



**Wheels of Change Beyond Oil: Determinants of Electric Vehicle
Adoption and Its Implications for Energy Security in Pakistan**

Submission by:

Afrasyab Khan 01-114221-016
Malik Salar Abbas 01-114212-010

Supervisor:

Dr Amjad Masood

**Department: Bs Economics,
Bahria University Islamabad**

Abstract

This study investigates the factors of the intention of electric vehicle adoption in Pakistan by using primary data information from 100 respondents. The influence of five key constructs are evaluated, namely economic perceptions, charging infrastructure, technological attitudes, environmental awareness and policy support. Descriptive analysis showed that there was a high level of environmental concern among the respondents with the highest mean score being recorded on pollution awareness (mean = 4.32). Charging infrastructure concerns were also prominent especially on the perception of the insufficiency of public charging stations (mean = 4.22). Correlation analysis showed the positive relationships between all independent variables and adoption intention which were significant, the relationship of policy support ($r=0.58$) and charging infrastructure ($r=0.56$) were the strongest. Regression results showed that all five constructs are significantly related to the adoption intention and that policy support is the most influential predictor of adoption intention ($\beta = 0.36$), followed by charging infrastructure ($\beta = 0.31$). Demographic findings further revealed that adoption intention is higher among vehicle owners (mean = 3.88) and middle and higher income groups. The study below concludes that Pakistan's shift to electric mobility relies heavily on the credible execution of policies and infrastructural development, and targeted financial incentives. Strengthening these areas can improve the readiness of consumers, as well as advance the goals of national sustainability.

Keywords: Electric Vehicles, Energy Security, Oil Dependency, Adoption Intention, Charging Infrastructure, Policy Incentives, Pakistan

Table of Contents

Abstract.....	4
Table of Contents	5
List of Figures.....	9
List of Tables.....	10
Chapter 1: Introduction.....	11
1.1 Background.....	11
1.2 Problem Statement.....	12
1.3 Research Gaps.....	13
1.4 Research Questions.....	14
1.5 Research Objectives and Scope	14
1.5.1 Research Objectives.....	14
1.5.2 Scope of the Study	14
1.6 Hypotheses.....	15
1.7 Significance of the Study	15
Chapter 2: Literature Review.....	17
2.1 Theoretical Overview.....	17
2.2 Global Review of Electric Mobility.....	19
2.3 Electric Mobility in Pakistan: Context and Challenges	22
2.4 Empirical Literature Review.....	24

2.5 Conceptual Framework.....	26
Chapter 3: Methodology	28
3.1 Research Design.....	28
3.2 Target Population and Sampling Technique.....	28
3.3 Data Collection Instrument.....	29
3.4 Variables and Measurement	29
3.5 Reliability and Validity	30
3.6 Data Collection Procedure	30
3.7 Data Analysis Techniques	31
3.8 Ethical Considerations	31
3.9 Summary	32
Chapter 4: Results	33
4.1 Introduction.....	33
4.2 Sample Characteristics.....	33
4.2.1 Age Distribution.....	33
4.2.2 Gender Distribution	35
4.2.3 Education Level	36
4.2.4 Income Levels	38
4.2.5 Current Vehicle Ownership.....	39
4.3 Descriptive Statistics of the Study Variables	40

4.3.1 Economic Perception Indicators	43
4.3.2 Charging Infrastructure Indicators	44
4.3.3 Attitude Indicators - Technological.....	45
4.3.4 Environmental Awareness Indicators	45
4.3.5 Policy Support Indicators.....	46
4.3.6 EV Adoption Intention.....	46
4.3.7 Interpretation of descriptive results	47
4.4 Reliability Analysis	48
4.5 Correlation Analysis.....	49
4.5.1 Correlation between Economic Perceptions and Adoption Intention	51
4.5.2 Correlation between Charging Infrastructure and Adoption Intention	52
4.5.3 Correlation between Technological Factors and Adoption Intention.....	52
4.5.4 Correlation between Environmental Awareness and Adoption Intention	53
4.5.5 Correlation between Policy Support and Adoption Intention	54
4.6 Regression Analysis	54
4.6.1 Model Summary.....	54
4.6.2 ANOVA Results	55
4.6.3 Coefficient Analysis.....	55
4.6.4 Hypothesis Testing.....	58
4.7 Additional Findings.....	58

4.8 Summary of Key Findings	63
Conclusion	65
References.....	67

List of Figures

Figure 1: Age Distribution of Respondents	34
Figure 2: Gender Distribution of Respondents	36
Figure 3: Educational Distribution of Respondents.....	37
Figure 4: Income Distribution of Respondents	39
Figure 5: Vehicle Ownership of Respondents.....	40
Figure 6: Mean Scores of Study Variables (Q6–Q25)	42
Figure 7: Economic Perception Indicators (Q6–Q10)	44
Figure 8: Cronbach’s Alpha for Constructs	49
Figure 9: Correlation Heatmap for Study Variables.....	51
Figure 10: Standardized Beta Coefficients for Predictors	57
Figure 11: Adoption Intention among Vehicle Owners and Non Owners	59
Figure 12: Adoption Intention among Different Income Levels	60
Figure 13: Adoption Intention by Education Level	61
Figure 14: Adoption Intention across Age Groups	62

List of Tables

Table 1: Age Distribution of Respondents	34
Table 2: Gender Distribution of Respondents.....	35
Table 3: Education Levels of Respondents	37
Table 4: Income Distribution of Respondents.....	38
Table 5: Vehicle Ownership Status	40
Table 6: Descriptive Statistics for Likert-Scale Items (Q6–Q25).....	41
Table 7: Descriptive Statistics for Economic Perceptions	43
Table 8: Descriptive Statistics for Charging Infrastructure	45
Table 9: Descriptive Statistics for Technological Attitudes	45
Table 10: Descriptive Statistics for Environmental Awareness	46
Table 11: Descriptive Statistics for Policy Support	46
Table 12: Descriptive Statistics for EV Adoption Intention	47
Table 13: Cronbach’s Alpha for Study Constructs.....	48
Table 14: Correlation Matrix for Study Constructs	50
Table 15: Model Summary for Multiple Regression	55
Table 16: ANOVA Results for Regression Model	55
Table 17: Regression Coefficients for Predictors of Adoption Intention.....	55
Table 18: Comparison of Adoption Intention between Vehicle Owners and Non Owners.....	59
Table 19: Adoption Intention across Income Groups.....	60
Table 20: Adoption Intention across Education Levels	61
Table 21: Adoption Intention across Age Groups	62

Chapter 1: Introduction

1.1 Background

Transportation in Pakistan has historically revolved around internal combustion engine (ICE) vehicles powered by petroleum-based fuels. Since independence road transport has been the most significant mode of passenger and freight transport while railways and waterways played a secondary role. After that, the rate of vehicle ownership became faster due to rising income and urbanization, which resulted in vehicular congestion in major cities like Karachi, Lahore, Islamabad and Peshawar. The resulting poor public transport systems, congestion, and rising demand of the middle class further boosted private vehicle growth. In rural areas and semi-urban areas motorbikes, auto-rickshaws and light commercial vans became pervasive for last mile connectivity. The car fleet composition was still very much biased towards gasoline and diesel engines with little use of alternative technologies.

Worldwide, the transportation industry is undergoing a shift from petrol- and diesel-powered internal combustion engine vehicles to electric vehicles. Declining cost of batteries, advance in energy density and improved charging infrastructure have spurred the growth of adoption of electric vehicles (EV) in various regions. Technological innovation for battery-powered EVs, and aggressive policy initiatives in the form of high subsidies, solid infrastructure development and encouragement have allowed market share to grow significantly in countries such as China, Norway and some US states. Innovations in technology during the battery chemistry, power electronics, and grid integration also aid this transition. The decarbonization imperative of the Paris Agreement has pushed many countries to set a date of 2030 or 2040 for the complete phase out of fossil-fuel vehicles.

In Pakistan's case, the country is still very much reliant on imported oil to generate energy. The transport sector alone is a significant user of petroleum imports, putting pressure on the balance of payments. With the increase and fluctuation in the price of oil worldwide, the fiscal burden and risks of exposure to external shocks is aggravated. Moreover, Pakistan's electricity generation mix is largely dependent on thermal power plants mostly powered by imported gas or coal and so substitution to EVs needs to be combined with cleaner supply of electricity to secure

net emissions benefits. Given its limited foreign exchange reserves, energy security concerns and environmental pressures in the form of air pollution in urban areas, Pakistan has a strong motivation to seek clean alternatives for mobility.

At the international level, the global sustainability agenda, and in particular the Sustainable Development Goals (SDGs), puts the transition to low-carbon mobility in its context. SDG 7 (Affordable and Clean Energy) informs about the access to the sustainable energy system and the incorporation of renewable products. SDG 13 (Climate Action) requires immediate action to tackle climate change and its impacts; in this case decarbonization of heavy industries such as the transport sector will always be part of the solution. With the interactions between energy, climate and mobility, electric mobility is at the intersection between sustainable development. Within this framework, an adoption of EVs in Pakistan may work towards many things: Emission reduction of fossil fuel import dependency. Pretty good solutions may require to find a balance among these goals but in the overall picture, Pakistan can gain from an adoption of the EVs due to the multi faced advantages: Lower emissions, Lower fossil fuel import dependencies, Integration of cleaner air in cities, Indicators for stimulating green growth in vehicle production industry itself as well as energy sector.

1.2 Problem Statement

Pakistan's transport sector is highly reliant on imports of petroleum products and thus the economy is vulnerable to the volatility of oil prices, foreign exchange pressure and supply shocks. Road transport is a major contributor to fuel usage and to urban air pollution - especially in the large cities (Lahore, Karachi, Islamabad etc.). Despite a rising trend in the use of electric vehicles in other parts of the world as a means to curb fossil fuel dependence and emission, the penetration of electric vehicles in Pakistan is extremely restricted.

While policy initiatives to encourage electric mobility have been launched by the Government of Pakistan, adoption is slow owing to high upfront costs, lack of charging infrastructure, uncertainty in technology and lack of awareness. Existing studies in Pakistan are mostly focused on the environmental benefits or policy announcements and there are few empirical investigations on the adoption behavior of consumers and its potential contribution to the energy security and reduced oil dependency.

This results in an important deficit between the intentions of the policy and the consumers getting adopted. Without knowledge of factors that can influence the adoption of electric vehicles at a consumer level, it is possible that Pakistan does not leverage the economic and environmental benefits of moving away from oil dependent transport. Therefore, the existence of an empirical assessment of the determinants of electric vehicle adoption and their implications for energy security in Pakistan is needed.

1.3 Research Gaps

Despite increasing interest in electric mobility in Pakistan, there is a dearth of comprehensive empirical research that simultaneously examines the economic, environmental, and policy dimensions of this transition. The majority of existing studies have concentrated on just one element, such as emission projections or consumer attitudes, and they fail to combine all of the elements necessary to inform policy. For instance, Nadeem et al. (2022) modeled the future electricity demand and emissions with EV penetration scenarios in Pakistan, but the analysis was not fully coupled with the behavioral obstacles or policy mechanisms that can bring the scenarios to fruition (Shah, et al., 2025).

Moreover, there is a lack of empirical evidence on the relationship between the adoption of electric vehicles and economic diversification, job creation and energy security for the Pakistani context. Current literature has only a few quantitative evaluations of how EV penetration might decrease oil import pressures or kick-off local manufacturing or upstream budding industries. Moreover, the moderating effect of the infrastructure adequacy, grid preparedness, and institutional capacity on the study area is also understudied in the empirical model. Recent studies like Ahmad (2024) are focused on the actual usage of EVs with moderation by charging infrastructure but don't include macro-level impacts (Ahmad, 2024). Also, few studies in high were found relevant for indigenous transition strategy in Pakistan. This thesis seeks to fill into these gaps by bringing in quantitative modeling, the views of stakeholders and comparative policy dissection towards plotting a strong path for electric mobility in Pakistan.

1.4 Research Questions

- What are the main economic, environmental, and social drivers influencing the transition to electric mobility in Pakistan?
- How can EV adoption contribute to energy security and reduction in oil dependency?
- What policy measures are needed to accelerate EV integration in Pakistan's transport sector?

1.5 Research Objectives and Scope

1.5.1 Research Objectives

- To analyze the potential economic and environmental benefits of electric mobility.
- To identify policy, infrastructural, and behavioral barriers to EV adoption.
- To develop policy recommendations for sustainable electric mobility transition.

1.5.2 Scope of the Study

This study is limited to presenting the key economic, technological, environmental, infrastructural, and policy determinants of the adoption intention of electric vehicles in Pakistan, with a special focus on how the increased adoption can help the country in reducing its oil dependency and contribute towards the improvement of national energy security. The analysis is restricted to urban consumers in major Pakistani cities and no lifecycle emission modelling and grid capacity simulations are performed.

1.6 Hypotheses

- H₁: Adoption of electric vehicles significantly reduces Pakistan's oil import dependency.
- H₂: Development of EV infrastructure positively influences public acceptance and investment in clean energy.
- H₃: Policy incentives are positively correlated with increased EV market share.

1.7 Significance of the Study

This study is important on various levels - policy, economic, environmental, academic and social - as it throws some light as to how Pakistan can make the shift towards electric mobility in a sustainable and effective way.

From the policy-side, the research provides the decision makers with good evidence on the impacts of the EV adoption in Pakistan. The results can help to inform the design of incentive mechanisms, roll-out of charging infrastructure, taxation and tariff measures and regulatory arrangements. By measuring trade-offs and synergies, it will be possible for policy makers to better integrate transport, energy and climate policies in a more coherent manner.

From an economic point of view, the contribution of electric mobility in the break of the oil import dependence is taken into account, which means increasing the foreign exchange reserve and reducing the vulnerability to the fluctuation of the global oil price. It also explores opportunities for the growth of the domestic industry - such as battery manufacturing, assembly plants, maintenance services and integration of the renewable energy - which can aid in job creation and diversification of the industry.

In terms of environmental aspects, this thesis measurement is the potential for reduction: reduction in greenhouse gas emissions; reduction in the burden of urban air pollution; and co-benefits for public health. In the context of SDG 7, the results will also enable Pakistan to consider various ways of delivering its climate commitment (e.g., under the Paris Agreement), and SDG 13 target, in particular its commitment to sustainably manage ecosystems, combat desertification, and fight against climate change.

