The Impact of Electric Vehicles on the Maltese Insurance Market and the General Public.

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ABSTRACT

The number of Electric Vehicles (EVs) has increased globally. However, like in some other European countries, the number of EVs in Malta is still low. Research studies, both on a national and an international level, were conducted to analyse the factors that mostly influence people when purchasing an EV. Driving range, lack of charging stations, lengthy charging time, high purchase price, safety, and design were some of the factors identified as pushing barriers towards the transition of EVs. On the other hand, research shows that EVs may introduce new risks due to high voltage electrical equipment in these vehicles. However, research on the effects EVs may have on insurance companies is limited. In view of these two scenarios, this study seeks to investigate; the attitudes and perceptions of the Maltese population towards EVs; and the impact of EVs on the Maltese insurance market.

The data collected from the online survey distributed on various media platforms shows that purchase price, government incentives, and maintenance costs were identified as the three barriers that would influence the Maltese population heavily when purchasing an EV. Data gathered from the open-ended questionnaires, distributed amongst five Maltese insurance companies, show that insurance companies in Malta have adapted differently to EVs, and only one insurance company offers an insurance policy specifically for EVs. All the participants representing the insurance companies stated that the low percentage of EVs in Malta is due to other factors other than the risks associated with EVs. The findings of this research study can guide the relevant stakeholders to take the necessary actions to encourage more residents in Malta to purchase an EV.

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LIST OF ABBREVATIONS

AA	Automobile Association
BEV	Battery Electric Vehicle
CO_2	Carbon Dioxide
EU	European Union
EV	Electric Vehicle
GHG	Greenhouse Gases
HEV	Hybrid Electric Vehicle
ICE	Internal Combustion Engine
MS	Member States
MTIP	Ministry for Transport, Infarstructure, and Capital Projects
NSO	National Statistics Office
PHEV	Plug-in Hybrid Electric Vehicle
SL	Subsidiary Legislation
SPSS	Statistical Package for the Social Sciences
TPB	Theory of Planned Behaviour
TPFT	Third-Party Fire and Theft
TPO	Third-Party Only
UK	United Kingdom
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
V2G	Vehicle-to-Grid

CHAPTER 1: INTRODUCTION

1.1 Introduction

In Subsidiary Legislation (SL) 460.32, an Electric Vehicle (EV) is defined as “a motor vehicle equipped with a powertrain containing at least one non-peripheral electric machine as energy convertor with an electric rechargeable energy storage system, which can be recharged externally.” As explained by Dobie and Whitehead (2020), an EV can either be a Battery Electric Vehicle (BEV), a Plug-In Hybrid Electric Vehicle (PHEV), or a Hybrid Electric Vehicle (HEV). A BEV relies solely on battery power and uses high voltage batteries usually made from lithium-ion, whereas PHEVs and HEVs use conventional combustion engines (ibid). The latter does not need to be plugged in as the charge is maintained through an internal combustion engine-generated power (ibid). On the other hand, a PHEV needs to have a plug-in battery (Denton, 2016). An HEV can either be powered by a battery, an internal combustion engine, or both (ibid). The source of power in an HEV is changed automatically, and it depends on the speed, the size of the engine, and the amount of battery charge (ibid).

EVs are not an invention of modern times (Anderson and Anderson, 2010). On the contrary, they have a long history dating back to the 1820s (ibid). Between 1828 and 1835, several innovators from different countries started to explore different small-scale EVs, and in 1832, Robert Anderson developed the first electric carriage (ibid). Furthermore, in the late 1890s, William Morrison created the first EV in the United States (US) (ibid). The 20th century saw the introduction of several models of EVs in the market. These vehicles were considered quiet, easy to drive, and did not emit smelly pollutants compared to gas and steam-powered automobiles. However, in this same period, gas-powered cars were cheaper due to the mass production of internal combustion engines (ibid). The price of gas started to increase in the 1960s and 1970s, leading many automakers to explore different options for alternative fuels (ibid).

In this same period, the problem of how to conserve air quality became a leading topic of international discussion, with the Montreal Protocol on Substances that Deplete the Ozone Layer signed in 1987 (Kuklinska *et al.*, 2015). This protocol followed the United Nations Framework Convention on Climate Change (UNFCCC), which was signed in 1992 to prevent human interference with the climate system and stabilizes Greenhouse Gases (GHG) in the atmosphere to levels that do not cause significant impacts on the environment (ibid). The Kyoto Protocol was the first set of international rules adopted to implement the UNFCCC. This protocol obliged industrialised countries to reduce GHG according to the established targets for each country (ibid). The Kyoto Protocol was succeeded by the Paris Agreement, which was signed in 2015 and aimed to limit global warming to below 2^{o}C, preferably to 1.5^{o}C compared to pre-industrial levels (Kuh, 2018). In line with these international agreements, throughout the years, several countries, and institutions, particularly the European Union (EU), have adopted different legislations regarding air protection (Kuklinska *et al.*, 2015). At the beginning of 2020, Regulation (EU) 2019/631 came into effect, establishing a set of targets to help accelerate the transition to zero-emission vehicles. Moreover, in the Low Carbon Development Strategy, adopted in 2021, Malta committed to having more than 65,000 EVs by 2030 (Ministry for the Environment, Climate Change, and Planning, 2021).

EVs became an important means to help reduce GHG emissions in a sector that contributes to approximately a quarter of the energy-related GHG emissions (OECD/IEA, 2021). Over the years, particularly from 2015 onwards, the global stock of EVs reached new values each year in contrast to the previous ten years (ibid). Between 2014 and 2015, new EV registrations increased by 70%, and in 2015 there were 1 million of EVs on the road globally (OECD/IEA, 2016). In 2016, the number of EVs sold globally was more than 750,000 while the global stock of EVs reached 2 million (OECD/IEA, 2017). According to statistics published by the National Statistics Office (NSO) in Malta, there were 901 EVs registered on the road in 2016, amounting

to 0.3% of the entire vehicle stock (NSO, 2017).

Furthermore, in 2017, more than 1 million new EVs were sold globally, a growth of 54% when compared to the previous year (OECD/IEA, 2018). This year's global EV stock was 3.1 million, an increase of 57% from 2016 (ibid). In 2017, Malta shown an increase in the stock of EVs by reaching a total of 1,255 EVs (NSO, 2018). In 2018, the global EV fleet increased by almost 2 million and reached 5.1 million (OECD/IEA, 2019). The number of new EV registrations nearly doubled this year (ibid). The number of EVs on the road in Europe increased to 1.2 million, and Europe had the world's second-largest fleet (ibid). On the other hand, in 2018, the EV fleet in Malta rose by 0.27%, reaching a total of 2,367 EVs (NSO, 2019). In 2019, the global EV stock was 7.2 million (OECD/IEA, 2020), while the number of EVs in Malta was 4,493 (NSO, 2020). The year 2020 recorded the highest number of EVs globally. The number of EVs this year increased by 2.8 million from the previous year and by 9 million from 2015 (OECD/IEA, 2021). In 2020, Europe superseded China and became the world's largest electric market, with 1.4 million registered EVs (ibid). By 2020, the number of EVs in Malta reached 6,017 (NSO, 2021). Moreover, in 2021, the total number of EVs on the world’s roads reached 16.5 million, accounting for almost 10% of the total global car sales (OECD/IEA, 2022). The EV stock in Malta reached 10,627 by 2021 (NSO, 2022a). Nevertheless, the global sales of EVs continued to increase in the first quater of 2022, recording a sales of 2 million whilst the number of EVs in Malta reached 11,544 (OECD/IEA, 2022; NSO, 2022b).

Even though there has been a strong increase in sales throughout the years, BEVs only account for 0.5% whilst PHEVs and HEVs account for 0.6% and 1.2%, respectively (ACEA, 2022). Therefore, this shows that petrol and diesel vehicles are still very dominant in the EU, accounting for 40% and 19.6%, respectively (ibid). This scenario can also be seen in Malta as

petrol and diesel are the most popular types of fuel, accounting for 59% and 38%, respectively, of the entire Maltese car fleet (NSO, 2022b).

1.2 Status of the Problem

By the end of 2030, more than 65,000 cars on the Maltese roads should be EVs (Ministry for the Environment, Climate Change, and Planning, 2021). According to the latest statistics published by NSO until March 2022, out of 414,669 cars on the road in Malta, only 11,544 are electric (NSO, 2022b). For Malta to reach the target by 2030, the number of EVs should increase by 53,456 over the next eight years. The transition to EVs may have several consequences on the insurance companies since new technology brings with it new risks (Panasiewicks, 2015). Therefore, insurance companies need to ensure that the premiums offered to their clients reflect that risk exposure (ibid). Part of the premium is based on the price of the vehicle, how fast it moves, and how costly it is to repair the car in case of any damages (Lockton, 2021). Repair and replacement costs for EVs are more expensive and time-consuming due to their sophisticated battery technology, particularly when they need to be examined by a specialist (ibid). EVs may sometimes require more attention when it comes to repairing expenses. Therefore, these vehicles can be less cost-effective (ibid). In view of these risks and features associated with these vehicles, insurers may need to change their underwriting strategy to accommodate the needs of EVs (ibid).

Even though throughout the past years, the Maltese government has introduced several incentives to encourage people to shift towards EVs, only 2.8% of the cars on the Maltese road are electric (NSO, 2022b). In 2021, the former Ministry for Transport, Infrastructure, and Projects (MTIP) announced the largest ever package of financial grants, aiming to incentivise Maltese citizens to use more sustainable and efficient means of transport (MTIP, 2021). However, statistics published by NSO in 2022 show that in Malta, the most used motor energy

type is still petrol, followed by diesel, with a total of 245,391 and 155,761, respectively (NSO, 2022b). This means that 96.7% of the Maltese population still relies on petrol and diesel vehicles (ibid).

1.3 Objectives of the Study

The main objectives of this research study are:

1. To assess how Maltese insurance companies which have an EV policy adapted their policies to address the risks associated with EVs and started to offer its clients an EV insurance policy;

2. To assess how Maltese insurance companies which do not have an EV policy to date should adapt and adjust their policies to cover EVs;

3. To examine and understand the perceptions of the Maltese population towards the transition to EVs and the barriers that are holding Maltese citizens from purchasing an EV;

4. To analyse if there is a correlation between the risks associated with the take-up of EVs and the low percentage of EVs in Malta.

1.4 Research Questions

The research questions that this study intends to answer are:

1. How did Maltese insurance companies adjust their policies to be able to insure EVs?

2. How should Maltese insurance companies which do not have an EV policy adapt to address the risks associated with EVs?

3. What are the attitudes of the Maltese population about transitioning from a petrol/diesel vehicle to an EV?

4. What correlation can be established between the low percentage of EVs in Malta and the risks associated with them?

1.5 Significance of the Study

To date, no research study has assessed how Maltese insurance companies are adapting their policies to offer their clients an adequate premium on EVs. Therefore, this research study aims to provide better insights on the risks Maltese insurance companies are facing in an environment where the push for EVs is increasing nationally and globally. On the other hand, this research study will highlight the concerns of the Maltese public about the transition to EVs that need to be addressed by the relevant stakeholders.

1.6 Outline of the Dissertation

The rest of the dissertation is divided into four chapters and will entail the following:

The Literature Review will provide an overview of (i) the differences between the standard motor insurance policy and an insurance policy precisely for EVs; (ii) the impacts EVs may have on insurance companies; and (iii) studies carried out across European citizens to assess their perceptions and attitudes towards EVs.

The Methodology will provide an overview of the methodology applied in this study, consisting of the rationale behind the research questions, research design used, the method of data collection, how the participants were chosen, the method of data analysis, the underlying ethical considerations, as well as the limitations of this research study.

The Analysis and Discussion will comprise of in-depth analysis of the collected data, followed by a discussion on the findings and the consulted studies in the literature review.

The Conclusion and Recommendations will discuss how the findings answered the research questions set out at the beginning of this research study, and how this research study

contributes to the insurance sector. The rest of the Chapter will include recommendations that need to be considered when conducting future studies.

CHAPTER 2: LITERATURE REVIEW

2.1 Overview of a Motor Insurance Policy

An insurance policy is a legal contract between the insurer and the insured which contains various attached documents, riders, or endorsements that may alter the coverage already provided (Outreville, 1998). Motor vehicle insurance is the most used type of insurance as it is illegal to drive a vehicle without having insurance (MFSA, n.d). In 1947, the Motor Vehicles Insurance (Third-Party Risks) Ordinance was introduced in Malta, obliging all motor drivers to have third-party insurance (ibid). Furthermore, Directive 2009/103/EC obliges EU motor vehicle drivers to have compulsory third-party insurance. Like ICE vehicles, EVs also need to be covered by an insurance policy.

