

**Assessing the Feasibility and implications of electric  
vehicle adoption in the modern era:  
A risk feasibility study on infrastructure and cost  
effectiveness in Malta**

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**A dissertation submitted in partial fulfilment of the requirements for the  
award of Master of Science in Insurance and Risk Management in the  
department of Insurance and Risk Management at the University of Malta**

**September 2024**



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## **Abstract**

The world's shift to electric vehicles (EVs) has quickened as worries about carbon emissions and environmental sustainability have grown. Small island nations like Malta, however, have particular difficulties implementing this technology because of infrastructure constraints and financial concerns. Through a thorough risk feasibility evaluation, this study examines the viability of broad EV adoption in Malta with a particular emphasis on cost-effectiveness and infrastructure readiness.

The study found a number of infrastructure issues, including a lack of public charging stations, restrictions on at-home charging alternatives, and worries about Malta's energy grid's ability to handle an increasing number of EVs. Wider adoption is still hampered by high upfront prices and uncertainties surrounding battery replacement and residual value, even though Malta has introduced government incentives targeted at lowering the financial burden for consumers. It has been discovered that EVs' TCO can save money over time on fuel and maintenance, but consumers aren't always aware of these advantages.

Understanding the financial and infrastructural obstacles to EV adoption is essential as Malta strives to meet the climate goals of the European Union and shift to more environmentally friendly modes of transportation. The research

utilises interviews with significant players, such as industry professionals, to obtain comprehensive understanding of the present condition of Malta's electric vehicle ecosystem.

This study emphasises the necessity of stronger government regulations and incentives to promote the adoption of EVs as well as the significance of public awareness initiatives to change consumer attitudes. The thesis also emphasises how urgent it is to close infrastructure gaps by investing in renewable energy integration and forming public-private partnerships.

Keywords: Electric Vehicles, Infrastructure, Cost-effectiveness, Feasibility

## **Acknowledgements**

I would like to express my deepest gratitude to my tutor, Dr. Andre Farrugia, for his invaluable guidance, support, and encouragement throughout this journey. His expertise and feedback have been instrumental in constructing my thesis, and I am truly grateful for this.

To my family, especially my mum and dad, for believing in me, your unwavering support has been my greatest source of strength.

To my boyfriend Matteo, thank you for your constant encouragement, understanding, and for always being there.

Finally, thank you to the participants because this study would not have been possible without you.

Thank you from the bottom of my heart.

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## List of Abbreviations

<b>EV</b>	<b>Electric Vehicle</b>
<b>PHEV</b>	<b>Plug-in Electric Vehicle</b>
<b>HEV</b>	<b>Hybrid Electric Vehicle</b>
<b>BEV</b>	<b>Battery Electric Vehicle</b>
<b>FCEV</b>	<b>Full-cell Electric Vehicle</b>
<b>EREV</b>	<b>Extended Range Electric Vehicle</b>
<b>SEV</b>	<b>Solar Electric Vehicle</b>
<b>ICE</b>	<b>Internal Combustion Engine</b>
<b>IEA</b>	<b>International Energy Agency</b>
<b>EU</b>	<b>European Union</b>
<b>CO2</b>	<b>Carbon Dioxide</b>
<b>V2G</b>	<b>Vehicle-To-Grid</b>

## **Chapter 1: Introduction**

### **1.1 Background on electric Vehicles**

An electric Vehicle (EV) is defined as a “motor vehicle equipped with a powertrain containing at least one non-peripheral electric machine as energy converter with an electric rechargeable energy storage system, which can be recharged externally” as stated by the subsidiary legislation (SL) 460.32.

Although electric cars are not a new concept, they have undergone several technological advancements since their debut in the 1800s (von Brockdorff and Tanti, 2017). According to studies, there are several types of electric vehicles: plug-in electric vehicles (PHEVs), hybrid electric vehicles (HEVs), and battery electric vehicles (BEVs), Full-cell electric vehicles (FCEV), Extended-range electric vehicles (EREVs), and solar electric vehicles (SEVs) (Types of electric vehicles, 2023). Plug-in hybrid electric vehicles and hybrid electric vehicles use the internal combustion engine to charge the battery instead of requiring an external plug to do so. When talking about a battery electric vehicle, it is powered by a battery that uses high voltage batteries and is made from lithium-ion. On the other hand, the PHEV has to have a plug-in battery so as for it to be powered, while the hybrid electric vehicle is to be charged automatically, depending on the size and power of the engine. Moving on to the full-cell electric vehicles, these are powered by hydrogen fuel cells, which create zero emissions; the extended range electric vehicle has a battery pack and range

extender and also creates zero emissions, while the solar electric vehicles depend on sunlight conditions to be powered.

Thanks to a variety of technological advancements in batteries and motors, engineering and automotive pioneers on both sides of the Atlantic produced the first electric vehicles in the early 1800s (Anderson and Anderson, 2010). Then EVs were first presented to the market as a greener form of transportation in the late 1990s; however, several issues prevented their market from growing (He, Wu, Yin, & Guan, 2013). These issues included long charging periods, low costs for gas and diesel, battery performance and cost, and customer expectations. People were deterred from buying EVs due to inadequate and nonexistent infrastructure for charging access (Markel, 2010). One of the most significant turning moments was the introduction of the Toyota Prius in 1997. When the Prius was released in Japan, it became the first hybrid electric vehicle to be produced in large quantities worldwide.

At their previous company, Eberhard and Marc had already seen an increase in lithium-ion battery capacity when they launched Tesla Motors in 2003.

Numerous major automakers accelerated the development of their own electric vehicles as a result of Tesla's eventual success. With the introduction of the Nissan LEAF in 2010, Nissan increased the competition. In 2021, there was a notable surge in the use of electric vehicles, particularly in the form of passenger cars. This growth is shown by three empirical points.

1. The number of electric vehicles (EVs) on the road has skyrocketed; from a small number in 2010 to about one million in 2016, there could be as many as 26 million EVs worldwide by the end of 2022.
2. Tesla has surpassed conventional combustion engine automakers to become the most valuable automobile firm in the world, according to co-founder and CEO Elon Musk, who is currently the richest person on the globe.
3. EV sales reached a record-breaking 10.6 million in 2022, up 60% from the previous year. 2022 saw over 14% of cars sold worldwide be electric.

(Trends in electric light-duty vehicles – global EV outlook 2023 – analysis)

It is anticipated that the main automotive market would transition to electric vehicles by 2035. The International Energy Agency (IEA) projects that, excluding two- and three-wheelers, the entire fleet of electric vehicles (EVs) would rise from over 30 million in 2022 to around 240 million in 2030, suggesting an estimated growth rate of 30% yearly. The European Union has declared that starting in 2035, all newly sold automobiles must have zero emissions. Even though we cannot predict the future precisely, these trends

along with the steadily expanding infrastructure for EV charging and the high demand for EVs indicate that electric mobility has a promising future.

## **1.2 Aim**

The aim of this study is to present an in-depth risk assessment of the viability of adopting electric vehicles (EVs), looking at the various opportunities and difficulties that have shaped the state of the EV market today. Particularly, it focuses on important issues, including the financial effects of owning and maintaining an electric vehicle and the suitability of the infrastructure for their use in Malta. This study aims to provide comprehensive knowledge of the pros and cons in the electric vehicle market by combining data from a variety of sources, including policy studies, first-hand information, and expert opinion.

Upon the completion of the research on the feasibility of purchasing electric cars, it will deliver a thorough analysis that tackles important issues and provides useful insights into electric vehicle risks. In particular, I plan to address issues like the cost implications of electric vehicles and the adequacy of the current infrastructure in Malta.

The research intends to offer a comprehensive outlook of the existing financial and infrastructural risks associated with electric vehicles while also presenting

possible ways to increase the accessibility and attraction of electric automobiles to a wider range of consumers in Malta. The objective is to make a meaningful contribution to academic research and to provide a useful basis that assists in the accelerated transition to sustainable transportation. To this end, the study ought to be a useful tool for shaping future judgments and regulations concerning electric cars.

### **1.3 Objectives**

This research will explore the state of the infrastructure in Malta. Despite the growing popularity of electric vehicles in the coming future, the availability and accessibility of charging stations is a main problem, which therefore poses a significant hurdle for potential electric vehicle owners. Furthermore, buyers who are used to the quick refuelling intervals of petrol vehicles are put off by the current charging facilities, which require frequent shortcomings in terms of convenience and charging speed. Also, electric vehicles take quite a long time to charge, and because of this, chargers need to be in areas where people leave their cars parked for longer periods of time. Workplaces, residences, and apartments are desirable locales. In summary, refuelling internal combustion engine vehicles presents distinct issues when it comes to charging electric vehicles (Prakash, 2022). The research therefore aims to critically analyse this infrastructural shortfall, in which I will be looking at the implications on the

consumer decision-making process, and the broader transition from the combustion engines to the electric ones will be explored.

Finally, another aspect of this study is that of cost effectiveness of the running of an electric vehicle. The high initial cost of the electric vehicle, largely attributed to their expensive battery systems, remains a substantial barrier for many consumers. Studies found that the cost of a typical electric vehicle battery replacement could reach 10,000 euros or more, which is comparable to replacing a combustion engine in a conventional automobile (Autoweek, n.d.). Through an examination of both existing cost obstacles and projected future trends in battery pricing and performance, the study seeks to shed light on the financial impact of owning an electric vehicle in Malta, which is necessary for the market for electric vehicles to grow sustainably. To comprehend electric vehicles' total affordability and to suggest ways to increase their accessibility to a wider variety of consumers, this analysis is essential.

## **1.4 Research Questions:**

1. What are the key infrastructural challenges and opportunities for the widespread adoption of electric vehicles in Malta?
2. How cost-effective is the adoption of electric vehicles for consumers and the government in Malta compared to traditional internal combustion engine vehicles?
3. What are the perceptions and attitudes of Maltese consumers towards electric vehicles, and how do these influence the adoption rate?

## 1.5 Dissertation Structure

**Chapter 1:** The introduction begins with a general overview of electric vehicles, including their history, present state, and future directions. Additionally, the goal of this chapter is to clarify the philosophy and the parameters of the research that was done for this dissertation.

**Chapter 2:** The literature review looks at how feasible electric vehicles are right now, specifically in Malta, and the current state of the infrastructure.

**Chapter 3:** Methodology describes the procedures and approaches chosen in accordance with the initial purpose of this study. Interviews will be conducted with experts and policymakers to collect as much data as possible. When evaluating the environmental and cost aspects, tools such as the cost-benefit analysis for economic feasibility will be used.

To gather consumer opinions, attitudes, and behaviours related to electric cars, a diverse group of survey participants is necessary. This includes potential buyers, general consumers, and electric vehicle owners. I will also need insights from professionals working in the electric vehicle industry. I will require permissions for interviews within an organization from relevant authorities.

**Chapter 4:** In this chapter, the outcomes gathered from the results section are thoroughly examined. A discussion will be followed on the research findings and presented with extracts taken from the data that has been collected.

**Chapter 5:** Conclusion provides an end to this dissertation. This chapter hence summarizes the research findings and includes suggestions for policy adjustments, strategies for infrastructure development, and so on.

## **Chapter 2: Literature review**

The dissertation takes a look into various aspects of EVs, their charging infrastructure, and their cost-effectiveness. It talks about the current context of the EV's, its public charging infrastructure, and also considers the different costs of owning an EV, government subsidies and incentives, and any long-term benefits.