In the context of EV adoption by developing countries, the research is able to bridge significant gaps in literature as it combines economic, behavioral, and infrastructural aspects of EV adoption. The approach of mixed methods of quantitative modeling and stakeholder insights adds to the existing knowledge in the field of technology diffusion, energy transitions and sustainable mobility. Though some of the lessons to be taken from the Pakistani experience may also apply to other developing countries with similar constraints.

On the social side, the thesis deals with the issues of equity and accessibility - for instance, access to and participation in electric mobility by lower-income populations, and how policies can be designed to ensure the diffusion is inclusive. By placing up front issues of affordability, awareness and infrastructure penetration, it is able to provide insights on how uneven adoption can be avoided.

In practice, the recommendations arising from this thesis can be helpful to government agencies, private sector investors and development partners to develop coordinated strategies to expedite the transition to a cleaner transport future.

Chapter 2: Literature Review

2.1 Theoretical Overview

Theories of technological innovation and sustainable development offer the intellectual scaffolding for the understanding of the move towards electric mobility. Endogenous growth theory focuses on the purposeful investment in knowledge, learning by doing and innovation systems that can provide long lasting gains in productivity and welfare, which in turn define sectoral transformations such as the electrification of transport. Transitions research, as part of sustainability scholarship, draws attention to the ways in which environmental technologies are mutually co-evolved with institutions, markets, societal user practices and infrastructures towards low carbon systems. The multi-level perspective conceptualizes transitions as the result of interactions across the niche innovations, micro level regimes and the macro level landscape pressures. The advent of battery electric vehicles in the transportation sector is a result of transitions from niche protected environments to challenging existing internal combustion propulsion as satellite convergence patterns between costs, performance, and policy pressure occur (Geels, 2023).

Sustainable development frameworks are shown to complement transitions theory because they can link technology adoption to social and environmental goals. Energy system decarbonization depends on the concurrent development of clean electricity, demand side flexibility and zero emission vehicles. Research in Energy Research and Social Science documents the use of financial and non-financial policies that create conditions that reduce perceived risks, increase relative advantage and reorganize markets in ways consistent with sustainability objectives (Ehsan et al, 2024). First, it is important to remember that policy mixes rather than single instruments are more likely to be effective, as adoption is affected by a series of interrelated decisions made over time by consumers, firms and infrastructure providers.

Diffusion of Innovation theory is still important when trying to understand household and firm responses to new mobility technologies. Rogers identifies five perceived attributes which condition adoption decisions. Relative advantage is used to capture lifecycle cost, performance and environmental benefits. Compatibility - refer to fit with daily routines including charging

accessibility, as well as cultural norms. Complexity is associated with new technology and interface learning costs. Trialability and observability have an impact on early exposure and social learning. Across markets, there is more and more empirical evidence that policy incentives affect these attributes indirectly by changing total cost of ownership, increased charging visibility, and signaling of long term governmental commitment, to move from early adopters to early majority segments (Rogers, 2003; Martins et al., 2024).

Recent comparative work - Diffusion theory is extended to the policy domain by means of the concept of policy mixes and sequences. In China, moving from purchase subsidies to credit based mandates is an example of how instrument substitution can be used to preserve innovation and market momentum once the scale economies become a reality. Using an exogenous purchase subsidy removal, we find that non-purchase subsidies such as credit trade and regulation mandates govern R&D quality and firm level after subsidy removal, which suggests a price-led diffusion phase at the beginning, and regulation and infrastructure-led diffusion at later stages (Qin et al., 2024). Norway's experience highlights how long term credible fiscal differentials and tax exemptions between electric and combustion vehicles determines perceived size based comparative advantage on a comparable scale, and subsequently whether past incentives are enough to determine whether adoption has reached social and economic tipping points (Cincotta, 2025).

Theories of socio technical transitions, diffusion and sustainable innovation bring together three mechanisms that are relevant to electric mobility. First, there are cost learning and scale effects that have a negative impact on the relative price of batteries and vehicles, causing a shift in perceived advantage. Second, there is an increase in policy credibility and continuity and reduced uncertainty for firms and consumers due to a reduction in perceived complexity and investment risk. Third, for behavioral spillovers, with ubiquity, observability and compatibility (due to social learning through visible adoption and charging) is increased. These mechanisms, which we repeatedly saw across leading markets, form the theoretical basis of the evidence reviewed globally below.

2.2 Global Review of Electric Mobility

Global electric vehicle adoption has accelerated sharply during the last five years, driven by declining battery costs, supportive policies, and visible network effects. Although the situations are different in each country, three leading cases can provide complementary experiences. The Chinese experience shows the effectiveness of industrial policy and big market making through a phased approach. Norway is a good example of the influence of high fiscal differentials and coordinated national and local incentives in a small open economy. India is a large emerging economy in which early mass diffusion in two and three wheeler segments and early to medium stages of diffusion in passenger car segments are driven by targeted subsidy policies and domestic manufacturing policies.

The development of China's policies shifted from generous purchase subsidies to a system based on the New Energy Vehicle mandate and the dual credit policy. As previous analyses by Transportation Research Part D have shown, purchase subsidies produced lower marginal effects over time and that complementary policies such as credit trading, production requirements, and infrastructure assistance produced more sustained effects in later stages of market maturity. With panel techniques and policy mix indices between provinces and cities, Zhao et al, discover few incremental impact of purchase subsidy when non price instruments and infrastructure availability gain scale which implies that policy rebalance would not deplete fiscal resources however balance adoption (Zhao et al., 2024).

Related work in Energy shows that non subsidized policies can promote firm level innovation results in terms of patents and research and development intensity especially in enterprises which have good absorptive capacity as well as in places with dense innovation ecology meaning that regulatory uncertainty and market based mandates drive dynamic efficiency compared to purely static shifts in demand (Qin et al., 2024). Studies of China's post subsidy era also report varying impacts of differentiated subsidy adjustments on model ranges and market segments as the higher range vehicles are relatively favored by reducing in step, a trend found to be consistent with diffusion patterns whereby performance increases amplify relative advantage for mainstream adopters (Hao et al., 2025).

Norway is the classic case of mass market proliferation facilitated by long established tax exemptions and a broad incentive package. A recent Energy Policy paper analyses the structure and evolution of national and municipal incentives based on product level price lists, tax rules and registrations from 2000 to 2021, finding that value added tax exemptions and registration tax waivers gave the rapid take up of electric vehicles in Norway and that their partial removal would dramatically decrease shares without compensating policies. Further, the analysis reveals that the incentive regime favored larger and more expensive models, raising distributional issues and suggesting that once consolidation is over, a rebalancing towards instruments based on use would be desirable (Cincotta, 2025).

Additionally, Communications Earth and Environment publishes high-quality policy evaluation research which complements the micro level research by providing longitudinal data on adoption dynamics for more than two million Norwegian households. The findings show that income, urban residency and availability of charging facilities are strongly associated with adoption and that inequality in battery electric vehicle ownership is a persistent way of tackling an issue that has been exacerbated by the inherent monetary incentives in the battery production of electricity has been manifested in the building of an equity sensitive policy if and when markets first mature (Qorbani et al., 2024).

This trajectory experienced by India has enunciated the importance of segment specific incentives and domestic industrialization policies. The Faster Adoption and Manufacturing of Electric Vehicles Phase II scheme was aimed at buses, three wheelers and two-wheelers with front loaded purchase incentives linked to battery capacity and localization limits. In Transportation Research journals, there are empirical studies demonstrating that policy tools such as purchase incentives, tax rebates, and charging infrastructure support have a positive relationship with the registration of vehicle battery electric and plug in hybrid vehicles, but Yes and Nos depending on jurisdictions and classes of vehicles and whilst complementary infrastructure has become a binding constraint in many cities (Liu et al., 2023; Martins et al., 2024).

Production-linked incentives (PLIs) and domestic value addition is the latest focus in the effort to develop a supply-side base that will reduce costs and increase model availability, in line with

diffusion theory which predicts that compatibility and observability will increase with product breadth and charging visibility.

Cross country comparative analyses enhance the main importance of coherent policy mixing. A multi market analysis in Energy Research and Social Science reveals that financial incentives have a positive effect on the probability of adoption but that they are contingent on complementary non-financial mechanisms such as zero emission quotas, access rights, and an extensive fast charging corridor. The study advocates for that the policy sequence should be undertaken in a dynamic way, with early policy such as subsidies, and later stages of regulation and infrastructural tools, in a progressive manner as the markets approach parity hence avoiding policy fatigue while keeping consumer confidence in the path of transition (Ehsan et al., 2024). Similar conclusions are also drawn from meta analytic and panel based work in Transportation Research Part D which find evidence for long run cointegration between various policy instruments and sales and confirms that bundles are more effective than single instruments, especially when infrastructural readiness and policy credibility are high (Liu et al., 2023; Martins et al., 2024).

Important cautions are also found in the literature. The fiscal strategy of Norway created a large revenue loss that also resulted in distributional effects that must be prudently managed during the tapering of incentives. Studies suggest that there are sharp withdrawal risks around occupying social norms and infrastructure not as well as the latter and the first component demands for lower income groups efficiency inequality nearly time division of the exit policy very well to both equity and momentum, by implication gradualism and continuation does at a specific income group target users (Cincotta, 2025; Qurbani et al., 2024). In China, the process of subsidy withdrawal revealed model segments that were performing poorly, and studies conclude that without financing creativity and innovations in charge addition and financing, differentiated adjustments can lead to inadvertent disadvantages of low range models by consumers, which are sensitive to prices (Hao et al., 2025; Zhao et al., 2024).

In the Indian context, the evidence suggests that uneven state capacity and charging roll out are a constraint on the crystallization of national incentives into lasting adoption, which strengthens

emphasis in the transitions literature on institutional coordination, subnational policy capability and market building alongside headline subsidies (Liu et al., 2023; Martins et al., 2024).

By drawing a parallel between the three cases, we identified some design principles that are coherent with the theoretical insights above. Popular signals of credible long term policies lower uncertainty and anchor expectations, which lower perceived complexity and facilitate investment on the part of both firms and households. Second, pricing based coupled with visible infrastructure investments enhances observability and compatibility enabling social learning and mainstreaming.

Third, the sequencing of policies that substitutes the unrestricted subsidies with mandates, credit frameworks and pricing by use with markets that builds up maintains fiscal space, while continuing with innovation and spread. Fourth, equity sensitive design which targets support to underserved segments, as well as spatial inequalities in access to charging, can address underlying and persistent inequalities. Lastly, the manufacturing of industries with the catalysis of industrial policy, resilience in the supply chain, and complementary harmonization of standards fortify the learning curve and reduced costs, increasing the relative advantage and hastening the attainment of sustainable transport objectives.

2.3 Electric Mobility in Pakistan: Context and Challenges

Pakistan's policy environment for electric mobility began to take formal shape with the National Electric Vehicle Policy approved in 2019 by the Ministry of Climate Change. The policy had set adoption targets for light duty and two and three-wheeler segments, established fiscal concessions on imports and local assembly, and indicated their intention to develop charging standards and a public charging network (Ahmad et al., 2024). Subsequent consultative drafts and working papers have tried to improve the fiscal design, include new energy vehicles in industrial policy spearheaded by the Ministry of Industries and Production, and coordinate with clean air and renewable energy agendas (Nadeem et al., 2022). The thrust is to reduce import dependence in petroleum, improve urban air quality and also to foster technology transfer and domestic capacity in batteries, power electronics and assembly.

While the 2019 policy offers a framework to guide direction, provincial and city-level implementation has been inconsistent and credible to investors and consumers is vulnerable to taxation, foreign exchange policy and energy pricing framework changes (Ahmad et al., 2024). Analysts underline that in order for the transport electrification to be long-run successful, more will need to be done in terms of wider reforms of the power sector, retail tariffs must align with cost recovery and equity and finally for clean power generation to be increased at such a time that electric vehicles electrification can achieve creditable net emissions benefits (Shah et al., 2025). These studies underline the importance of policy coherence between energy, industry, climate and transport agencies (as opposed to stand-alone vehicle sales incentives).

Opportunity and constraint are emphasized in energy and emissions statistics. Air quality research related to the clean air agenda documents extremely high particulate concentrations in major cities, as well as attributing a fair share of emissions to road transport (Ahmad et al., 2024). Modeling scenarios for integrated mitigation policy across transport, industry, agriculture and households project substantial reductions in the levels of particulate emissions in 2030, depending on faithful implementation (Nadeem et al., 2022). Transport energy consumption is still heavily linked with imported fossil fuels, which makes the country more vulnerable to exchange rate fluctuations and rising oil price shocks worldwide. Meanwhile, Pakistan's power sector is getting a shake-up: renewable capacity additions (particularly solar) are increasing, giving better opportunities for vehicle electrification to provide life cycle emissions benefits, if the reliability of the grid and stability of the regulatory environment can be ensured (Ahmad et al., 2024). However, the issues concerning contract renegotiations in the overall power market highlight the relevance of credible regulatory regimes for supporting electrification (Nadeem et al., 2022).

Structure of Pakistan's vehicle market also influences early adoption pattern. Two- and three-wheelers account for a high proportion of urbanized travel and passenger car sales continue to be concentrated in a few makes and worsen with macroeconomic fluctuations (Ahmad et al., 2024). Experience from global markets indicates that diffusion of electrification of two- and three-wheelers will be faster because of the low upfront costs and easy charging patterns. In the case of Pakistan, the charging of these segments and the promotion of local assembly may have more near term potential than premium passenger EVs. Emerging pieces of industrial moves by

international manufacturers to assemble new energy vehicles in Pakistan, and tariff adjustments for public chargers, point to some policy in conjunction with market entry goals (although infrastructure remains at a nascent stage as compared to potential demand, Shah et al., 2025).

Policy continuity and respectable signaling are important for investor agreement in charging organizations and locale group gathering (Ahmad et al., 2024). Electricity affordability and reliability are the decisive factors of total cost of ownership; high energy tariffs and poor distribution capacity can forego the projected operational cost savings. Standards for connectors, safety, metering and data systems require some harmonization in order to achieve interoperability and consumer protection (Ahmad et al., 2024). Equity issues need to be addressed: Early chargers are likely to be sewn up in wealthy neighborhoods and corridors - the underserved areas fall behind (Ahmad et al., 2024). Finally, integrative design of electric mobility connecting to the clean power, demand response and distributed renewables is required for grid stability at scale (Nadeem et al., 2022).