Three different types of insurance coverages are found under the motor insurance policy; Third-Party Only (TPO), Third Party - Fire and Theft (TPFT), and Full Comprehensive (MFSA, n.d). TPO is the minimum coverage required by law to be able to drive a vehicle (ibid). As the name implies, TPO provides coverage in cases where the individual is held liable for causing injuries to third parties and damages to third party's property while driving the vehicle (ibid). This type of insurance can also be extended to cover passengers involved in the accident (ibid). Under this insurance policy, the driver who causes the accident is not covered even in cases when the individual is not to blame (ibid). Therefore, the driver must pay for all the damages caused (ibid). The premium payable for this type of insurance is less expensive than the two other types of insurance policies (ibid). TPFT is similar to TPO; however, it also covers damages that a vehicle may have due to fire or theft (ibid). Like individuals insured by TPO, individuals insured by TPFT will not be covered if the car suffers from any damages, and the insured is not to blame for the injuries (ibid). On the other hand, the Full Comprehensive insurance policy covers the damages caused to third parties and the damages caused to the driver's car, even if the accident results from the insured (ibid).

The EV insurance policy of three insurance companies based in the United Kingdom (UK), Aviva, Automobile Association (AA), and Admiral show that additional terms were included to address the different features of EVs. Under these three policies, an EV's battery is included to cover damages that may arise from fire accidents, accidental damages, or thefts. Furthermore, the charging equipment is also covered under the insurance policy provided by AA and Admiral. These two insurance companies provide cover in cases where liability to other people arises as someone may suffer injuries due to tripping over a charging cable situated outside someone's else property. Furthermore, these three insurance companies offer their clients additional benefits at their expense. These add-ons are related to personal injury, personal belongings, child equipment, courtesy vehicle, legal motor protection, and roadside assistance cover.

Furthermore, a motor insurance policy includes several general exclusions. Some of the exclusions identified in all the three consulted UK insurance companies include;

1. loss or damage due to wear and tear;
2. mechanical, electrical, electronic, cyber incident, computer failure or breakdown;
3. confiscation or detention of the insured car by the government;
4. theft due to the individual's negligence;
5. market value after a vehicle is stolen or damaged;
6. tyre damage due to bursts, punctures, braking, and cuts; and
7. death or bodily injury to an employee of the insured party arising out of or in due course of the individual's employment unless stated in the Road Traffic Acts, amongst others.

Other exclusions under such policy include terrorism, war, riot, radioactive contamination, and explosive nuclear assembly, among others.

2.2 The Impact EVs May Have on Insurance Companies

The combustion engine has been the most used source of vehicle power in the last 150 years (Dobie and Whitehead, 2020). Throughout the years, the design of the vehicle, its production, reliability, and safety have advanced (ibid). A difference that distinguishes an ICE vehicle from an EV is that the latter comprises of parts that are more integrated through sensors and embedded software (ibid). Moreover, since EVs use micro products, these products are not designed and produced together (ibid). Therefore, insurers need to carefully evaluate the product development cycles as they become faster and testing periods become shorter (ibid). Also, professional liability insurance may also need to change to account for the increasing dependence on software and data within EVs (ibid). Furthermore, “the creation of new supply chains and contractual relationships further complicates matters for insurers, especially where there are contractual mismatches at various stages of the product chain” (Kjosevski *et al.*, 2017).

From a product liability perspective, EVs bring several technical, environmental, and operational risks (Dobie and Whitehead, 2020). BEVs, PHEVs, and HEVs are made up of different technology compared to ICE vehicles (Kjosevski *et al.*, 2017). These vehicles can put their users and the environment at risk (ibid). In fact, these vehicles introduce new types of dangers mainly due to high voltage electrical equipment present in the car (ibid). Some features of these vehicles can also be dangerous even when the car is parked and not being used (ibid). Leakage of acid from the battery, particularly after a collision, is another dangerous feature of these vehicles (ibid). If the lifecycle of various parts in one component is not the same, the repair costs

can be costly (Dobie and Whitehead, 2020). In view of these features, insurance companies should consider the significant risks when insuring these types of vehicles to ensure that the premiums reflect these risk exposures (ibid).

The battery is the most critical part of this type of vehicle (ibid). The most commonly used battery in EVs is a lithium-ion battery, which offers the best mileage when fully charged compared to other options (Panasiewicz, 2015). Even though this type of battery has its benefits, a lithium-ion battery is highly explosive (ibid). Most EV fire accidents are caused by the thermal runaway of lithium-ion batteries (Sun *et al.,* 2020). A thermal runaway can occur either due to an increase in the battery's temperature (more than 10°C/min) or the activation of safety vents (ibid). The latter happens when electrochemical, exothermic, and thermochemical reactions are initiated (ibid). The most common causes of EV fires that arise due to the thermal runaway of a lithium-ion battery include fire while the vehicle is charging, self-ignition while driving, and fire after a traffic accident such as a high-speed collision (ibid). When one of these scenarios occurs, the battery ejects large amounts of dark smoke, hot sparks, and powerful jet flames (ibid).

Furthermore, a lithium-ion battery is made to receive and store a pre-defined level of energy in a predetermined period (ibid). Charging too quickly or overcharging can result in either premature failure or reduced performance (ibid). Moreover, unlike ICE vehicles, when EVs are parked, they are not de-energized, and the battery is always on (Panasiewicz, 2015). Due to this feature, there is a risk of electrical fault and electric malfunction, increasing the risk of electric shock (ibid). Improperly installed at-home charging stations can pose a potential hazard (ibid). Due to the fire and explosion risks associated with lithium-ion batteries, Dobie and Whitehead (2020) stated that the number of claims for property insurers will increase. These same authors noted

that marine insurers had encountered container ship fire losses due to lithium-ion batteries (ibid). Furthermore, commercial/residential property claims may also increase due to overcharging or problems related to power connection (ibid).

Like other vehicles, EVs are also subject to theft and vandalism risks. Jones *et al.* (2020) explained that using raw materials, particularly copper, in the production of EVs is of great importance; however, using this material in EVs can lead to several cable theft incidents, which may lead to various implications for the insurance sector. Gao *et al.* (2015) also recognized the danger of vandalism; however, these authors stated that wireless charging systems in public spaces could help overcome the problem of vandalism. Therefore, individuals interested in purchasing an EV insurance policy should ask the insurance company whether certain EV features are covered under such policy (Henshaw, 2021). These may include legal liability for anyone who trips over the charging cable, theft or damage of charging cables and adaptors, and an electric courtesy vehicle in case an individual has an accident and requires a vehicle (ibid).

EVs will continue to evolve, and it is estimated that in a few years, the software will account for 30% of a BEV makeup compared to 10% in 2020 (Dobie and Whitehead, 2020). In a study by Eling and Lehmann (2018), the concept of digitalisation is further highlighted as an essential aspect of EVs as EVs are considered a more connected source of mobility solution since, they carry an increased level of data and connectivity within them. However, digitalisation may give rise to several cyberattacks, resulting in various implications for the insurance sector. Various studies throughout the years, namely; Niyato *et al.* (2017), Hoang *et al.* (2017), Mihet-Popa and Saponara (2018), and Acharya *et al.* (2020), highlighted this issue as a real risk that can be minimised if insurance companies adopt cyber insurance on EVs. In the studies carried out by Hoang *et al.* (2017), and Niyato *et al.* (2017), data communication arising from Vehicle-to-Grid

(V2G) Systems was identified as a risk because it is subject to cyberattacks.

Furthermore, software updates may lead to changes in risks during the lifetime of an EV (ibid). As Dobie and Whitehead (2020) stated, insurers will need to start offering cyber insurance to cover exposures on the use of data and connectivity to limit the chances of fraud, extortion, and vehicle theft. These authors stated that these new developments need to be evaluated and rated very carefully, according to their risk exposure, as they might increase claims complexity (ibid).

New technology like EVs will bring unknown risks and exposures to the market, which may differ from those of ICE vehicles (Dobie and Whitehead 2020). Moreover, liability within the supply chain will shift (ibid). These two factors can increase insurance claims (ibid). Therefore, insurance companies should be on the lookout for any risks EVs might bring with them so that these companies can address them accordingly.

2.3 The Perceptions of European Citizens on the Uptake of EVs

As part of the Fit 55 package, which is currently being discussed on different levels, the European Commission proposed that after 2035 it will no longer be possible to place cars or vans with an internal combustion engine on the market in the EU (COM (2021) 550 final). In 2020, the European EV market experienced unprecedented growth, with more than 1.36 million EVs being sold across the Member States (MS) (Bernard *et al.,* 2021). The EV shares in Sweden, the Netherlands, Finland, and Denmark were above 15% in 2020 (ibid). Furthermore, the EV shares in Portugal, Germany, France, Belgium, Austria, and Ireland ranged between 7% and 14% (ibid). On the other hand, the EV shares in Hungary, Spain, Italy, Malta, and Poland ranged between 2% and 5% (Bernard *et al.,* 2021; NSO, 2022b). These differences in

percentages amongst different European MS indicate that consumer acceptance varies from one country to another. Ozaki and Sevastyanova (2011) identified consumer acceptance as one of the main factors leading to a successful sustainable transportation transition.

Nonetheless, consumers resist unfamiliar and unproven new technology (ibid). The factors influencing consumer behaviour according to the Theory of Planned Behaviour (TPB) include attitudes based on the knowledge and experience of the individual, subjective norms which the individual considers as acceptable by the society s/he forms part of, and the perceived impact of their behaviour (Ajzen, 1991). Different authors conducted several research studies to investigate the public perceptions and attitudes towards EVs and, indirectly, how knowledgeable European citizens are on these types of vehicles to understand the barriers that are pushing people from purchasing an EV.

The responses provided by the participants in different research studies indicate that people still lack knowledge on EVs. One of the participants in Zaunbrecher *et al.*'s study (2014) was unsure if EVs drive like normal cars, while another participant lacked knowledge on how far an EV would be able to go. These statements indicated that these participants lacked knowledge on electromobility (ibid). Furthermore, nearly half (48.61%) of the Portuguese in Vrösch's (2018) study were unaware of how to charge an EV. Moreover, when the participants were asked about the driving range of an EV, 18.52% answered 'do not know,' 11.11% answered 'up to 50km', 3.70% answered 'up to 100km', 16.05% answered 'up to 200km', 30.86% stated 'up to 300 km' while 19.75% said 'more than 300km'. These differences in percentages show that most of the participants lacked knowledge on what is the driving range of an EV.

Some of the participants in Zaunbrecher *et al.*'s (2014) study expressed their concern about the 'memory effects' of the battery due to several charging times (ibid). However, an expert in this field who participated in this research study denied this concern (ibid). Ziefle *et al.* (2014) conducted a Spearman Rho study to analyse if there is any correlation between consumers' knowledge on electric mobility and consumers' acceptance towards this type of mobility. From this research study, the authors concluded that the more an individual is knowledgeable about electric mobility, the more s/he is acceptable of this type of mobility (ibid). Therefore, the perceived costs, risks, and potential technology barriers are minimised (ibid). Furthermore, Simsekoglu and Nayuum (2019) identified a strong relationship between lack of knowledge and consumers' willingness to buy an EV. These authors stated that consumer beliefs and attitudes are important factors that influence purchase intentions (ibid). Lack of consumer knowledge and experience was also identified as one of the main barriers towards the transition to EVs by the experts who participated in the study conducted by Noel *et al.* (2020). The experts in this study worked within institutions related to transport technology, policy, and practice in different Nordic countries (ibid). One of the experts in this research study stated that the biggest barrier in Denmark towards the transition to EVs was the mental barrier (ibid). Moreover, another participant stated that lack of knowledge on EVs was leading to the persistence of myths about these types of vehicles in Norway (ibid).

The design of these vehicles also acted as a barrier to some of the participants participating in the consulted studies. The participants in Zaunbreacher *et al.*'s (2014) study stated that the models of EVs they knew were ugly and that they should have a more conventional design. Furthermore, some of the participants indicated that EVs should be bigger with more storage and seats (ibid). Moreover, after the end of the seven days of using a BEV or PHEV, some of the participants who participated in Graham-Rowe *et al.*'s (2012) study viewed EVs as 'soulless' and lacking in visual appeal. These perceptions are important to consider in view that a car

might represent the driver's personality (Schuitema *et al.,* 2013). Therefore, a poor design might affect the satisfaction of owning an EV (ibid). On the other hand, 40% of the participants in Berkeley *et al.*'s (2018) study stated that the design and aesthetics of an EV are not the critical factors that will stop them from purchasing an EV. Only 29% of the participants stated that the aesthetics and design of an EV are decisive factors when purchasing an EV (ibid).