By presenting this comprehensive analysis, the purpose of this dissertation is to lay a strong foundation for knowledge about the existing status of the infrastructure for EV charging and associated costs with owning an EV.

### **2.1: Introduction**

The global trend towards sustainable transportation solutions has raised interest in electric vehicles (EVs) as a competitive alternative to traditional internal combustion engine (ICE) vehicles. Concerns about air pollution, climate change, and the depletion of fossil fuel supplies are what are causing this transition. Electric cars have become a crucial part of transport plans for the future as nations work to satisfy their environmental goals. But there are a lot of obstacles to overcome before EV adoption becomes widespread, especially in small island nations like Malta, where there are distinct infrastructure and topographical limitations. Given the possible revolution in personal mobility that

electric cars are bringing about, it is critical that we thoroughly review the vast amount of academic literature that has already been written on the subject.

This comprehensive approach ensures a holistic understanding of the electric vehicle landscape. Through a critical analysis and synthesis of these various sources, this literature review seeks to establish a solid foundation for the dissertation's later chapters. By doing this, it paves the way for a more thorough examination of the viability and ramifications of the adoption of electric vehicles, which is a topic of great importance in our search for ecologically friendly and sustainable transportation options.

The scope of this literature review is deliberately broad but focused, enclosing key areas that are critical to understanding the feasibility of electric vehicle adoption. It seeks to explore the feasibility of widespread electric vehicle adoption in Malta, focusing on two core areas: infrastructure readiness and cost-effectiveness.

First, the evaluation will look at the current infrastructure—such as grid capacity, charging stations, and any future upgrades—that is required to support EVs. The infrastructure needed to accommodate electric vehicles is as significant. A smooth transition depends critically on the quantity and accessibility of charging

stations, the strength of the national electrical infrastructure, and urban development issues. Sufficient infrastructure not only fulfils the pragmatic requirements of electric vehicle (EV) users, but also tackles the issue of range anxiety, which continues to be a major obstacle to adoption. Creating a dependable and easily accessible electric vehicle infrastructure poses a number of opportunities and challenges for a nation like Malta, given its distinct topography and urban features. Important considerations that must be made include how charging infrastructure will fit into the current urban fabric, how the electrical grid will be able to handle additional demand, and where charging stations should be placed.

The second aspect of the evaluation will deal with how cost-effective electric cars are, comparing the direct and indirect expenses of owning an EV to those of an internal combustion engine. Cost-effectiveness is a crucial factor that both customers and legislators must consider. Electric cars (EVs) can be more economically viable overall even though their initial cost is still greater than that of conventional internal combustion engine (ICE) vehicles due to many variables, including lower running costs and government subsidies. To properly evaluate the economic viability of EV adoption in Malta, one must have a thorough understanding of the total cost of ownership, which includes the original purchase price, fuel expenses, maintenance, and any prospective government subsidies. This part of the cost analysis process is critical because

it will decide the speed and scope of the transition based on the financial burden on customers and the government's economic consequences.

This analysis of the literature will examine previous investigations into the viability of EV adoption and the infrastructure needed for it, taking inspiration from worldwide developments and placing it in the context of the Maltese environment. Interviews with industry experts will add a practical perspective to the literature and enhance comprehension of the potential and challenges unique to Malta. This study intends to add to the conversation on the viability of adopting electric vehicles in Malta by looking at these factors and offering insightful information to customers, industry players, and policymakers. A thorough grasp of the external variables influencing the adoption of electric vehicles and their long-term viability as a cornerstone of sustainable transportation will be provided by this investigation into the legislative aspects.

## **2.2: Global and regional trends in EV adoption**

The first small-scale electric automobiles were produced in the 1820s and 1830s, and the history of electric vehicles (EVs) begins in the early 19th century. But EVs didn't start to get much notice as a competitive alternative to internal combustion engine (ICE) cars until the late 1990s and early 2000s.

Growing environmental concerns and breakthroughs in battery technology were the driving forces behind its comeback. In 1997, the Toyota Prius was released,

marking a significant turning point in the contemporary history of electric vehicles. It was the first hybrid car to be built in large quantities. The Prius' success opened the door for more innovation by proving that EVs are a viable commercial option (Anderson & Anderson, 2010).

The 2008 release of the Tesla Roadster, the first highway-legal electric car with a lithium-ion battery range of more than 200 miles on a single charge, by Tesla Motors completely changed the EV industry. Tesla's creative approach and clever marketing techniques had a big impact on how people saw EVs, elevating them to the status of luxury, sustainability, and cutting-edge technology. The transition to electric transportation was further solidified in 2010 with the introduction of the Nissan Leaf, the first mass-market all-electric car (Bohnsack, Pinkse & Kolk, 2014).

### **2.2.1: Current Global Market Overview**

Over the last ten years, there has been exponential growth in the worldwide EV market. The number of electric cars on the road worldwide climbed from barely 17,000 in 2010 to over 7.2 million in 2019, according to the International Energy Agency (IEA), with sales rising by 40% year over year in 2019 alone (IEA, 2020). Sales of electric vehicles (EVs) hit a record high in 2022, at 10.6 million units, or around 14% of all new car sales globally (IEA, 2023). A number of

variables, such as improvements in battery technology, falling battery prices, government subsidies, and tighter environmental laws meant to cut greenhouse gas emissions, are responsible for this growth.

With more than half of all electric car sales occurring there, China is currently the largest market worldwide. The nation has made significant investments in infrastructure for charging EVs, generous government subsidies, and pro-EV industrial policies. The US and Europe are other important markets; in recent years, Europe's EV sales growth rate has surpassed China's, thanks to strict emissions rules and generous subsidies offered by several European nations (BloombergNEF, 2022).

### **2.2.2: European Market Overview**

Because of its aggressive climate goals and dedication to lowering greenhouse gas emissions, the European Union (EU) has established itself as a pioneer in the shift to electric transportation. The EU's Green Deal intends to reduce transport emissions by 90% from 1990 levels by 2050, making Europe the first continent to achieve climate neutrality. The European Commission has suggested that as part of this program, all new cars sold from 2035 onwards be zero-emission vehicles (European Commission, 2020).

With the sale of over 1.4 million electric cars, Europe overtook China in 2020 as the region with the greatest market for electric vehicles. The EU's CO2 emission regulations, which penalise automakers if their fleet-wide emissions surpass certain thresholds, had a major role in this change. To comply with legislative requirements, numerous automakers have expanded their electric vehicle (EV) lineup and accelerated their manufacturing (IEA, 2021).

### **2.2.3: Implications for Malta**

In order to match its policies with more expansive European objectives, Malta has to have a thorough awareness of these regional and global trends.

Important lessons on the significance of favourable legislative frameworks, consumer incentives, and infrastructural investment to promote EV adoption can be learnt from the experiences of other European nations. Due to Malta's small size and distinct geographic features, there may be opportunities as well as problems for the deployment of EVs. As such, customised methods utilising knowledge from successful European models are required.

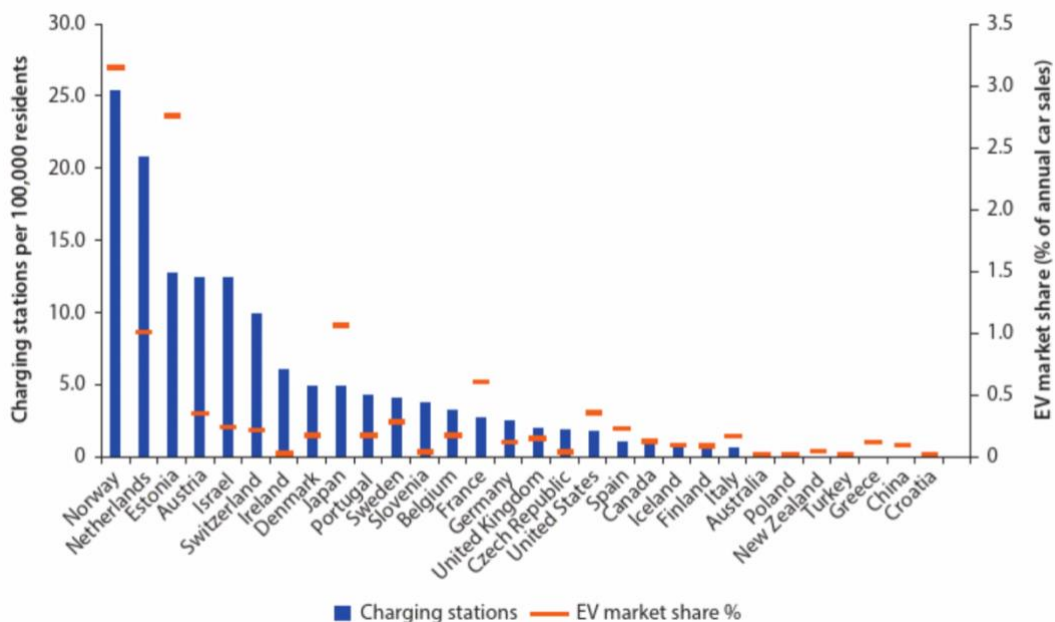
## **2.2.4: Infrastructure**

### **2.2.4.1: The importance of charging infrastructure**

From influencing customer choices to guaranteeing the operational dependability of EVs, charging infrastructure can be considered the spine of the EV ecosystem. The availability and accessibility of infrastructure for charging electric vehicles (EVs) is a crucial component that determines their success in being adopted. In contrast to internal combustion engine (ICE) cars, which can be refuelled at conveniently located petrol stations in a matter of minutes, electric vehicles (EVs) need a charging infrastructure that can accommodate different charging locations and speeds (World Bank, 2016). A common concern amongst the EV users is that of having “range anxiety,” meaning that users fear running out of their battery power and having no access to charging their vehicle. The number of charging stations worldwide up until 2022 had reached 1.3 million, according to the International Energy Agency (IEA, 2023).

There are typically two terminals or outlets for an electrical supply on both AC and DC charging stations. The majority of AC chargers have two points and can charge two cars at once. Although they usually have two outlets, DC chargers may normally charge a car in DC and another in AC. For both DC and AC charging outlets, there are particular power outlet connector specifications that must be followed (Government of Malta, 2022).

There are various kinds of infrastructure for charging, and it is divided into three stages: Level 1 is sluggish charging, and chargers are connected straight into a 120-volt AC outlet. This offers an EV range of approximately three to five miles per hour. It can take up to 40 to 50 hours to fully charge an electric vehicle (BEV) battery when it is empty, and 5 to 6 hours for a plug-in hybrid electric car (PHEV). The next level is that of Level 2, where the chargers operate at 208V in commercial applications or 240V in residential. This offers an EV range of around 18 to 25 miles per hour. A plug-in hybrid electric vehicle (PHEV) can take one to two hours to fully charge, whereas an empty BEV battery may take four to ten hours. Level 3 is the direct current fast charge, where it supplies between 50 and 350 KW of power (Charette, 2023).



**Figure 2.1: Correlation between number of charging stations and EV uptake per country Source: (Zhu et al., 2016)**

As shown in figure 1, a direct and positive relationship can be seen between the availability of charging stations and the consumption of EV's. One can see that in Ireland, the market share for Ev's is very low considering the number of charging stations; therefore, there exist differences in the data.

