will drive the petrol vehicle than, although petrol tank takes less time to fill. The other problem is the non-availability of repairing workshops. The problem may be resolved once the EVs become popular in the market but at the moment the problem exists. Third problem is the non-availability of spare parts of the vehicle. If something is damaged due to any accident, the same will have to be imported. No spare parts are available in the country on immediate basis. One owner stated "*Whenever I am driving this vehicle, I am always worried about the remaining battery and always looking at the battery status because it has not that much range. I always feel uncomfortable while driving this vehicle.*" There is a scenario of uncertainty in fact a certain condition that you can't go far away on this vehicle. You can't go on long drive. Another problem is the charging time. It takes more than 30 minutes after plugging in the charger and if another vehicle is already plugged in then this time increases.

4.1.3 Generating Initial Codes

A reflexivity journal has been maintained for defining themes and generating codes. Respondent's data have been reviewed thoroughly; only relevant segment of the information that addresses the specific question has been considered. Codes have been systematically generated on the basis of this reflexivity journal and have been arranged in following four patterns; -

National EV Policy Makers

(1) Objectives of NEVP

(2) Actors in Implementation

(3) Barriers / Issues / Challenges in Implementation

EV Manufacturers/ Importers / Distributors

(1) Reason for Initiating EV Manufacturing

(2) Marketing Measures

(3) Barriers / Problems in Manufacturing

EV Charging Station Owners

(1) Reason for Establishing EV Charging Stations

(2) Public Response and Future Plan

(3) Barriers / Problems in Operating Charging Station

EV Owners

(1) Reason for Purchasing EV

(2) Benefits of EVs

(3) Barriers / Problems in Operating EVs

4.1.4 Defining Themes

From the data provided by the respondents, following themes have been demarcated. Total 109 themes have been defined. Themes have been categorized according to the codes for all four major stakeholders of EVs.

National EV Policy Makers.

Objectives of NEVP	Actors / Aspects in Implementation	Barriers / Issues / Challenges in Implementation
(1) Definition of EV	(1) Incentives	(1) Charging Infrastructure
(2) Clean and Green Pakistan	(2) Facilitating the Investors	(2) Affordability of Government
(3) Climate Change	(3) HTV Specific Environment	(3) Private Sector Investment
(4) Indigenization	(4) Potential	(4) Hesitation by investors
(5) New Technology	(5) Evolve	
(6) Fuel Import	(6) On road EVs	
(7) GHG Emissions		

(7) Standards for EVs
(8) Support from Cooperative Associations like PAMA, PAAPAM, PPDA,
(9) Lithium-Ion Batteries
(10) Electric Motors
(11) Awareness
(12) Feedback
(13) Programs for Policy Implementation

(5) Auto Manufacturers
(6) Heavy investment
(7) Road Infrastructure
(8) Long Travel
(9) Overloading
(10) Changing Tax Rates
(11) Changing Electricity Prices

EV Manufacturers/ Importers / Distributors.

Reason for Initiating EV Manufacturing

(1) Clean and Green Pakistan
(2) New Technology
(3) Trending
(4) Attractive Policy Incentives

Marketing Measures

(1) After Sales Services
(2) Easy to Drive
(3) Features of Vehicles
(4) Extra Accessories
(5) Percentage of Bikes
(6) Environment Friendly
(7) Benefits of EVs
(8) Media (Social, Print, Electronic)
(9) Content Marketing
(10) Role of Distributors
(11) Loyal Customers

Barriers / Problems in Manufacturing/ Marketing

(1) Mobility Rate
(2) Car Prices in Pakistan
(3) Inconsistency in Government Policies
(4) Uncertainty
(5) Political Instability
(6) Economic Conditions
(7) Per Capita Income
(8) OEMs
(9) Brand Consciousness of People
(10) Existing Auto Manufacturers
(11) Less Mileage
(12) More Charging Time

(13) Public Charging Stations
(14) Charging Stations for e-Bikes

EV Charging Station Owners/ Managers.

Reason for Establishing EV Charging Stations	Public Response and Future Plan	Barriers / Problems in Operating Charging Station
(1) Demand of Public	(1) Charger Types	(1) Electricity Supply
(2) Popularity	(2) Location of Charging Stations	(2) Electricity load management
(3) Widespread Adoption	(3) More Charging Stations	(3) Electricity Prices
(4) Future of Transport	(4) Long Term Investment	(4) No Incentives for Charging Stations
		(5) Heavy Taxes on Electricity Bills
		(6) Fuel Price Adjustments
		(7) Investment on Charging Stations

EV Owners (Two and Four Wheeler).

Reason for Purchasing EV	Benefits of EVs	Barriers / Problems in Operating/ Driving EVs
(1) Promoting Indigenization	(1) Scheduled Maintenance	(1) Charging Infrastructure
(2) New Technology	(2) Driving Behavior	(2) Spare Parts
(3) Unique Type of Vehicle	(3) Plain Roads	(3) Body Parts
(4) Brand	(4) Top Auto Brands	(4) Less Reliability
	(5) Trust	(5) Running Cost
	(6) Cost Effectiveness	(6) Battery Life
	(7) Power of Vehicle	(7) Battery Type
	(8) Within City Moving	(8) Hilly Area
		(9) Weather Conditions

(10) Comparison with CVs
(11) Top Auto Brands
(12) Price of Vehicle
(13) Repairing Workshops
(14) Uncertainty Regarding Remaining Battery
(15) Long Drive Issues
(16) Slow Charging at Homes
(17) Different Slabs of Electricity for Domestic Users
(18) Registration of EVs
(19) Power of Vehicle
(20) Maximum Speed of Vehicle
(21) Resale Value
(22) Alternate Vehicle in Home

4.1.5 Reviewing Themes

In this part, we have removed repeating / common themes or themes that have same impacts like Power of Vehicle and Powerful Electric Motor both have same impact, similarly Long Drive Issues and Mileage of Vehicle both have same impacts and some of them have been removed due to having fewer relevancies with the research question. With this effort, themes have been reduced from 109 to 49. By reviewing the themes methodically, we realize that there are following major clusters of themes:

Objectives. Following are the major and common objectives of formulating NEVP by Government, manufacturing EVs by Auto sector and adoption of EVs by Public:

(1) Mitigate negative aspects of climate change through reduction in emission from transport sector through introduction of fuel efficient and environment friendly technology

(2) To promote indigenization by contributing through transport sector indigenization by adopting a technology which is comparatively easy to indigenize which will create employment for the people of Pakistan

(3) Create a pivot to industrial growth in Pakistan and encourage auto and related industry to adopt EV that is a new and trending technology

(4) Contribute to reduction of external deficit through reduction in overall share of oil import bill by shifting to EVs

Barriers / Issues / Challenges.

At the End of Government

(1) Inconsistency in Government Policies
(2) Affordability of Government
(3) Political Instability
(4) Economic Conditions
(5) Per Capita Income
(6) Mobility Rate
(7) Car Prices in Pakistan
(8) Road Infrastructure
(9) Changing Tax Rates
(10) Changing Electricity Prices
(11) Electricity Supply
(12) Electricity load management
(13) Electricity Prices
(14) Different Slabs of Electricity for Domestic Users
(15) No Incentives for Charging Stations
(16) Heavy Taxes on Electricity Bills
(17) Fuel Price Adjustments
(18) Registration of EVs

At the End of Private Sector

(1) Auto Manufacturers
(2) Top Auto Brands
(3) Private Sector Investment
(4) Hesitation by investors
(5) Heavy investment
(6) Car Prices in Pakistan
(7) Price of Electric Vehicle
(8) Uncertainty
(9) Comparison with CVs
(10) Power of Vehicle
(11) Maximum Speed of Vehicle
(12) Less Reliability
(13) Running Cost
(14) Less Mileage
(15) Battery Life
(16) Hilly Area
(17) Weather Conditions
(18) Repairing Workshops
(19) Slow Charging at Homes

(20) OEMs
(21) Spare Parts
(22) Body Parts
(23) Charging Infrastructure
(24) Investment on Charging Stations
(25) Public Charging Stations
(26) More Charging Time
(27) Charging Stations for e-Bikes

4.1.6 Write-Ups. Adoption of EVs in the country cannot be made possible with just Government efforts. It involves endeavor from various actors. This includes various Government departments and various sectors in private and finally from general public as well. If anyone of them is not willing to play its role, the policy will be going difficult to implement. National Electric Vehicles Policy is the first step towards initiating the EV adoption in the country. Formulating and implementing NEVP is not the only step from government sector; there are still a lot of things to be done by the various Government departments. Private sector always plays major role in adoption of new technology of any sector. In the field of EVs efforts are necessitated from private sector in various fields that include but not limited to auto manufacturing, original equipment manufacturing for auto industry, power distribution companies and fuel / charging stations. But all of the sectors are facing problems from each other and that problems are acting as barriers in developing EV industry in the country and thus becoming "*Issues and Challenges in Implementation of National Electric Vehicles Policy of Pakistan*". To distinguish impacts of these factors on the policy and to highlight the factors in the sequence of having most effect to least effect, the viewpoint of respondents has been analyzed in a different way.