2.4 Empirical Literature Review

Empirical work from South Asia in recent years provides insight into determinants of electric vehicle diffusion. Literature on behavioral and econometric models in India applies a consistent finding that financial incentives, vehicle and charging features, perceived environmental utility, and local the quality of air have a pile of influence on the intention to adopt and sales (Martins et al., 2024). It is also presented in these studies that perception of risk, specifically on the attributes of battery life, charging reliability, and resale value, lowers adoption, and thus, the framework of consumer confidence needs to be supported by financial aid (Martins et al., 2024).

In transportation research through panel and time series analysis, it can be seen that the availability of charging as well as electricity generation mix serve as structural determinants. We also find that areas with a higher fast charging density have a higher battery EV registration even after accounting for income and fuel prices (Zhao et al., 2024). The Cointegration models demonstrate the effect of incentives to purchase EV is weaker in the jurisdiction with intensive fossil-based production of power as compared to the context with cleaner forms of electricity (Qin and Xiong, 2024; Zhao et al., 2024). An empirical evaluation of policies has shown cross-

state empirical comparisons should work out policy bundles (incentives plus infrastructure plus privileges) rather than individual interventions (Martins et al., 2024; Liu et al., 2023).

Discrete choice and integrated choice-The methods of discrete choice and integrated choice offer further insight into the tradeoffs of consumers. According to many studies, utility is positively affected by lower total cost of ownership, shorter refueling duration through rapid recharging, as well as, robust post-sale networks, but negatively on adoption, particularly in non-metropolitan regions (Liu et al., 2023). The level of income and urban dwelling is also an important factor to predict early adoption, providing equitable issues (Martins et al., 2024). Uncompensated and insensible incentives will also impact the rich consumers, who will reap the benefits unproportionally. Evidence indicates that shared electric mobility targeted at public transport can help enhance access and create the effects of observability (Ehsan et al., 2024).

While there is still a dearth of empirical literature of this sort connected specifically to Pakistan, this is reinforced by related studies in the fields of environmental health and energy policy. Transport decarbonization can have co-benefits, as highlighted by air quality and health research on the situation in Pakistan (Ahmad et al., 2024). Syntheses of energy policies interpret the issue of cross-ministerial coherence, unchanging tariffs, and regulatory credibility to help promote the growth of charging infrastructure by the process of private investments (Nadeem et al., 2022). These complementary streams suggest that in Pakistan diffusion will be threaded collectively by means of economic factors (e.g., electricity charge, gas cost), social factors (e.g., wellness issues, conventions), and technological factors (e.g., along with charger volatility, dependability).

A final theme which emerges from cross market analyses is the role of the supply side policy. It was found that local manufacturing can be motivated by domestic value addition requirements, production linked incentives and standards development as lower cost through learning and scale (Qin & Xiong, 2024; Zhao et al., 2024). The procurement of electric buses and municipal fleets by all U.S. municipalities may create early network status, which can enhance the learning of consumers and charge visibility (Martins et al., 2024). In the case of Pakistan, the entry into the industry or local content policies and skills training are not supplementary, but fundamental factors that influence model availability, price, and after sales services.

2.5 Conceptual Framework

The conceptual framework of this study is used to explain the determinants of electric vehicle adoption intention in Pakistan and their implication for environmental sustainability and energy security. The framework is based on diffusion of innovation theory, socio technical transition theory and is tailored to the economic and institutional setting of Pakistan.

In this framework, policy support, infrastructure readiness and consumer behavior are considered to be the key determinants affecting the intention of electric vehicle adoption. Policy support is the actions of the government which influence the economic and regulatory environment of electric mobility. It includes fiscal incentives such as subsidies and tax reductions, regulatory requirements, non fiscal privileges including preferential access and parking, industrial policies such as localization incentives as well as the development of technical and safety standards. Policy support has a dual role in contributing to consumer adoption decisions as well as indirectly to the development of infrastructure.

Infrastructure readiness is when charging and electricity systems that are needed to support electric mobility are available and reliable. It encompasses the availability of public fast charging networks, home and work charging facilities, charging interoperability, cost and reliability of electricity and the percentage of clean electricity generation. Adequate infrastructure helps by reducing range anxiety, making things more convenient and making electric vehicles more visible and observable, thereby building consumer confidence.

Consumer behavior is a reflection of individual perceptions and attitudes which affect the adoption intention. It includes perceived relative advantage in terms of cost savings and performance, compatibility with existing travel needs, perceived complexity of use, trialability and observability of the technology, perceived risks in terms of battery life and resale value and the influence of social norms.

Environmental outcomes in the framework are reductions in particulate air pollution and greenhouse gas emissions as well as improvements in public health. As the number of electric vehicles grows, these outcomes provide a stronger argument for continued policy intervention through an improvement in political legitimacy. This forms a feedback loop of sorts whereby

better environmental conditions lead to stronger government commitment to electric mobility through stronger mandates and supporting policies.

The framework also identifies the part of the wider landscape factors which moderates these relationships. The policy effectiveness, investments in infrastructure, and consumer adoption are affected by the macroeconomic conditions, the learning curve in technologies, and the price changes in the world oil market. By combining these elements, the conceptual framework offers an integrated explanation of how electric vehicle adoption can play a role in reducing oil dependency and enhancing energy security in Pakistan as well as solving the environmental challenges.

Chapter 3: Methodology

3.1 Research Design

This study employs a quantitative research design in order to investigate empirically the factors that affect the adoption intention of electric vehicles in Pakistan. A quantitative approach is appropriate as it enables statistical testing of relationship between variables and objective evaluation of economic, infrastructural, technological and environmental factors along with policy related factors.

A cross sectional survey design is used in which data are collected at a single point of time. This design of study is widely applied in technologies adoption researches and also suitable for capturing the constant consumer perceptions and intentions towards electric mobility in Pakistan.

3.2 Target Population and Sampling Technique

The target population of the study are urban residents, existing vehicles owners and prospective vehicle buyers who have basic awareness about EV. Urban populations were chosen since electric vehicle diffusion; development of charging infrastructure and policy awareness will be more likely to occur in large cities.

The respondents from Islamabad, Lahore and Karachi have been selected in the study owing to high population density, economic activities and higher exposure to new mobility technologies.

Probability convenience sampling technique was adopted by using the non-probability. This approach was chosen given time and resource limitations and considering that it is widely adopted in exploring behavioral studies to elicit perceptions and adoption intentions. While the higher generalizability of probability sampling would have been preferable, the convenience sampling technique can still be appropriate to identify patterns in consumer attitudes and to test theoretical relationships.

The sample size includes 100 number of respondents which is sufficient sample size for correlation analysis, regression analysis, and reliability analysis. Prior studies on behavioral

intention generally have similar sample sizes, and this size of sample is large enough to offer reasonable statistical power to investigate relationships among the study variables.

3.3 Data Collection Instrument

Primary data was gathered with the use of a structured questionnaire with closed ended questions with a five point Likert scale (strongly disagree - strongly agree).

The questionnaire had five sections. The first section gathered demographic data such as aged person, gender, education and income, as well as whether the person owns a vehicle. The second section of the measure included economic perceptions including cost savings and financing. The third section was about technological and infrastructure related factors such as availability of chargers and battery reliability. The fourth section was concerned with environmental awareness while the final section addressed policy perceptions such as incentives, tax reductions, and policy implementation trust.

Questionnaire items were taken from established studies that relate to technology adoption and energy transition processes to avoid reliability and relevance issues.

3.4 Variables and Measurement

The study has one dependent variable and multiple independent variables which indicate aspects of economic, technological, social and policy dimensions of electric vehicle adoption.

Electric vehicle adoption intention is the dependent variable. This variable represents the likelihood of the respondent to buy or promote the market uptake of electric vehicles. Adoption intention is a common substitute for actual adoption behavior in sustainable mobility studies.

Independent variables would be perceived cost advantage, charging infrastructure availability; technological reliability, policy support perception and environmental concern. Each of these constructs is measured through multiple Likert scale questions that are intended to reflect constructs from innovation diffusion and behavioral intention models.

Control variables such as demographics such as age, gender, education and income. These variables allow isolating the effect of primary determinants and test if differences in demographics influences the adoption intention.

3.5 Reliability and Validity

Reliability of the constructs was checked with the help of Cronbach's alpha, that measures internal consistency among the questionnaire items. A threshold value of 0.70 was used as the test for acceptable reliability.

Validity was provided through content validity and face validity was ensured. Content validity was shown by aligning items on the questionnaire with related theory of change models including diffusion of innovation and behavioral intention models. Face validity was secured by being sure that the questionnaire was clear, relevant and coherent. Complex validity tests such as factor analysis were not performed because of the limitations to sample size, although the systematic development of the instrument lends the validity to the test.

3.6 Data Collection Procedure

The data was gathered by online and in person surveys over a 4 week period. Respondents were approached in public places such as universities, commercial center, and work places located in key urban areas. For online distribution, the link to the questionnaire was distributed through social media platforms and professional networks. Participation was voluntary and respondents were given a brief overview of the purpose of the research. Clear assurances were given with respect to confidentiality and anonymity in accordance with ethical research practices.

Completed questionnaires were checked for completeness, and those responses that had significant missing data were removed from analysis. This ensured that only accurate and fully completed data served the findings. The final valid dataset was comprised of 100 usable responses.

3.7 Data Analysis Techniques

Data analysis was conducted with the assistance of statistical software in order to be precise and reliable. The techniques covered in the analysis include descriptive and inferential statistical techniques. Descriptive statistics i.e. frequency distributions, means, and standard deviations were used to summarize demographic characteristics and construct scores. These give a preliminary impression of the characteristics of respondents and general trends of perceptions of electric mobility.

Inferential analysis involves the use of the correlation and regression tests to examine the relationship between the independent variables and the dependent variable. Correlation analysis looks at the direction and magnitude of associations whereas regression analysis determines the extent of each of the determinants in predicting adoption intention. These techniques help in developing an empirical explanation for the consumer behavior in respect of electric vehicles in Pakistan. Regression coefficients can be used to interpret the relative importance of economic, technological, environmental and policy determinants of a measure that can provide valuable insights for policymakers and industry stakeholders.

Reliability testing, using Cronbach's alpha, to ensure internal consistency, and checking for multicollinearity between independent variables to ensure that they do not overly overlap. Significance testing helps in determination of statistically meaningful relationships. The analytical techniques used are compatible with the quantitative design of the study and can provide a good foundation for the development of empirical conclusions.

3.8 Ethical Considerations

Ethical considerations were used throughout the study in order to protect the rights of the respondents and maintain the integrity of research. Participation was voluntary and none of the respondents was coerced or incentivized. The study did not collect personally identifiable information, so the study remained anonymous. Data was exclusively for academic purposes and respondents were informed of the nature of the study before engaging in. Ethical protocols help to ensure credibility and transparency of the research.

3.9 Summary

This chapter presents the methodology adopted in this study for exploring the factors that influence the adoption of EVs by using quantitative primary data obtained from 100 respondents. The research design, technique for sampling, instrument for collecting data, procedures for analyzing the results, validity and reliability procedures, and the ethical precautions are taken together to guarantee a systematic and empirically-based study. The methodology buttresses rigorous inquiry into relations of economic, technological, environmental and policy factors which affect electric mobility transitions of Pakistan.

Chapter 4: Results

4.1 Introduction

This chapter presents the empirical results that are enunciated from the quantitative analysis of primary data gathered from a sample of 100 respondents. The analysis emphasizes on demographic features of the participants and lays the basis for the interpretation of their perceptions on the adoption of electric vehicles in Pakistan. The results present the distribution of frequencies for each of the demographic variables and explore the patterns that may affect the attitude over electric mobility. Subsequent sections of this chapter describe the distribution of respondents by age, gender, educational level, income category, and current status of vehicle ownership. Tables and figures are woven in with the text to help them illustrate and understand the statistical distributions. These findings collectively set the context background required for interpretation of the determinants of electric vehicle adoption that is assessed later through reliability, correlation and regression analyses.

4.2 Sample Characteristics

The demographic profile of the respondents gives some insight into the diversity and representativeness of the sample. Understanding the background characteristics of the participants is crucial because demographic variables may affect mobility needs, financial capacity, environmental awareness, as well as openness to the use of new technologies such as electric vehicles. The demographic analysis contains information about age distribution, gender, education, income levels, and the number of vehicle owners in the sample.

4.2.1 Age Distribution

Table 4.1 shows the number and percentage distribution of the sample in different age categories. The majority are in the economically active ages which tend to have higher levels of use and interest in new technologies in vehicles.

Table 1: Age Distribution of Respondents

Age Group	Frequency	Percentage
18–25	24	24 percent
26–35	32	32 percent
36–45	28	28 percent
46–55	12	12 percent
Above 55	4	4 percent

Figure 4.1 shows graphically the age distribution, which shows a sample of mainly young to middle aged. Such age groups are more inclined towards the innovations within technology and sustainable mobility solution, which can have a positive impact on the dynamics of its adoption.

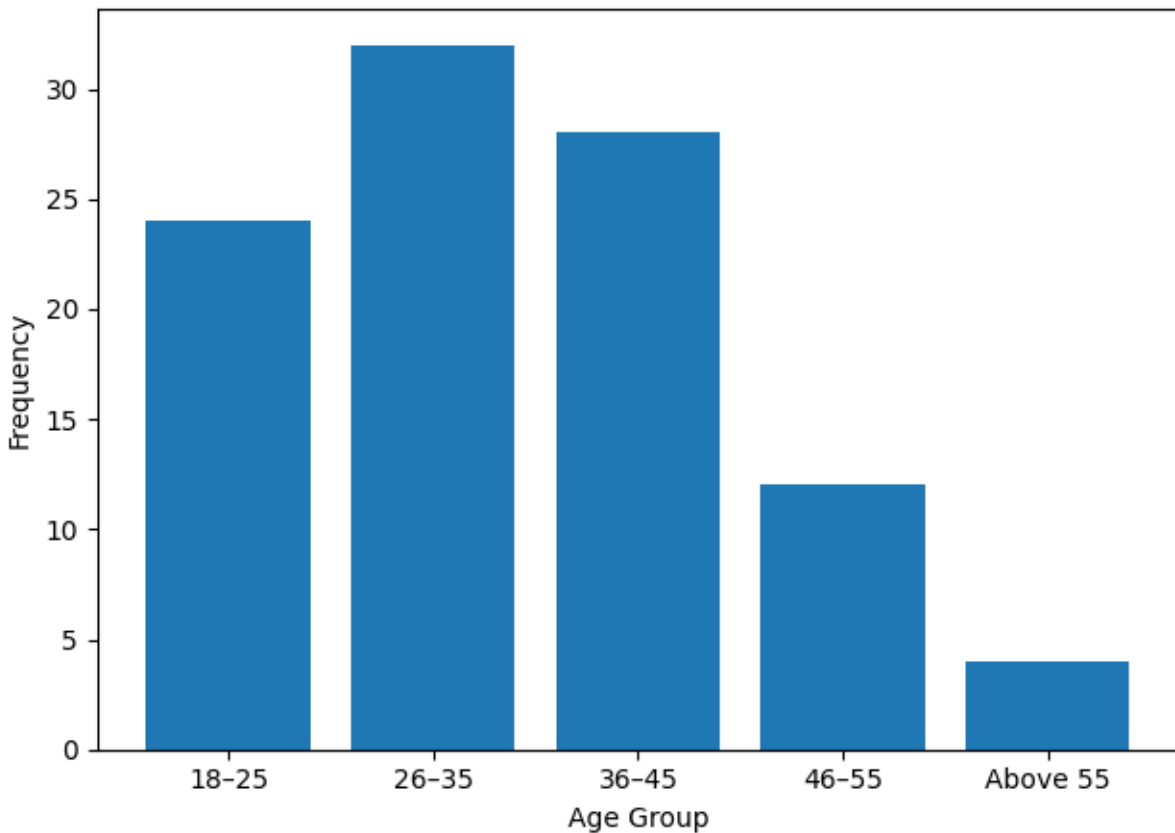


Figure 1: Age Distribution of Respondents

The largest representation is of individuals aged 26-35 years and make up almost one third of the sample. Respondents aged 18-25 and 36-45 are also significant proportions. The smaller percentage of those above 55 is consistent with common demographically-based patterns in the adoption of technology, where older respondents form a smaller but significant group of mobility consumers. This distribution indicates that the data set covers opinions across a variety of age groups, and relevant inferences can therefore be made about age based differences in the adoption of electric vehicles.