Because of its small size, dense population, and urban settlement layout, Malta has a unique requirement for a planned approach to charging infrastructure. Strategic placement of charging stations in high-traffic areas, like business zones, residential complexes, and near public transportation hubs, is necessary to ensure convenience and accessibility. Fast chargers can improve the usefulness of electric vehicles (EVs) for long-distance driving and increase their appeal to potential consumers by installing them at strategic locations.

#### **2.2.4.2: Grid Capacity**

The electrical system is under a great deal of additional strain as a result of the switch to electric automobiles (Brigham, 2023). Inadequate planning may cause the grid to become unstable due to the increasing demand, particularly during peak charging hours. Ensuring that the electrical grid can manage the extra load resulting from the widespread use of electric vehicles is a crucial aspect of infrastructure preparation. The demand for domestic electricity is predicted to rise by up to 18% by 2030 and 38% by 2035 starting in 2022, as said by

Princeton University. Princeton's data indicates that by 2035, the electricity consumption of light-duty vehicles which exclude large trucks and aircraft could climb by as much as 3,360% relative to current levels. So as for the grid capacity to be working accordingly, there need to be major changes. Such changes would be costly, but on the other hand, they will be effective.

The new Tesla Model 3 is an example of an electric vehicle that consumes quite a lot of electricity. When comparing it to home appliances, although with different variables, over the course of a year, the new Tesla Model 3 driver who travels the national average of roughly 14,000 miles per year would use roughly the same amount of electricity to charge their car at home as they would to run their electric water heater, and roughly ten times more than they would to power a brand-new, energy-efficient refrigerator (Brigham, 2023).

In 2023, for the first time, the National Grid ESO and Octopus Energy are conducting a demonstration in which electric vehicles are balancing supply and demand on the UK power grid (Latief, 2023). Incorporating renewable energy is essential to both meeting demand and ensuring that the shift to electric vehicles advances the larger objective of lowering carbon emissions (Mwasilu et al. 2014).

The Malta Resources Authority highlighted the significance of creating a smart grid capable of controlling the erratic nature of EV charging. By employing technologies like demand response and load control to avoid overloading during peak hours, smart grids can more efficiently balance supply and demand. Malta can promote a more sustainable EV ecosystem by optimising the use of existing electrical resources, minimising the need for expensive infrastructure extensions, and facilitating the integration of renewable energy sources through the implementation of a smart grid system (Malta Resources Authority, 2020).

Having a good charging infrastructure is the most important aspect while planning to enlarge the EVs on the road. The greatest number of EV users are probably going to be found in urban areas; therefore, constructing charging infrastructure there needs to be done carefully. In locations like retail malls, office buildings, apartment buildings, and public parking lots where people frequently leave their automobiles for extended periods of time, charging stations ought to be placed in an easy-to-access location (Globish et al., 2019).

Taking into consideration a country that has improved over time with EVs, is Iceland, where it has constructed a charging network that is highly efficient notwithstanding the fact that it is small in size and in a remote location. The Icelandic government has provided backing for the installation of charging

stations around the nation, guaranteeing that no area of the island is more than 100 km away from a charging station. This network serves as an example of how renewable energy may be included in the EV infrastructure because it is predominantly fuelled by the nation's substantial renewable energy resources, which are hydroelectric and geothermal power (Orkustofnun, 2021).

Another country that also implements EV infrastructure successfully is that of the Azores, which is an archipelago in Portugal. In order to guarantee that every island has sufficient charging infrastructure, the Azores have created a decentralised charging network. Furthermore, by using renewable energy to power these stations, the region has been able to lessen its need on imported fossil fuels, which is in line with its sustainability goals (Cristina Camus et al., 2012).

These illustrations show how crucial it is to build EV infrastructure in tiny island nations strategically, emphasising the integration of renewable energy sources, the placement of charging stations in strategic locations, and the use of public-private partnerships.

Malta's high population density and restricted land supply present unique issues. These limitations call for creative ways to incorporate infrastructure for

charging. One way to make effective use of available space is to integrate charging outlets with already-installed street infrastructure, including public parking meters or streetlights. Additionally, creating multipurpose public areas that double as EV charging stations and community hubs can improve user comfort and maximise land usage. Government agencies, business partners, and local communities must work together to plan cities effectively for EV infrastructure. Authorities must make sure that laws encourage the construction of infrastructure for EV charging and that EV users' needs are considered when planning new metropolitan areas. In order to accelerate adoption, public-private partnerships can leverage both public funding and private capital to finance and develop the charging network (Hall and Lutsey, 2017).

### **2.2.5: Cost-effectiveness Analysis**

The adoption rates of electric vehicles (EVs) are significantly influenced by their cost-effectiveness. Even though EVs are frequently linked to environmental advantages like lower emissions, customers' and governments' ability to afford them plays a significant role in the decision-making process. In order for EVs to be widely adopted, they need to be viewed as both economically viable for people and as a means for the state to establish a wider infrastructure. Comparing EVs to conventional internal combustion engine (ICE) vehicles, this section will examine the total cost of ownership of EVs, including

upfront prices, running expenses, battery replacement costs, and the influence of government incentives.

One important statistic used to evaluate the financial sustainability of electric vehicles is the total cost of ownership. TCO consists of the initial purchase price, ongoing expenses such as insurance, maintenance, and charging, and the vehicle's gradual depreciation. Even though EVs often cost more to buy at first than ICE cars, over time a number of variables balance these expenses. When comparing operating costs between the EV's and the ICE, the cost is lower for the EV's due to the lower price of electricity than the gasoline or diesel that the ICE's use. Palmer et al., (2018) stated that EV owners save around 25% of their maintenance costs compared to ICE vehicles. ICE vehicles require at least a yearly engine oil change, in which EV's do not require wear and tear components such as the brakes because EV's have a regenerative braking system. Moreover, consuming less fuel over the lifetime of an EV reduces the TCO because electricity is cheaper and more stable than gasoline or diesel.

Despite having low operational savings, EVs on the other hand, are expensive to purchase, and this can create a barrier for consumers. Having said that, the higher purchase price is because of the cost of the battery, which is the most

expensive component of the vehicle, and it accounts for between 30% and 50% of the total cost (Wu et al., 2015).

Taking Malta into consideration, for many prospective consumers, the initial cost of an electric car is still higher than that of an internal combustion engine ICE. There's a widespread belief that electric vehicles EVs are exclusively available to affluent people who can spare the upfront costs. Even though the initial cost is a barrier, it's important to look past the sticker price and consider the long-term cost reductions that electric vehicles can provide. Over time, EVs become more inexpensive because, in many circumstances, their lower operating expenses can balance their higher initial cost.

Fuel savings are one of the main benefits of electric vehicles over internal combustion engine automobiles. Nonetheless, it appears that most car buyers don't put much effort into weighing the fuel efficiency of various models when making their selection (Lane, B., and Banks, N., 2010). Depending on energy rates, EVs typically use 15 to 30 kWh of electricity every 100 kilometres, which is a substantial savings over fuelling an ICE car (Transport Malta., 2022).

EVs' lower total cost of ownership is also largely due to their decreased maintenance expenses. Compared to ICE vehicles, EV's have fewer moving

parts, which lowers the risk of mechanical failure and the requirement for routine maintenance. The traditional vehicles require oil changes, coolant refills, transmission repairs, and any other related maintenance that does not apply to the EVs. The average maintenance cost of an EV is 30% less than that of an ICE vehicle, as shown by the U.S. Department of Energy (2020).

Insurance is another cost that can influence the TCO of an EV. Because of their greater initial cost of purchase and the expense of replacing or repairing batteries, electric cars EVs sometimes have higher insurance premiums than ICE vehicles in many markets. These costs should drop, though, as EVs gain popularity and insurance providers modify their risk estimates. Unknown hazards and exposures, such as those associated with EVs, will enter the market with new technology and may not be present with ICE vehicles (Dobie and Whitehead, 2020). Consequently, insurance firms ought to be alert to any potential risks that electric vehicles may pose so that they can respond appropriately.

Moreover, EV's are also subject to any vandalism and theft, like other vehicles. As a result, anyone considering getting an EV insurance policy should find out from the insurance provider whether or not specific EV features are covered (Henshaw, 2021). Gao et al. (2015) and Jones et al. (2020) acknowledged the

risk of vandalism and theft as well, but they also suggested that wireless charging stations in public areas could aid in reducing the issue.

The depreciation of a vehicle is another component of the cost effectiveness.

The depreciation of a vehicle is defined as the value loss of the vehicle over time. Due mostly to worries about battery life and technological obsolescence, EVs have historically tended to lose value far more quickly than gasoline-powered vehicles. The value of electric automobiles has increased due to advancements in battery technology, expansion of public charging infrastructure, and greater consumer acceptability. Therefore, the disparity is getting closer (Pod Point, 2024). There are certain factors that affect the depreciation of an electric vehicle, and these include the mileage of the vehicle, where a higher mileage leads to a lower value and also more wear and tear. Its also the brand and model, where due to their reputation for high quality, dependability, and longevity, some brands and models may see a rise in demand and customer willingness to pay. The battery's health also affects depreciation; if the battery has a high capacity, it means it can hold its charge well, and this is important for an EV.

The depreciation of EVs may be impacted by regional circumstances, such as the availability of reasonably priced battery replacements and the demand for pre-owned electric vehicles in Malta, where the market for used cars is very limited. The possible implementation of new laws limiting the sale of ICE

automobiles in the future is another aspect of depreciation to consider. The value of ICE vehicles may decrease more quickly as the European Union draws closer to its objective of outlawing the sale of new ICE vehicles by 2035, whereas EVs may hold their value better due to rising demand and governmental backing (Cardino., 2023).

The future of EVs is being swiftly shaped by technological developments, which are also helping to lower the TCO and increase customer interest in EVs. The most significant developments are taking place in the areas of battery technology, charging infrastructure, and vehicle design. These areas all help to lower prices, increase vehicle longevity, and improve performance. Lithium-ion battery packs were around \$1,100 per kilowatt-hour (kWh) in 2010; by 2021, however, the price had dropped by more than 90%, according to BloombergNEF (2023). The initial cost of ownership for electric cars (EVs) is anticipated to drop in tandem with the ongoing decline in battery prices, hence increasing their cost competitiveness with ICE vehicles.

Improvements in battery energy density, or the quantity of energy stored per unit of weight, have allowed EV's to attain longer driving ranges in addition to cost savings. For instance, the high-energy-density batteries in the Tesla Model S Long Range allow it to achieve a range of more than 600 kilometres on a

single charge (Tesla, 2023). Increased range improves the usability and appeal of EVs by reducing "range anxiety," a prevalent worry among prospective EV purchasers.

Improvements in the infrastructure for charging EVs are essential for increasing their overall cost-effectiveness and convenience, in addition to advances in battery technology. EVs are now more feasible for daily use and long-distance driving because of the advancement of fast-charging technologies, which have drastically shortened the time needed to charge an EV. Some EVs may now be charged to 80% of their battery capacity in as little as 20 to 30 minutes thanks to DC fast chargers, also known as Level 3 chargers, which can currently provide up to 350 kW of power (Melton et al., 2016). For instance, using a 270 kW fast-charging station, the Porsche Taycan, which has an 800-volt design, can charge from 5% to 80% in just over 20 minutes (Porsche, 2023).