Table 11: Numerical Presentation of Responses of Interviewees on Re-Defined Themes

Factors 🡻|Respondents 🡺	Policy Makers (Max-2)	EVs Manufacturers (Max-5)	Charging Stations (Max-2)	EV Owners (Max-6)	**Total (Max-15)**
Inconsistency in Government Policies	0	4	1	3	**8**

No Incentives for Charging Stations	1	0	2	0	**3**
Electricity Supply	1	3	2	5	**11**
Electricity load management	2	0	2	2	**6**
Electricity Prices	2	4	2	5	**13**
Different Slabs of Electricity for Domestic Users	1	0	0	5	**6**
Heavy Taxes on Electricity Bills	0	3	2	6	**11**
Fuel Price Adjustments on Electricity Bills	0	3	2	6	**11**
Registration of EVs	0	2	0	3	**5**
Auto Manufacturers	2	5	1	3	**11**
Private Sector Investment	2	5	2	2	**11**
Hesitation by investors	2	5	0	4	**11**
Political Instability	0	5	2	2	**9**
Economic Conditions	1	5	2	3	**11**
Top Auto Brands	1	2	0	6	**9**
Comparison with CVs	2	4	0	5	**11**
Power of Vehicle	2	4	1	6	**13**
Maximum Speed of Vehicle	2	3	0	5	**10**
Less Reliability and Uncertainty	2	2	0	6	**10**
Running Cost	2	4	2	6	**14**
Less Mileage	2	5	2	6	**15**
Battery Life	2	5	2	6	**15**
OEMs	2	5	0	1	**8**
Body and Spare Parts	2	4	0	5	**11**
Price of Electric Vehicle	2	2	0	6	**10**
Road Infrastructure	2	3	0	5	**10**

Car Prices in Pakistan	2	2	0	6	**10**
Mobility Rate	2	2	0	3	**7**
Per Capita Income	2	3	0	4	**9**
Repairing Workshops	2	3	0	5	**10**
Charging Time	2	4	2	5	**13**
Charging Infrastructure	2	5	2	6	**15**
Affordability of Government	2	0	0	0	**2**

If we sort the table accordingly from the most effective factor to the least, outcome will be as under:

Table 12: Numerical Presentation of Responses of Interviewees on Re-Defined Themes (Sorted from Highest to Lowest)

Factors 🡻|Respondents 🡺	Policy Makers (Max-2)	EVs Manufacturers (Max-5)	Charging Stations (Max-2)	EV Owners (Max-6)	Total (Max-15)
Less Mileage	2	5	2	6	15
Battery Life	2	5	2	6	15
Charging Infrastructure	2	5	2	6	15
Running Cost	2	4	2	6	14
Electricity Prices	2	4	2	5	13
Power of Vehicle	2	4	1	6	13
Charging Time	2	4	2	5	13
Electricity Supply	1	3	2	5	11
Heavy Taxes on Electricity	0	3	2	6	11
Fuel Price Adjustments on Electricity Bills	0	3	2	6	11
Auto Manufacturers	2	5	1	3	11
Private Sector Investment	2	5	2	2	11
Economic Conditions	1	5	2	3	11
Comparison with CVs	2	4	0	5	11
Body and Spare Parts	2	4	0	5	11
Hesitation by investors	2	5	0	4	11

Maximum Speed of Vehicle	2	3	0	5	10
Less Reliability and Uncertainty	2	2	0	6	10
Price of Electric Vehicle	2	2	0	6	10
Road Infrastructure	2	3	0	5	10
Car Prices in Pakistan	2	2	0	6	10
Repairing Workshops	2	3	0	5	10
Political Instability	0	5	2	2	9
Top Auto Brands	1	2	0	6	9
Per Capita Income	2	3	0	4	9
Inconsistency in Government Policies	0	4	0	3	8
OEMs	2	5	0	0	8
Mobility Rate	2	2	0	3	7
Electricity load management	2	0	2	2	6
Different Slabs of Electricity for Domestic Users	1	0	0	5	6
Registration of EVs	0	2	0	3	5
No Incentives for Charging Stations	1	0	2	0	3
Affordability of Government	2	0	0	0	2

After presenting the respondent's data numerically we realized that there are some factors that are more important than others as they are affecting all the four major stakeholders of the sector, so we are categorizing the responses into three categories

Most Affecting Factors (Response total is more than 70 %)

(1) Less Mileage
(2) Battery Life
(3) Charging Infrastructure
(4) Running Cost
(5) Electricity Prices
(6) Power of Vehicle
(7) Charging Time
(8) Electricity Supply
(9) Heavy Taxes on Electricity

(10) Fuel Price Adjustments on Electricity Bills
(11) Auto Manufacturers
(12) Private Sector Investment
(13) Economic Conditions
(14) Comparison with CVs
(15) Hesitation by investors
(16) Body and Spare Parts

Average Affecting Factors (Response total is more than 50 %)

(1) Maximum speed of vehicle
(2) Less Reliability and Uncertainty
(3) Price of Electric Vehicle
(4) Road Infrastructure
(5) Car Prices in Pakistan
(6) Repairing Workshops
(7) Political Instability
(8) Top Auto Brands
(9) Per Capita Income
(10) Inconsistency in Government Policies
(11) OEMs

Least Affecting Factors (Response total is less than 50 %)

(1) Mobility Rate
(2) Electricity load management
(3) Different Slabs of Electricity for Domestic Users
(4) Registration of EVs
(5) No Incentives for Charging Stations
(6) Affordability of Government

4.2 Discussions

Currently China is leading in EV market in context with manufacturers as well as users, let's see how China overcome barriers has in adoption of EVs: -

4.2.1 EV Technology

It includes power, mileage, reliability, speed and battery life of vehicle. China has taken the EV industry towards a different direction. Instead of focusing on the environmental impacts of EVs, China has focused on smartification of the vehicles. They have increased features in EVs as compare to CVs. Today, EVs have been preferred in China not because of their environmental impacts but because of their unique features and advanced technology. Mileage of the vehicle is increasing gradually; new models can be driven more than 800 kilometers on single charge, motors are becoming more powerful and battery life is being increased and becoming suitable for any weather. Pakistan being close ally of China can take advantage of

EVs growth in China. Direct foreign investment, capacity building and technology transfer are various considerable options.

4.2.2 Charging Infrastructure

Currently China has the largest network of charging stations in the world. China has initially focused on developing charging infrastructure throughout the country and increased number of charging points on each charging station. Currently there are more than 69000 charging stations in the country with an average of 32 charging points on each charging station. It means there are total more than 2.2 million charging points in China, while in US there are only 0.11 million charging points. More than 60% of highway gas stations are equipped with fast charging facility. Government has offered direct subsidies and easy financing through banks for the companies intending to establish charging stations.

4.2.3 Energy Factors

China has the world's richest resources of hydro-power. There are more than 22000 large dams in China which is nearly fifty percent of the world's total dams. In China 100 % of population have electricity supply. No doubt that the initial cost of building dams is quite high but this is one-time investment. Electricity generated through hydro power plants is very cheap. China's power generation capacity as of 2021 is 8112.2 TWh which is increasing year by year. China is generating 107 % of the demand of energy.

4.2.4 Financial Factors

It includes initial price and running cost of vehicle along with price difference between EV and CV. Vehicle prices in China are already low due to heavy manufacturing capacity of local industries. EVs prices are always high as compare to CVs but China has done a lot to reduce this price gap between EVs and CVs therefore, China is manufacturing cheapest EVs of the world. Major reason behind this is reduction in price of batteries. Battery prices have been reduced up to 1/3 since 2014.

4.2.5 Industry Factors

It includes Auto manufacturers and spare parts manufacturers. Government is providing strong policy support to the Auto manufacturers as well as to the OEMs.

China is already enriching in auto manufacturing industries. Less input costs, cheap labor, comfortable business environment, political stability and economic stability are other major reasons behind industrial growth in China and hence, availability of cheap EVs.

4.3 Results / Findings

By above discussion we have found objectives of formulating NEVP by the government and important factors that affect implementation of the policy.

4.3.1 Objectives of the National Electric Vehicles Policy

There are four major objective of the policy i.e.

(1) Mitigate negative aspects of climate change through reduction in emission from transport sector through introduction of fuel efficient and environment friendly technology

(2) To promote indigenization by contributing through transport sector indigenization by adopting a technology which is comparatively easy to indigenize which will create employment for the people of Pakistan

(3) Create a pivot to industrial growth in Pakistan and encourage auto and related industry to adopt EV that is a new and trending technology

(4) Contribute to reduction of external deficit through reduction in overall share of oil import bill by shifting to EVs

4.3.2 Issues and Challenges in Implementation of NEVP

We have found that there are sixteen factors that have been considered most affecting for implementation of NEVP, eleven factors that are less important but still they play important role in implementation of NEVP and six factors that have been considered as least affecting. Although last six factors have been considered as least affecting but still they are important and their importance cannot be ignored as they will play their role in implementation of the policy and hence in adoption of EV. We have already got factors effecting the implementation of NEVP sorted from most effective to least effective. Now let's have a look that which stake holder is responsible to tackle with which factor / problem in implementation of NEVP in same sorted sequence. By responsibility we mean that which sector can make efforts to tackle with that specific

barrier and can work to remove that barrier and that will help removing obstacles from the way of adoption of EVs and so implementation of NEVP.