Many of the participants from different research studies agreed that the driving range of an EV should be extended. Most of the participants in Zaunbrecher *et al.*'s (2014) study stated that the range should be extended even though some knew that the existing range was enough for daily commuting. One of the participants even said she was unwilling to drive the vehicle at a lower speed to cause less damage to the battery because she would need twice the time to travel (ibid). The driving range was also identified as a barrier by the participants who participated in the research study by Jensen *et al*. (2013) after having a hands-on experience with an EV. Limited driving range for day-to-day needs was ranked 5th out of 19 by the participants participating in the research study by Berkeley *et al.* (2018). The findings of these research studies show that EVs do not meet the driving range needs of the driver. Due to this limitation, range anxiety is another barrier that may put people off from purchasing an EV. Neubauer and Wood (2014) defined range anxiety as "the fear of fully depleting a BEVs battery in the middle of a trip, leaving the driver stranded." Some of the participants in Zaunbrecher *et al.*'s (2014) study stated that they would use either hybrid cars or range extenders to avoid getting stuck somewhere when the battery is dead. Even though distances between one locality to another are short in Malta compared to other European countries, 55% of the participants in Pisani's (2020) study feared that their car would run down before recharging their vehicle. On the other hand, 26% of the participants were not worried about the limited driving range, while 19% were impartial (ibid). These percentages indicated that the participants in this research study fear range anxiety more than the inconvenience of charging (ibid). Moreover, the risk of running out

of power was classified as the 2nd barrier hindering 21.38% of participants in Vrösch's (2018) study from buying an EV. On the other hand, range anxiety ranked relatively low, 14th out of 16, among the participants participating in Giansoldati *et al.*'s (2020) study. This low ranking may be due to Italy being a densely populated country; therefore, daily commuting does not have to take place over long distances (ibid). Experts stated that range is not a natural technical barrier but is more related to consumer knowledge and experience (Noel *et al.,* 2020). Furthermore, there may be a mismatch between the range they would like to drive in their everyday lives and the range that EVs provide (Jensen *et al.,* 2013).

Another common factor mentioned by the participants from different research studies was the charging process to charge an EV and the number of charging points available to charge these vehicles. In Zaunbrecher *et al.*'s (2014) study, the participants stated that it was stressful to plan the recharging of an EV because this process required a lot of time. This same barrier was also identified by the participants in Graham-Rowe *et al.*'s (2012) study. In fact, the participants in this study considered the waiting time to charge the vehicle as dead time and that it jeopardises their freedom of movement (ibid). Furthermore, 4.83% stated that charging the car daily was the main barrier pushing them from buying an EV (ibid). Research carried out by Deloitte Malta (2020) amongst consumers from different nationalities shows that most consumers in this study will not wait more than 30 minutes to recharge a BEV. On the other hand, the percentage of consumers willing to wait 4 hours or more to charge their BEV varied from 1% in Spain to 6% in the United Kingdom (UK). On the other hand, 51% of the participants in Pisani's (2020) study, strongly disagreed or disagreed that having to plug-in and unplug an EV to recharge would put them off from buying this type of vehicle. Only 26% strongly agreed or agreed that having to plug-in and unplug an EV to recharge would put them off from buying this type of vehicle and 22% had impartial attitudes (ibid).

Besides the lengthy time required to charge an EV, lack of charging infrastructure was identified as another burden. In fact, the insufficient number of fast charging stations, particularly along the Italian highways, was identified as the main barrier by Italian drivers participating in Giansoldati *et al.*'s (2020) study. The authors found that participants without a garage faced additional charging costs (ibid). Lack of charging stations was also identified as one of the top barriers in Berkeley *et al.*'s (2018) study. Furthermore, in Vrösch's (2018) study, 20.69% of the participants stated that the main barrier hindering them from buying an EV was not being able to charge an EV at home. Additionally, 60% of the participants said they would not purchase an EV if there were insufficient charging stations.

Installing charging pillars at home or work can help mitigate these two barriers. The participants in Zaunbrecher *et al.*'s (2014) study stated that charging stations at home or work are helpful so that EVs can be recharged overnight or during working hours. More than half of the respondents in Vrösch's (2018) study claimed that charging spots at home and work, public charging spots in the city centre, and charging locations on highways are crucial. Some of the participants in Zaunbrecher *et al.*'s (2014) study stated that there should be parking spaces available in the supermarket parking lot and street lights which function as charging stations.

Security and safety concerns were factors mentioned as barriers by several participants in Zaunbrecher *et al.*'s study (2014). These participants stated that the battery of an EV was an issue of concern for them, and they considered accidents with EVs more dangerous than having an accident with ICE vehicles. Furthermore, the participants associated EVs with plastic cars and considered them less robust than ICE vehicles (ibid). The participants argued that an EV would lose in a crash against an ICE vehicle (ibid). On the other hand, poor safety due to the risk of fire was not considered a barrier by the participants in Giansoldati *et al.*'s (2020) study.

Even though EVs are considered to have a positive impact on climate change and reduction of CO_2 emissions (Zaunbrecher *et al.,* 2014; Giansoldati *et al.,* 2020; Berkeley *et al.,* 2018), some of the participants in different research studies were skeptical of whether EVs are really green (Zaunbrecher *et al.,* 2014; Graham-Rowe *et al.,* 2012). Some of the participants in the study carried out by Zaunbrecher *et al.* (2014) stated that as long as the source of electricity for EVs is generated from fossil fuels or nuclear power plants, these types of vehicles are not environmentally friendly. Moreover, other participants stated that the production and disposal of an EV battery might negatively affect the environment (ibid). On the other hand, battery disposal and negative environmental impacts were ranked 15th and 16th out of 20 criteria towards buying an EV by the participants in Giansoldati *et al.*'s study (2020), indicating that the participants were not convinced that EVs would do less harm to the environment than ICE vehicles. Furthermore, 92% of the students participating in Pisani's (2020) study strongly agreed or agreed that EVs emit less CO_2 than ICE vehicles. Moreover, 56.2% of the participants in Vrösch's (2018) study stated that the main reason for buying an EV was because these vehicles are considered environmentally friendly.

Another common factor referred to by many participants from different research studies, which was putting individuals off from buying an EV was the purchase price of an EV. Lewicki *et al.* (2021) carried out a research study amongst Polish citizens, and only 8% of the participants stated that the purchase cost of EV was not high. On the other hand, 87% of the participants agreed that the cost of purchasing an EV was high. The participants in Berkeley *et al.*'s (2018) study and Bienias *et al.*'s (2019) study identified the purchase price as one of the top factors deterring people from buying an EV. Furthermore, 86% of the participants in Pisani's study (2020) considered the purchase price of an EV higher than the price of an ICE vehicle. Moreover, 29.66% of the participants in Vrösch's (2018) study stated that the main barrier that pushed them from buying an EV was the purchase cost because EVs were considered too

expensive. In this research study, the participants classified the purchase cost as the main reason hindering participants from buying an EV.

In several research studies (Graham-Rowe *et al.,* 2012; Steinhilber *et al.,* 2013; Zaunbrecher *et al.,* 2014), trust and faith in new technology were identified as barriers hindering participants from buying an EV. In Zaunbrecher *et al.*'s (2014) study, some participants expressed their concern that the grid is not yet capable of supplying the electricity required to charge an EV. These participants even stated that garages do not cater to EVs in case of problems. On the other hand, in Berkeley *et al.*'s (2018) study, trust and faith in new technology were not one of the top concerns of the participants. The barrier of least concern for the participants in this study was the 'belief that EVs are an inferior or unreliable technology' (ibid). Furthermore, 41% of the participants stated that they would delay their decision to purchase an EV due to future improvements to EV technology. The participants in Graham-Rowe *et al.* 's (2012) study and Rezvani *et al.*'s (2015) study also, put forward this statement.

The response was different when the participants in some of the consulted studies were asked if they would change their vehicle in the next few years. In Lewicki *et al.*'s (2021) study, 62% of the participants stated that they would not be changing their vehicle, while only 13% said that they would change their vehicle. On the contrary, 25% of the participants were undecided. Moreover, in Pisani's (2020) study, only 14% of the participants stated that they did not have the intention of replacing their vehicle. Furthermore, 65.4% of the participants in Bienias *et al.*'s (2019) study said they would buy an innovative good when they needed it. On the contrary, 25% of the participants stated that they are not willing to buy an innovative product unless their peers have bought it and are satisfied with its purchase (ibid). Additionally, 7.7% of the participants stated that they make their consumption decisions irrespective of their peers' opinions (ibid).

Moreover, when the participants were asked what motivates them to buy an EV, 26% of the participants stated financial subsidiary to lower the financial burden, followed by free parking zones (19%), exemption from excise tax (19%), extended warranties (15%), and excess to recharge charging stations (15%) (ibid). Furthermore, the authors of this research study concluded that consumers' willingness to purchase an EV increases with (i) size of the household members and the hometown; (ii) basic knowledge on these types of vehicles and; (iii) positive opinions on the impact of EVs on the environment, their safety, and social prestige (ibid). When the size of the household members and hometown increase, consumers may be more willing to purchase an EV due to an increase in recharging stations, and they can also make use of bus lanes and free parking places (ibid).

Low operating and fuel costs to maintain an EV should balance the abovementioned barriers (Pisani, 2020). Maintenance costs are expected to be lower than the costs of an ICE vehicle, mainly due to fewer parts that can break alone (ibid). The participants in Egbue and Long's (2012) study and Sierzchula *et al.*'s (2014) study considered EVs a worthy investment because they believe that gas prices will rise in the coming years. Furthermore, Krause *et al.* (2016) stated that fuel costs are expected to rise at a higher rate than electricity prices.

2.4 Chapter Conclusion

Research studies show that EVs' features differ from those of ICE vehicles; therefore, insurance companies have to consider the risks associated with these new types of vehicles when designing their respective premium. The top four crucial barriers pushing the participants involved in the research above studies from buying an EV included the price to purchase an EV, the charging time, the driving range, and the lack of charging infrastructure. No research study was carried out to assess the impact of EVs on Maltese insurance companies, the changes these companies have to undergo to offer its clients a reasonable premium, and the concerns of

the Maltese public about the transition towards EVs. Therefore, this research study intends to address these identified research gaps.

CHAPTER 3: METHODOLOGY

3.1 Introduction

This chapter provides an overview of the methodology applied in this study, consisting of the rationale behind the research questions, research design used, the method of data collection, how the participants were chosen, the method of data analysis, the underlying ethical considerations, as well as the limitations of this research study.

3.2 Research Questions

After analysing the published literature of the subject and established the objectives of this study, the following four research questions were identified:

1. **How did Maltese insurance companies adjust their policies to be able to insure EVs?**

Through this research question, the researcher seeks to understand:

- how have Maltese insurance companies adjusted their policies to address the risks associated with EVs;
- what kind of insurance policy do they offer to their clients who have an EV and how this policy differs from the standard motor insurance policy; and
- whether insuring an EV is riskier than insuring an ICE vehicle from the perspective of those insurance companies which already have an EV policy.

2. **How should Maltese insurance companies which do not have an EV policy adapt to address the risks associated with EVs?**

Through this research question, the researcher seeks to understand:

- what is holding Maltese insurance companies which currently do not have an EV insurance policy from adjusting their policies to address the risks associated with EVs;

- how will they intend to adjust their policies if their company has the intention to start offering an EV insurance policy in the next two years; and

- whether insuring an EV is riskier than insuring an ICE vehicle from the perspective of those insurance companies which currently do not have an EV insurance policy.

3. What are the attitudes of the Maltese population about transitioning from a petrol/diesel vehicle to an EV?

Through this research question the researcher aims to understand:

- to what extent residents in Malta are familiar with the term EV;

- the factors that would influence residents in Malta when purchasing an EV and how do these factors differ from the factors identified by other authors in other research studies;

- how willing are residents in Malta to buy an EV within the next 2 years; and

- what will incentivise residents in Malta to purchase an EV.

4. What correlation can be established between the low percentage of EVs in Malta and the risks associated with them?

Through this research question the researcher aims to understand:

- to what extent residents in Malta and insurance companies consider EVs riskier compared to ICE vehicles; and

- if there is any correlation between the low percentage of EVs in Malta and the risks associated with these vehicles and if not why the percentage of EVs in Malta is low.

3.3 Research Approach

Research questions can be answered either through a deductive or an inductive approach (Bryman, 2012). When using a deductive approach, the researcher makes use of the literature to identify the theory from which the hypothesis (or hypotheses) is (are) deduced (ibid). Therefore, with a deductive approach, both the theory and hypothesis (or hypotheses) are first to be developed (ibid). Then a research strategy is designed in order to test the hypothesis (or hypotheses) (ibid). With a deductive approach, a clear theoretical position is created before the collection of data (ibid).

On the other hand, with an inductive approach, the researcher first collects the data and then establishes the theory based on the results gathered (ibid). In other words, the researcher opts to gather and analyse the data from which the theories are then developed, which will subsequently relate to the literature (ibid). This kind of approach is often referred to as building theory as theory would follow data (ibid). Therefore, by using an inductive approach, the researcher gains a better understanding of the meanings human beings attach to certain events and to the research context itself (ibid).