Another type of charging is that of the wireless charging technology. When an electric vehicle is parked over a charging pad, it can immediately charge thanks to wireless or inductive charging, which does away with the need for physical connectors and connections. Autonomous vehicles are an example where wireless charging can be used. An autonomous car that needs to be plugged in for human charging makes no sense, better yet would be an autonomous car

that parked itself on a wireless EV charging station, in line with the efficiency and automation that autonomous cars are supposed to bring to the automotive sector (While, C., 2023). Though it is still in its early phases of commercialisation, this technology has the potential to streamline the charging procedure and boost EV adoption in metropolitan areas where setting up conventional charging infrastructure may be challenging (Jang, 2018).

The incorporation of vehicle-to-grid technology, which enables EVs to discharge electricity back into the grid, is another significant advancement in charging infrastructure. With the use of this technology, power supply and demand may be more evenly distributed, particularly during peak hours. EV owners can also receive financial rewards for returning excess energy from their cars to the grid (Sovacool et al., 2017).

Advances in vehicle design and efficiency also attract the cost-effectiveness of EVs. To increase the efficiency of electric vehicles and increase their range, automakers are putting more emphasis on energy-efficient drivetrains, lightweight materials, and aerodynamic designs (Stevic and Radovanovic, 2012). For instance, a lot of contemporary EVs are built from lightweight materials like carbon fibre and aluminium, which lowers the vehicle's overall weight and increases energy efficiency. Because EVs are lighter, they can go

farther between charges, which minimises the need for frequent charging and cuts operating expenses for owners (Wu et al., 2015).

Speaking about advancements of Ev's, another factor is the regenerative braking system. (S Vasiljević et al., 2022) stated that Depending on the driving circumstances, regenerative braking can increase an electric vehicle's range by up to 30% by turning kinetic energy back into electrical energy. Additionally, this technology lessens brake deterioration, which lowers maintenance expenses throughout the course of the vehicle's lifetime.

These technological developments are especially important in Malta, where there are government incentives for EV purchases and fuel prices are high. Switching to an electric car makes financial sense more and more as fast-charging infrastructure is developed and battery prices continue to decline. Long-distance or frequent drivers can benefit from fuel savings that alone can outweigh the greater initial cost of ownership, and further benefits include, longer vehicle lifespan and reduced maintenance costs.

## **2.3: EU Policies, directives, and incentives for the adoption of electric vehicles**

### **2.3.1: Introduction**

As transport contributes over 25% of Europe's greenhouse gas emissions, increasing e-mobility is essential to meeting climate targets. The infrastructure for charging must be in line with the new objectives. The European Union persistently and energetically supports initiatives that can potentially lead to an increase in the adoption of electric vehicle which leads to decarbonization and the reduction of carbon pollutants in areas. As a result, reducing the number of internal combustion engine (ICE) vehicles on the road and deploying electric vehicles are potential answers for a better, more sustainable future. Hence, with the introduction of more electric vehicles, there is the need for a proper infrastructure system, reducing initial and battery costs of vehicles, and maintaining the environment.

Consequently, new policies and initiatives were implemented by the European Commission, which mainly aims at making the European Union achieve climate neutrality by 2050. Launched in 2019, there is the European Green Deal. This is a collection of legislative measures to put the European Union on the road to a greener transition. It highlights the need for a comprehensive, cross-sectoral approach where all relevant policy areas contribute to the ultimate climate-

related goal. The package includes initiatives in the closely related fields of energy, transportation, industry, agriculture, climate change, environment, and sustainable financing. It also specifies how Europe will pay for this deployment and distribution.

### **2.3.2: Policies and Directives**

Research indicates that by 2030, lower CO<sub>2</sub> emission performance standards will be implemented. Passenger cars and vans, also referred to as "light commercial vehicles," are responsible for between 12% and 2.5% of the EU's total carbon dioxide (CO<sub>2</sub>) emissions. The main greenhouse gas is CO<sub>2</sub>.

Since 2020, there have been new regulations on stricter CO<sub>2</sub> emissions. In fact, the new cars that were being registered between 2019 and 2020 show that their emissions were reduced by 12% and moreover by 12.5% between the years of 2020 and 2021. Targets to reduce CO<sub>2</sub> emissions from automobiles by 55% and vans by 50% by 2030 have been proposed recently. As part of the 'Fit for 55' legislation plans, it also suggests fully eliminating emissions from brand-new automobiles and vans by 2035. It will take a large increase in the adoption of electric vehicles to meet these objectives.

Additionally, on April 19, 2023, the European Parliament and Council strengthened the CO<sub>2</sub> emission performance standards for new passenger cars and new light commercial vehicles by adopting Regulation (EU) 2023/851, which amends Regulation (EU) 2019/631. This action is consistent with the increased climate ambition of the European Union.

### **2.3.3: Incentives**

The EU is taking a holistic strategy to promote the adoption of electric vehicles (EVs), combining financial incentives with environmental goals to establish an environment that is favourable to EV use. The objective of this chapter is to analyse and comprehend the variety of EU-implemented incentives that have been crucial in pushing the area to the forefront of the electric vehicle revolution.

The EU has a wide range of policies, from tax breaks and financial subsidies to big infrastructure projects that improve charging network accessibility and lower consumer costs. Furthermore, the strict pollution standards and restrictions set by the EU created a strong precedent that forced automakers to innovate and embrace electric technologies. These incentives highlight the EU's commitment to cutting carbon emissions and switching to a sustainable transport paradigm,

and they are presented within the larger framework of the European Green Deal.

Starting with the first incentive, the registration tax benefits. This includes those zero-emission cars being purchased, and hence these are exempt from paying any registration taxes. Comparing this to the other vehicles, such as the internal combusted engines, the system is different, with registration taxes paid on the different levels of CO<sub>2</sub> emissions. Moving on, the European Union included the ownership tax benefits, where until 2023 there will be no road tax for the fully electric vehicles and a 50% reduction on the tax for the plug-in hybrids.

Company tax benefits are also included, where the rate for petrol cars is that of 22% and for battery electric cars it was of 4%, which then increased to 16% in 2022, and currently it is still the same. There are also incentives, such as the purchase subsidies, where in 2023 the funding rate was that of 2,950 euros for a new battery electric vehicle.

## **Chapter 3: Methodology**

### **3.1: Introduction**

This chapter offers an overview of the methodology applied in this investigation, including the justification for the research questions posed, the research design employed, the technique for gathering data, any underlying ethical issues, and the study's limits. To achieve this, a qualitative approach was adopted. This methodology facilitates a comprehensive analysis of the research questions.

Interviews with important stakeholders were conducted as part of the study's qualitative component in order to provide in-depth, context-specific insights. The purpose of these interviews was to get professional comments on the infrastructure for EVs as it stands now, future obstacles to overcome, and possible legislative initiatives to encourage EV adoption. The interview also addresses the cost-effectiveness of EVs compared to traditional internal combustion engine vehicles.

The research design, data collection techniques, sample strategy, data analysis, and ethical issues are the elements that make up the methodology chapter. Every section offers comprehensive details on the study methodology and the reasoning behind the chosen approaches.

### **3.2: Research design**

A researcher must select between two primary methods when studying a given subject: qualitative or quantitative. When using a qualitative approach, non-numerical data must be gathered. This kind of method explores the lived experiences and perspectives of the research participants, offering insightful information on the subject matter. This approach's flexibility in the data collection stage is one of its advantages. It enables responders to generate original thoughts and concepts, which may further knowledge of the subject matter. There are also constraints to qualitative data, which include the small sample size of the participants. Having a small number of participants can make it hard to draw conclusions from the participant's perceptions (Surendran, 2018).

On the other hand, a quantitative approach puts the emphasis on numerical data. Quantitative analysis includes a large number of participants therefore a larger sample size. The researcher can test theories and draw conclusions from the data gathered by using this methodology. However, this method might not accurately represent real-life experiences because it depends so much on numerical data. Furthermore, because each researcher has a different interpretation and set of presumptions, their interpretation of the data may be biased, just like in quantitative research (Surendran, 2018b).

The research design used in this study is qualitative, which is appropriate for examining intricate social phenomena like the uptake of electric cars. The qualitative technique offers deep, contextual insights into participants' viewpoints, experiences, and attitudes, in contrast to quantitative methods, which concentrate on numerical data. Given that a variety of factors, such as governmental frameworks, consumer attitudes, and infrastructure constraints, impact the adoption of electric vehicles in Malta, this approach allows the researcher to collect detailed data that may not be obtained by quantitative surveys or secondary data analysis.

Semi-structured interviews were selected as the primary data collection method. Semi-structured interviews offer a defined framework to guarantee that important subjects are covered while allowing for flexibility in examining participants' points of view. This approach makes it possible for the interviewer to clarify comments, delve deeper into particular topics, and ask follow-up questions. It is especially crucial when talking about complicated topics like EV infrastructure and cost considerations.

This study's qualitative methodology is intended to successfully address its research questions, especially those pertaining to the obstacles to EV adoption that are related to cost and infrastructural issues. A thorough evaluation of the

viability of the adoption of electric vehicles in Malta is made possible by the combination of consumer views and professional insights.

### **3.3: Data Collection**

A range of stakeholders were interviewed in a semi-structured manner, including policymakers, insurance companies, EV importers, and electric vehicle buyers. The way in which these groups are chosen guarantees a wide range of perspectives, representing the opinions of people in charge of establishing EV regulations, those engaged in putting EV infrastructure into place, and individuals who already own an electric vehicle.

The interview questions were designed in a way to cover the main themes of the research, which include:

**Infrastructure:** The existing and future status of EV charging infrastructure, the ability of Malta's electrical grid to accommodate EVs, and the difficulties of growing EV charging networks in Malta were presented in the questions.

**Cost-effectiveness:** Interviewees were asked about the economic viability of EVs for both consumers and the government and private. This included

discussions on government incentives, any long-term savings from purchasing EVs, cost-related barriers, and the TCO of EVs.

Public perception and policy: enquiries focused on the attitudes of Maltese customers towards EVs, and the part played by policy in encouraging EV uptake. The purpose of the interview was to investigate how perceptions about EVs may affect their adoption.

Every interview was performed in person or over video conference, based on the interviewee's availability and preference, and lasted roughly 45 minutes each. With the participants' permission, the interviews were taped, and the transcripts were then transcribed for analysis.

### **3.4: Sampling Strategy**

Purposive sampling is a non-probability sampling method in which participants are chosen according to particular traits or standards pertinent to the study subject (Patton, 2014). This technique is frequently applied in qualitative research to guarantee that the individuals selected have firsthand knowledge or experience relevant to the study topics under investigation. Purposive sampling, for instance, might involve choosing legislators, vehicle importers, and EV users for a study looking at the viability of EV adoption because these groups are most likely to provide insightful information about the opportunities and difficulties related to EV adoption.

Interview subjects were chosen using a purposive sampling technique, which made sure that only those with specialised expertise and experience pertinent to the study's subject matter were included. Because participants in this method were chosen based on their direct involvement in infrastructure construction, policy formulation related to electric vehicles (EVs), or decision-making processes as potential consumers, the data collected would be comprehensive and valuable.

The sample for this study consisted of eight participants, and it was divided into three main categories: industry experts, EV users, and government officials. While the sample size of eight interviewees might seem small, qualitative research frequently prioritises depth over breadth and aims to achieve data saturation over statistical generalisation.