Table 13: Factors / Issues in Implementation of NEVP along with Responsibilities

Most Affecting Factors / Issues	**Responsibility**
Less Mileage	Private Sector
Battery Life	Private Sector
Charging Infrastructure	Public and Private Sector
Running Cost	Public and Private Sector
Electricity Prices	Public Sector
Power of Vehicle	Private Sector
Charging Time	Private Sector
Electricity Supply	Public Sector
Heavy Taxes on Electricity Bills	Public Sector
Fuel Price Adjustments on Electricity Bills	Public Sector
Auto Manufacturers	Private Sector
Private Sector Investment	Private Sector
Economic Conditions	Public Sector
Comparison with CVs	Private Sector
Hesitation by investors	Public Sector
Body and Spare Parts	Private Sector
Average Affecting Factors / Issues	**Responsibility**
Maximum speed of vehicle	Private Sector
Less Reliability and Uncertainty	Private Sector
Price of Electric Vehicle	Public and Private Sector
Road Infrastructure	Public Sector
Car Prices in Pakistan	Public and Private Sector

Repairing Workshops	Private Sector
Political Instability	Public Sector
Top Auto Brands	Private Sector
Per Capita Income	Public Sector
Inconsistency in Government Policies	Public Sector
OEMs	Private Sector
Least Affecting Factors / Issues	**Responsibility**
Mobility Rate	Public and Private Sector
Electricity load management	Public Sector
Different Slabs of Electricity for Domestic Users	Public Sector
Registration of EVs	Public Sector
No Incentives for Charging Stations	Public Sector
Affordability of Government	Public Sector

Table 14: Factors / Issues in Implementation of NEVP Sorted Responsibilities Wise

Sector Responsible	Most Affecting Factors	Average Affecting Factors	Least Affecting Factors
Public Sector (16 Factors)	(1) Electricity Prices (2) Electricity Supply (3) Heavy Taxes on Electricity Bills (4) Fuel Price Adjustments on Electricity Bills (5) Economic Conditions	(1) Road Infrastructure (2) Political Instability (3) Per Capita Income (4) Inconsistency in Government Policies	(1) Electricity load management (2) Different Slabs of Electricity for Domestic Users (3) Registration of EVs (4) No Incentives for Charging Stations (5) Affordability of Government

	(6) Hesitation by investors		
Private Sector (13 Factors)	(1) Less Mileage (2) Battery Life (3) Power of Vehicle (4) Charging Time (5) Auto Manufacturers (6) Private Sector Investment (7) Comparison with CVs (8) Body and Spare Parts	(1) Maximum speed of vehicle (2) Less Reliability and Uncertainty (3) Repairing Workshops (4) Top Auto Brands (5) OEMs	
Shared Responsibility of Public and Private Sector (4 Factors)	(1) Running Cost (2) Charging Infrastructure	(1) Car Prices in Pakistan (2) Price of Electric Vehicle	Mobility Rate
There are total 33 factors / issues in implementation of NEVP.			

Based upon the results found in Para 4.2 and summarized in Table 15, following are the concern departments / organizations / associations along with the issues and challenges in implementation of the National Electric Vehicles Policy to be addressed by them specifically:

Government Sector Departments

Engineering Development Board, Ministry of Industries and Production (For policy review, comprehensive policy, consistency in policy, and incentives for establishing charging station), NEPRA / WAPDA / Other Power Distribution Companies (For electricity prices, electricity supply, multiple taxes on electricity bills, fuel price adjustments on electricity bills, electricity load management, and different slabs of electricity for domestic users), Ministry of Finance (For economic conditions and

dealing with per capita income),Trade Development Authority of Pakistan (TDAP) (Hesitation by Investors),National and Provincial Highway Authorities (road infrastructure and traffic rules to avoid over loading) and FBR (Including Inland Revenue Services, Customs and Excise and Taxation Departments) (For taxation rates, registration of EVs, and customs support)

Private Sector Associations

PAMA (Pakistan Auto Manufacturers Association) / PEVMA (Pakistan Electric Vehicles Manufacturers Association) (for top / branded auto manufacturers support, private sector investment, mileage of vehicle, power of vehicle, ICE comparable vehicle, charging time, speed of vehicle, and good quality vehicle)and PAAPAM (Pakistan Association of Automotive Parts and Accessories Manufacturers) (For body parts, spare parts, lithium-ion batteries, battery life, battery price, and powerful electric motors)

Public and Private Both Support Sector

Ministry of Finance, FBR and PAMA (For car prices, mobility rate, EV prices, NEPRA (National Electric Power Regulatory Authority), WAPDA and Pakistan Petroleum Dealers Association) and charging infrastructure development

4.3.3. Summary

If we summarize the whole chapter, there are following factors that are affecting the implementation of NEVP and adoption of EVs:-

Social Factors, Policy Factors, Energy Factors, Infrastructural Factors, Financial Factors and Technology Factor

CHAPTER – 5: RECOMMENDATIONS AND CONCLUSION

5.1 Recommendations

Based upon the results and finding briefly discussed in chapter 4, following implementation model is recommended to be adopted: -

5.1.1 Implementation Model

Electric Vehicle industry is a very broad industry which involves actions from several government and private sectors. Following is the catalog of government departments and private associations that are involved in this process: -

Public Sector

Engineering Development Board, Ministry of Industries and Production, National Electric Power Regulatory Authority (NEPRA) / Water and Power Development Authority (WAPDA) / Other Power Distribution Companies (PDCOs), Ministry of Finance, Trade Development Authority of Pakistan (TDAP), National and Provincial Highway Authorities, FBR (Including Inland Revenue Services, Customs and Excise and Taxation Departments), State Bank of Pakistan, and Ministry of Climate Change

Private Sector

Pakistan Auto Manufacturers Association ((PAMA)) / Pakistan Electric Vehicles Manufacturers Association (PEVMA), Association of Pakistan Motorcycle Assemblers(Chapman), Pakistan Association of Automotive Parts and Accessories Manufacturers (PAAPAM), Pakistan Electric Vehicles and Parts Manufacturers and Traders Association (PEVPMTA), All Pakistan Motorcycle Spare Parts Importers and Dealers Association (APMSPIDA), Pakistan Petroleum Dealers Association (PPDA)

Implementation is only possible with the support from all above mentioned actors of the industry with top hand of the Government to formulate and regulate the process. So the implementation process is a two-way process i.e. vertical and horizontal. Vertically Top-Down model to be adopted to formulate and regulate the process of implementation but it is only possible with horizontal support from private sector, because any Government cannot alone invest such a big amount and in long term and Government of Pakistan has not enough resources to invest neither in manufacturing EVs nor in developing charging infrastructure and private sector

without government policy and support is cannot regulate the process and development. So following process / model is recommended to be adopted:

Vertical. Engineering Development Board of Ministry of Industries and Production holds the responsibility of formulating, implementation, liaison, controlling and defining the policy and its implementation process. As EDB is top government department therefore the approach for implementation will be Top-Down Approach. All above mentioned government departments are required to follow NEVP in true letter and spirit while formulating their concern policies e.g. while preparing budget, ministry of finance should take good care of the taxation rates mentioned in NEVP and should not increase those taxation rates. Similarly, Customs department should also amend their policy according to the NEVP for import of EVs and related equipment.

Horizontal. After complete approval of policy, support from all above mentioned private sector industries is mandatory to implement the policy formulated by the government. Without huge support from these private sector associations / industries, the policy can never be implemented and government holds very scarce resources. Private sector should take advantage of the incentives being provided by the government and invest in EVs various sectors e.g. manufacturing, spare parts, charging stations etc. Detailed recommendations are being enlisted in Para 5.1.2. Implementation model is well described in following figure.

This can be called a type of **"Support Building Approach" as** in this approach policy implementaion process is adopted in coordination between top and bottom and is prepared with the consultation of experts from top position holders and representatives of the target population.