An inductive approach was seen as the best research approach to answer the research questions in Chapter 1.4. This type of approach was chosen since both the quantitative and qualitative data are guided by specific objectives. Therefore, by using an inductive approach, the researcher can better understand the crucial meanings of the data collected and their relevance in answering the research questions.

3.4 Research Design

3.4.1 Quantitative Method: An Online Survey

After analysing each quantitative method individually, a self-administered online survey through Google Forms was chosen as the most appropriate research method to reach a threshold of 385 participants. Self-administered online surveys were selected because they are cheap and quick to administer when compared to interviews (Bryman, 2012). Also, this research method minimises the researcher's influence on the participants because the survey was carried out at a time convenient for the participants (ibid). Every individual with a driving license, currently residing in Malta, and having access to different media platforms was eligible to participate in this online survey circulated across various social media platforms for a month. The online survey was composed of 29 closed-ended questions, including a mix of multiple-choice questions, Likert Scale questions, checkbox questions, and one open-ended question. The survey comprised six sets of information relating to (i) demographic characteristics; (ii) car ownership and travel behaviour; (iii) familiarity with the concept of EV; (iv) factors influencing the purchase of EVs; (v) risks associated with EVs; and (vi) levels of EVs adoption. The questions asked in the online survey can be found in Appendix 1.

3.4.2 Qualitative Method: Open-Ended Questionnaires

After analysing each qualitative method individually, structured interviews through Google Forms were chosen as the most appropriate research method. Structured interviews were chosen because they are straightforward to conduct and focus on asking questions in a predetermined sequence (Bryman, 2012). Furthermore, structured interviews allow the researcher to quickly compare responses between participants in a uniform context, identify any patterns, and highlight areas that require further study (ibid). Two sets of questions were designed; one for insurance companies that already offer an EV insurance policy, and another one for those that do not yet have an EV insurance policy. The set of questions designed

included multiple-choice questions and open-ended questions. At the start of the structured interview, the representatives appointed by the company were asked about their role within the company, how long they have been working in that role and whether the company they represent offers an EV insurance policy. Representatives who stated that their company offers an EV insurance policy were mainly asked to (i) provide an overview of the EV insurance policy; (ii) what adjustments were undertaken by the company to start offering an EV insurance policy; and (iii) what differences there are between standard motor insurance and an EV insurance policy. The questions asked to Maltese insurance companies which already have an EV insurance policy can be found in Appendix 2. Representatives who stated that their company does not offer an EV insurance policy were asked (i) why their company does not offer such a policy; (ii) whether the company has any intention to introduce an EV insurance policy within the next two years; and (iii) what changes need the company to undergo if the company decides to introduce an EV insurance policy. The questionnaires distributed to the representatives of the insurance companies can be found in Appendix 3. All the representatives of the insurance companies were asked questions on risks associated with EVs and ICE vehicles. Through these questionnaires, the researcher will understand (i) the perspectives of the five main insurance companies in Malta on EVs; and (ii) the adjustments made by the insurance companies to accommodate these vehicles.

3.4.3 Pilot Tests

Pilot tests are conducted before distributing questionnaires or interviews with the chosen participants to ensure that the required information will be gathered and the research instrument functions well (Bryman, 2012). Pilot tests are crucial to be carried out when the researcher opts out to carry out self-administered questionnaires, which need to be completed by the participants themselves without the researcher's presence (ibid).

Five participants, well versed in academic research, were used to test the questions of the online survey designed for the public and the open-ended questionnaire for the insurance companies. These five participants were identical for both questionnaires and had different knowledge of the subject. In the pilot tests, each participant answered the same questions designed to collect information from the public and insurance companies. The suggestions put forward by the participants were all taken into consideration, and the research collection tools were amended. Since the data collection methods were validated, the data gathered through these methods can be considered valid and reliable.

3.5 Sample

The participants for this study were chosen through two sampling methods; purposive sampling and random sampling. Purposive sampling, also known as judgmental sampling, enables the researcher to use his/her judgement to select certain cases which will provide an adequate answer to the research questions and ultimately meet the objectives outlined in the research study (Bryman, 2012). This kind of sampling is often used when sample sizes are small and when the researcher wishes to choose particularly informative cases (ibid). The insurance companies invited to participate in this research study were selected through purposive sampling. On the other hand, random sampling is the most straightforward probability sampling method and provides the ground for an equal probability of inclusion to exist in each unit of the population (Thomas, 2020). This type of sampling is used when the researcher needs to make statistical inferences about a population (ibid). With this type of sampling, high internal validity and lower impact of potential confounding variables can be obtained (ibid). Since the threshold that must be met for this research study was 385, random sampling was considered the ideal method to select the participants for the survey. A 385 threshold was derived as the confidence level was set at 95%, while the margin of error was set at ±5%. The sample size gathered from the online survey was 408, an increase of 5.974% from the

threshold.

After gaining approval from the University Research Ethics Committee (UREC), the chosen insurance companies were informed about this research study through email. Attached with this email was an information sheet (Appendix 4) explaining the objectives of the research study, their role in this research study, the aims of the open-ended questionnaire, and that participation in this research study was voluntary. Upon confirming the company's participation in this research study, the company appointed a representative to complete the open-ended questionnaire and filled out a consent form (Appendix 4).

Regarding the online survey, at the start of the survey, the participants were provided with the objectives of this research study, their role in this study, and their participation in this study was voluntary (Appendix 5). Before completing the survey, the participants agreed to participate in this study. This survey was circulated on different social media platforms for a month.

3.6 Data Analysis Tools

3.6.1 Quantitative Data Analysis

Several non-parametric tests and regression analyses were carried out through the Statistical Package for Social Sciences (SPSS) to analyse the information gathered from the online survey. Unlike parametric statistical analysis, the non-parametric statistical analysis does not require the assumption of normality to be satisfied (Nahm, 2016). The assumption of normality assumes that the means of the sample population are normally distributed, and the variances of the samples and their corresponding population are the same (ibid). Therefore, non-parametric statistical analysis can be used when the distribution of the sample is either skewed or when there is an unknown distribution (ibid). The data gathered from the online survey was deemed

best to be analysed through non-parametric statistical analysis because the researcher cannot make any assumptions about the population. Furthermore, through regression analysis, the researcher can establish which factors are the most important, which factors can be disregarded, and how these factors impact one another (ibid).

The first non-parametric test is the independent t-test or the unrelated t-test (Hinton *et al.,* 2014). This type of test is used when the samples are unrelated and considers different participants in each sample (ibid). Kruskal-Wallis test is a type of an independent t-test that can be used when analysing a single independent variable with more than two samples (ibid). This test was used to examine if there is any significant difference between the familiarity of EVs, gender, age, and household size. The second non-parametric test is the related t-test or the repeated measures t-test (ibid). Unlike the independent t-test, this type of test is used when the samples are related and considers the same participants in each sample (ibid). Friedman's Two-Way test is a type of a related t-test that can be used when analysing the order of the participants' results when given a set of factors that need to be ranked (ibid). This test was used to analyse the order of the different factors that can influence the purchase of EVs.

The first regression analysis evaluated the levels of EVs adoption in relation to gender and age. The second regression analysis assessed whether the variables of age, gender, and household size have an impact on the purchase price. The third regression analysis evaluated whether the variables of age, gender, and household size have an impact on government incentives. The fourth regression analysis assessed whether the variables of age, gender, and household size have an impact on maintenance costs.

3.6.2 Qualitative Data Analysis

From the four qualitative data analysis approaches put forward by Bhandari (2012); content analysis, thematic analysis, textual analysis, and discourse analysis, data gathered from the open-ended questionnaires and the open-ended question of the online survey was best deemed to be analysed through thematic analysis. Thematic analysis is a useful method when the researcher needs to familiarise himself/herself with the participants' beliefs, opinions, knowledge, experiences, and values (Caulfield, 2019). Additionally, this type of analysis provides the researcher with a lot of flexibility when interpreting the data and allows the researcher to sort large data sets into broad themes (ibid).

After clarifying any unclear responses with the respective respondents, each participant was given a code to ensure the anonymity of the participant and that none of them can't be identified by the reader. After getting familiarised with the data collected, the data was codified, and themes were set up. An exercise was carried out on which themes to keep and which to discard. The themes kept were those put forward by half of the participants or more in the case of insurance companies and two or more participants in the case of the general public because only 54 participants opted for the open-ended question in the online survey.

3.7 Limitations

1. Only persons with access to social media platforms could complete the survey. Persons interested in the subject but do not have access to the social media platforms used could not participate in this research study.

2. Due to a lack of research based in Malta on this subject, the results obtained could not be compared or corroborated with other research studies using different data collection methods.

3. Even though the sample was representative of local insurance companies (80%), the sample size was still very small that it cannot be used to compare with results from foreign countries.

CHAPTER 4: ANALYSIS AND DISCUSSION

4.1 Introduction

Two different research methods were used to collect data for this study; an online survey and an open-ended questionnaire to understand (i) the perceptions of the Maltese population towards the transition to EVs; and (ii) the impact of EVs on the Maltese insurance market. The chapter is divided into three sub-chapters (4.2, 4.3, and 4.4). Chapter 4.2 presents the information gathered from the online survey to understand the perceptions of the Maltese population towards the transition to EVs. Chapter 4.3 presents the information collected from the open-ended questionnaire to understand the impact of EVs on Maltese insurance companies. A discussion of the results of this research study with reference to the literature found on this subject matter follows in Chapter 4.4.

4.2 The Perceptions of the Maltese Population Towards the Transition to EVs

Persons currently residing in Malta, in possession of a driving license, and reachable through different social media platforms were invited to participate in an online survey to help the researcher answer the following research questions:

Research Question 3: What are the attitudes of the Maltese population about transitioning from a petrol/diesel vehicle to an EV?

Research Question 4: What correlation can be established between the low percentage of EVs in Malta and the risks associated with them?

After an online survey was promoted on different social media platforms for 30 days, a total of 408 persons accepted to complete this online survey voluntarily. All these 408 participants satisfied the criteria required to complete the survey. The eligibility criteria to be met were (i)

currently residing in Malta and (ii) possessing a driving license. An additional 12 responses were considered invalid; 1 because the person completing the survey was not residing in Malta and 11 because the persons conducting the survey did not have a driving license. Therefore, these 12 persons were omitted from continuing to answer the survey and from this research study. The percentage figures representing the participants' responses will be rounded to three decimal places.

Figure 1 illustrates that 60.294% (246) of the participants were male, 39.461% (161) were female, and 0.245% (1) classified themselves as 'Other.' These figures show that the majority of the participants who completed this survey were male.

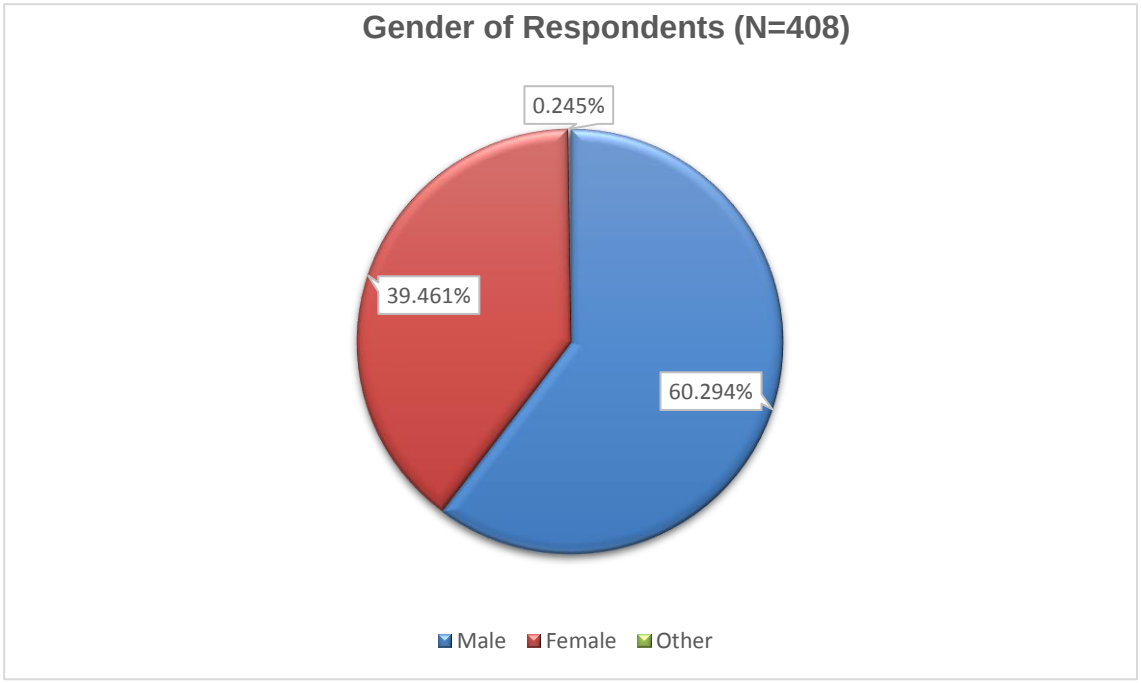

Figure 1: Distribution of Respondents by Gender

Furthermore, Figure 2 illustrates that 37.500% (153) of the participants in this study were between 31 to 45 years, 32.108% (131) aged between 18 and 30 years, 23.529% (96) aged between 46 to 60 years, 6.618% (27) aged between 61 and 75 years and 0.245% (1) aged over 76 years.