After interviewing the eight participants, saturation had been reached. This means that no new information has been collected. The eight interviews were conducted and analysed, and it was evident that all of the major themes—infrastructure preparation, cost-effectiveness, and public perceptions—had already been fully addressed. The final interviews did not yield any particularly noteworthy new revelations. Saturation guaranteed that the major concerns related to EV adoption in Malta were thoroughly addressed and that there was

enough data gathered to meet the research questions. The study ensured a strong grasp of the subject while adhering to the qualitative research premise of obtaining rich, in-depth insights by concentrating on this idea of saturation.

### **3.5: Data Analysis**

#### **3.5.1: Transcriptions**

In qualitative research, transcribing plays a critical role in the analysis of the data obtained (Poland, 2003). In this study, the transcription process involved listening to all eight interviews and then transcribing them verbatim. During this process, the researcher has to maintain transparency and make sure that the results are based on the collected data.

#### **3.5.2: Thematic Analysis**

A thematic analysis technique was employed in the examination of the interview data. A qualitative technique for finding, examining, and summarising patterns (themes) in data is thematic analysis. This method was selected because it offers a formal framework for data organisation but also permits flexibility in the analysis of the interview content. For this study, the researcher has gone through the process of five steps in thematic analysis.

- (i) Data Familiarisation: transcribing, reading information more than once to gain insights, and identifying themes raised by participants.
- (ii) Coding: labelling portions of the text that relate to specific themes or ideas. This is crucial for organising data.
- (iii) Identify themes: grouping similar codes into broader themes. For example, codes related to “lack of charging stations” or “grid capacity issues” were amalgamated into “infrastructure”.
- (iv) Reviewing themes: Initial themes were reviewed to ensure that they accurately represented the data.
- (v) Interpreting data: The researcher interpreted the themes with regards to the research questions and literature. This is then grouped to present a final report based on Braun and Clarke (2006).

### **3.6: Ethical considerations**

Strict ethical rules were adhered to during the study to guarantee participant confidentiality and wellbeing. An informed consent form outlining the study's objectives, the voluntary nature of participation, and the participants' right to withdraw at any moment without consequence was given to each participant before the interview. Participants received guarantees that the information they provided would be kept private and that any personally identifiable details would be removed from the final report.

The ethical norms of the University of Malta were also adhered to during the research procedure, which included getting permission from the appropriate ethical review board prior to conducting interviews. Because public policy and infrastructure development are delicate topics, great effort was taken to make sure participants could express their honest ideas without worrying about the consequences.

### **3.7: Limitations of the study**

It is crucial to recognise the limitations of the qualitative technique, despite the fact that it offers deep, comprehensive insights. Initially, the results of the study are derived from a somewhat limited participant sample, which would restrict how broadly the findings can be applied. The opinions revealed in the interviews might not be representative of the general community, even if purposeful sampling was utilised to choose participants with pertinent experience.

The study lacks a quantitative evaluation of the viability of EV adoption due to its emphasis on qualitative interviews. Although the thematic analysis reflects the ideas and viewpoints of stakeholders, it does not provide quantitative information regarding the infrastructural readiness or cost-effectiveness of electric vehicles in Malta. A mixed-methods approach could be useful in future studies to provide a more thorough assessment.

### **3.8: Conclusion**

This study's methodology makes it possible to thoroughly examine the variables impacting Malta's adoption of electric vehicles. The study's qualitative methodology allows for the collection of in-depth views from important stakeholders, resulting in a comprehensive picture of the potential and problems related to EV adoption. While accepting the limits of the qualitative method, the thematic analysis of the interview data adds significantly to the academic and practical understanding of the infrastructure and cost-related concerns surrounding EVs.

## **Chapter 4: Analysis and Results**

### **4.1: Introduction**

The examination and findings of the qualitative data gathered from key stakeholder interviews (which included vehicle importers, insurance companies, and owners of EVs) are presented in this chapter. This analysis aims to give a comprehensive overview of the current situation regarding the adoption of electric vehicles in Malta, with particular attention to infrastructure readiness, cost-effectiveness, and the potential and problems associated with increasing EV use throughout the nation. An in-depth analysis is conducted on the data gathered by the researcher from a total of 8 interviews.

The aim of this analysis is to answer the following research questions:

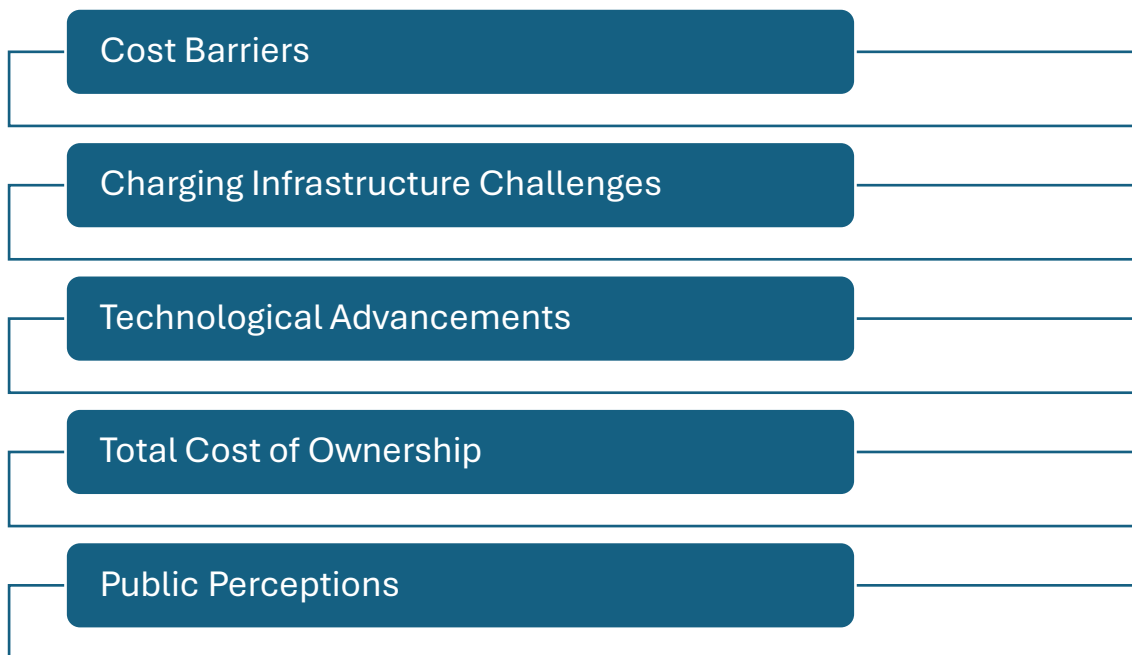
1. What are the key infrastructural challenges and opportunities for the widespread adoption of electric vehicles in Malta?
2. How cost-effective is the adoption of electric vehicles for consumers and the government in Malta compared to traditional internal combustion engine vehicles?
3. What are the perceptions and attitudes of Maltese consumers towards electric vehicles, and how do these influence the adoption rate?

## **4.2: Thematic Analysis Approach**

The principal technique utilised for examining the qualitative information gathered from interviews was thematic analysis. This method was chosen because it is adaptable and can offer an in-depth understanding of intricate themes that surface from the responses of the participants.

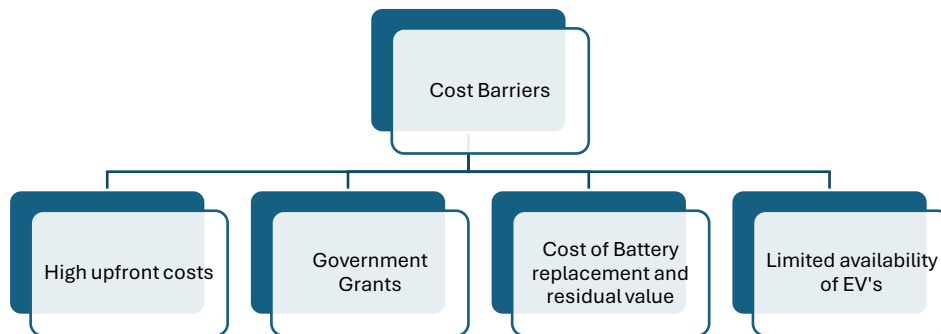
Data familiarisation was the first step in the procedure, during which the researcher carefully went through the transcripts of the interviews to obtain a general understanding of the subject matter. The next step involved coding, which involved identifying and labelling particular words, phrases, and concepts related to the research topics. Following the first round of coding, the researcher proceeded to identify themes by classifying related codes into more general categories (Braun and Clarke, 2013).

To make sure the themes adequately reflected the important trends in the data, these were then examined and adapted. The researcher connected the interview results to the more general study questions in the last stage by interpreting and contextualising the themes.



*Figure 4.1: Main Themes representing the main themes that were created using codes from the interview responses (created by author, 2024)*

### 4.3: Cost Barriers



*Figure 4.2: Cost Barriers (created by author, 2024)*

As seen in figure 3, the first main theme pinpointed is that of cost barriers. Sub-themes emerged from this theme include the high upfront costs, government grants, cost of battery replacement and residual value, and the limited availability of EVs. The most prominent issue that came out of the interviews was the high-cost obstacles to Malta's adoption of EVs. Participants highlighted a number of cost issues that discourage people from buying electric vehicles. Even if there is a growing interest in electric cars worldwide, pricing is still a major deciding factor for local consumers.

### **4.3.1: High Upfront Costs**

High upfront costs of purchasing an electric vehicle were one of the main issues mentioned. Most of the interviewees stated that compared to the ICE vehicles, EVs are costly to purchase for a large portion of the Maltese population. One participant stated that "the majority of consumers are put off by the higher purchase price of EVs, even with government incentives in place". Although the government offers grants when purchasing EV's, and these help to reduce the initial purchase price, it is still not enough to bridge the gap between the ICE and EV vehicles. Another participant who is an industry expert, pointed out that "the price gap is still a major issue. Even with the grants available, people still find EVs too expensive". This remark underscores a widespread belief held by Maltese customers, namely that the cost of switching to electric vehicles is still too expensive to be justified.

From the perspective of another participant, an insurer, explained that "With EV's we do not know exactly what the residual value would be because we do not have enough of them". Because of these limitations, manufacturers are unable to produce EV cars at more competitive prices, which makes it harder for typical consumers to find reasonably priced solutions. The ultimate price that customers pay is further increased by the importation expenses related to bringing specific models to Malta.

Additionally, consumers are hesitant to commit to such a large upfront cost, particularly if they are not aware of the long-term advantages of electric vehicles. An EV owner voiced his concern "I know that EVs are supposed to save you money in the long run, but when you're standing in the dealership and you see the price tag, it's hard to think about fuel savings years down the road".

The small selection of reasonably priced EV cars in Malta is another factor driving up the price barrier. An industry expert stated, "Most EV models in Malta are either luxury or higher-end models, and there are few options for those who want a cheaper alternative." Having said this, consumers therefore need to either purchase another traditional vehicle or wait for another affordable model to enter the market. According to the interviews, many Maltese customers will continue to consider EVs as being out of reach financially unless there is a wider range of EV models available at various price points, especially in the lower-cost category.

Interviewees contended that although government incentives like tax breaks and rebates offer some respite, they are not enough to narrow the gap between EVs and ICE cars. Another expert argued that these rebates are insufficient to narrow the gap between the ICE and EVs. "The rebates are helpful, but when you're still paying €5,000 to €10,000 more upfront, the incentives don't seem like enough."