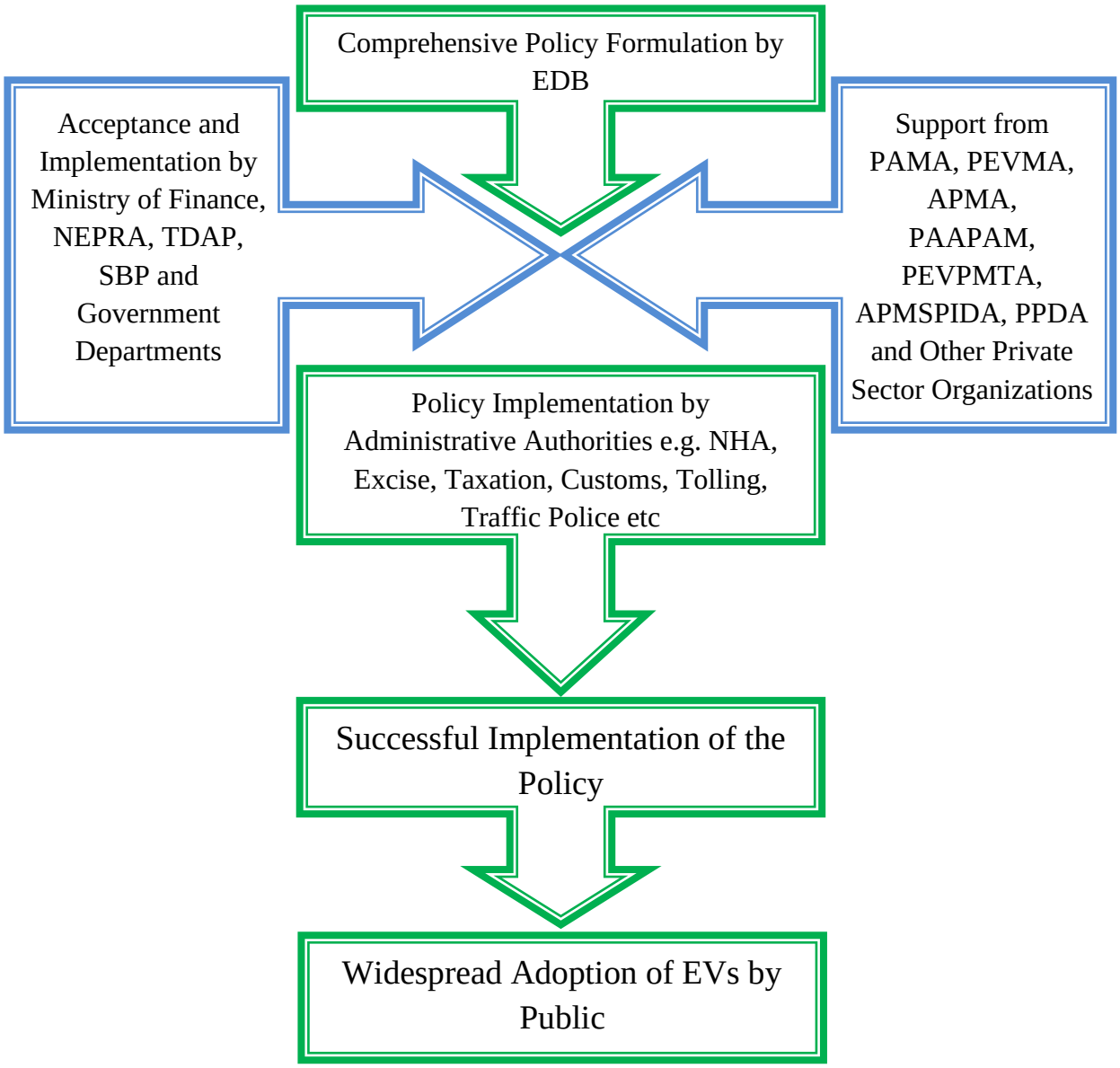

Figure 28: Policy Implementation Model

5.1.2 Recommendations

After brief and comprehensive working, following steps are recommended for tackling with the barriers / issues and challenges and implementation of the policy:

(1) Pakistan Electric Vehicles Commission/ Authority. As Earlier described, NEVP implementation involves various government departments / organizations and various private sector associations, so to formulate a comprehensive policy and to regulate the implementation process, it is recommended that a commission under chairmanship of Ministry of Industries

and Production with members from all relevant government departments / organizations and all relevant private associations (as mentioned in Para 5.1.1) be established on immediate basis. This commission should be responsible for: Taking input/ feedback from all relevant stake holders e.g. manufacturers, owners, charging stations etc to formulate and update the policy accordingly, setting standards for EVs and their parts manufacturing, issuing license for EVs manufacturing / import of equipment related to EVs / establishing charging station etc and acting as a regulatory authority for all matters related to EVs

(2) Policy Amendments. Current policy does not include definitions, procedures, standards for EVs and there are many loop holes in the policy, therefore, following policy amendments are recommended

Comprehensive Policy. Policy should include all aspects of all types of EVs. And all parts of NEVP should be applicable on all four types of EVs i.e. Battery Electric Vehicle (BEV), Hybrid Electric Vehicle (Sotnyk et al.), Plugged-In Hybrid Electric Vehicle (PHEV) and Fuel Cell Electric Vehicle (FCEV). *While suggesting incentives, focus should be on incentives that could reduce the initial cost and running cost of the vehicle as both these factors play important role in selection of vehicle while purchasing.*

Incentives for Charging Station Owners. Less developed charging infrastructure is one of the top barriers in implementation of NEVP, therefore this point should be given due consideration and incentives that could reduce charging cost for both station owners and vehicle owners should be focused on.

Revision in Incentives for Manufacturers. Currently there is only one two wheeler manufacturer and one four wheeler manufacturer of EVs after more than one year of policy approval. Government should consider revision in incentives in consultation with PAMA through PECO (Pakistan EVs Commission). Focus should be on such

incentives that could reduce the cost price of the vehicle. Less costly vehicle is always attractive as compare to costlier vehicles.

Revision in Incentives for Owners. Currently there are very few incentives for EV owners in Pakistan as compare to other countries. Some more incentives should be offered like free tolling, free parking, reduction in traffic fines, tax credit etc.

Revision in Incentives for OEMs. OEMs play major role in manufacturing process and prices of vehicles are linked with the equipment prices, therefore import of all type of plants and machineries for EVs parts manufacturing should be free from all duties and taxes and other incentives should be made part of policy in consultation with OEMs.

Separate Electricity Connections for Charging Stations. Charging stations are facing problem due to high electricity prices, therefore it is recommended that separate electricity connection should be provided to all EV charging points.

Free charging facilities for e-bikes. Electric bikes consume very small amount of electricity to charge therefore free and fast charging should be provided to all e-bikes in public places like parks, government and private schools/ colleges/ universities and government and private offices.

Fixed Electricity Rates for Charging Stations. Always changing electricity prices are a major barrier in EVs adoption therefore it is recommended that per unit rate of electricity should be fixed and inclusive of all but less taxes for charging station's separate meters.

Fuel Price Adjustments. Fuel price adjustments are big issue in electricity prices and indirectly play major role of barriers in implementation of NEVP. In the electricity bills of December 2021, amount of fuel price adjustments was 60% of total bill which means that rate for fuel price adjustments was more than 100 % of the cost of

electricity. Separate meters for EVs should be exempted from fuel price adjustments.

Standards for EVs. There are currently no standards set for EVs due to which some e-bike manufacturers are using dry batteries for e-bikes. Dry batteries have very less life and company is offering only two months' warranty. This is resulting into bad impression of e-bikes for owners and their connecting people. Once the e-bike lost the trust of people due to low standards, it will take much time re-win the consumer's trust. Therefore, it is recommended that standards for EVs especially for Electric motors and batteries should be set and strictly followed.

Easy Auto Financing. Currently there are very few four wheeler EV owners in the country and all of them belong to elite class. To make the vehicle attractive for middle class and people who can afford only one vehicle, there should through be Easy Auto Financing available for all sorts of EVs in all banks with reduce interest rate, zero KIBOR and more financing time.

Mileage Limit. Mileage of the vehicle plays an important role in EV adoption and it is one of the top barriers in implementation of NEVP. Therefore, it is recommended that minimum mileage limit should be set for different type of vehicles like 150 kilometers for Two Wheelers, 200 kilometers for three Wheelers, 500 kilometers for four wheelers passenger cars and so on in consultation with relevant stake holders.

(3) Steps to be taken by all other relevant departments. All departments / organizations (as stated in Para 5.1.1) should just strictly follow NEVP while amending their policies. For example, NEPRA while changing electricity tariffs and updating fuel price adjustments should exempt charging stations and separate electricity meters for EVs from those changes. Similarly, Ministry of Finance should exempt all EV stake holders from revised taxation and duties rates and so all relevant departments as well.

(4) Awareness Campaigns. Media plays an important role in spreading awareness regarding any political, social, environmental or other issues. Electronic, print and social media platforms should be used to creating awareness among people regarding benefits of EVs.

(5) Steps to be taken by Private Sector. As earlier stated that government alone can never implement NEVP as various identified issues and challenges are directly linked with the private sector and only private sector can address those issues. Following are the sector who should play their role in implementation of the policy:

Auto Sector. Following are the steps to be taken by Auto sector to promote EVs: Powerful Electric Motors that can easily move the vehicle in hilly areas and take load according to capacity especially in case of commercial vehicles.

Reduce EV Prices: Vehicle prices are very much high, but it can be reduced in case of EVs by government incentives, less imported parts and removal of engine cost. They should seriously think upon reducing the prices and keeping the prices constant for a long period of time. More Mileage: Mileage is one of the top barriers in implementation of NEVP. Therefore, steps to be taken to increase the mileage of the vehicle. Weight reduction, larger batteries and small size of vehicle can play role in this regards. Reduce Charging Time by enabling Fast Charging: Fast charging options to should be included in EVs so that charging time should be reduced. As time is money. High Standards Motors and Batteries should be used to make the vehicle reliable. Safety Measures for EVs especially for e-Bikes: Lithium is good flammable material, therefore safety of the passengers should be given due consideration, especially for two and three wheelers.