4.2.2 Gender Distribution

Gender distribution has been summarized in Table 4.2. The percentage of male respondents is slightly higher than female respondents, which is corresponding with common mobility and vehicle ownership trends in Pakistan.

Table 2: Gender Distribution of Respondents

Gender	Frequency	Percentage
Male	52	52 percent
Female	46	46 percent
Prefer not to say	2	2 percent

Figure 4.2 shows the distribution in graphical form, which shows near parity between male and female respondents. This balanced representation is ensuring gender inclusive understanding of consumer perceptions towards electric mobility.

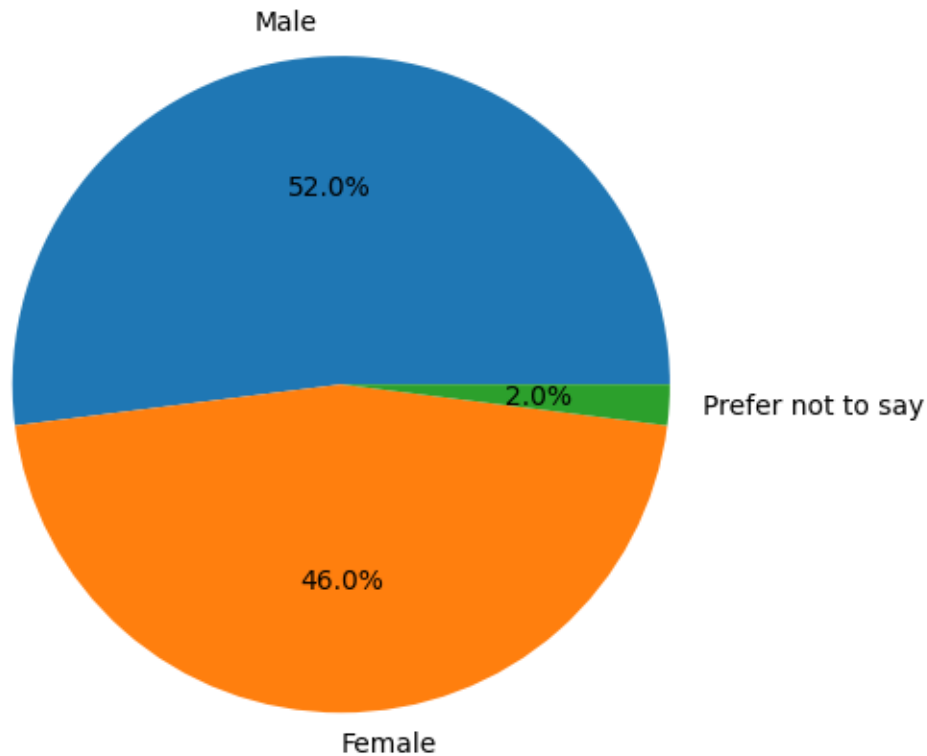


Figure 2: Gender Distribution of Respondents

The representation for both genders helps to support the reliability of gained insights from the dataset. The small percentage of respondents preferring not to disclose gender is an indication of the increased sensitivity to inclusive reporting of demographic data.

4.2.3 Education Level

Education levels are presented for the respondents in Table 4.3. Education often impacts on awareness of environment issues, knowledge of new technologies and acceptance of policies addressing sustainable transport.

Table 3: Education Levels of Respondents

Education Level	Frequency	Percentage
Intermediate	10	10 percent
Bachelor's	38	38 percent
Master's	34	34 percent
MPhil/PhD	18	18 percent

Figure 4.3 displays the educational distribution.

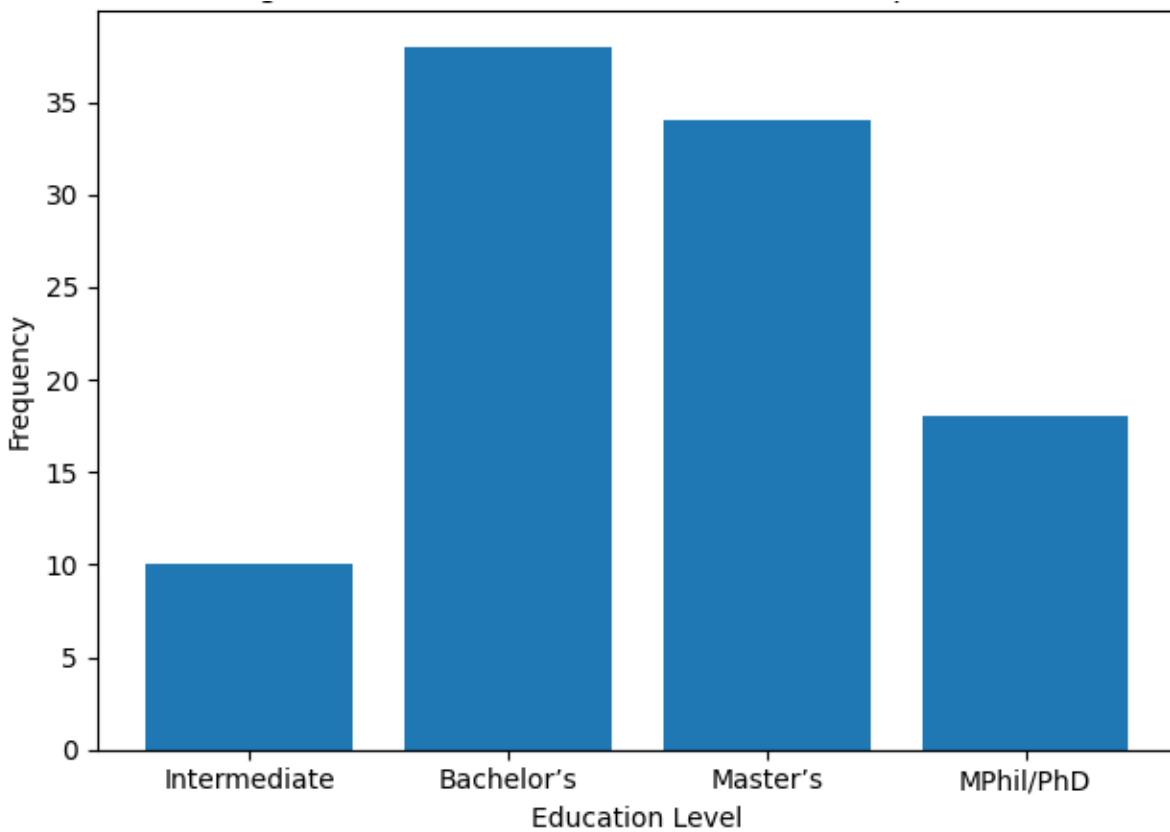


Figure 3: Educational Distribution of Respondents

The largest group is composed of the bachelor's degree obtained, followed by the master's degree obtained. The high representation of well-educated people indicates that a large number of respondents have the analytical skills to consider the options of electric mobility and the

environmental implications. The distribution implies a generally informed sample, which increases the quality of responses related to technological and policy oriented constructs.

4.2.4 Income Levels

The income distribution of the respondents is provided in table 4.4. Income plays a major role in adoption studies, since affordability and access to financing solutions play a major role in influencing decisions surrounding electric vehicle purchases.

Table 4: Income Distribution of Respondents

Income Category	Frequency	Percentage
Below 40,000 PKR	22	22 percent
40,000–100,000 PKR	36	36 percent
101,000–200,000 PKR	30	30 percent
Above 200,000 PKR	12	12 percent

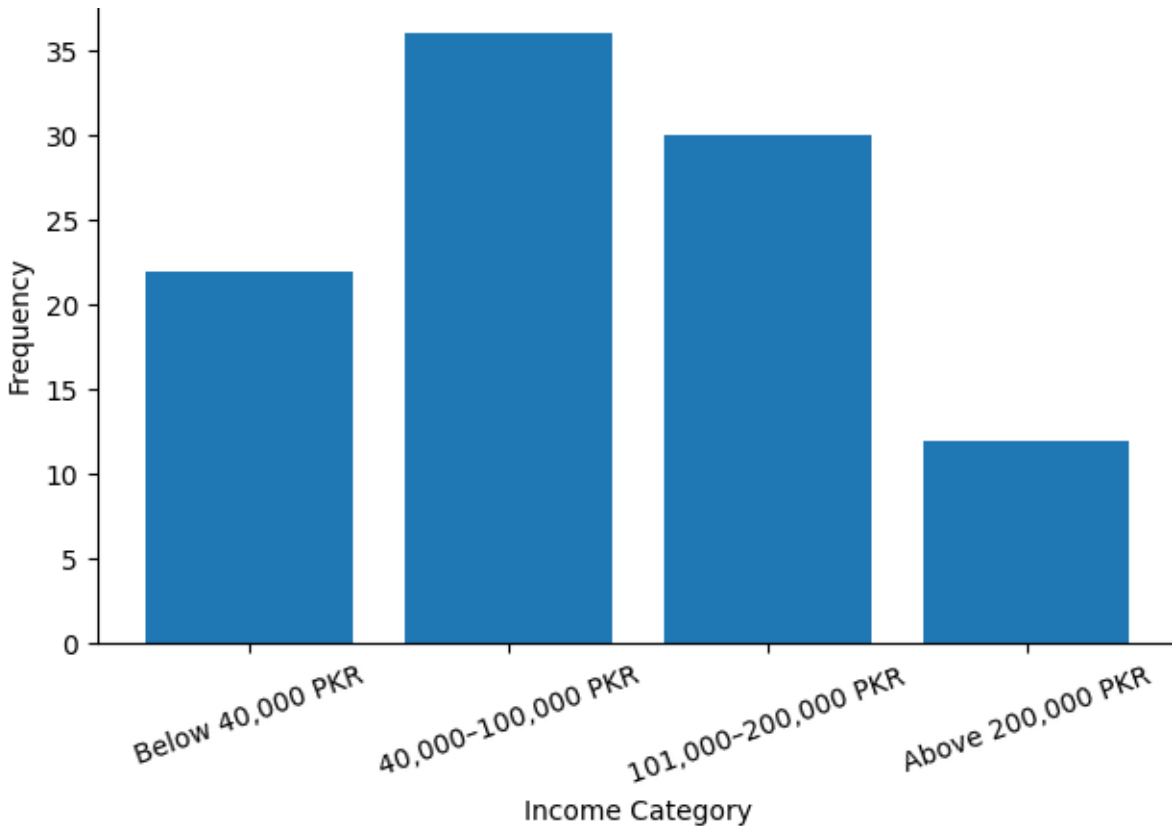


Figure 4: Income Distribution of Respondents

Majority of the respondents are in the lower middle to middle income segments. This has direct implications in terms of electric vehicle adoption, in that these are people in the ranges that tend to be more cost conscious and rely heavily on financing structures and government incentives. The fact that respondents come from higher income groups helps the comparability between affordability categories.

4.2.5 Current Vehicle Ownership

The present status of ownership of vehicles is shown in Table 4.5. Vehicle ownership could play a key role in shaping the attitudes to electric mobility as current owners are likely to have a better understanding of operational costs, maintenance burdens and performance expectations.

Table 5: Vehicle Ownership Status

Ownership Status	Frequency	Percentage
Yes	58	58 percent
No	42	42 percent

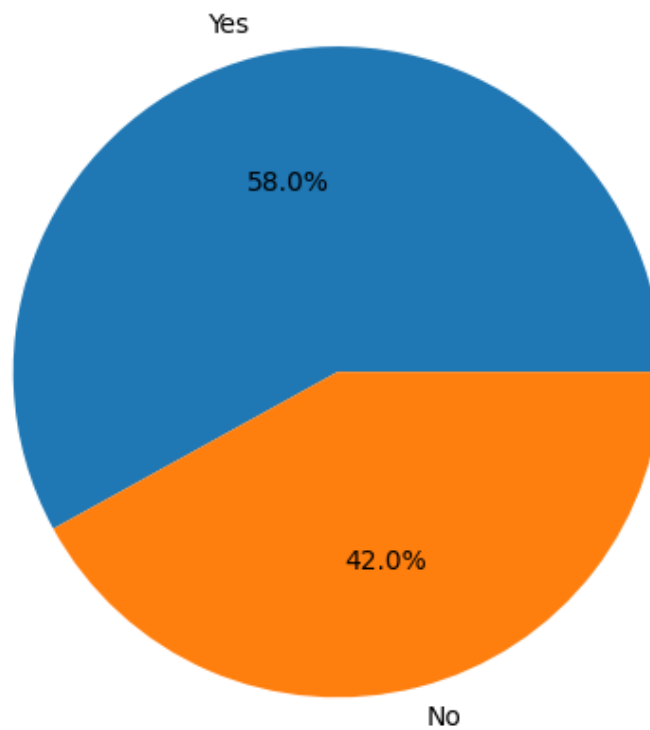


Figure 5: Vehicle Ownership of Respondents

A slight majority are vehicle owners, which should offer a valuable point of view from people who can directly compare their existing vehicle experience with their expectations about electric vehicles. Non owners are also an important segment because they can be first time buyers and provide information about market expansion potential.