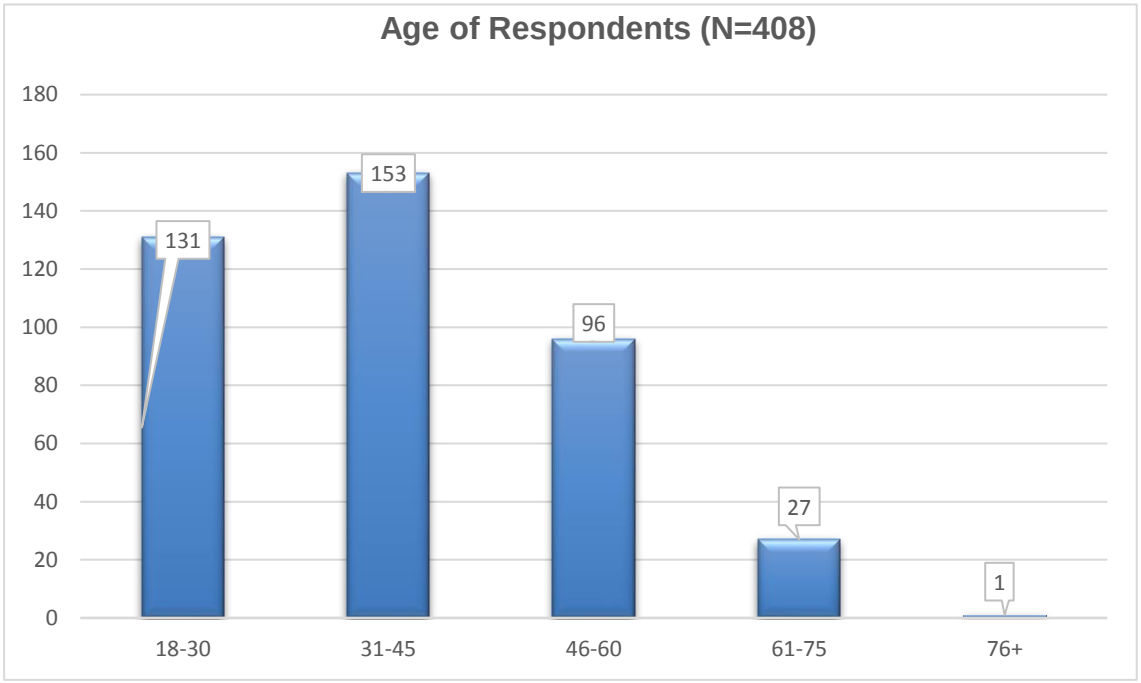

Figure 2: Distribution of Respondents by Age

Moreover, Figure 3 illustrates the household size of each participant. 30.147% (123) of participants share their household size with two other persons, followed by 28.922% (118) participants having a household size of 4, 24.012% (98) of participants share their household with someone else, 9.314% (38) of the respondents have a household size of 5 and 4.657% (19) of the respondents live on their own. Moreover, 2.206% (9) of the participants have a household size of 6, and only 0.735% (3) have a household size of 7 or more.

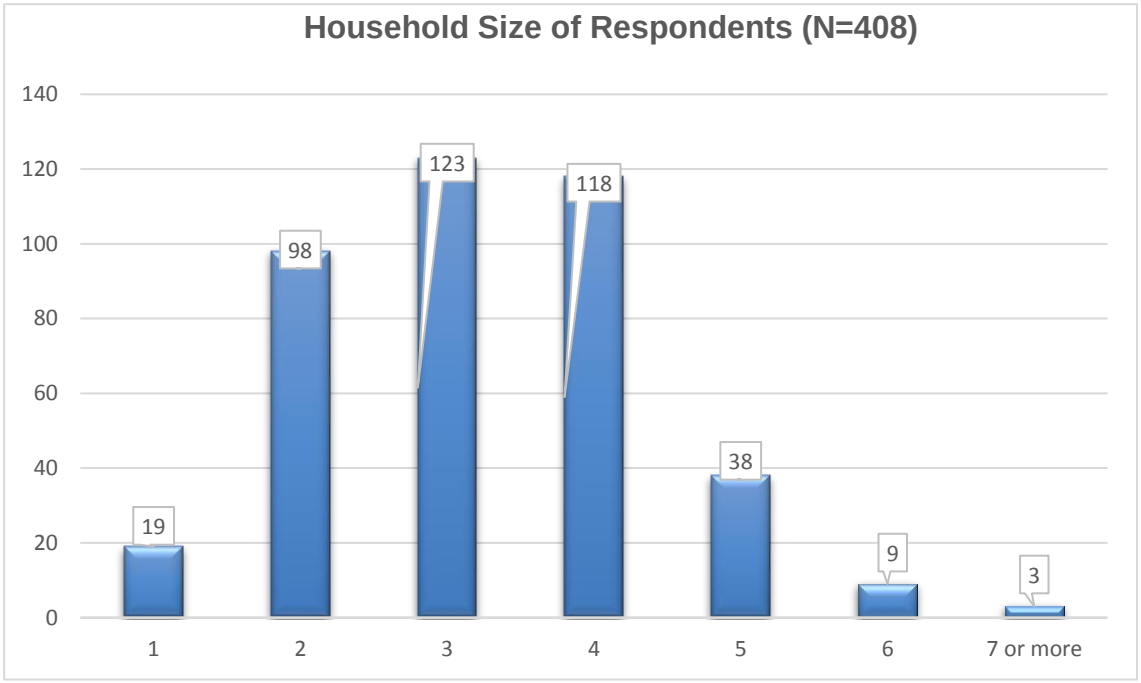

Figure 3: Distribution of Respondents by Household Size

As illustrated in Figure 4, almost all participants (97.79%, 399) owned a car in this survey. Only 2.206% (9) do not own a car. Of the 97.794% (399) of the participants who own a car, only 30.882% (126) own an EV. The rest of the participants, 9.118% (282), do not own an EV, as displayed in Figure 4.

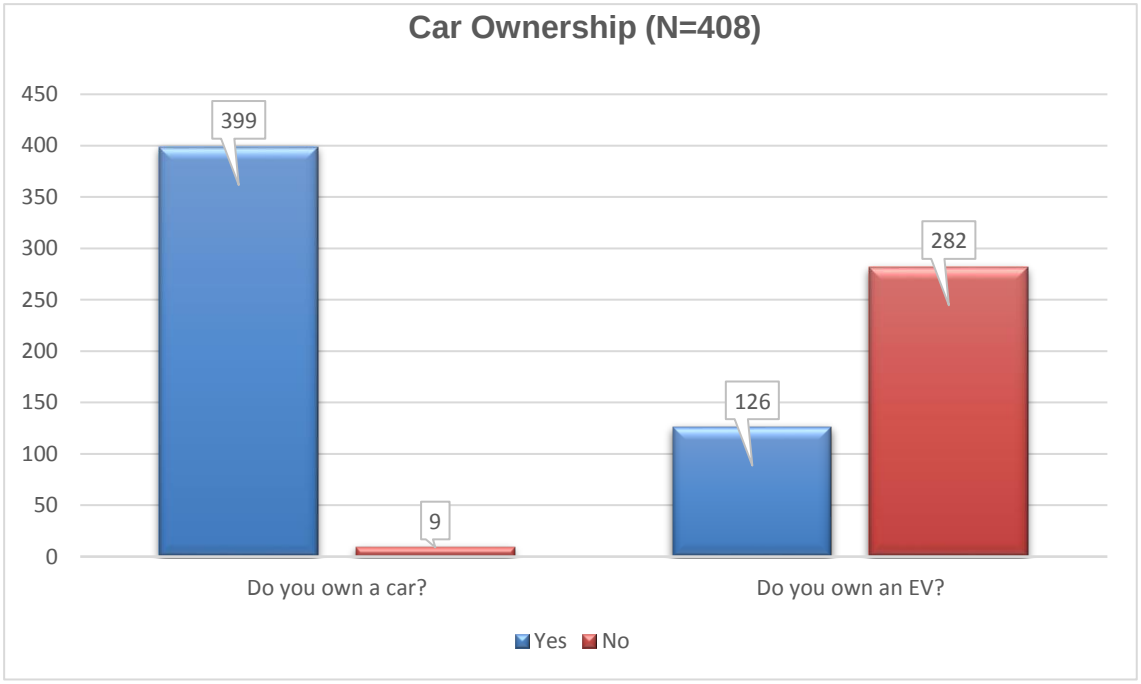

Figure 4: Car Ownership by the Participants

Moreover, the participants were asked whether they would be willing to purchase an EV in the next two years. 28.431% (116) of the participants stated that they already own an EV, while 33.333% (136) said they would consider buying an EV in the next two years. On the other hand, 25.980% (106) of the participants stated that they would think about purchasing an EV but not within the next two years, while 8.578% (35) of the participants indicated that they were not interested in buying an EV. 3.676% (15) of the participants stated that they do not know, as illustrated in Figure 5.

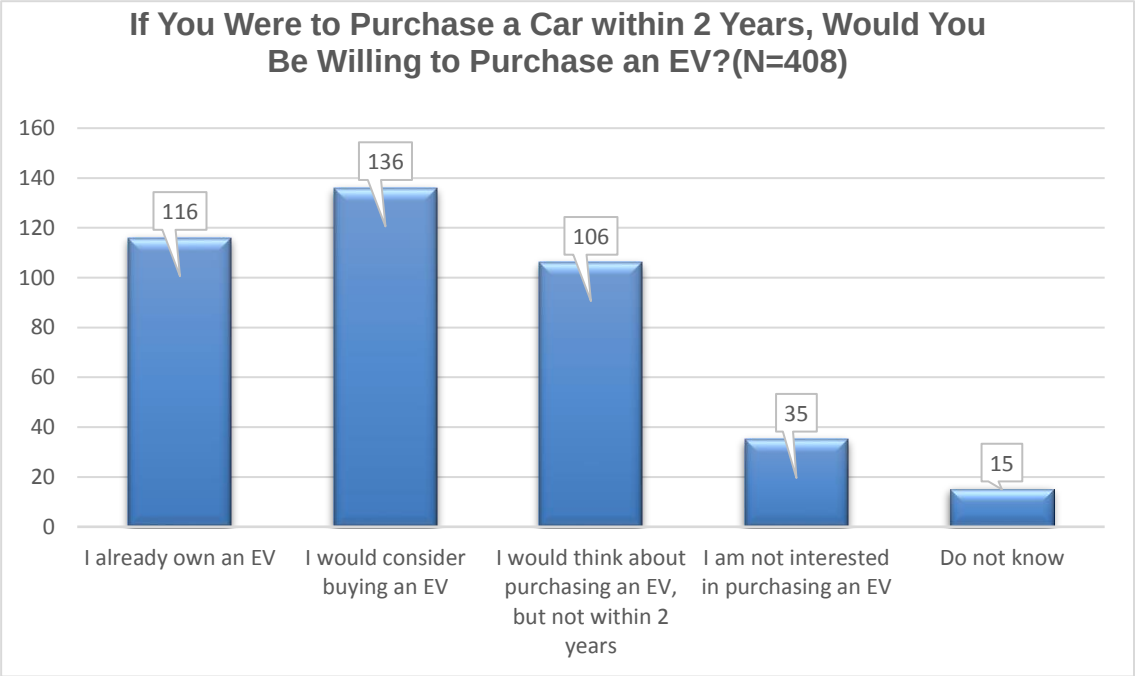

Figure 5: Levels of EVs Adoption by the Participants

Additionally, the participants who currently do not own an EV were asked whether they considered shifting to an EV if gasoline prices were to increase in the next two years. Figure 6 shows that 35.430% (107) 'Strongly Agree', 25.828% (78) 'Agree', 22.848% (69) were 'Undecided', 9.272% (28) 'Disagree' and 6.623% (20) 'Strongly Disagree' with this statement.