Fuel / Charging Stations Sector. Charging Stations Network on all major Highways, Motorways, on the way to all tourist destinations and charging stations in urban and rural areas be established. Other responsibilities are to reduce Charging time, more charging points on single charging station,

DCFC charging options for bikes, DCFC installation at homes and to have facility of battery swapping.

(6) Policy Implementation Strategies:

City Wise Programs. Programs to implement NEVP are mandatory. Without initiating specialized programs, it would be difficult to implement the policy. Implementation programs are recommended to be initiated in following phases: Two types of programs are suggested that can change the whole scenario. (1) Invitation should be offered for installing EV charging stations with benefits of separate electricity meters with specialized electricity tariffs and (2) interest free auto financing services should be provided.

Phase One – Capital Cities. These two programs should be started in federal and all provincial capitals initially in urban areas and then in rural areas. This phase should be considered as short term measures and should remain applicable for at least three to five years.

Phase Two – Major Cities. In second phase these two programs can be started in all major cities of the country initially in urban areas and then in rural areas.

Phase Three – Tourist Destinations. In third phase all tourist destinations to be marked and theses programs should be started for them.

Phase two and three should be considered as medium term measures and should remain applicable from five years to ten years.

Phase Four – Throughout the Country. In last phase all these programs should be applied throughout the country.

Phase four should be considered as long term measures and should remain applicable from ten years to twenty years.

These phases can be further staggered into wheel wise programs e.g. in the first phase primary focus should be on two

wheelers, then on public transport, thirdly on government vehicles, then on all passenger vehicles and finally on commercial vehicles.

Term-Based Programs. Considering table 15, following priorities should be set for addressing the issues and challenges in implementation of NEVP:

Short Term. Most affecting factor / issues in implementation of NEVP should be addressed at top priority and should be addressed with short term measures. As these factors are playing role of top barriers in implementation of NEVP.

Medium Term. Average affecting factor / issues in implementation of NEVP as per table 15 should be dealt in medium term programs.

Long Term. And finally least affecting factor / issues in implementation of NEVP should be tackled in long term programs.

Vehicle Category Preference. Out of total on-road transport in Pakistan, there are 76 % two wheelers which mean conversion of 100% conventional bikes into e-bikes means conversion of 76% conventional transport into electric transport. E-bikes are less costly as compare to four wheeler EVs and these bikes can be easily charged at home using 220V AC connection. Therefore, adoption of e-bikes may be preferred. Conversion of existing conventional bikes into electric bikes may be considered at second stage.

Phase One – Capital Cities. These two programs should be started in federal

5.1.3 Important Factors that should be considered in line with the implementation of NEVP.

(1) Electricity Load Management. With the implementation of NEVP and widespread adoption of EVs in the country, demand of electricity will be increased. Steps should be taken to meet the expected demand in long terms and manage the load of electricity.

(2) Electricity Prices. Electricity prices are increasing day by day majorly due to IMF programs. The conditions imposed by IMF always include increase in electricity prices. This trend of increasing electricity prices can create problems in implementation of NEVP in long term. Subsidies and incentives can be providing for a limited period of time and cannot be provide for unlimited period of time. Government should take steps to reduce the electricity prices and keep them constant.

(3) Reduced Share of Government Earnings. With shift from fuel vehicles to electric vehicles, the demand of petrol will have decreased, taxes and other duties on several items will be decreased in NEVP. This will result in decrease in government earnings. Steps should be taken on creating alternate earning for government to keep the current account balanced.

(4) Economic and Political Stability. Economic and political stability plays important role in foreign and local investments. If political and economic conditions of the country are not stable, investors hesitate in putting their funds there. Therefore, steps should be taken to permanently stabilize the economic and political conditions of the country. Per capita income plays a major role in the life style of the people, high income means more affordability. This will increase the purchase power of the buyer and people will be able to afford high priced EVs.

(5) Car prices as compare to India. Vehicles prices are very much high as compare to the neighbor countries especially India and prices are increased by companies several times in a year. Price control policy should be formulated and profit ration should be fixed for auto sector. Vehicle is a necessity but unfortunately it is considered as a luxury in Pakistan.

5.2 Conclusion

Electric Vehicles are new technology vehicles that are being adopted rapidly by the world and becoming popular technology vehicles which have several benefits which include but not limited to environment friendly, cost effective and many others. Considering the various benefits and the growing trend of EVs in the world including neighborhood of Pakistan, Ministry of Industries and Production through Engineering

Development Board prepared the first ever National Electric Vehicles Policy of Pakistan which was approved in December 2020.EVs are new technology vehicle so people around the world initially hesitated in adoption of EVs and switching from CVs to EVs. Similar is the situation in the Pakistan. In addition to that there are some other factors that are affecting adoption of EVs in Pakistan. In this study we have identified those factors to highlight issues and challenges in implementation of NEVP using qualitative methods. In Depth Interviews have been taken from fifteen relevant persons from four major fields of EVs i.e. policy makers, manufacturers, owners and charging station owners. Snow ball technique was used for sampling. After profound analysis using thematic analysis technique, 33 factors have been identified that are playing the role of barriers in implementing the policy. We have identified that EV Policy makers, EV manufacturers (including OEMs), Charging Station owners and EV owners are the major stake holders of the policy. All of the four major stake holders of the electric vehicles are facing various problems which are turning out to be the barriers, issues and challenges in implementation of the NEVP. Most of the problems faced by one sector can be handled by the other sector if timely communicated in a proper way. Therefore, there is a need to bring together all the four stakeholders so that they could discuss their problems at one forum and address them all on the same forum. This strong and single forum coordination will ease the policy implementation which will result in early adoption of EVs and that will benefit all the stakeholders. After some policy amendments, many other government organizations have to play supportive role and various private sector fields (including Auto manufacturers, parts manufacturers, fuel stations etc) have to play their role. Only after that, smooth policy implementation will become possible. Because the issues that have been identified cannot be dealt by the relevant government department alone, support from other government departments and private sector associations is mandatory for better implementation of the policy. Along with that media forums should be used to create awareness among the public regarding benefits and importance of EVs. There are 76 % two wheelers in total on road transport vehicles in Pakistan. Therefore, in initial stages primary focus should be on electric motorbikes. Electric bikes are less expensive as compare to electric vehicles. If we

could achieve conversion of at least 50 % bikes on electric, it means that 38 % of total vehicles in Pakistan will be converted into electric transport. Implementation programs should be initiated to achieve the 2030 targets that have been set in NEVP. City wise implementation programs can help making adoption of EVs smooth and steady.

5.3 Research Limitations

EV is a new phenomenon in Pakistan therefore there are several research limitations, some of them are as under: -

(1) Limited country specific literature available

(2) Sample Size and locating Samples

(3) Financial constraints

5.4 Future Research

After having details discussion in this topic we have identified that there is very limited research available in EVs sector in context of Pakistan and there are various sectors of EVs available for future research. Some of that are related to the field of management sconces and social sciences and that are as under: -

(1) Impact of policy on adoption of EVs.

(2) Adoption behavior of people for a new technology vehicle

(3) Reasons for low motorization rate in the country

(4) Most suitable type of EV for the scenario in Pakistan

(5) Impact of EVs on transport

(6) EV Industrial Development Impacts

(7) Electricity Generation and its Demand and Supply Management

(8) Need of Indigenous Technology Development for EV Sector

REFERENCES

(PAMA), P. A. M. A. (2021). MONTHLY PRODUCTION & SALES OF VEHICLES. 2021. Retrieved 17-Oct-2021, 2021, from https://www.pama.org.pk/monthly-production-sales-of-vehicles/

Agency, E. P. (2014). Global Greenhouse Gas Emissions Data. Retrieved 20-Aug, 2022, from https://www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data

Agrawal, S., Kumar, P., Narang, P., & Singh, T. (2020). Challenges to Electric Vehicle Forecasting and Implementation in India. *Available at SSRN 3567658*.

Ahmad, F., Alam, M. S., Alsaidan, I. S., & Shariff, S. M. (2020). Battery swapping station for electric vehicles: opportunities and challenges. *IET Smart Grid, 3*(3), 280-286.

Ahmed, M. R., & Karmaker, A. K. (2019). *Challenges for electric vehicle adoption in Bangladesh.* Paper presented at the 2019 International Conference on Electrical, Computer and Communication Engineering (ECCE).

Asadi, S., Nilashi, M., Samad, S., Abdullah, R., Mahmoud, M., Alkinani, M. H., & Yadegaridehkordi, E. (2021). Factors impacting consumers' intention toward adoption of electric vehicles in Malaysia. *Journal of Cleaner Production, 282*, 124474.

Bandara, H., AN, N., Perera, D., & SWGK, B. Key Factors Influencing Consumer Purchase Intention of Electric Cars in Sri Lanka.

Bangla, A. (2021). Cheapest Cars in Bangladesh. Retrieved 17-Oct-2021, 2021, from https://autosbangla.com/cheapest-car-in-bangladesh.html

Bank, W. (2021). World Bank Open Data. Retrieved 17-Oct-2021, 2021, from https://data.worldbank.org/

Bansal, P., Kumar, R. R., Raj, A., Dubey, S., & Graham, D. J. (2021). Willingness to pay and attitudinal preferences of Indian consumers for electric vehicles. *Energy Economics*, 105340.