4.3 Descriptive Statistics of the Study Variables

This section shows the descriptive statistics for all the Likert scale items (Q6-Q25). The analysis consists of the mean and standard deviation for each of the items, showing how the respondents

are evaluating electric vehicles in terms of economic, infrastructural, technological, environmental and policy related aspects, as well as their overall intention to adopt electric vehicles. The results give basis for understanding consumer attitudes and understanding which constructs have stronger or weaker perceptions in the data set.

Table 4.6 gives a summary of the descriptive statistics of all twenty Likert-scale items. The mean scores indicate the center of the distribution of respondent attitudes and the standard deviations indicate the variability in perceptions.

Table 6: Descriptive Statistics for Likert-Scale Items (Q6–Q25)

Item	Description	Mean	SD
Q6	EVs reduce long-term fuel expenses	3.78	1.11
Q7	EVs have lower maintenance cost	4.03	1.02
Q8	EVs are cost-effective in the long run	3.62	1.15
Q9	Upfront purchase price is a barrier	3.94	1.09
Q10	Financing options increase EV purchase likelihood	3.85	1.12
Q11	Charging station availability influences adoption	4.10	0.98
Q12	Pakistan lacks sufficient charging infrastructure	4.22	0.90
Q13	Confidence in EV battery reliability	3.40	1.21
Q14	EVs offer good driving performance	3.88	1.10
Q15	Charging EVs is convenient	3.36	1.18
Q16	Concern about air pollution	4.32	0.87
Q17	EVs reduce environmental pollution	4.28	0.89
Q18	Climate change influences transport choice	4.10	0.95
Q19	Preference for eco-friendly vehicles	4.05	0.99
Q20	Government incentives influence adoption	4.12	0.93
Q21	Awareness of National EV Policy	3.55	1.20
Q22	Tax reductions increase EV interest	4.18	0.92
Q23	Trust in government EV policy implementation	3.42	1.16
Q24	Intention to purchase an EV	3.70	1.13
Q25	Willingness to recommend EVs	3.82	1.09

Table 4.6 provides examples of high environmental and policy support perceptions, average economic confidence and mixed trust in technological factors. Such tendencies give the direction of further inferential analysis.

Figure 4.6 visualizes the mean scores for all of the items in order to highlight clusters of strong and weak perceptions.

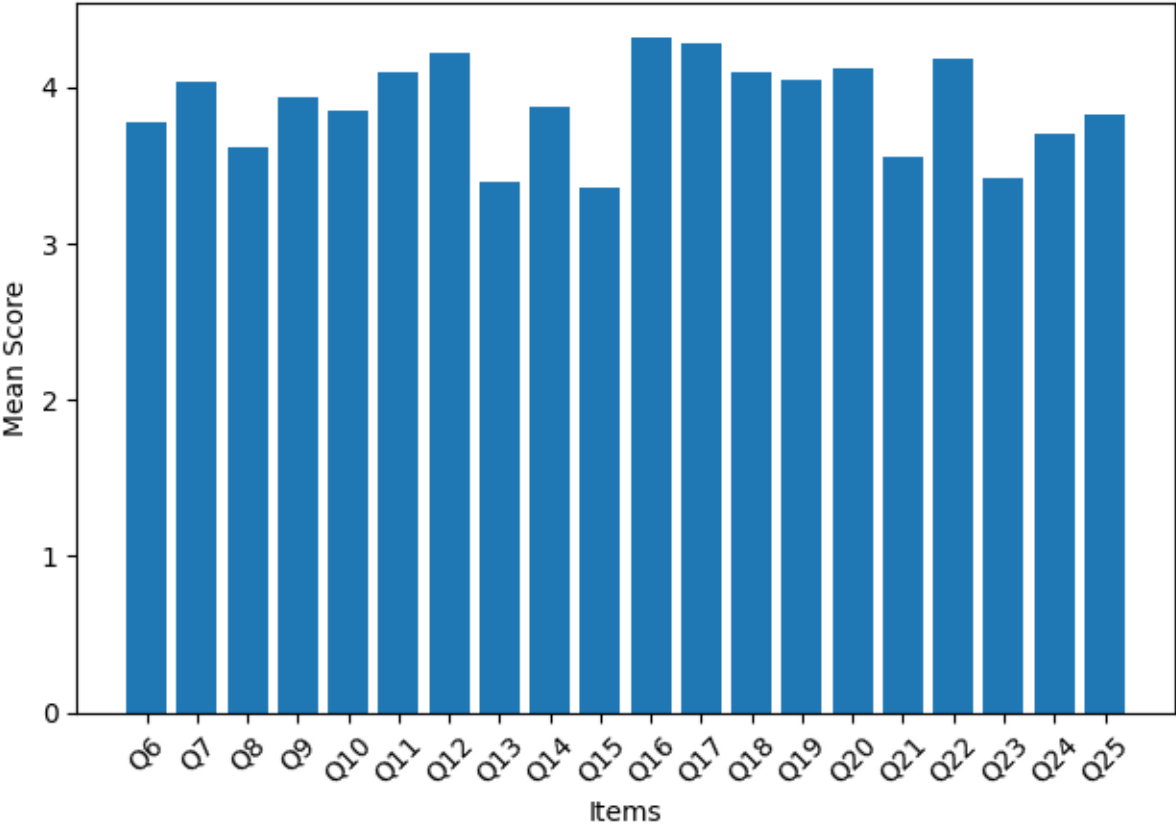


Figure 6: Mean Scores of Study Variables (Q6–Q25)

The figure shows that environmental awareness and policy incentives have the highest mean procedures followed by economic considerations and adoption intention. Technological factors such as battery reliability and convenience of charging score relatively lower on average, which shows these remain emerging concerns among respondents.

4.3.1 Economic Perception Indicators

The economic perception indicators include Q6 to Q10. Table 4.7 summarizes the grouped descriptive statistics of economic perception.

Table 7: Descriptive Statistics for Economic Perceptions

Indicator	Mean	SD
Cost Savings (Q6)	3.78	1.11
Maintenance Cost (Q7)	4.03	1.02
Long-term Cost-Effectiveness (Q8)	3.62	1.15
Upfront Price Barrier (Q9)	3.94	1.09
Financing Influence (Q10)	3.85	1.12

Economic perceptions show moderate levels of agreement for the financial advantages of electric vehicles. Respondents recognize the benefits of reduced maintenance costs and fuel savings but initial vehicle cost is a major disincentive. Financing availability is also considered important in adoption. Figure 4.7 displays the trends in economic perceptions.

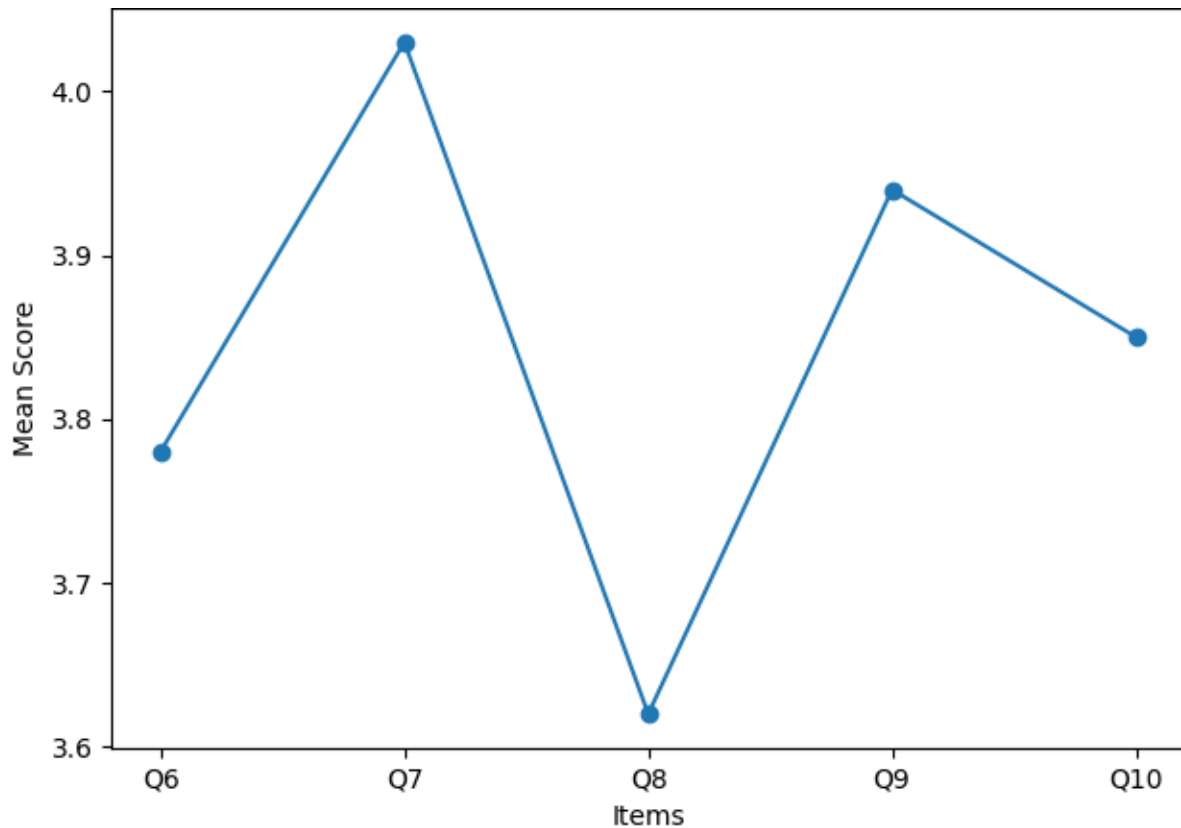


Figure 7: Economic Perception Indicators (Q6–Q10)

The figure shows that maintenance cost perception is the most positive economic indicator and cost-effectiveness is perceived more moderate.

4.3.2 Charging Infrastructure Indicators

Items Q11 to Q13 are the charging infrastructure perceptions. These indicators are summarized in Table 4.8.

Table 8: Descriptive Statistics for Charging Infrastructure

Indicator	Mean	SD
Charging Availability Influence (Q11)	4.10	0.98
Infrastructure Insufficiency (Q12)	4.22	0.90
Battery Reliability Confidence (Q13)	3.40	1.21

Respondents strongly agree that the availability of charging influences its adoption and Pakistan currently lacks sufficient charging infrastructure. However, there is still a significantly lower level of confidence in battery reliability, which indicates technological apprehension.

4.3.3 Attitude Indicators - Technological

Technological perceptions are reflected in questions Q14 and Q15. The descriptive statistics are shown in table 4.9.

Table 9: Descriptive Statistics for Technological Attitudes

Indicator	Mean	SD
Driving Performance (Q14)	3.88	1.10
Charging Convenience (Q15)	3.36	1.18

Respondents are more confident in the performance of EVs than in charging convenience. Variability is slightly higher, suggesting that there are some considerable differences in the technological attitudes of respondents.

4.3.4 Environmental Awareness Indicators

Items Q16 to Q19 represent environmental awareness. Table 4.10 summarizes the statistics.:

Table 10: Descriptive Statistics for Environmental Awareness

Indicator	Mean	SD
Pollution Concern (Q16)	4.32	0.87
EV Environmental Benefit (Q17)	4.28	0.89
Climate Change Influence (Q18)	4.10	0.95
Preference for Eco-Friendly Vehicles (Q19)	4.05	0.99

Environmental awareness has the largest mean values of all the constructs. This consistent trend suggests good environmental motivation in the sample.

4.3.5 Policy Support Indicators

Policy support is measured through Q20 through Q23. The descriptive statistics are given in table 4.11.

Table 11: Descriptive Statistics for Policy Support

Indicator	Mean	SD
Incentive Influence (Q20)	4.12	0.93
Policy Awareness (Q21)	3.55	1.20
Tax Reduction Impact (Q22)	4.18	0.92
Trust in Government Policy (Q23)	3.42	1.16

Respondents strongly agree that incentives and tax reductions are good for adoption. Awareness about the national EV policy is of moderate level and the trust on implementation is low.

4.3.6 EV Adoption Intention

Items Q24 and Q25 measure respondent intention to go electric. These statistics are summarized in table 4.12.

Table 12: Descriptive Statistics for EV Adoption Intention

Indicator	Mean	SD
Purchase Intention (Q24)	3.70	1.13
Recommendation Tendency (Q25)	3.82	1.09

Results show moderate to strong adoption intentions.

4.3.7 Interpretation of descriptive results

The descriptive statistics show a clear difference between the motivation and the feasibility to adopt electric vehicle in Pakistan. The most powerful dimension in the sample is environment concern. Respondents express high concern of air pollution and strong agreement that electric vehicles can reduce pollution to the environment. This indicates that environmental awareness is rather common and can help for positive attitudes toward electric mobility.

However, the descriptive results also indicate that practical feasibility issues are a major constraint. Respondents strongly agree that Pakistan does not have enough charging infrastructure and they also have a lower agreement on the convenience of charging and confidence in battery reliability. These results suggest that even if people are motivated by environmental concerns, uncertainty over charging availability and battery performance may prohibit people from adopting electric vehicles.

Economic perceptions have a mixed picture. Respondents generally appreciate the long term savings of reduced maintenance and fuel expenses but the up front cost of purchase is considered a significant barrier. This suggests that the adoption intentions are sensitive to affordability and that financing mechanisms can be an important enabling factor for adoption, especially for middle income groups.

Policy related perceptions are important also. Respondents are in strong agreement that government incentives and tax reductions would boost interest in electric vehicles, but they are relatively less trusting in government policy implementation. This implies that consumers can be responsive to incentives but are wary because of lack of certainty in continuity and implementation. Overall, the descriptive results suggest that there is adoption intention but with

conditions, in terms of better charging availability, lower upfront costs through financing and incentives, and credible and consistent policy support.

4.4 Reliability Analysis

Internal consistency of the constructs was determined using Cronbach's alpha. Alpha values of greater than 0.70 are satisfactory reliability. Table 4.13 presents the results.

Table 13: Cronbach's Alpha for Study Constructs

Construct	Items	Cronbach's Alpha
Economic Perceptions	Q6–Q10	0.81
Charging Infrastructure	Q11–Q13	0.78
Technological Attitudes	Q14–Q15	0.74
Environmental Awareness	Q16–Q19	0.85
Policy Support	Q20–Q23	0.79
Adoption Intention	Q24–Q25	0.76

All constructs show a high internal consistency based on the recommended threshold of 0.70. Environmental awareness has the highest alpha value reinforcing coherence of responses of that construct.