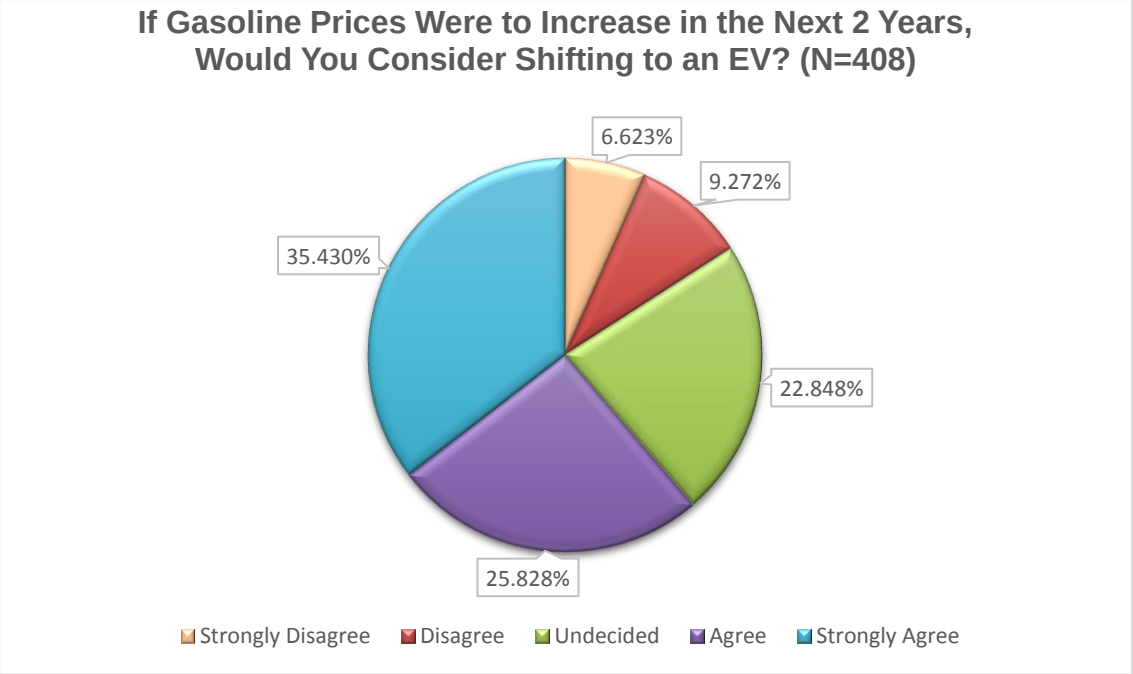

Figure 6: If Gasoline Prices Were to Increase in the Next 2 Years, Would You Consider Shifting to an EV?

The participants were asked how frequently they make use of their vehicle. As illustrated in Figure 7, 65.163% (260) of the respondents stated that they use their vehicle daily, 16.291% (65) frequently, 13.033% (52) occasionally, 3.759% (15) rarely, and only 1.754% (7) never used their vehicle. These figures show that more than half of the participants depended on their car and used it daily.

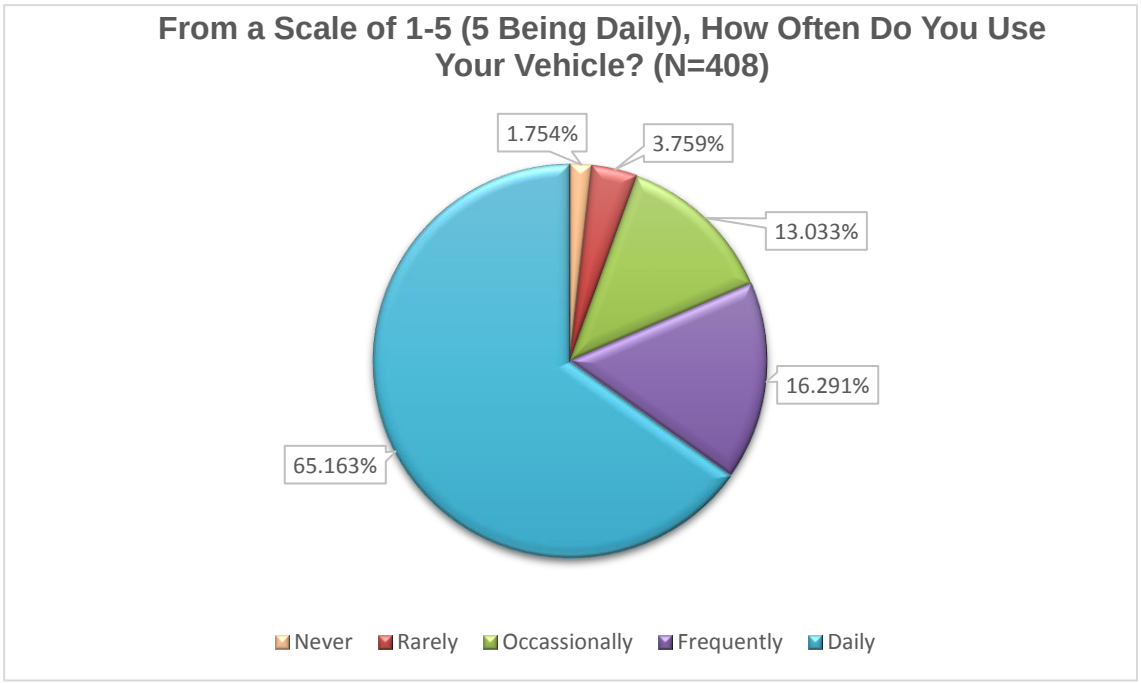

Figure 7: Travel Behaviour by the Participants

After being asked demographic questions and whether they own a driving license and a car, the participants were asked how familiar they were with the term EV on a scale of 1 to 5, with 1 being not familiar at all and 5 being very familiar. As depicted in Figure 8, 63.480% (259) of the respondents stated that they were very familiar with the concept of EV, 20.343% (83) familiar, 11.029% (45) moderately familiar, 3.676% (15) slightly familiar, while only 1.471% (6) of the were not familiar at all with the concept. These percentage figures show that more than half of the participants are very familiar with the term EVs.

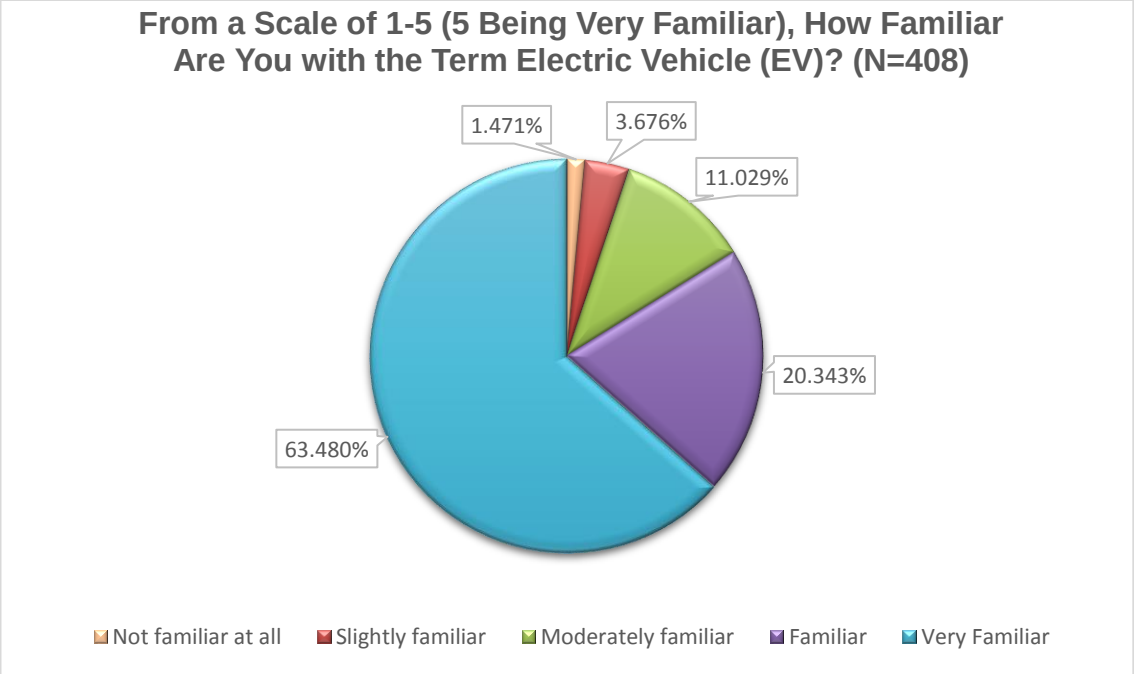

Figure 8: Familiarity with the Concept of EV by the Participants

In Questions 10 to 23 of the online survey found in Appendix 1, the participants had a set of factors found in other studies. The participants had to rank each factor on a scale of 1 to 5; how much each factor would influence them when purchasing an EV, with 1 being not at all and 5 being very much. As Figure 9 illustrates, more than half of the participants stated that battery range, charging costs, charging infrastructure, government incentives, maintenance costs,

purchase price, and safety would influence them ‘very much’ when purchasing an EV. The top three factors that the participants voted as the most factors that would affect them ‘very much’ were the purchase price (65.931%, 269), government incentives (62.990%, 257), and maintenance costs (58.088%, 237). These three factors were followed by safety (55.637%, 227), charging costs (55.147%, 225), and battery range (52.696%, 215). The other factors were considered by 50% or less of the participants as the factors that would influence them ‘very much’ when purchasing an EV. The most negligible factor chosen by the participants as the factor that would affect the participants ‘very much’ when buying an EV was the resale value, as only 19.605% (80) of the respondents chose this factor as the one that would influence them ‘very much’ when purchasing an EV.

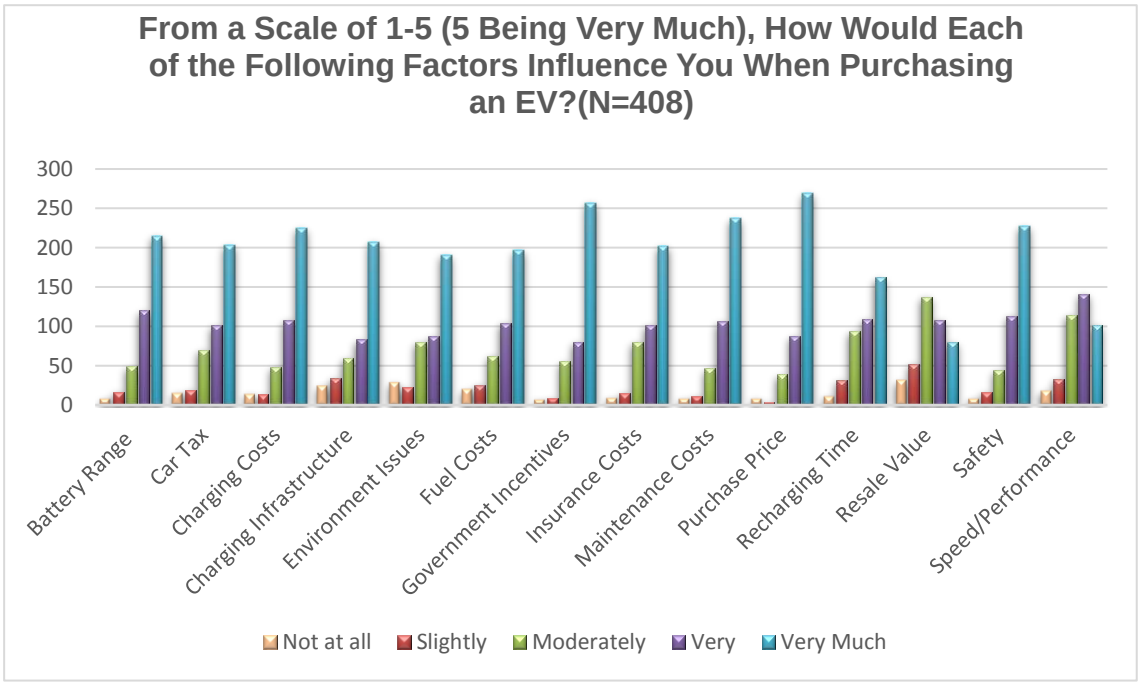

Figure 9: Factors Influencing the Purchase of EVs by the Participants

The participants were then presented with four statements on risks associated with EVs based on the literature found and had to choose to what extent they agree with each statement, with 1 being 'Strongly Disagree,' and 5 being 'Strongly Agree.' The first statement was, 'EVs introduce new types of danger due to high voltage electric equipment that is present in these types of vehicles.' Figure 10 illustrates that 9.314% (38) ‘Strongly Agree', 14.951% (61) 'Agree', 35.784% (146) were 'Undecided', 21.814% (89) 'Disagree', and 18.137% (74) 'Strongly Disagree' with this statement.