### **4.3.2: Battery replacement costs and residual value**

Another point raised by the interviewees was the potential cost of the battery replacement. Although they are among the most expensive parts of the car, EV batteries only last so long until they die. However, new technologies are making this longer possible. According to the participants, a lot of customers are afraid of the potential expense of changing an EV battery, which can run anywhere from €5,000 to €10,000, depending on the model. An expert commented, "Battery costs are a major sticking point for consumers. They're worried that, once the warranty period expires, they'll be faced with an expensive replacement."

Warranty is usually given on batteries, but some consumers are still cautious, especially here in Malta, where the replacement parts are limited. Customers' confidence is severely hampered by the perceived risk and expense of replacing a battery, particularly if they consider their car to be a long-term investment.

As raised by one participant, the residual value of an EV is still quite unknown because of lack of data. Therefore, any potential buyers will be worried to invest, as one may fear that their vehicle loses value faster than anticipated. He said that with EVs, we do not know exactly what the residual value would be

because we do not have enough of them in the market to track how they depreciate over time, especially as battery technology evolves."

### **4.3.3: Limited availability of EVs**

A pertinent concern brought up by multiple interviewees is Malta's restricted supply of electric vehicle models. Numerous respondents observed that the Maltese market is devoid of a broad selection of reasonably priced electric cars, with the majority of choices leaning towards more expensive models. The limited variety of models offered limits the options available to consumers, especially those looking for more affordable options. As one participant said, "The EV market in Malta is still in its infancy, and we simply don't have enough variety for consumers to feel comfortable making the switch".

Respondents proposed that broadening the range of models and promoting more reasonably priced EV imports could mitigate some of these pricing issues; however, these initiatives would necessitate more robust collaborations between foreign manufacturers and the government.

### **4.3.4: Government Grants**

Although the financial hardship of buying an EV was acknowledged to be lessened by government incentives, the majority of interviewees said that these

incentives were insufficient to lower the average consumer's cost of ownership. Adoption is aided by the current incentives, which are restricted in scope and include rebates, tax reductions, and exemptions from road taxes. One industry expert explained, "The incentives are good, but they only go so far. For many buyers, especially those in lower-income brackets, the cost is still prohibitive." In order to further lower the total cost of ownership, interviewees also recommended that the government consider offering incentives for things other than buying cars, such as funding for installing home charging stations.

#### 4.4: Charging infrastructure Challenges

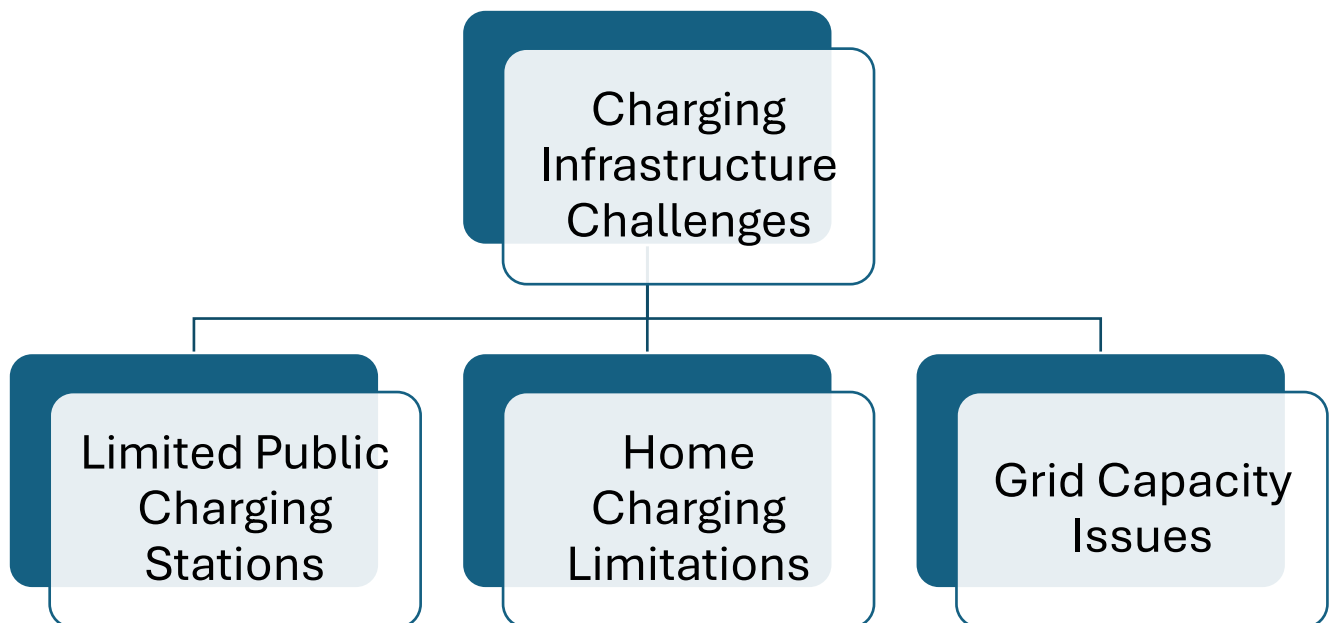


Figure 4.3: Charging Infrastructure Challenges (created by author, 2024)

Every interviewee from legislators to vehicle importers voiced worries regarding the inadequate nationwide charging infrastructure. This theme draws attention to a variety of important difficulties, such as the scarcity of public charging stations, restrictions on home charging, and grid capacity problems.

#### **4.4.1: Limited Public Charging**

The scarcity of public charging stations was mentioned by interviewees as one of the main issues. Malta has made some progress in setting up public EV chargers, but many still believe that the present infrastructure is insufficient to encourage the broad use of EVs. A participant remarked, "The number of public charging stations is simply not enough to handle the growing demand. EV owners often struggle to find available chargers, especially in more remote areas". In addition to reducing the ease of owning an EV, this scarcity exacerbates range anxiety, a persistent problem where prospective purchasers fear running out of gas without access to a charging station.

The unequal distribution of charging stations—the majority of which are now found in urban areas was another issue brought up in the interviews. We need a more widespread network that covers all parts of the country, not just the main cities. Otherwise, people will continue to see EVs as impractical for long-distance travel," said another participant.

#### **4.4.2: Home Charging Limitations**

The difficulty of home charging was another important issue that surfaced from the interviews, especially for people living in metropolitan areas without access to garages or private parking. An expert in EV infrastructure stated, "In Malta, many people live in apartments or townhouses with no dedicated parking space, which makes it difficult to install home chargers." Residents in high-density locations where on-street parking is frequent are disproportionately affected by this issue, which forces them to rely on public charging, which is already scarce.

#### **4.4.3: Grid Capacity Issues**

Interviewees expressed worries regarding grid capacity in addition to the difficulties associated with the actual infrastructure for charging. Concerns have been raised over whether Malta's meagre and remote electrical system can support the additional load that comes with a broad adoption of electric vehicles. Another industry expert, explained, "If we're going to have more electric vehicles on the roads, we need to ensure that our grid can cope with the additional load. Otherwise, we'll run into serious issues with power shortages or blackouts."

Another respondent expressed similar concerns, pointing out that peak demand periods, like the nights when most people get home and charge their cars, could significantly tax the system. It's possible that the grid won't be able to handle many EVs charging at once without adequate planning and modifications. In order to better control energy distribution and avoid overloading, the respondents stressed the significance of smart grid integration and grid modernisation.

An infrastructure planner, mentioned, "There's definitely movement in the right direction. We're seeing more investment in fast chargers, especially in key locations like shopping malls and transport hubs." Faster chargers are also needed, according to a number of respondents. One example is the DC fast charger, which can charge a car to 80% capacity in around 30 minutes. Long-distance travellers or those without access to home chargers would especially benefit from these.

Furthermore, the incorporation of sustainable energy sources into the infrastructure for charging was suggested as a possible long-term resolution to grid capacity issues and sustainability objectives. A sustainability advocate, suggested, "By incorporating solar-powered charging stations, we can reduce the strain on the grid and make EVs even more environmentally friendly."

## 4.5: Technological Advancements

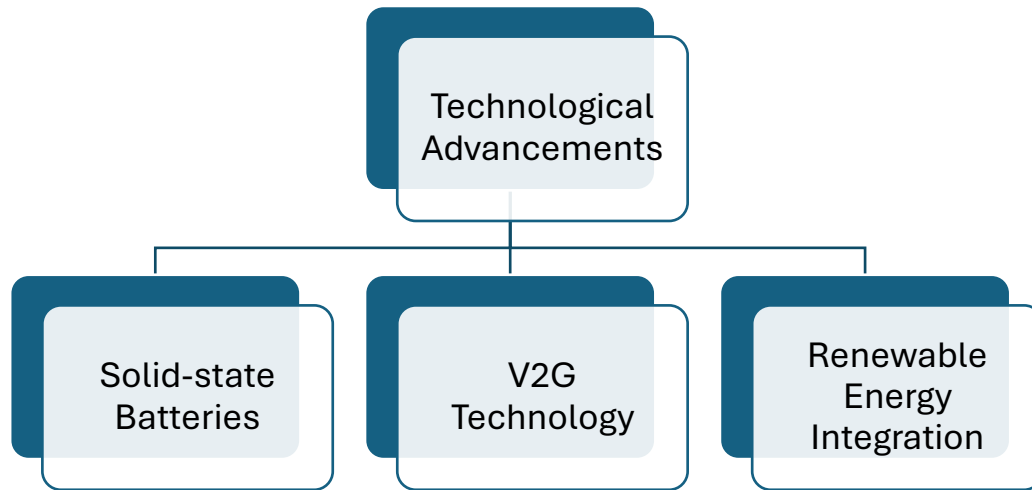


Figure 4.4- Technological Advancements (created by author, 2024)

Respondents repeatedly emphasised the significance of technological advancements that may decrease expenses, increase car range, and allay worries about battery life. This theme examines how important technological developments, including solid-state batteries, V2G technologies, and the incorporation of renewable energy might promote the wider use of EVs in Malta.

### 4.5.1: Solid-state Batteries

The creation of solid-state batteries was mentioned by interviewees as one of the most promising technological developments. Solid-state batteries, as opposed to traditional lithium-ion batteries, employ a solid electrolyte, enabling higher energy density, longer lifespans, and improved safety. Though it is still in

the early stages of research, this technology has the potential to revolutionise the EV industry very soon.

An industry expert emphasized the potential of solid-state batteries to address concerns related to battery degradation and replacement costs. He stated, "Solid-state batteries could revolutionize the EV market by providing longer-lasting batteries that don't degrade as quickly as current lithium-ion batteries." One of the main concerns for prospective EV purchasers in Malta would be decreased, with the help of this innovation, the frequency and expense of battery changes. In addition, solid-state batteries' higher energy density promises to boost vehicle range, which will help consumers who are hesitant to convert to electric vehicles by reducing their range anxiety.

Several interviewees noted that the adoption of solid-state batteries could significantly reduce the overall cost of electric vehicles in the long run. "Once solid-state batteries become commercially viable, we could see the price of EVs drop substantially," one participant explained, indicating that technological advancements could help overcome the current cost barriers associated with electric vehicles.