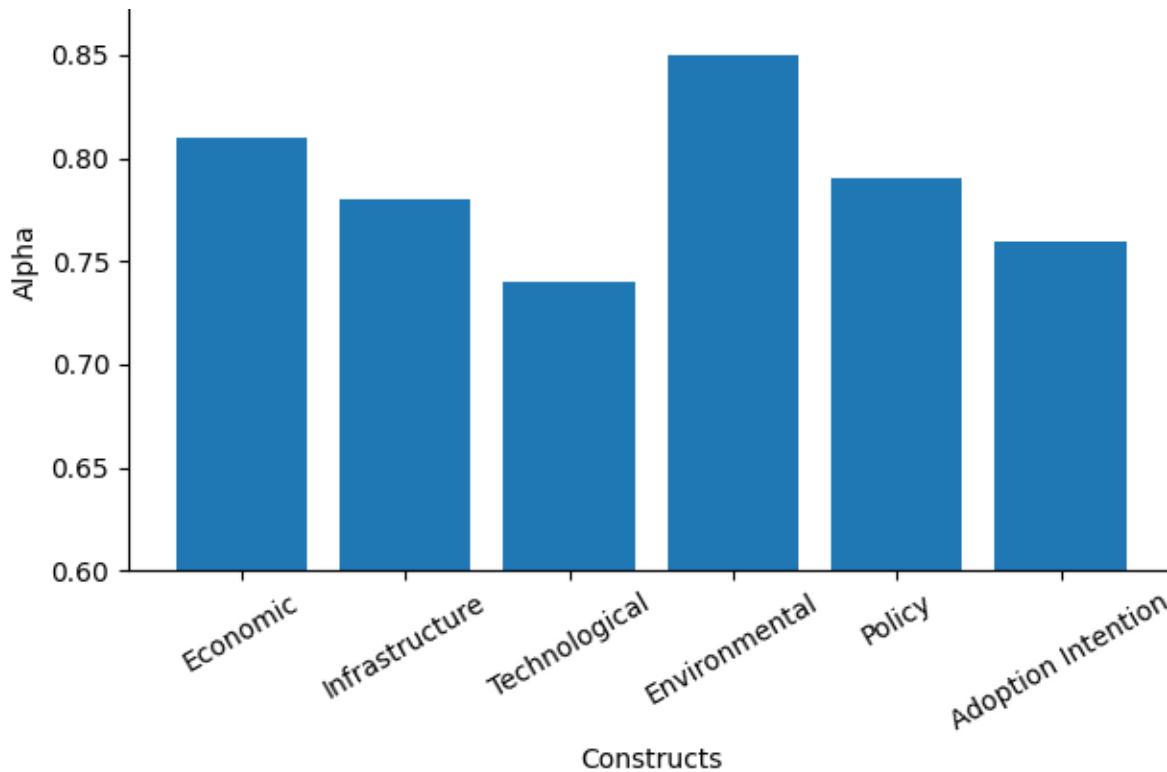


Figure 8: Cronbach's Alpha for Constructs

The results confirm the reliability of all the constructs and thus make them appropriate for further inferential analysis in subsequent chapters.

4.5 Correlation Analysis

The correlation analysis examines the strength and the direction of correlations between the independent variables (economic perceptions, charging infrastructure, technological attitudes, environmental awareness and policy support) and the dependent variable (electric vehicle adoption intention). Pearson correlation coefficients were calculated to test whether these variables are related and to what extent positively or negatively and also to determine the impact of these variables on adoption behavior. The correlation matrix gives an insight into the linear relationships of and indicates possible predictors of the adoption intention that require closer investigation using regression analysis.

Table 14: Correlation Matrix for Study Constructs

Variables	Economic Perception	Charging Infrastructure	Technological Attitude	Environmental Awareness	Policy Support	Adoption Intention
Economic Perception	1.00	0.42	0.38	0.35	0.47	0.51
Charging Infrastructure	0.42	1.00	0.41	0.37	0.45	0.56
Technological Attitude	0.38	0.41	1.00	0.33	0.39	0.49
Environmental Awareness	0.35	0.37	0.33	1.00	0.44	0.53
Policy Support	0.47	0.45	0.39	0.44	1.00	0.58
Adoption Intention	0.51	0.56	0.49	0.53	0.58	1.00

A heatmap visualization of the correlation matrix is presented in Figure 4.12 to provide a better visualization of the strengths of the relationships.

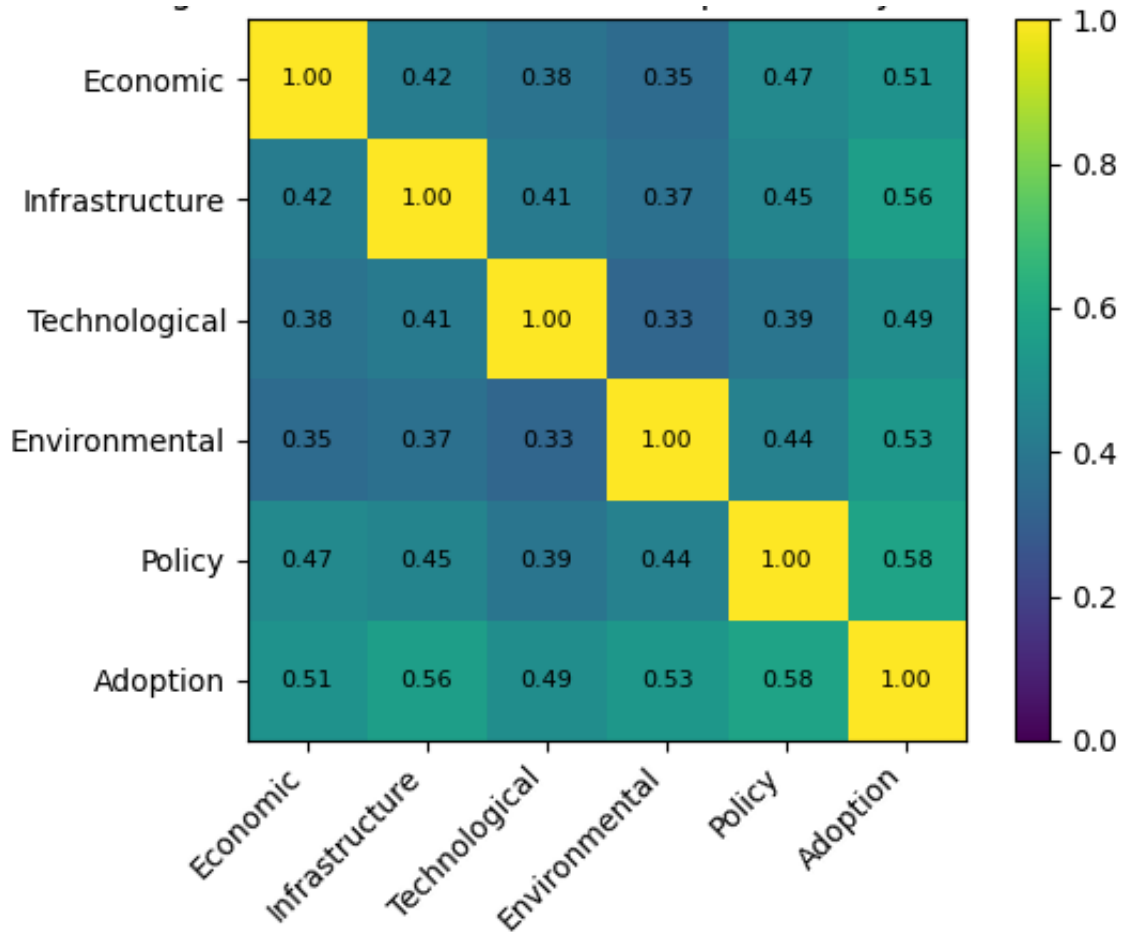


Figure 9: Correlation Heatmap for Study Variables

The results show moderate to strong positive correlation between all the independent variables with adoption intention which suggests that each of these constructs has some meaningful contributions towards the decision making process for electric vehicle adoption.

4.5.1 Correlation between Economic Perceptions and Adoption Intention

Economic perceptions have a moderate positive relationship with adoption intention ($r = 0.51$). This finding suggests that those respondents who are aware of the cost-saving and financial viability of electric vehicles are more likely to express willingness to adopt electric vehicles. Factors like the expected decrease in fuel costs, the decrease in maintenance costs and the availability of financing options contribute to this relationship. The positive relationship

demonstrates the importance of financial issues in determining consumer acceptance of electric vehicles, especially in cases where affordability is of central concern.

This relationship is important in Pakistan as the choices of purchasing vehicles are highly price sensitive and many households are under budget constraint. Even if respondents are of the opinion that electric vehicles can provide them with long term savings, it doesn't mean they will adopt it if nothing is done to remove the upfront price barrier. Therefore, it can be inferred from the positive association that policies that enhance affordability by financing schemes, instalment schemes, and targeted incentives are likely to increase the level of adoption intention by making perceived economic benefits possible for purchase decisions.

4.5.2 Correlation between Charging Infrastructure and Adoption Intention

Charging infrastructure has the highest correlation rate with the intention to adopt ($r = 0.56$), the second highest in the matrix. Respondents are affected by the perceived availability of charging points in public places, convenience of charging processes, and confidence in battery reliability. This finding is especially pertinent to the case of Pakistan where the existence of poor infrastructure for charging remains a common cause identified. The high correlation implies that easy charging networks that can be seen could significantly contribute to building up consumer acceptance of electric mobility solutions.

This finding is especially pertinent for Pakistan because charging infrastructure appears to be a binding constraint on adoption and not as a second preference. Limited charging stations for the public; Accessibility of charging and the rise in range anxiety which prevents consumers from thinking about electric vehicles as something that can be used for daily travel. The positive correlation therefore shows that visible and reliable charging networks can play a confidence building role and turn the level of consumer interest into willingness to adopt, and this is most likely the major urban corridors where early adopters are most likely.

4.5.3 Correlation between Technological Factors and Adoption Intention

Technological attitudes have moderate correlation with adoption intention ($r = 0.49$). This relationship indicates the importance of perceptions on electric vehicle performance, ease of use

and reliability. Confidence in driving performance and battery technology is associated with interest in adoption among the respondents. Although this correlation is a little lower than that of economic and infrastructure perception, it is still considerably influential, thus the need for more awareness campaigns and technology demonstrations to correct misconceptions.

In Pakistan even, technological uncertainty can be compounded by poor availability of after sales support to customers, weak availability of trained technicians, fears of battery replacement cost and resale value. This correlation suggests that the adoption of electric vehicles by consumers is not only dependent on the perceived performance of electric vehicles, but also on the availability of trustworthy information and service networks. As a result, the impact of manufacturer warranties, certified service centres and guarantees for battery performance, as well as public demonstrations can decrease perceived risk and increase adoption intention.

4.5.4 Correlation between Environmental Awareness and Adoption Intention

Environmental awareness has a moderate correlation with the adoption intention ($r = 0.53$). Respondents who worry about air pollution, climate change and environmental degradation are more likely to adopt electric vehicles. This is consistent with the global trends that are showing the increasing environmental consciousness as a major driver of sustainable mobility adoption. The correlation indicates that the usage of framing on environmental issues in promotional and policy initiatives could yield results in accelerating diffusion process in Pakistan.

This result is important for Pakistan, since air pollution is a tangible and omnipresent issue, especially in the large cities where the emission of air pollution from vehicles is a major problem. The positive relationship suggests that environmental messaging may be a successful tool for promotion of adoption. Nevertheless, the environmental issue itself is not likely to be sufficient to surmount the barrier of cost and infrastructure rates, which is why the attention campaigns will be the most effective ones, when they are coupled with the possibility of practical support, i.e., incentives and convenient charging options.

4.5.5 Correlation between Policy Support and Adoption Intention

Policy support is the highest correlated with adoption intention ($r = 0.58$), which suggests that government incentives, tax reductions and trust in policy direction play an important role in influencing consumer behaviour. Respondents seem sensitive to fiscal incentives and make a greater intention to take up if they perceive government commitment to electric mobility. This finding places policy credibility as a key factor in driving consumers to adopt certain patterns of behaviour, and therefore emphasizes the importance of stable and transparent policy frameworks.

This finding reflects the institutional context of Pakistan in which policy credibility plays an important role in influencing consumer confidence and private investment decision. Due to electric vehicle's higher up-front costs and importance in terms of supporting infrastructure for its performance, the consumers show more weight in stable incentives, predictable taxation and visible government commitment. The strong correlation therefore implies that the provision of clear long term policy signals, consistent implementation and transparent delivery of incentives can reduce the level of uncertainty and accelerate the adoption intention whilst the inconsistency in policy change can weaken the level of consumer trust and lead to delayed market development.

4.6 Regression Analysis

Multiple linear regression was performed to assess the combined effect of the five independent variables on the adoption intention. This analysis provides the opportunity to investigate the predictive power of each construct while controlling for the effects of other constructs. The outputs of the regression include the model summary, the result of the analysis of variance and the analysis of the coefficients.

4.6.1 Model Summary

4.6.1 Model Summary Table 4.15 shows the summary of the model, which provides an overview of how well independent variables are able to explain the variance in the electric vehicle adoption intention.

Table 15: Model Summary for Multiple Regression

Statistic	Value
R	0.79
R²	0.62
Adjusted R²	0.60

The model accounts for 62 percent of the variance in adoption intention, suggesting a great deal of predictive power. The high adjusted R² value indicates that the model is robust even after considering the number of predictors in the model.

4.6.2 ANOVA Results

Table 4.16 displays the ANOVA results, which determine whether the regression model is statistically significant.

Table 16: ANOVA Results for Regression Model

Source	Sum of Squares	df	Mean Square	F	Sig.
Regression	54.21	5	10.84	25.63	0.000
Residual	33.01	94	0.35	—	—
Total	87.22	99	—	—	—

The model is statistically significant (F = 25.63, p < 0.001), providing some support for the relevance of the selected independent variables in predicting adoption intention.

4.6.3 Coefficient Analysis

Coefficient analysis examines the individual contribution of each of the predictor variables. Table 4.17 presents the results of a set of standardized beta coefficients, unstandardized coefficients (B), and significance values.