Beauchamp, C. (2009). Beauchamp TL, Childress JF Principles of biomedical ethics: Oxford.

Bernier, N. F., & Clavier, C. (2011). Public health policy research: making the case for a political science approach. *Health promotion international, 26*(1), 109-116 %@ 1460-2245.

Bhattacharyya, S. S., & Thakre, S. (2020). Exploring the factors influencing electric vehicle adoption: an empirical investigation in the emerging economy context of India. *foresight*.

Bowen, G. A. (2009). Document analysis as a qualitative research method. *Qualitative research journal, 9*(2), 27-40.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology, 3*(2), 77-101.

Brinkel, N., Schram, W., AlSkaif, T., Lampropoulos, I., & van Sark, W. (2020). Should we reinforce the grid? Cost and emission optimization of electric vehicle charging under different transformer limits. *Applied Energy, 276*, 115285.

Burgess, M., King, N., Harris, M., & Lewis, E. (2013). Electric vehicle drivers' reported interactions with the public: Driving stereotype change? *Transportation research part F: traffic psychology and behaviour, 17*, 33-44 %@ 1369-8478.

CCP. (2021). Latest Car Models With Prices and Specs. Retrieved 17-Oct-2021, 2021, from https://www.ccarprice.com/lk/

Chapman, L. (2007). Transport and climate change: a review. *Journal of transport geography, 15*(5), 354-367 %@ 0966-6923.

Chinda, T. (2022). Long-term trend of electric vehicle sales in Thailand. *Engineering Management in Production and Services, 14*(1), 13-25.

Collantes, G., & Sperling, D. (2008). The origin of California's zero emission vehicle mandate. *Transportation Research Part A: Policy and Practice, 42*(10), 1302-1313.

Collins, C. M., & Chambers, S. M. (2005). Psychological and situational influences on commuter-transport-mode choice. *Environment and behavior, 37*(5), 640-661 %@ 0013-9165.

Creswell, J. W. (2014). *A concise introduction to mixed methods research*. Los Angeles: SAGE Publications.

Creswell, J. W., & Clark, V. L. P. (2011). *Designing and Conducting Mixed Methods Research* (Second Edition ed.). Los Angeles: Sage Publications, Inc.

DE SILVA, M. M., & KUMARAGE, A. S. A Gap Analysis of EV Policies for promoting E-Mobility in Sri Lanka.

Division, F. (2019-20). Pakistan Economic Survey (M. o. F. Finance Division, Pakistan, Trans.) (Vol. 2019-20, pp. 516). Islamabad Pakistan: Finance Division, Ministry of Finance, Pakistan.

Dong, X., Zhang, B., Wang, B., & Wang, Z. (2020). Urban households' purchase intentions for pure electric vehicles under subsidy contexts in China: Do cost factors matter? *Transportation Research Part A: Policy and Practice, 135*, 183-197.

Fang, Y., Wei, W., Mei, S., Chen, L., Zhang, X., & Huang, S. (2020). Promoting electric vehicle charging infrastructure considering policy incentives and user preferences: An evolutionary game model in a small-world network. *Journal of Cleaner Production, 258*, 120753.

Feng, K., Lin, N., Xian, S., & Chester, M. V. (2020). Can we evacuate from hurricanes with electric vehicles? *Transportation research part D: transport and environment, 86*, 102458.

Funke, S., Jochem, P., Ried, S., & Gnann, T. (2020). Fast charging stations with stationary batteries: A techno-economic comparison of fast charging along highways and in cities. *Transportation Research Procedia, 48*, 3832-3849.

Gao, Y., Leng, M., Zhang, Y., & Liang, L. (2022). Incentivizing the adoption of electric vehicles in city logistics: Pricing, driving range, and usage decisions under time window policies. *International Journal of Production Economics*, 108406.

Ghimire, L. P. (2019). *Two Essays on Electric Vehicle Use in Nepal.* 서울대학교 대학원.

Goel, P., Sharma, N., Mathiyazhagan, K., & Vimal, K. (2021). Government is trying but consumers are not buying: A barrier analysis for electric vehicle sales in India. *Sustainable Production and Consumption, 28*, 71-90.

Gosden, D. (1990). MODERN ELECTRIC VEHICLE TECHNOLOGY USING AN AC MOTOR DRIVE. *Journal of Electrical and Electronics Engineering, 10*(1).

Graham-Rowe, E., Gardner, B., Abraham, C., Skippon, S., Dittmar, H., Hutchins, R., & Stannard, J. (2012). Mainstream consumers driving plug-in battery-electric and plug-in hybrid electric cars: A qualitative analysis of responses and evaluations. *Transportation Research Part A: Policy and Practice*, *46*(1), 140-153 %@ 0965-8564.

Gregg, D. G., Kulkarni, U. R., & Vinzé, A. S. (2001). Understanding the philosophical underpinnings of software engineering research in information systems. *Information Systems Frontiers, 3*(2), 169-183.

Guarnieri, M. (2012). *Looking back to electric cars.* Paper presented at the 2012 Third IEEE HISTory of ELectro-technology CONference (HISTELCON).

Guba, E. G., & Lincoln, Y. S. (1994). Competing paradigms in qualitative research. *Handbook of qualitative research, 2*(163-194), 105.

Hardman, S., Kurani, K. S., & Chakraborty, D. (2020). The usual policy levers are not engaging consumers in the transition to electric vehicles: a case of Sacramento, California. *Environmental Research Communications, 2*(8), 085001.

Harvey, L. D. (2020). Rethinking electric vehicle subsidies, rediscovering energy efficiency. *Energy policy, 146*, 111760.

Hasan, S., & Simsekoglu, Ö. (2020). The role of psychological factors on vehicle kilometer travelled (VKT) for battery electric vehicle (BEV) users. *Research in Transportation Economics, 82*, 100880.

Heale, R., & Shorten, A. (2017). Ethical context of nursing research. *Evidence-based nursing, 20*(1), 7-7.

Jain, N. K., Bhaskar, K., & Jain, S. (2022). What drives adoption intention of electric vehicles in India? An integrated UTAUT model with environmental concerns, perceived risk and government support. *Research in Transportation Business & Management, 42*, 100730.

Javadi, M., & Zarea, K. (2016). Understanding thematic analysis and its pitfall. *Demo, 1*(1), 33-39.

Jena, R. (2020). An empirical case study on Indian consumers' sentiment towards electric vehicles: A big data analytics approach. *Industrial Marketing Management, 90*, 605-616.

Joshi, N., Malhotra, M., & Singh, J. (2022). Assessing adoption intention of electric vehicles in India: The mediating role of government policies. *European Journal of Transport and Infrastructure Research, 22*(1), 1-16.

Karki, A., Shrestha, B. P., Tuladhar, D., Basnet, S., Phuyal, S., & Baral, B. (2019). *Parameters matching for electric vehicle conversion.* Paper presented at the 2019 IEEE Transportation Electrification Conference (ITEC-India).

Karlsson, S. (2020). Utilization of battery-electric vehicles in two-car households: Empirical insights from Gothenburg Sweden. *Transportation Research Part C: Emerging Technologies, 120*, 102818.

Kester, J., Sovacool, B. K., Noel, L., & de Rubens, G. Z. (2020). Between hope, hype, and hell: Electric mobility and the interplay of fear and desire in sustainability transitions. *Environmental Innovation and Societal Transitions, 35*, 88-102.

Khan, N. U., & Deeba, F. (2020). CLIMATE JUSTICE AND RIGHT TO DEVELOPMENT IN INTERNATIONAL ECONOMIC LAW (IEcL): PUBLIC POLICY AND IMPLICATIONS FOR PAKISTAN. *Pakistan Journal of Society, Education and Language (PJSEL), 6*(2), 144-157.

Khurana, A., Kumar, V. R., & Sidhpuria, M. (2020). A Study on the Adoption of Electric Vehicles in India: The Mediating Role of Attitude. *Vision, 24*(1), 23-34.

Kincheloe, J. L., McLaren, P., & Steinberg, S. R. (2011). Critical pedagogy and qualitative research. In N. K. Denzin & Y. S. Lincoln (Eds.), *The SAGE handbook of qualitative research* (pp. 163-177). London: Sage.

Klee, A. (2021). THE GROWTH OF ELECTRIC VEHICLES IN AMERICA.

Konečný, V., Gnap, J., Settey, T., Petro, F., Skrúcaný, T., & Figlus, T. (2020). environmental sustainability of the vehicle fleet change in public city transport of selected city in central Europe. *Energies, 13*(15), 3869.

Kongklaew, C., Phoungthong, K., Prabpayak, C., Chowdhury, M. S., Khan, I., Yuangyai, N., . . . Techato, K. (2021). Barriers to Electric Vehicle Adoption in Thailand. *Sustainability, 13*(22), 12839.

Krupa, J. S., Rizzo, D. M., Eppstein, M. J., Lanute, D. B., Gaalema, D. E., Lakkaraju, K., & Warrender, C. E. (2014). Analysis of a consumer survey on plug-in hybrid electric vehicles. *Transportation Research Part A: Policy and Practice, 64*, 14-31.