### **4.5.2: Vehicle-to-Grid Technology**

An infrastructure expert, explained "V2G technology could help alleviate some of the pressure on Malta's grid by turning EVs into mobile energy storage units." With the use of V2G technology, EV owners would be able to resell their extra energy to the grid, giving customers a financial incentive and enhancing the resilience of the grid as a whole. As more EVs are embraced, some respondents pointed out that this technology might be extremely important in lessening the load on Malta's rather small and remote electrical system. Another participant added, "If we can implement V2G technology alongside smart grid systems, EVs could become an integral part of Malta's energy solution, rather than a burden on the grid."

Interviewees did concede, though, that infrastructural improvements would be required in order for Malta to fully benefit from V2G technology. "We need a smarter grid that can handle the bi-directional flow of energy and manage demand more effectively," pointing out that the current electrical grid would need to be updated, and substantial expenditure would be needed for this.

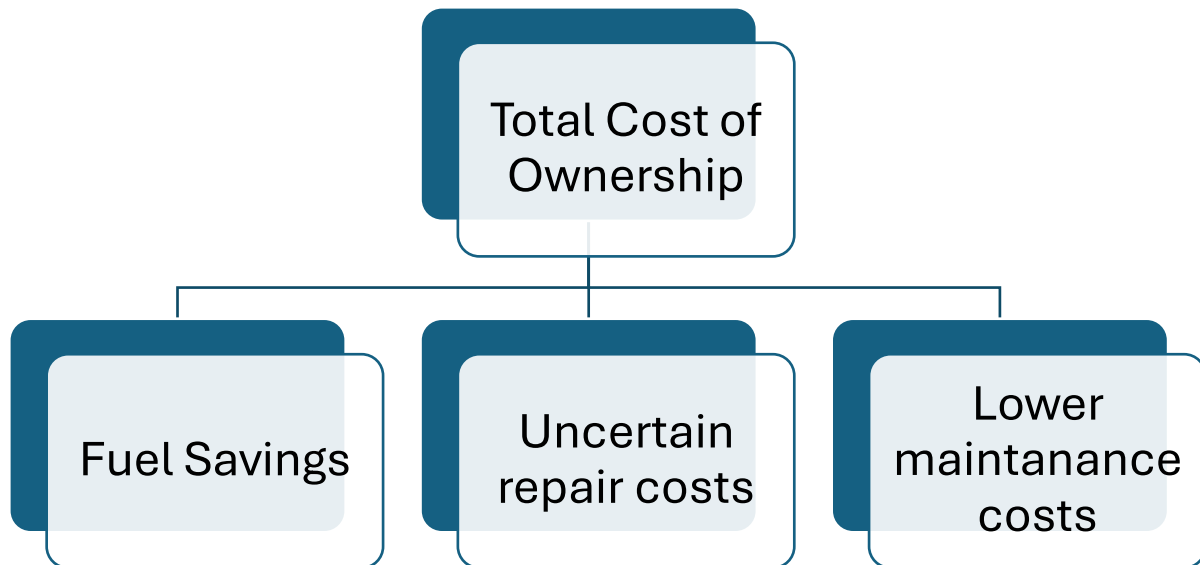
### **4.5.3: Renewable Energy Integration**

The incorporation of sustainable energy sources into Malta's infrastructure for charging was an additional technological innovation that was deliberated by

those surveyed. The possibility of utilising renewable energy sources, such as solar or wind power, to power EVs is considered a major opportunity to increase the environmental benefits of EVs as the nation strives to lessen its reliance on fossil fuels.

Two participants emphasized the importance of aligning EV adoption with Malta's renewable energy goals. He stated, "To truly make EVs a part of Malta's green transition, we need to ensure that the electricity used to power them is coming from renewable sources." Malta might benefit from solar-powered charging stations, according to a number of interviewees, especially in rural areas and places with lots of sunlight. "We have an abundance of solar energy that we aren't fully utilizing. Installing solar panels at charging stations could reduce reliance on the grid and lower operational costs". This quote, particularly, states that the use of solar energy for EV charging could reduce some grid concerns so as to handle the large amount of EVs.

## 4.6: Total Cost of Ownership



*Figure 4.5- Total Cost of Ownership (created by author, 2024)*

When determining whether EV's are economically feasible for consumers in Malta, TCO has become an important consideration. Although the initial investment in an EV is usually greater than that of a conventional ICE car, interviewees highlighted the possibility of long-term fuel, maintenance, and other operating cost reductions. But fears about unpredictable repair costs and battery deterioration were also raised, which might affect how affordable EVs are all around in the long run.

### **4.6.1: Fuel Savings**

The reduced fuel expenses linked to owning an EV was one of the main benefits of EVs that was regularly brought up in the interviews. Petrol costs are typically higher and more erratic than power prices due to Malta's fuel imports, which encourages the use of electric vehicles. An industry expert pointed out, "The cost of electricity in Malta is relatively stable compared to fuel prices, and this makes EVs much cheaper to run in the long term."

Interviewees emphasised that within a few years, fuel savings could balance the greater initial cost of an EV for customers who drive long distances. "For those who use their vehicles frequently, especially for commuting or business purposes, the savings on fuel are substantial". These cost savings offer a compelling financial case for EV adoption, especially for drivers who incur heavy mileage.

### **4.6.2: Lower Maintenance Costs**

EVs' lower total cost of ownership is also largely due to their need for less maintenance. Respondents clarified that because electric cars have fewer moving parts than ICE, they are less likely to break down mechanically and require expensive repairs. "There's no need for oil changes, fewer parts wear out, and overall, EVs require less regular servicing." Customers who are used

to the frequent and perhaps expensive maintenance needed for conventional automobiles were thought to gain greatly from this.

The EVs' regenerative braking systems, which lessen brake component wear and tear and further cut maintenance costs, were also mentioned by the interviewers. An EV owner remarked, "It's not just about avoiding the cost of fuel; you also save a lot on the routine maintenance that comes with a traditional car." These maintenance savings, combined with fuel savings, could significantly lower the TCO for EV owners, making them more attractive over time.

#### **4.6.3: Uncertain Repair Costs**

Numerous respondents voiced concerns regarding unpredictable repair costs, particularly with relation to the EVs battery and electrical components, despite the possible long-term savings on gasoline and maintenance. A participant voiced his concern, "While maintenance is lower, the cost of repairing or replacing parts, especially the battery, can be very high, and this is something that worries potential buyers."

Degradation of batteries was mentioned as a significant source of uncertainty. One of the priciest parts of an electric vehicle is its battery, and while their longevity is increasing, the possible expense of having to replace one is still a

worry. "Once the battery warranty runs out, consumers could be faced with a significant expense if their battery needs to be replaced." He pointed out that Malta, where the EV sector is still in its early stages and there is no information available on the long-term performance of older EV models, is one place where this uncertainty is most evident.

Additionally, a number of respondents brought up Malta's lack of specialist EV repair providers, which may raise repair costs. "There are very few mechanics who are trained to work on EVs, and this could drive up the cost of repairs".

#### 4.7: Public Perceptions

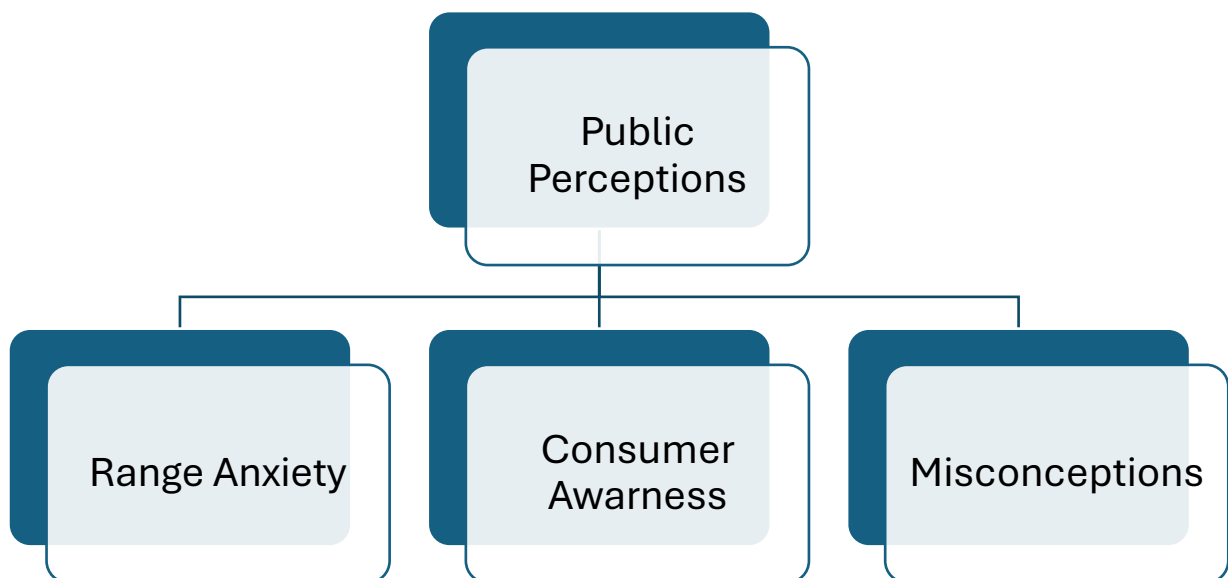


Figure 4.6- Public Perceptions (created by author, 2024)

One important factor affecting Malta's uptake of EVs is public perceptions. The results of the interviews showed that although public knowledge of EVs' environmental benefits is rising, a number of issues, such as range anxiety, a lack of consumer education, and false beliefs about EV technology, still prevent EV adoption from becoming widely used.

#### **4.7.1: Range Anxiety**

Range anxiety, or the fear that an electric vehicle would run out of battery power before reaching a charging station, was one of the most common concerns voiced by interviewees. As mentioned in Theme 2, this problem is directly related to the belief that Malta's infrastructure for charging phones is inadequate. Several respondents noted that prospective purchasers of EV's are reluctant to convert from conventional automobiles due to concerns about having enough range for longer island trips or everyday commuting.

"Despite Malta being a small island, the limited number of charging stations and concerns about their reliability make people nervous about whether they can rely on an EV for everyday use." Although many contemporary EVs have ranges much beyond what is required for normal driving distances in Malta, he pointed out that people are still unsure about whether owning an EV is realistic due to a lack of infrastructure.

Automotive analyst supported this sentiment, saying, "People are used to being able to fill up their fuel tanks easily, and the idea of having to plan their journeys around charging stations is a big mental shift for many consumers." Despite an increasing understanding of the advantages of electric vehicles, many consumers are still hesitant to adopt them in large part because of this psychological barrier.

#### **4.7.2: Consumer Awareness**

Even though the need for more environmentally friendly transportation options has come up more frequently in public conversation, many interviewees believed that consumers were still unable to fully appreciate the benefits of electric vehicles due to incomplete or inaccurate information.

An industry expert, remarked, "Many people still don't realize that electric vehicles can actually save them money in the long run due to lower fuel and maintenance costs." He recommended that in order to tell people about the overall cost of ownership and the wider environmental advantages of converting to electric vehicles, additional outreach and education initiatives are required.

Several interviewees also pointed out that consumers often have outdated perceptions of EV technology. "People still think of EVs as slow or only suitable for short distances, but modern EVs have ranges comparable to traditional cars

and offer much better performance". The widespread adoption of electric vehicles in Malta is hindered by the disconnect between customer beliefs and the state of EV technology.