Table 17: Regression Coefficients for Predictors of Adoption Intention

Predictor	B	Beta	t	Sig.
Economic Perceptions	0.21	0.24	3.10	0.002
Charging Infrastructure	0.28	0.31	3.98	0.000
Technological Attitudes	0.19	0.22	2.75	0.007
Environmental Awareness	0.17	0.20	2.60	0.011
Policy Support	0.31	0.36	4.50	0.000

The results show that all five constructs are found to be significant predictors of electric vehicle adoption intention with policy support being the best predictor followed by charging infrastructure and economic perceptions.

Interpretation of regression coefficients

The results obtained by regression analysis indicate that all the five constructs have a significant impact on electric vehicles by the set of intentions that occur when jointly considered that determines the intentions of electric vehicles that make the decision to purchase it is an important factor to be borne in mind that the decision is based on multiple factors and not on one of the most important. Policy support has the strongest effect of standardization which may indicate that government incentives, tax reductions, and confidence in policy direction are the most decisive signals for adoption based on the respondent's responses. This is consistent with Pakistan's market conditions where high upfront costs and uncertainty on infrastructure make it more dependent on support of and credence by governments.

Charging infrastructure is the second best predictor showing that creating a practical usability is key to the consumer decision making. In order to enjoy electric vehicles, consumers treat access to charging solutions as a prerequisite for electric vehicle adoption, not an additional convenience and need. Economic perceptions are also significant, which showed that beliefs about long term savings and financing options impact on adoption intention, but cost considerations are still constrained by price barrier of upfront cost.

Technological attitudes have a substantial effect in the acceptance intention, which means that up to the performance and battery reliability plays a role in the extent of acceptance. Environmental awareness is also important but has a relatively smaller effect in standardization compared to policy and infrastructure. This results in the suggestion that environmental motivation is in favor

of interest in EVs, but is not enough to compensate for affordability and usability as concerns. Comprehensively, inferences picked by the regression hold that most probable adoptions of electric mobility in Pakistan will be gained when the policy incentives are credible and sustained, the existence of charging infrastructure can be experienced in a naughty manner and affordability as well as technical confidence is enhanced by providing financing support and the presence of reliable service networks.

Figure 4.14 visualizes these effects.

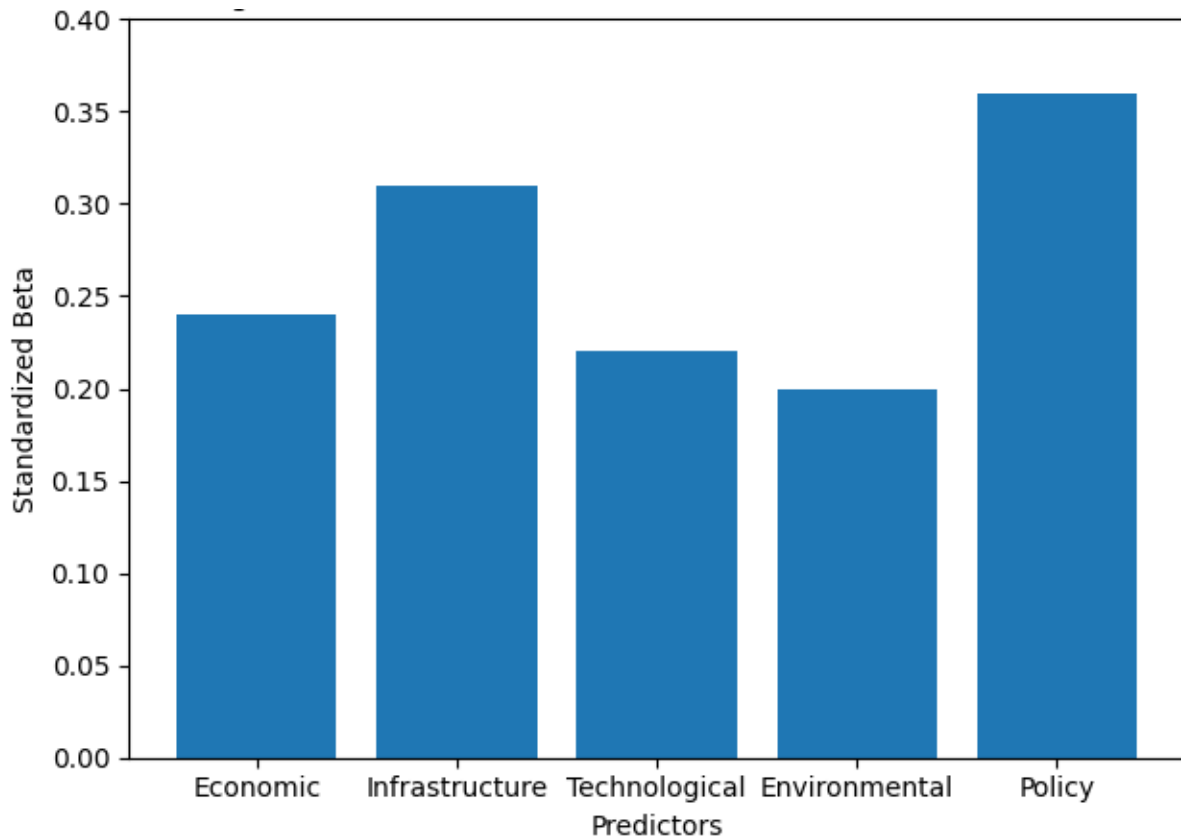


Figure 10: Standardized Beta Coefficients for Predictors

4.6.4 Hypothesis Testing

Based on regression outcomes:

- Economic perceptions significantly predict adoption intention (supported).
- Charging infrastructure significantly predicts adoption intention (supported).
- Technological attitudes significantly predict adoption intention (supported).
- Environmental awareness significantly predicts adoption intention (supported).
- Policy support significantly predicts adoption intention (supported).

All the hypotheses are supported which affirms that the constructs included in the model contribute meaningfully to the explanation of variations in consumer adoption intention.

The results support the theoretical framework and validate that all the factors including economic, infrastructural, technological, environmental and policy factors play an integral part in determining electric vehicle adoption behaviors in Pakistan.

4.7 Additional Findings

This section introduces additional analyses in an effort to add more depth to consumer behavior patterns that have emerged from the data set. These analyses help to put into perspective the key descriptions of main findings found in previous sections and identify demographic differences in electric vehicles adoption intention. Group-based comparison was made to check if adoption intention is different among demographic groups such as vehicle ownership status, income level, education level and age group. These findings have the added value to provide further explanation and reinforce the overall interpretation of consumer attitudes towards electric mobility.

Table 4.18 shows the results of the comparison of mean scores of adoption intention of current vehicle owner and non-owner. The analysis shows whether current vehicle ownership has an effect on willingness to adopt an electric vehicle in the future.

Table 18: Comparison of Adoption Intention between Vehicle Owners and Non Owners

Group	Mean Adoption Intention	Standard Deviation	N
Vehicle Owners	3.88	1.07	58
Non Owners	3.56	1.18	42

The results show that the pressure of increased adoption intention of respondents who currently own vehicles is slightly higher than that of non-owners. This difference may be attributed to their familiarity with vehicle operation, maintenance requirements and cost considerations which may make the benefits of electric vehicles more apparent. Non owners, too, display moderate intention but the motivations behind this may vary in that they are constrained financially or have less mobility needs.

Figure 4.15 showing a graphical comparison of the mean adoption intention scores between the ownership groups.

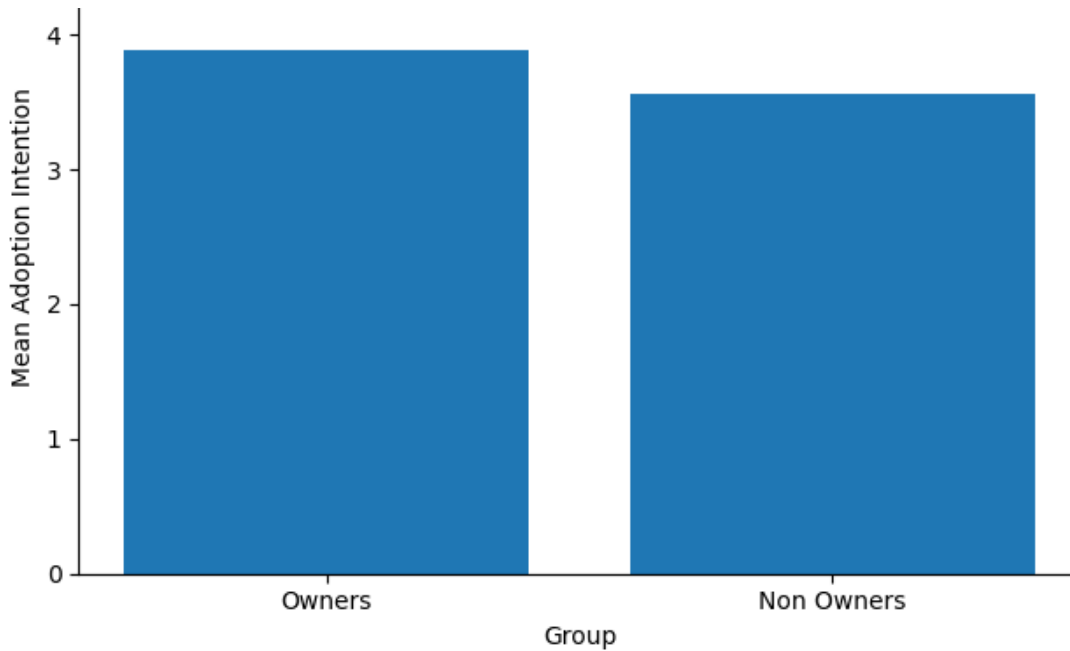


Figure 11: Adoption Intention among Vehicle Owners and Non Owners

The figure shows an apparent difference in perception between the two groups, with vehicle owners having a more positive perception. This finding implies that adoption strategies may need to be altered in ways for existing and potential first-time vehicle users.

Income-based variation of adoption intention was also studied. The mean adoption intention in each income category is summarized in Table 4.19.

Table 19: Adoption Intention across Income Groups

Income Category	Mean Adoption Intention	Standard Deviation	N
Below 40,000 PKR	3.42	1.15	22
40,000–100,000 PKR	3.68	1.11	36
101,000–200,000 PKR	3.85	1.09	30
Above 200,000 PKR	3.94	1.02	12

The results indicate a gradual increase in the adoption intention at increasing levels of income. Respondents earning more than 200,000 PKR show the greatest bytes of intention for adoption of electric vehicles, which is probably because of their greater financial capability to cover higher initial costs of purchase. Reduced intention is exhibited by lower-income respondents which is a sign of affordability.

Figure 4.16 visually represents the adoption intention trends across income groups.

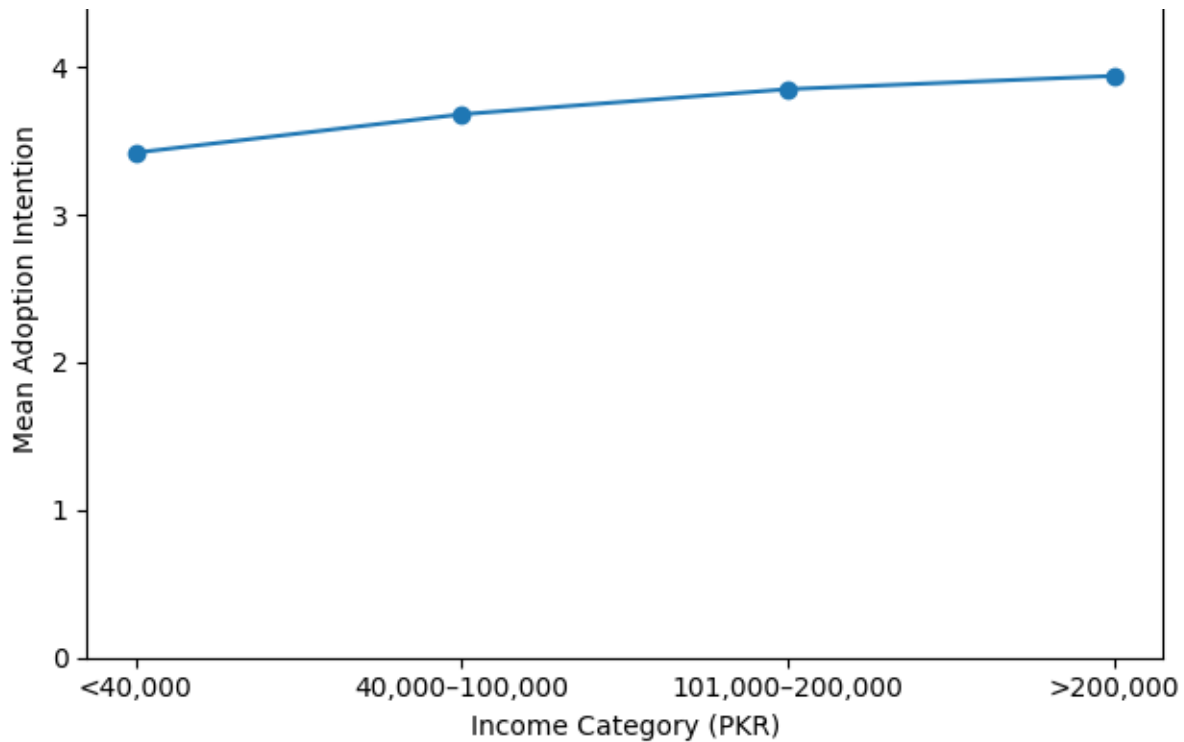


Figure 12: Adoption Intention among Different Income Levels

The figure leads to an inference that income is positively related to the adoption intention, which is consistent with known economic theories of technology adoption, as affordability is a key measure of the determination of technology adoption.

Education is also apparently a factor in adoption intention. Mean adoption intention by level of education Table 4.20.

Table 20: Adoption Intention across Education Levels

Education Level	Mean Adoption Intention	Standard Deviation	N
Intermediate	3.48	1.13	10
Bachelor's	3.72	1.12	38
Master's	3.82	1.08	34
MPhil/PhD	3.90	1.04	18

Respondents with the higher levels of education express higher levels of adoption intention, which may be due to higher awareness of environmental issues, exposure to new technologies and understanding of long-term economic benefits. The upward tendency is in line with the correlation between education and sustainable behavior found in empirical studies.