Kubański, M. (2020). Prospects for the Use of Electric Vehicles in Public Transport on the Example of the City of Czechowice-Dziedzice. *Transportation Research Procedia, 44*, 110-114.

Kumar, S., & Bharj, R. (2020). Solar hybrid e-cargo rickshaw for urban transportation demand in India. *Transportation Research Procedia, 48*, 1998-2005.

Kwon, Y., Son, S., & Jang, K. (2020). User satisfaction with battery electric vehicles in South Korea. *Transportation Research Part D: Transport and Environment, 82*, 102306.

Lane, B., & Potter, S. (2007). The adoption of cleaner vehicles in the UK: exploring the consumer attitude–action gap. *Journal of cleaner production, 15*(11-12), 1085-1092 %@ 0959-6526.

Lane, P. J., Koka, B. R., & Pathak, S. (2006). The reification of absorptive capacity: A critical review and rejuvenation of the construct. *Academy of management review, 31*(4), 833-863 %@ 0363-7425.

Launis, V. (2015). Ihminen kliinisen lääketieteellisen tutkimuksen kohteena. *Kliinisen tutkimuksen etiikka. Helsinki: Kustannus oy Duodecim*.

Leech, N. L., & Onwuegbuzie, A. J. (2009). A typology of mixed methods research designs. *Quality & Quantity, 43*(2), 265-275.

Li, W., Long, R., Chen, H., Chen, F., Zheng, X., He, Z., & Zhang, L. (2020). Willingness to pay for hydrogen fuel cell electric vehicles in China: A choice experiment analysis. *International Journal of Hydrogen Energy, 45*(59), 34346-34353.

Li, W., Long, R., Chen, H., Dou, B., Chen, F., Zheng, X., & He, Z. (2020). Public preference for electric vehicle incentive policies in China: a conjoint analysis. *International journal of environmental research and public health, 17*(1), 318.

Library, H. (2021). Passenger Cars Per 1,000 People. Retrieved 17-Oct-2021, 2021, from https://www.helgilibrary.com/indicators/passenger-cars-per-1000-people/

Lim, M. K., Mak, H.-Y., & Rong, Y. (2015). Toward mass adoption of electric vehicles: Impact of the range and resale anxieties. *Manufacturing & Service Operations Management, 17*(1), 101-119.

Ližbetin, J., Hlatká, M., & Bartuška, L. (2018). Issues concerning declared energy consumption and greenhouse gas emissions of FAME biofuels. *Sustainability, 10*(9), 3025.

Logan, K. G., Nelson, J. D., & Hastings, A. (2020). Electric and hydrogen buses: Shifting from conventionally fuelled cars in the UK. *Transportation Research Part D: Transport and Environment, 85*, 102350.

Lopez-Arboleda, E., Sarmiento, A. T., & Cardenas, L. M. (2021). Systemic approach for integration of sustainability in evaluation of public policies for adoption of electric vehicles. *Systemic Practice and Action Research, 34*(4), 399-417.

Lu, T., Yao, E., Jin, F., & Pan, L. (2020). Alternative Incentive Policies against Purchase Subsidy Decrease for Battery Electric Vehicle (BEV) Adoption. *Energies, 13*(7), 1645.

Mali, B., Shrestha, A., Chapagain, A., Bishwokarma, R., Kumar, P., & Gonzalez-Longatt, F. (2022). Challenges in the penetration of electric vehicles in developing countries with a focus on Nepal. *Renewable Energy Focus, 40*, 1-12.

Mir, K. A., Purohit, P., & Mehmood, S. (2017). Sectoral assessment of greenhouse gas emissions in Pakistan. *Environmental Science and pollution research, 24*(35), 27345-27355.

Mustajoki, H., & Mustajoki, A. (2017). *A new approach to research ethics: Using guided dialogue to strengthen research communities*: Taylor & Francis.

Naseem, S. A., Uddin, R., Rashid, A., Chishti, S. O. A., & Naseem, S. W. (2019). *Electric vehicle (ev) a sustainable policy recommendation for zero ghg emission in pakistan.* Paper presented at the IEEE Inter. Elect. Eng. Conf.

Noel, L., de Rubens, G. Z., Kester, J., & Sovacool, B. K. (2020). Understanding the socio-technical nexus of Nordic electric vehicle (EV) barriers: A qualitative discussion of range, price, charging and knowledge. *Energy Policy, 138*, 111292.

Oxner, E. S. (2020). *FET technology and application*: CRC Press.

Panwar, U., Kumar, A., & Chakrabarti, D. (2019). Barriers in implementation of electric vehicles in India. *International Journal of Electric and Hybrid Vehicles, 11*(3), 195-204.

Patyal, V. S., Kumar, R., & Kushwah, S. (2021). Modeling barriers to the adoption of electric vehicles: An Indian perspective. *Energy, 237*, 121554.

Peters, B. G., & Pierre, J. (2006). Handbook of public policy.

Pietilä, A.-M., Nurmi, S.-M., Halkoaho, A., & Kyngäs, H. (2020). Qualitative research: Ethical considerations *The application of content analysis in nursing science research* (pp. 49-69): Springer.

Pietrzak, K., & Pietrzak, O. (2020). Environmental effects of electromobility in a sustainable urban public transport. *Sustainability, 12*(3), 1052.

Punch, K. F. (2013). *Introduction to social research: Quantitative and qualitative approaches* (Third ed.). London: Sage.

Ram, A. (2020). Consumer Behavior towards Buying Electric Vehicles.

Rastogi, A., Thomas, R. G., & Digalwar, A. K. (2021). Identification and analysis of social factors responsible for adoption of electric vehicles in India. *CURRENT SCIENCE, 121*(9), 1180.

Resnik, D. B., & Elliott, K. C. (2016). The ethical challenges of socially responsible science. *Accountability in research, 23*(1), 31-46.

Rezvani, Z., Jansson, J., & Bodin, J. (2015). Advances in consumer electric vehicle adoption research: A review and research agenda. *Transportation research part D: transport and environment, 34*, 122-136.

ROBINSON, M., & RAJAVIGNESH, P. (2020). MARKET OPPORTUNITIES OF ELECTRIC VEHICLES–A LITERATURE REVIEW.

Schuitema, G., Anable, J., Skippon, S., & Kinnear, N. (2013). The role of instrumental, hedonic and symbolic attributes in the intention to adopt electric vehicles. *Transportation Research Part A: Policy and Practice, 48*, 39-49 %@ 0965-8564.

Severengiz, S., Finke, S., Schelte, N., & Forrister, H. (2020). Assessing the environmental impact of novel mobility services using shared electric scooters as an example. *Procedia Manufacturing, 43*, 80-87.

Shashank, G., Sairam, D., Reddy, B. R., Afreed, K., & Sridharan, R. (2020). *Analysis of enablers and barriers in adopting electric vehicles in India: DEMATEL-ISM approach.* Paper presented at the 2020 International Conference on System, Computation, Automation and Networking (ICSCAN).

Shetty, D. K., Shetty, S., Rodrigues, L. R., Naik, N., Maddodi, C. B., Malarout, N., & Sooriyaperakasam, N. (2020). Barriers to widespread adoption of plug-in electric vehicles in emerging Asian markets: An analysis of consumer behavioral attitudes and perceptions. *Cogent Engineering, 7*(1), 1796198.

Skippon, S., & Garwood, M. (2011). Responses to battery electric vehicles: UK consumer attitudes and attributions of symbolic meaning following direct experience to reduce psychological distance. *Transportation Research Part D: Transport and Environment, 16*(7), 525-531 %@ 1361-9209.

Sotnyk, I., Hulak, D., Yakushev, O., Yakusheva, O., Prokopenko, O. V., & Yevdokymov, A. (2020). Development of the US electric car market: macroeconomic determinants and forecasts. *Polityka Energetyczna, 23*.

Statistics, P. B. o. (2020). Compendium on Environment Statistics 2020 (D. S. I. Ministry of Planning, Pakistan, Trans.) (2020 ed., Vol. 2020, pp. 276). Islamabad, Pakistan: Pakistan Bureau of Statistics.

Tarigan, A. K. M., Bayer, S. B., Langhelle, O., & Thesen, G. (2012). Estimating determinants of public acceptance of hydrogen vehicles and refuelling stations in greater Stavanger. *International Journal of Hydrogen Energy, 37*(7), 6063-6073 %@ 0360-3199.

Thiel, C., Tsakalidis, A., & Jäger-Waldau, A. (2020). Will Electric Vehicles Be Killed (again) or Are They the Next Mobility Killer App? *Energies, 13*(7), 1828.

Tiwari, V., Aditjandra, P., & Dissanayake, D. (2020). Public Attitudes towards Electric Vehicle adoption using Structural Equation Modelling. *Transportation Research Procedia, 48*, 1615-1634.

Ul-Haq, A., Jalal, M., Hassan, M. S., Sindi, H. F., Shah, A., & Anjum, A. (2020). Electric Transportation in Pakistan Under CPEC Project: Technical Framework and Policy Implications. *IEEE Access, 8*, 162394-162420.