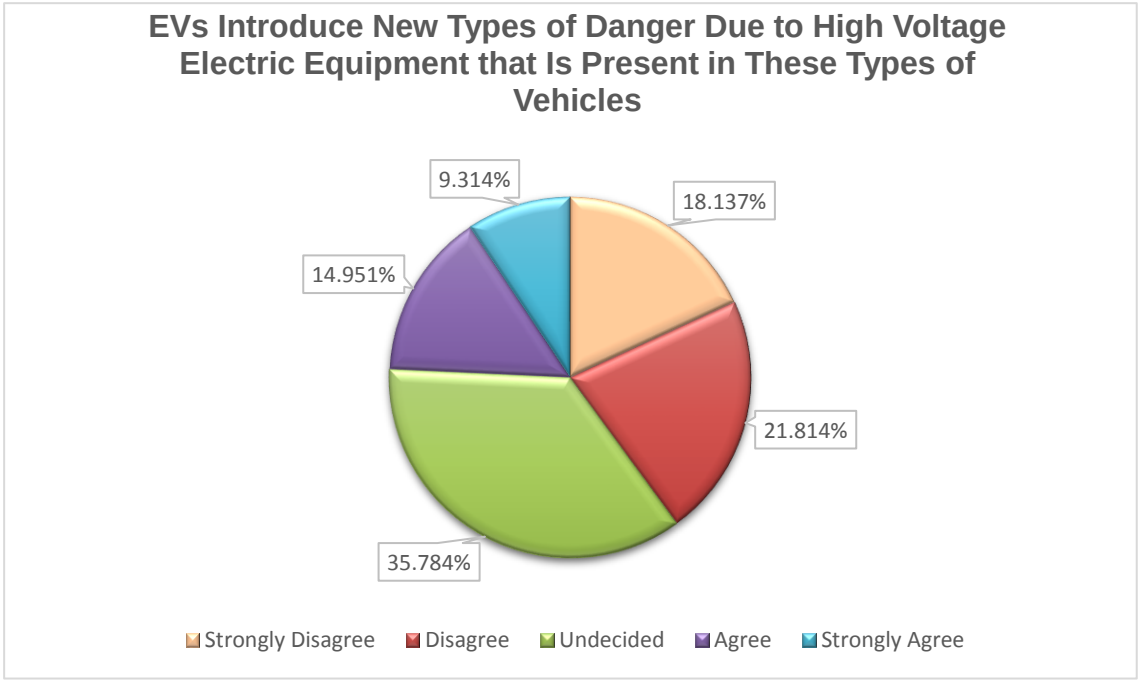

Figure 10: Level of Agreement with the Statement ‘EVs Introduce New Types of Danger Due to High Voltage Electric Equipment That Is Present in These Types of Vehicles’

The second statement was, ‘There is a risk of electric fault when EVs are parked because the battery is always on.’ Figure 11 shows that 5.882% (24) of the participants ‘Strongly Agree’, 11.275% (46) ‘Agree’, 27.941% (114) were ‘Undecided,’ 27.451% (112) ‘Disagree’, and 27.451% (112) ‘Strongly Disagree’ with this statement.

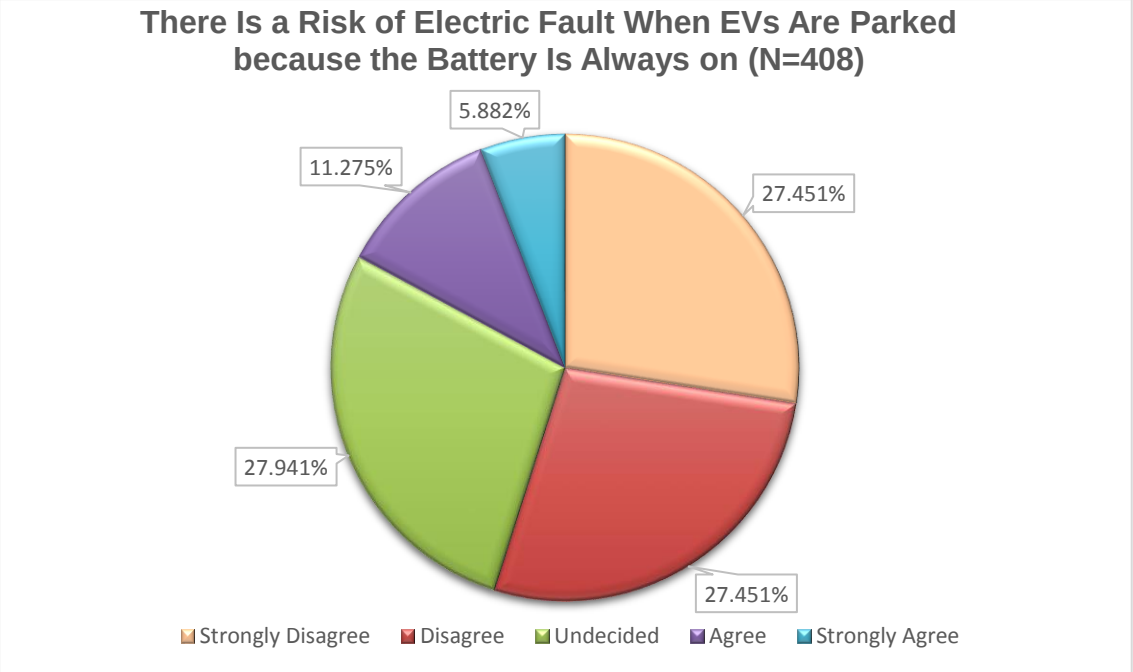

Figure 11: Level of Agreement with the Statement ‘There Is a Risk of Electric Fault When EVs Are Parked because the Battery Is Always On’

The third statement was, ‘Wireless charging infrastructure can help overcome the problem of theft and vandalism attached with EVs. Figure 12 illustrates that 20.098% (82) ‘Strongly Agree’, 26.961% (110) ‘Agree’, 29.412% (120) were ‘Undecided’, 16.912% (69) ‘Disagree’, and 6.618% (27) ‘Strongly Disagree’ with this statement.

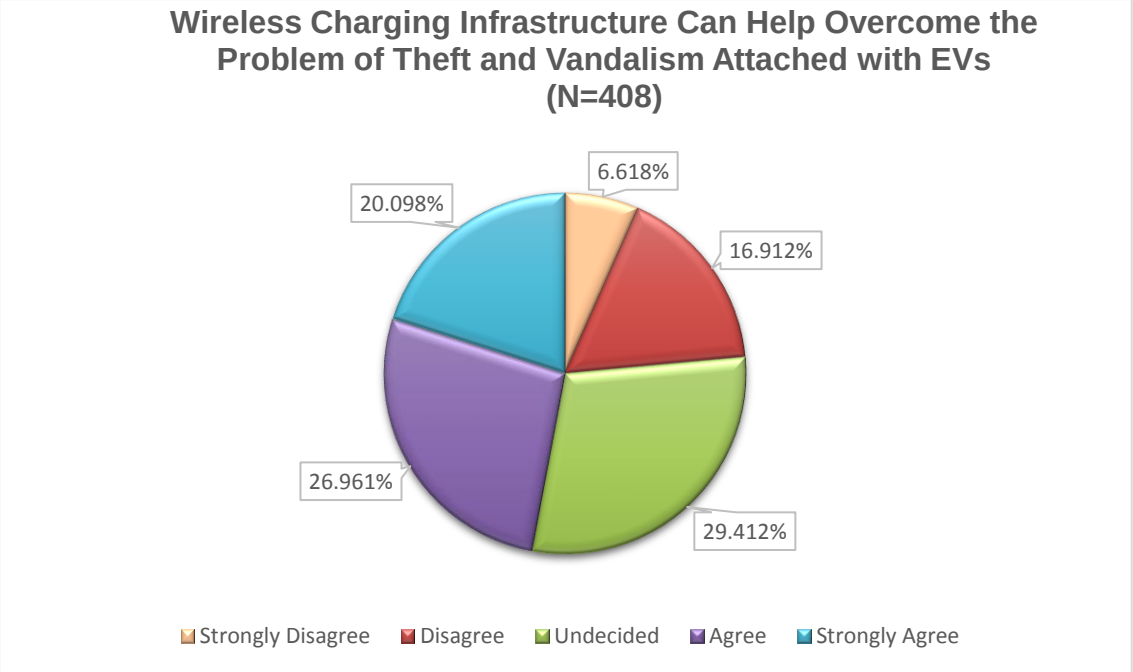

Figure 12: Level of Agreement with the Statement ‘Wireless Charging Infrastructure Can Help Overcome the Problem of Theft and Vandalism Attached with EVs’

The fourth and last statement was, ‘EVs are more prone to cyberattacks because they are considered a more connected mobility solution’. Figure 13 shows that 7.843% (32) ‘Strongly Agree’, 17.402% (71) ‘Agree’ , 34.559% (141) were ’Undecided’, 24.510% (100) ‘Disagree’, and 15.686% (64) ‘Strongly Disagree’ with this statement.

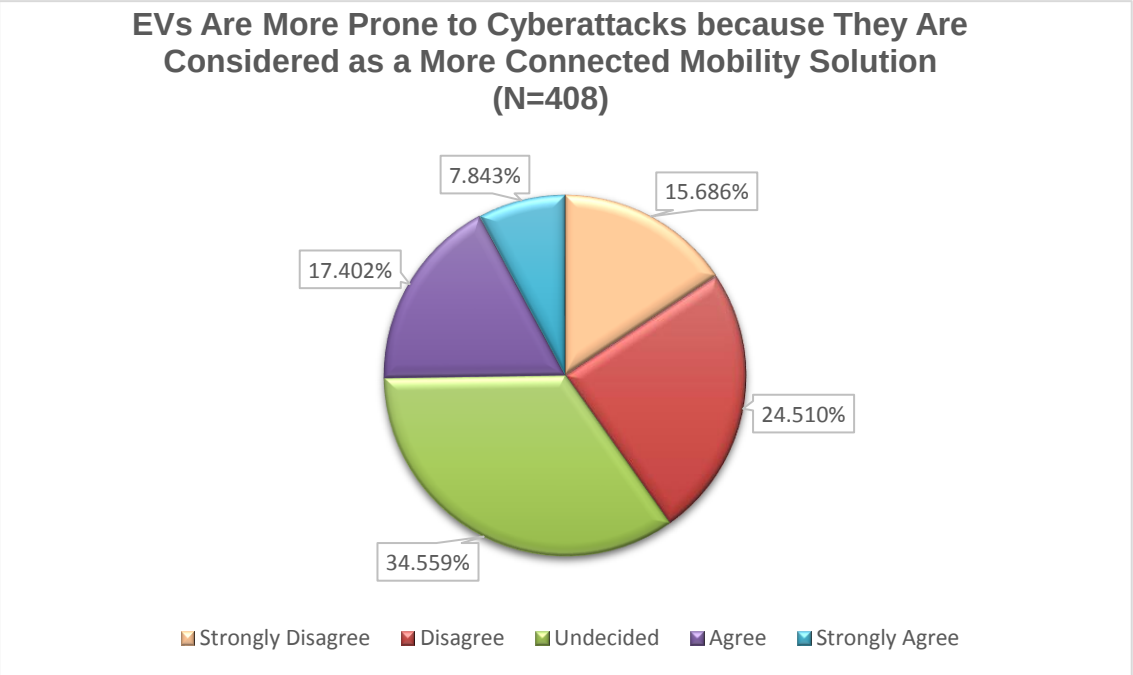

Figure 13: Level of Agreement with the Statement ‘EVs Are More Prone to Cyberattacks because They Are Considered as a More Connected Mobility Solution’

Less than half of the participants strongly agreed or agreed with the above four statements. The only statement with which almost half of the participants (47.059%) strongly agreed or agreed is with the third statement stating, ‘Wireless charging infrastructure can help overcome the problem of theft and vandalism.’ On the other hand, more than half of participants (54.902%) strongly disagreed or disagreed with the second statement stating, ‘There is a risk of electric fault when EVs are parked because the battery is always on.’

Finally, the participants were asked what should be done to encourage residents in Malta to purchase an EV. As illustrated in Figure 14, 78.676% (321) of the participants stated that more charging stations are required, followed by 69.853% (285) saying that more government incentives are necessary. Moreover, 48.529% (198) stated that more awareness of how EVs function is required, and 48.039% (196) said that more knowledge on how to charge EVs at home/work is needed. Only 3.922% (16) of the participants stated that none of the above should be implemented.