### **4.7.3: Misconceptions**

In addition to a general lack of awareness, several misconceptions about electric vehicles persist among Maltese consumers. According to interviewees, a lot of people still think EVs aren't powerful enough for everyday driving demands, especially when it comes to acceleration and top speed. This myth probably originated with previous EV cars, which were thought to be less capable than their internal combustion engine rivals. A participant emphasized the need for test drive opportunities and public demonstrations to show potential buyers the capabilities of electric vehicles.

Additionally, a few interviewees indicated that there are myths regarding the lifespan of batteries and the accessibility of charging infrastructure. "I've heard that the batteries don't last long and that it's hard to find a charging station, so I'm not sure if it's worth it." Such misconceptions highlight the importance of providing accurate and up-to-date information about EV technology and infrastructure to address consumer concerns.

## **4.8: Discussion**

The purpose of this study was to evaluate the viability of EV adoption in Malta with an emphasis on public opinion, cost-effectiveness, and infrastructure preparedness. Important information was obtained to answer the research questions through qualitative interviews with consumers, policymakers, and industry experts. This section describes how the results address the research questions and discusses the findings in light of the literature.

The first research question examined the primary infrastructure obstacles and prospects for the extensive integration of electric vehicles in Malta. The interviews uncovered a number of important infrastructure-related obstacles, mainly in relation to grid capacity and charging stations. The absence of public charging outlets was cited by numerous interviewees as a primary barrier to EV adoption. This is consistent with research from the literature showing that a common obstacle to the adoption of EVs in many nations is a lack of adequate infrastructure for charging them (Globisch et al., 2019).

Although Malta has started to invest in charging stations, it was felt that these efforts were insufficient, particularly in the countryside. As highlighted by one participant, "There are very few public chargers in less urbanized areas, making EV ownership less practical for rural drivers."

Although Malta has started to invest in charging stations, it was felt that these efforts were insufficient, particularly in the rural areas. As highlighted by a participant, "There are very few public chargers in less urbanized areas, making EV ownership less practical for rural drivers". Concerns regarding grid capacity, a problem acknowledged in smaller countries with inadequate energy infrastructure, exacerbate this problem even further (Camus et al., 2012).

Notwithstanding these obstacles, it was thought that there was a big chance to include renewable energy into the EV charging network. Solar-powered charging stations were brought up by a number of interviewees as a potential remedy, which is consistent with international best practices for the development of sustainable EV infrastructure (Hall and Lutsey, 2017).

Therefore, the results validate the literature's focus on the necessity of a strong, widely dispersed charging infrastructure to get over range anxiety and guarantee EV adoption's success.

Moving on to the second research question, this focused on the cost-effectiveness of EV's. From the interviews gathered, the respondents highlighted the significant cost barriers to EV ownership, mainly that of the battery replacement costs. The initial cost of ownership was the main problem, and this is shown in the literature of Wu et al. (2015), where he stated that

battery costs amount to between 30% and 50% of the total cost of the vehicle. Although government subsidies have contributed to closing this disparity, they are insufficient to enable the typical customer to purchase an EV. "Even with the subsidies, EVs remain out of reach for a large portion of the population," stated one participant.

Total Cost of Ownership research, however, showed that EVs can save a lot of money over time, especially when it comes to fuel and maintenance. This result is consistent with the literature, which demonstrates that because EVs require less electricity and have fewer mechanical parts, they have reduced operating costs (Palmer et al., 2018). The interviewees also mentioned, and Vasiljević et al. (2022) support, that regenerative braking systems help reduce brake wear and tear, thus cutting maintenance expenses.

Another major concern noted in the interviews was that of the uncertainty of the battery costs and the residual value of the vehicle. This finding aligns with global concerns about battery degradation, with the literature suggesting that depreciation remains a significant challenge for the EV market (Cardino, 2023).

The third research question answered the problem of public perceptions and how these attitudes influence adoption. The study found that the main barriers to EV adoption are range anxiety, false beliefs about EVs, and a general lack of

consumer understanding. Despite the fact that most Maltese commutes would fall well within the range of contemporary EVs due to the island's small size, the interviews revealed that range anxiety is still a major worry for Maltese consumers. Numerous studies have shown that this psychological barrier is a major impediment to the adoption of EVs (Globisch et al., 2019).

The interviews also highlighted the influence of popular perceptions on government policies. A number of attendees advocated for more extensive incentive schemes and increased public-private collaborations to improve infrastructure and raise consumer consciousness. This is consistent with research that emphasises the value of government support for EV adoption, especially in the form of tax breaks and subsidies (Dobie and Whitehead, 2020).

This study addresses the research issues and adds to the expanding body of information on EV adoption in small island nations like Malta by connecting these findings to the literature. To ensure the effective adoption of electric vehicles, future efforts should concentrate on addressing battery-related concerns, building up the infrastructure for charging, and raising customer awareness.

## **Chapter 5: Conclusion and Recommendations**

The purpose of this study was to evaluate the viability of EV adoption in Malta with an emphasis on public opinion, cost-effectiveness, and infrastructure preparedness. A thematic analysis of interviews with legislators, business leaders, and EV owners identified a number of important opportunities and constraints related to the adoption of EVs.

According to the report, infrastructural issues, specifically the scarcity of public charging stations and worries about grid capacity, remain the biggest obstacles to the broad adoption of EVs in Malta. The government has started to work on growing the network of charging stations, but more funding is required to provide a robust and widely available infrastructure. These difficulties are exacerbated by the restrictions on home charging that city dwellers without private parking must deal with.

Despite government incentives, many consumers are still deterred from purchasing EVs due to their high upfront cost, which affects their cost-effectiveness. However, an examination of the TCO reveals that EVs can save money in the long run, especially in terms of fuel and maintenance expenses. Consumer decisions have also been found to be significantly influenced by concerns around residual value and the expense of replacing batteries.

This study adds significantly to our understanding of EV adoption, which is especially important for small island states like Malta, where infrastructure and location constraints create special difficulties. Through the consideration of both infrastructure readiness and cost-effectiveness, the study offers a comprehensive understanding of the potential and challenges related to the transition to electric transportation.

The results have important ramifications for strategic planning and policy formation. It is critical to solve the identified infrastructure gaps if Malta is to reach the climate goals set forth by the European Union. The study's identification of infrastructural inadequacies poses noteworthy obstacles to the extensive implementation of EVs in Malta. One of the main issues is the scarcity of public charging stations, which limits EV users' accessibility and ease of charging, especially in rural and less urbanised areas. In addition, the scarcity of private parking in metropolitan areas limits the amount of charging that can be done at home, which makes installing personal charging stations challenging for many homeowners. Concerns about grid capacity were also expressed since, without major changes, Malta's electrical grid could not be able to support a significant rise in EV usage, especially during times of peak demand. In addition, the convenience of long-distance travel was perceived to be hampered by the lack of fast charging choices, such as DC fast chargers in strategic areas. Finally, even if incorporating renewable energy sources into the network

of EV charging stations is a promising solution, there are now only a small number of solar-powered charging stations that can help ease the strain on the grid. These inadequacies in the infrastructure underscore the necessity of deliberate investment and planning in order to facilitate Malta's shift to electric vehicles.

The study emphasises the value of public-private partnerships in growing the network of charging stations as well as the potential contribution of integrated renewable energy to easing worries about grid capacity. The study also reveals the necessity of ongoing government subsidies to increase the general public's financial accessibility to EVs.

More broadly, the study adds to the conversation around the need for regional policies, which include the unique obstacles small, remote areas face as well as the global shift to electric vehicles. The results provide insight into the particular circumstances of Malta and emphasise the significance of public attitudes and the availability of charging infrastructure as major factors in the adoption of electric vehicles.

There are a few areas that need more research. Subsequent investigations may employ a mixed-methods approach, integrating quantitative evaluation with qualitative perspectives to offer a more comprehensive evaluation of

infrastructure preparedness and economic viability. To help legislators decide which charging infrastructure improvements to prioritise in the future, for instance, a cost-benefit analysis of various investments could provide insightful information.

Future studies should also look into how EV battery technology is developing and how it can affect the market. A more thorough analysis of how solid-state batteries and V2G technologies might lower the cost of battery replacement and improve grid stability would be extremely beneficial, given the impending introduction of these breakthroughs. Lastly, studies on how renewable energy supports EV infrastructure may offer crucial information for Malta's energy shift. Considering the nation's pledge to cut carbon emissions, incorporating solar-powered charging stations and investigating smart grid technologies may be essential to guaranteeing that the transition to electric vehicles is consistent with more general sustainability objectives.

In summary, this study shows that adopting EVs in Malta is feasible while also highlighting the major issues that need to be resolved to enable a smooth transition. The results highlight how crucial it is to close infrastructure gaps, lower financial obstacles, and change public opinion in order to promote EV adoption. Through sustained investment in charging infrastructure, integration of renewable energy, and public awareness campaigns, Malta may make

significant progress towards realising its sustainability objectives and emerging as a frontrunner in the shift towards electric transportation.

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## Appendix 1: Information Sheet for Participants of the Interview

Subject: Request for Interview: Master's Thesis on Electric Vehicle Adoption in Malta

To whom it may concern,

My name is Rachelle Camilleri and I am currently pursuing a Master's degree in Insurance and Risk Management at the University of Malta. As part of my thesis research, I am conducting a study on the feasibility of electric vehicle (EV) adoption in Malta, with a specific focus on infrastructure readiness and cost-effectiveness.

I aim to gather insights from industry experts and policymakers like yourself to understand better the practical considerations and strategic initiatives needed to support this transition.

I would be honoured to have the opportunity to interview you and gain your valuable perspective on these topics. The interview is expected to take approximately 30 minutes and I am happy to schedule it at a time that is most convenient for you. If you agree to participate, please let me know your availability, and I will coordinate the details accordingly. Please be assured that all information shared during the interview will be treated with the utmost confidentiality and used solely for academic purposes. A summary of findings can be shared with you upon request.

Thank you for considering my request. I look forward to the possibility of discussing this important topic with you.

Kind regards,

Rachelle

Department of Insurance and Risk Management

University of

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Camilleri

Malta

## Appendix 2: Interview Questions

1. What are the main cost-related barriers to the widespread adoption of electric vehicles in Malta?
2. How do you perceive the total cost of ownership of electric vehicles compared to internal combustion engine vehicles for consumers in Malta?
3. What role do you think the private sector (e.g., car manufacturers, charging station providers) should play in making electric vehicles more cost-effective for consumers?
4. What do you consider to be the biggest infrastructural challenges for electric vehicle adoption in Malta?
5. What is the current state of charging infrastructure in Malta, and how is it expected to evolve in the next 5-10 years?
6. Do you foresee any technological advancements that could significantly impact the development of EV infrastructure in Malta?
7. How do you balance the need for environmental sustainability with the economic considerations of electric vehicle adoption?
8. Are there any ongoing collaborations or partnerships between the government, private sector, and international organizations to support EV adoption?
9. What do you believe are the key success factors for the successful adoption of electric vehicles in Malta?
10. In your opinion, what lessons can Malta learn from other countries that have successfully implemented electric vehicle infrastructure and policies?
11. Is there anything else you would like to add or any advice you would give to stakeholders looking to promote electric vehicle adoption in Malta?