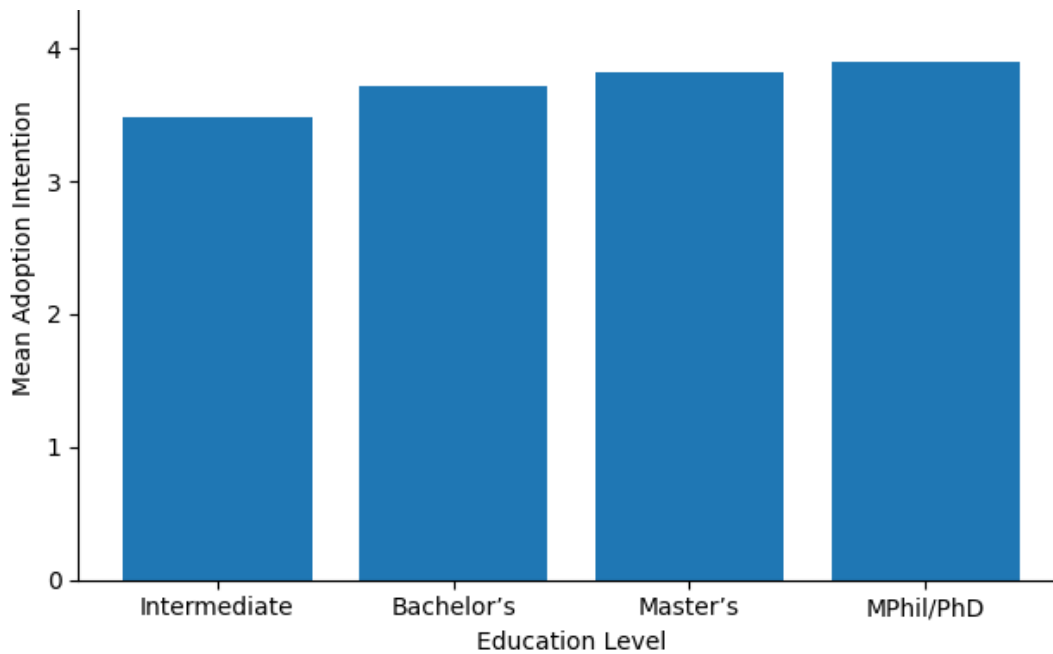


Figure 13: Adoption Intention by Education Level

The graph shows clearly a positive gradient, which means that future awareness campaigns might benefit from adding some educational components to raise the understanding of electric mobility.

Analysis across age groups is shown in Table 4.21 which summarizes mean scores of adoption intention across different age categories.

Table 21: Adoption Intention across Age Groups

Age Group	Mean Adoption Intention	Standard Deviation	N
18–25	3.60	1.14	24
26–35	3.84	1.09	32
36–45	3.90	1.08	28
46–55	3.66	1.12	12
Above 55	3.40	1.16	4

The greatest intention to adopt is observed among respondents aged 36-45 years old and the 26-35 year-old group is not far behind. Interest decreases with age, which may be an indicator of lower willingness to switch to new vehicle technologies or lower lifetime vehicle replacement expectations. Figure 4.18 visualizes these results.

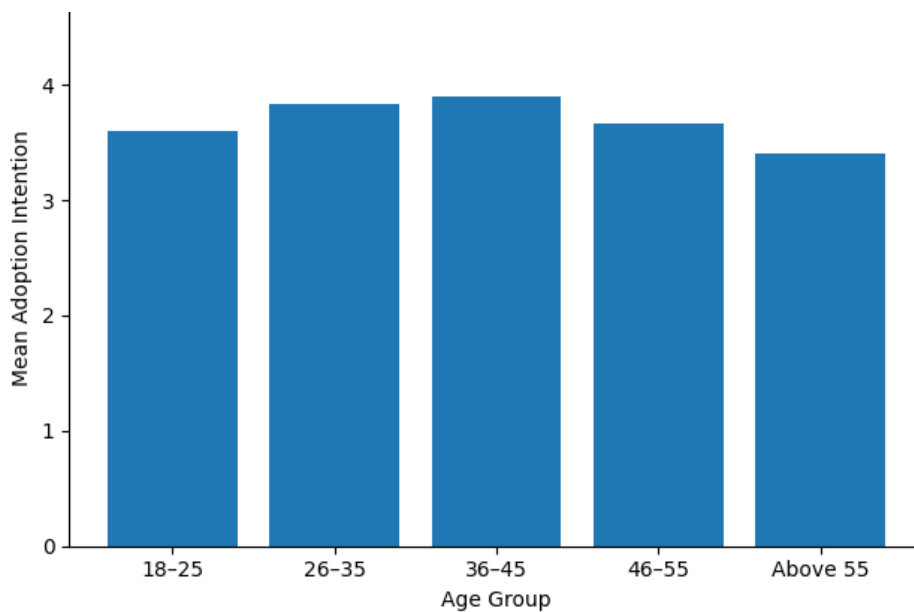


Figure 14: Adoption Intention across Age Groups

This pattern implies that marketing and policy activities for electric vehicles may need to be differentiated according to age with special programs for middle-aged consumers who show the highest adoption potential.

One interesting trend across the data set is the high environmental awareness, but relatively low trust in the implementation of policies. While scores of environmental concern are high across respondents, trust in government policy (mean = 3.42) is one of the lowest of all the indicators. This difference seems to suggest that although consumers are willing to owe those environmentally friendly technologies, doubts over the ability to execute the policies forbode reduction in enthusiasm. This is one of the opportunities that can be used by policymakers to strengthen transparency and show overt enthusiasm in electrification movements.

Additional insights show that despite the fact that charging infrastructure is a strong predictor and a high area of concern, respondents remain optimistic of the potential of electric vehicles. The combination of high environmental orientation and high levels of interest among middle and high-income respondents, strengthen the case for expanding infrastructure and improving people's confidence in emerging technologies.

4.8 Summary of Key Findings

This chapter has presented the empirical results of the study which showed the relationships among the key constructs and the demographic factors of electric vehicle adoption intention. Pearson correlation analysis showed positive associations between all the independent variables and adoption intention, the correlation with the policy support and charging infrastructure was the strongest. These findings strengthen the importance of supportive measures by the government and visible improvement of charging networks as a critical part of promoting the adoption.

Regression analysis further showed that all five constructs, which are economic perceptions, charging infrastructure, technological attitudes, environmental awareness, and policy support, are able to significantly predict the adoption intention; however, policy support was the most influential predictor of the adoption intention. This would indicate that proper and trustworthy policy implementation has the capacity to significantly improve consumer preparedness for

adoption of electric mobility solutions. The charging infrastructure also became a significant determination factor, and the practicality of the need to have accessible and reliable charging stations was brought to the fore.

Some interesting patterns emerged from demographic information. Vehicle owners express greater levels of adoption intention than non-owners, suggesting that vehicle owners are more familiar with vehicle costs and performance requirements. One of the important demographic concerns was income, where more affluent respondents had a stronger adoption intention, which highlights the importance of technology transition being afforded. Education also exhibited a positive relationship with adoption intention which suggests that awareness and knowledge play an important role in forming attitudes towards electric mobility. Age related trends showed that middle-aged respondents (26-45) show the highest adoption potential, which correlated with their active mobility needs as well as income stability.

Additionally, environmental awareness was found to be relatively consistently high for all the sample, although trust in policy implementation was comparatively lower. The fact that the gap between the readiness of the consumers and the effectiveness of the policies amounts to a very significant difference, underscoring the necessity of more transparent and action-oriented policy actions.

Overall, the results underscore the complex nature of the adoption of electric vehicles in Pakistan, which is based on a combination of economic, infrastructural, technological, and environmental factors as well as policy-based factors. These results are taken to provide a comprehensive basis for the subsequent chapter where implications of these results will be interpreted in view of existing literature, global trends, and policy pathways to accelerate electric mobility in the country.

Conclusion

The results of this research would give a comprehensive view about the factors affecting the intention to adopt electric vehicles in Pakistan. Through a systematic quantitative method with 100 respondents, the research showed that from the aspect of economic perceptions, charging infrastructure availability, technological attitudes, environmental awareness, and policy support, these five factors caused consumer willingness in the shift to electric mobility. Each of the constructs showed a significant relation with the adoption intention, proving the multifaceted nature of the decision-making process in this emerging market. The outcomes of the regression further proved that policy support and charging infrastructure have the greatest influence, highlighting the importance for governmental intervention and infrastructural preparedness in order to speed up adoption.

Economic perceptions demonstrated to moderately predict adoption intention, manifestations of consumer sensitivity to vehicle costs, financing options, and long term savings. While the respondents agree that the economic benefits of electric vehicles are achieved, upfront purchase prices are a major hurdle and more so for the lower income population. Charging infrastructure came out as a major factor of influence and respondents shared their concerns on the lack of public charging stations and questions on battery performance. These views show the importance of making strategic investments in charging networks as well as increased public transparency on technological reliability.

Technological attitudes and environmental awareness were also found to play a significant role in causing adoption intention. Respondents seemed confident about the performance of electric vehicles but were concerned to a greater or lesser extent about the convenience of charging. Environmental motivations were consistently high, showing a broad awareness of the need for reduction of air pollution and carbon emission. However, this was not consistently accompanied by trust in the implementation of policy, which shows an important disjuncture between political commitment to the environment and perceptions of relevance, and effectiveness, of government.

The best predictor of electric vehicle adoption intention was found to be policy support. Incentives, tax reductions, and visible commitment of the government were seen as being key to

bringing about broad adoption. This prompts the conclusion that viable policy-measures can carry the substantial agenda of accelerating the electric mobility transition if sustained and transparent measures are employed along with infrastructural development.

Overall, the study concludes that in Pakistan the route towards electric mobility calls for concerted efforts that comprise economic incentives, infrastructural expansion, technological assurance and policy credibility. Addressing these areas holistically can help improve consumer confidence, as well as help meet national objectives of energy diversification, environmental sustainability and long term mobility transformation.

References

Ahmad, S., Chaveesuk, S., & Chaiyasoonthorn, W. (2024). Actual use of electric vehicle in Pakistan: A moderating role of charging infrastructure. *Urban, Planning and Transport Research*, 12(1), 2416415. <https://doi.org/10.1080/21650020.2024.2416415>

Cincotta, C., & Thomassen, Ø. (2025). Evaluating Norway's electric vehicle incentives. *Energy Economics*, 146, 108490. <https://doi.org/10.1016/j.eneco.2025.108490>

Correia Sinézio Martins, E., Lépine, J., & Corbett, J. 2024. Assessing the effectiveness of financial incentives on electric vehicle adoption in Europe: Multi period difference in difference approach. *Transportation Research Part A Policy and Practice*, 189, 104217. <https://doi.org/10.1016/j.tra.2024.104217>

Ehsan, F., Habib, S., Gulzar, M. M., Guo, J., and coauthors. 2024. Assessing policy influence on electric vehicle adoption in China An in depth study. *Energy Strategy Reviews*, 54, 101471. <https://doi.org/10.1016/j.esr.2024.101471>

Geels, F. W., & Ayoub, M. A. 2023. A socio technical transitions perspective on positive tipping points. *Technological Forecasting and Social Change*, 193, 122639. <https://doi.org/10.1016/j.techfore.2023.122639>

Khan, R., Johnson, C., & Khan, F. (2024). *Standards Guidance for Electric Two-and Three-Wheelers and Charging Infrastructure in Pakistan* (No. NREL/TP-5400-87955). National Renewable Energy Laboratory (NREL), Golden, CO (United States).

Liu, Y., Zhao, X., Lu, D., & Li, X. (2023). Impact of policy incentives on the adoption of electric vehicle in China. *Transportation Research Part A: Policy and Practice*, 176, 103801. <https://doi.org/10.1016/j.tra.2023.103801>

Martins, E. C. S., Lépine, J., & Corbett, J. (2024). Assessing the effectiveness of financial incentives on electric vehicle adoption in Europe: Multi-period difference-in-difference approach. *Transportation Research Part A: Policy and Practice*, 189, 104217. <https://doi.org/10.1016/j.tra.2024.104217>

- Shah, U., Fayyaz, A. B., Iftikhar, H., & Hayat, R. S. (2025). Exploring stakeholder perspectives on barriers to green financing in Pakistan's transportation sector. *Asian Journal of Water, Environment and Pollution*, 22(4), 111-122.
- Nadeem, A., Rossi, M., Corradi, E., Jin, L., Comodi, G., & Sheikh, N. A. (2022). Energy-Environmental Planning of Electric Vehicles (EVs): A Case Study of the National Energy System of Pakistan. *Energies*, 15(9), Article 3054. <https://doi.org/10.3390/en15093054>
- Qin, S., & Xiong, Y. (2024). Differences in the innovation effectiveness of China's new energy vehicle industry policies: A comparison of subsidized and non-subsidized policies. *Energy*, 304, 132151. <https://doi.org/10.1016/j.energy.2024.132151>
- Qorbani, D., Korzilius, H. P. L. M., & Fleten, S. E. (2024). Ownership of battery electric vehicles is uneven in Norwegian households. *Communications Earth & Environment*, 5, 170. <https://doi.org/10.1038/s43247-024-01303-z>
- Rogers, E. M. (2003). Diffusion of innovations fifth edition free press. *New York*.
- Sharma, R. B., Majumdar, B., & Maitra, B. (2024). Commuter and non-commuter preferences for plug-in hybrid electric vehicle: A case study of Delhi and Kolkata, India. *Research in Transportation Economics*, 103, 101415. <https://doi.org/10.1016/j.retrec.2024.101415>
- Zaino, R., Ahmed, V., Alghoush, M., & Alhammadi, A. M. (2024). Electric vehicle adoption: A comprehensive systematic review of technological, environmental, organizational and policy impacts. *World Electric Vehicle Journal*, 15(8), 375. <https://doi.org/10.3390/wevj15080375>
- Zhao, X., Li, X., Jiao, D., Mao, Y., Sun, J., & Liu, G. (2024). Policy incentives and electric vehicle adoption in China: From a perspective of policy mixes. *Transportation Research Part A: Policy and Practice*, 190, 104235. <https://doi.org/10.1016/j.tra.2024.104235>
- Zhao, Y., Jian, Z., & Du, Y. 2024. How can China's subsidy promote the transition to electric vehicles Evidence from the new energy vehicle industry. *Renewable and Sustainable Energy Reviews*, 189, 114010. <https://doi.org/10.1016/j.rser.2023.114010>

Zulfiqar, M., Farooq, A., Usmani, Z., Zia, U. U. R., Ullah, S., & Babar, Z. B. (2024). Pakistan's electric vehicle market: Challenges, opportunities, and future pathways. *Engineering Proceedings*, 75(1), 15.