Utami, M. W. D., Yuniaristanto, Y., & Sutopo, W. (2020). Adoption Intention Model of Electric Vehicle in Indonesia. *Jurnal Optimasi Sistem Industri, 19*(1), 70-81.

Van Acker, V., Mokhtarian, P. L., & Witlox, F. (2014). Car availability explained by the structural relationships between lifestyles, residential location, and underlying residential and travel attitudes. *Transport Policy, 35*, 88-99 %@ 0967-0070X.

Verma, M., Verma, A., & Khan, M. (2020). Factors Influencing the Adoption of Electric Vehicles in Bengaluru. *Transportation in Developing Economies, 6*(2), 1-10.

Vidhi, R., & Shrivastava, P. (2018). A review of electric vehicle lifecycle emissions and policy recommendations to increase EV penetration in India. *Energies, 11*(3), 483.

Volumes, E. (2022). Global EV Sales of 2021. Retrieved Oct 2021, 2021, from https://www.ev-volumes.com/country/total-world-plug-in-vehicle-volumes/

Wakefield, E. H. (1993). *History of the electric automobile battery-only powered cars*.

Wattana, B., & Wattana, S. (2022). Implications of electric vehicle promotion policy on the road transport and electricity sectors for Thailand. *Energy Strategy Reviews, 42*, 100901.

Wheels, P. (2021). Find New Cars in Pakistan. Retrieved 17-Oct-2021, 2021, from https://www.pakwheels.com/new-cars/

Wolbertus, R., & van den Hoed, R. (2020). Fast Charging Systems for Passenger Electric Vehicles. *World Electric Vehicle Journal, 11*(4), 73.

Wu, Y. A., Ng, A. W., Yu, Z., Huang, J., Meng, K., & Dong, Z. (2021). A review of evolutionary policy incentives for sustainable development of electric vehicles in China: Strategic implications. *Energy Policy, 148*, 111983.

Xiao, X., Chen, Z., Wang, C., & Nie, P.-Y. (2020). Effect of an Electric Vehicle Promotion Policy on China's Islands: A Case Study of Hainan Island. *Frontiers in Energy Research, 8*, 132.

Zhang, C., Greenblatt, J. B., MacDougall, P., Saxena, S., & Prabhakar, A. J. (2020). Quantifying the benefits of electric vehicles on the future electricity grid in the midwestern United States. *Applied Energy, 270*, 115174.

Zhang, W., Wang, S., Wan, L., Zhang, Z., & Zhao, D. (2022). Information perspective for understanding consumers' perceptions of electric vehicles and adoption intentions. *Transportation Research Part D: Transport and Environment, 102*, 103157.

Annexure

Annex – I

INFORMATION SHEET

DEPARTMENT OF GOVERNANCE AND PUBLIC POLICY

NATIONAL UNIVERSITY OF MODERN LANGUAGES (NUML)

ISLAMABAD

Introduction

This is Muhammad Umer from Department of Governance and Public Policy at National University of Modern Languages (NUML), Islamabad. I am conducting my M.Phil study on the topic of "*Issues and Challenges in Implementation of Public Policy: a Case Study of National Electric Vehicles Policy of Pakistan*". You are requested to be a part of this research for betterment of the society.

Objective of the Study

This study is being conducted to analyze issues and challenges in implementation of National Electric Vehicles Policy in Pakistan and give suggestions for the better implementation of the policy

Type of Research Intervention

This research will involve your participation in in-depth interviews. That will take twenty to thirty minutes.

Participants Selection

You are being invited to be a part of this study as you are one of four major stake holders of EVs i.e. EV policy makers, EV manufacturers, EV owners and EV charging station owners.

Voluntary Participation

Having freedom of expression, you are being invited to participate in this study on voluntary basis, you can choose between being of part of this study or not.

Procedure

You are being asked questions related to EVs which can be answered by maximum available inputs from your side. You can offer additional comments on the topic as well.

Duration

Research will be concluded in two years.

Risks

The research does not entail any risk as you participate. No person will be harmed physically, psychologically or emotionally. Neither any equipment nor any vehicle or any other installments will be affected during conduct of the research.

Benefits

There will be no direct benefits to you but your valuable inputs will help us achieving objectives of the study.

Confidentiality

The data provided by you will only be used for research purpose and will not be provided to anyone else for any purpose. Identity of the respondents will be kept confidential and will not be shared with anyone outside this study.

Sharing the results

Results of the study can be shared to the respondents. Information provided by you will not be shared to any irrelevant person or institution.

Right to Refuse / Withdraw

You do not have to take part in this research if you do not wish to do so. You may stop participating in interviews at any time you wish and responses can be withdrawn before concluding the study as well.

How to Contact

Queries related to the study can be addressed by contacting the scholar directly at hafiz.umer2022@gmail.com or through supervisor Dr. Athar Rashid, Assistant Professor of Department of Governance and Public Policy, National University of Modern Languages, Islamabad at atharrashid@numl.edu.pk. This study will be reviewed and approved by NUML Faculty Board of Study which is a committee responsible to ensure protection of participants. If you do have any further questions please contact Dean Faculty of Social Sciences, Professor Dr. Khalid Sultan through email dean-fss@numl.edu.pk.

Annex – II

CERTIFICATE OF CONSENT

I have been invited to participate in research titled as "*Issues and Challenges in Implementation of Public Policy: a Case Study of National Electric Vehicles Policy of Pakistan*". I have read the forgoing information, or it has been read to me. I have had the opportunity to ask questions and any questions I have been asked and have answered to my satisfaction. I give my consent voluntary to be a participant of this study.

Name of Participant: _____

Signature of Participant: _____

Date: _____

Annex – III

STATEMENT BY THE RESEARCHER

I have accurately read out the information sheet to the potential participant and to the best of my ability made sure that participants understand the detail of the research. I confirm that the participants were given an opportunity to ask questions about the study, and all the questions asked by the participants have answered correctly and to the best of my ability. I confirm that the individuals have not been forced by any means to give consent, and that consents have been given freely and voluntarily.

A copy of this informed consent form has been provided to the participant.

Name of Researcher: **Muhammad Umer**

Signature of Researcher: _____

Date: **31-August-2022**

Annex – IV

Interview Questions

A. For Policy Makers:

1. Which vehicle comes under the definition of EV as it is not mentioned in NEVP?
2. Who has taken initiative of EV policy and what was the major reason behind this?
3. Is there any R&D taken or what is the basis of the various recommendations made in the policy?
4. What are the current climate change problems of Pakistan?
5. What gasses are emitted by the transport sector and what is the share of these gasses in all GHG emissions?
6. What measures are being taken to create awareness regarding EVs among public?
7. What are different government initiatives for promoting EVs?
8. Is there any other option considerable instead of BEV?
9. What measures are being taken to ensure uninterrupted electricity supply to the EV charging stations?
10. How does price of electricity will affect the EVs adoption?
11. Are there any specific programs initiated for implementing NEVP?
12. What steps are being taken by the government for achieving following sales targets set in NEVP:-

    50 % sales of EVs in total two and three wheeler vehicles new sales by 2030

    50 % sales of EVs in total new busses sales by 2030

    30 % sales of EVs in total new passenger vehicles sales by 2030

    30 % sales of EVs in total new trucks sales by 2030
13. What steps are being taken by the government for achieving following charging infrastructure targets set in NEVP:-

    One DCFC station at every 3 km in all major cities

    DCFC stations on all motorways at every 15 to 30 kms

14. Are there any incentives for charging infrastructure developers?
15. How will the finances be managed for these several hundred charging stations and how will the electricity load be managed?
16. What are the standards set for manufacturers in manufacturing EV as low standard vehicle will discourage people?
17. What are the barriers / challenges in implementation of this policy as per your understanding?
18. Any other important point you want to mention for the better implementation of NEVP?

B. For EV Manufacturers

1. What are the major reasons for initiating manufacturing of Electric Vehicles?
2. What are the environmental impacts of using Electric Vehicles?
3. What optimization techniques are being used for Electric Vehicles?
4. What measures are being taken to create awareness regarding Electric Vehicles?
5. What marketing measures are being taken for promoting Electric Vehicles?
6. What are the major benefits of electric Vehicles?
7. What are the challenges faced by EV market in Pakistan?

C. For EV Owners

1. What is the environmental impact of EVs?
2. Do you own only EV or you have another vehicle as well?
3. How often do you use EV?
4. Would you go on EV at night or in any emergency?
5. If you can only afford on vehicle, would you choose EV to buy?
6. What is the mileage of vehicle?
7. How much time does it take to fully charge the batteries?
8. What is per 1000 km running cost of the vehicle?
9. What is the maximum life of batteries?
10. What problems do you face using EV?
11. What is your main reason for buying this electric vehicle?

12. Would you like to sell it? And would like to buy another EV?

D. For EV Charging Station Owners

1. Why did you install this charging station?
2. What is the tariff of IESCO for this charging station?
3. What are you charging from the customer?
4. Is the charging station business running in profit?
5. Are you receiving any special incentives from the Government?
6. What is the frequency of vehicles arriving for charging?
7. How many types of chargers are available there?
8. What is the cost of charging and how is it calculated?
9. Are you planning installation of more charging stations