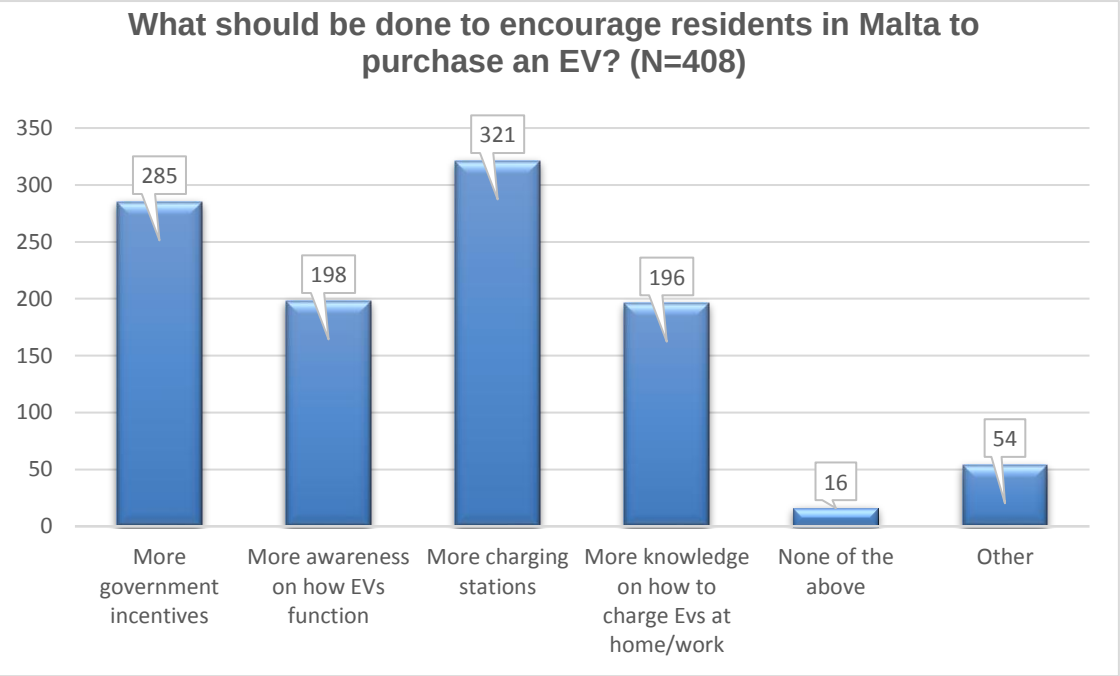

Figure 14: What should be done to encourage residents in Malta to purchase an EV?

In Question 17, the participants were allowed to add other opinions on what should be done to encourage residents in Malta to purchase an EV. Figure 15 illustrates the main themes identified after the information was analysed and gathered.

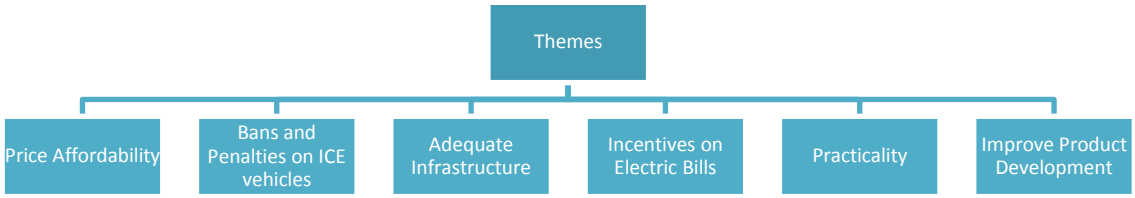

Figure 15: Themes Identified from the Responses Provided by the Participants on What Should Be Done to Encourage More Residents in Malta to Purchase an EV

Theme 1 - Price Affordability

The claim that the price of EVs should be lowered and be made affordable because it is expensive was put forward by several participants. Moreover, one of the participants stated that "the base prices need to be lower as the government incentives can't last forever.'' On the other hand, another participant stated that "it's easy to find a cheap 2nd hand car at around 5k, but that can't be said for an EV," while another participant stated that "their prices should be in line with non-EV cars." Furthermore, one participant stated that:

"The cost to the purchaser should be net of the grant. Even though the grant is generous, a purchaser is required to settle the full payment to the seller before applying for the grant. This means that even when taking out a loan, this will have to cover the full cost of the vehicle. Consequently, the installments are worked out on the full price, and these are often not affordable. Having to finance a vehicle that is €11k cheaper is far more attractive to a buyer. This issue is what is hindering me from purchasing an EV (apart from the fact that they are very expensive, to begin with)."

On the other hand, besides the purchase price, other participants stated that the battery prices, parts prices, and insurance costs should be lower. The participant who said that the price of parts should be reduced explained that "to replace EV car battery costs as much as buying the whole new car brand new is ridiculous and at the end of the day it's not saving our planet." Another participant stated that replacing the battery with a new one would cost €25,000, which is too expensive. Additionally, two of the participants stated that government monitoring is required on inflated prices by dealers caused by government schemes. Another participant stated that the price should be subsidised.

Theme 2 - Bans and Penalties on ICE vehicles

Some of the participants stated that bans/penalties should be introduced on new ICE vehicles. One of the participants who stated that penalties should be introduced further suggested that electric public transport should be improved to reduce the overall number of vehicles on the road. On the other hand, licenses, taxes, and fees associated with ICE vehicles should be more expensive. Furthermore, another participant stated that 2nd hand imports that use fuel should be reduced. On a different note, one of the participants stated that certain areas should be restricted only to EVs rather than to all cars.

Theme 3 - Adequate Infrastructure

One of the participants stated that in Malta, we do not have the ideal infrastructure, and as a country, we should invest in multisensory parking. Another participant noted that it should be ensured that “the wider infrastructure is able to handle the increase in electricity demand due to increase in EVs.” Furthermore, this same participant stated that in Malta, “we already have a wobbly grid as it is, let alone if we all shift to EVs.” Moreover, another participant stated that “Malta is not prepared to supply enough electricity.”

Theme 4 - Incentives on Electric Bills

One of the participants stated that charging your EV at home every day will lead to expensive electricity bills. This participant and another one said that people charging the car at home should be given an incentive on the electricity bill to reduce the costs attached to charging the car at home. Moreover, one of these participants stated that "the EV meter incentive is not good enough since the installation of an additional meter has many requirements."

Theme 5 – Practicality

One participant stated, "if you own a garage, you should be driving an EV. If you don't, the debate is wide open." Another participant stated that home charging points should be allowed without having a garage. Another participant noted that solutions should be found to charge vehicles without a garage. A suggestion put forward by another participant was "incentivise reserved parking at a yearly cost in front of EV owner so that he can charge directly from inside the home." On a completely different note, one of the participants stated that there should be simpler and easier ways to contact Enemalta for assistance regarding installing the home meter and taking meter readings.

Theme 6 – Improve Product Development

One participant stated that the EV model types need to increase, especially in the city car class. Another participant also said, "I have yet to see a family 7-seater yet compact EV. Unfortunately, they are too small." Moreover, some of the participants stated that the specifications of the battery should be modified and be more long life because there is the belief that the battery life of an EV is between 7 and 10 years and afterwards, the car has no value.

4.3 The Impact of EVs on the Maltese Insurance Market

Five insurance companies established in Malta were invited to participate in an open-ended questionnaire to help the researcher answer the following research questions:

Research Question 1: How did Maltese insurance companies adjust their policies to be able to insure EVs?

Research Question 2: How should Maltese insurance companies which do not have an EV policy adapt to address the risks associated with EVs?

Research Question 4: What correlation can be established between the low percentage of EVs in Malta and the risks associated with them?

Four out of the five invited insurance companies accepted to participate in this research study and appointed a representative to answer the questions set out in the open-ended questionnaire. All the representatives appointed occupy a top-level position within the company they work for, ranging from Head of Product Management to Chief Officer in the Personal Insurance Operations. The participants' experience within their role ranged from 1.33 years to more than 22 years. On the other hand, one out of the five invited insurance companies opted out of participating in this research study. Several reminders were sent to the insurance company. However, this company did not appoint a representative to complete the questionnaire. For anonymity, the insurance companies' names and their respective representatives will be referred to as *Insurance Company A, Insurance Company B, Insurance Company C,* and *Insurance Company D*.

One of the four participant companies, *Insurance Company C,* offers its clients an insurance policy specifically for EVs. The other three insurance companies do not provide an insurance

policy specifically for EVs. *Insurance Company C* has been offering this insurance policy for the last year. On the other hand, *Insurance Company A* offers different rates and additional specific cover to EVs under its standard motor insurance policy. *Insurance companies B* and *D* offer only the standard motor insurance policy. The representative of *Insurance Company D* explained that the company's standard insurance policy of the company s/he works for already offers the same coverage provided by other insurance companies with a dedicated EV insurance policy. Furthermore, the representative of this respective company stated that having an insurance policy, particularly for EVs, is like having an insurance policy, one for petrol vehicles and another for diesel vehicles. In this participant's opinion, "the only value of having a separate EV policy was in marketing." Therefore, it does not make sense to have a separate EV insurance and is not considering offering an EV insurance policy in the next two years.

4.3.1 Thematic Analysis

Figure 16 illustrates the five main themes identified after the information gathered through the open-ended questionnaire was analysed and codified. Several sub-themes emerged from the main themes, as displayed in this figure. All the themes and sub-themes identified were put forward by more than half the participants.

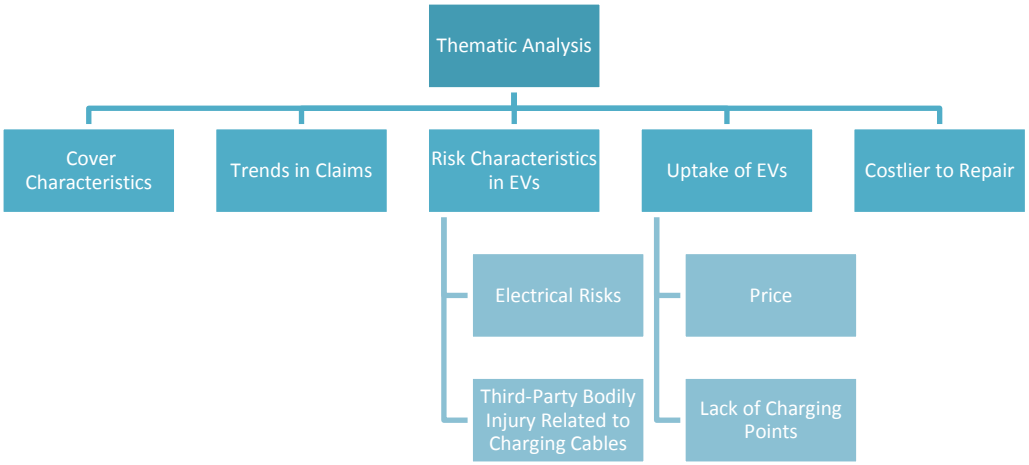

Figure 16: Themes and Subthemes Identified from the Responses Provided by the Insurance Companies

Theme 1 - Cover Characteristics

This theme was derived from the responses provided by the participants when asked to give a brief overview of their company's EV policy, the main differences between a standard motor insurance and an EV insurance policy, and how the company adjusted its motor policy to start accommodating EVs. The participant representing *Insurance Company B* stated that there is not much difference between an EV and an ICE vehicle regarding coverage. The company's damage policy covers the vehicle irrespective of whether it is an EV or an ICE vehicle. Therefore, both vehicles will be covered in an accident regardless of whether the vehicle operates by an engine or an array of batteries. Furthermore, this same participant stated that even though EVs carry a risk of overvoltage because they need to be plugged in to be charged, this factor does not impact the coverage provided because an ICE vehicle's battery works similarly to a conventional charger which poses the same risk as an EV. Moreover, when this participant was asked how its company adjusted its motor policy to start accommodating EVs, the participant stated that their motor insurance policy never excluded EVs. The participant from *Insurance company D* also agreed with the participant from *Insurance Company B* that there is not much difference between an EV and an ICE vehicle in terms of coverage. The participant from *Insurance Company D* stated that "EVs do not require any special underwriting or pricing treatment or a dedicated policy wording."

The representative of *Insurance Company A* explained that under the conventional motor policy, the company offers different rates and additional specific cover to EVs due to its battery and any third-party liability related to plug-in cables. When the representative from *Insurance Company A* was asked what the differences are between a standard motor insurance and an EV insurance, the participant stated that both types of insurance policies offer the same level of protection. On the other hand, the participant representing *Insurance Company C* explained that the company s/he works for offers the standard motor policy and a separate EV insurance

policy. The EV insurance policy provides additional coverage for different circumstances such as electric overload damage due to lightning strikes and short circuits, animal bites on the drive battery resulting in damage, scrappage costs after an accident, and decontamination costs, amongst others. Furthermore, the company has also changed the breakdown assistance services offered. Battery boost assistance does not apply to fully electric vehicles but only to hybrid cars. While the 'out of fuel' service applies to hybrid vehicles only, fully EVs will be towed to the nearest charging point. The adjustments made by *Insurance Company* C to accommodate EVs were "mainly in terms of additional coverage offered specifically to these types of vehicles and amendments in the breakdown assistance service (to reflect the needs of EVs)." The representative of this insurance company stated that the other insurance companies in the Maltese market offer the standard motor cover, which is not tailor-made for the needs of hybrid cars and EVs. On the other hand, the product offered by *Insurance Company C* is "more comprehensive for these types of vehicles", according to the participant representing this company in this research study.

Theme 2: Trends in Claims

The theme of trends in claims was derived from the responses provided by the participants when asked if EVs will impact the number of insurance claims. The insurance companies' representatives disagree that EVs will increase the number of claims lodged. The participant representing *Insurance Company D* explained that EVs include automatic braking systems, lane assist, pedestrian detection, adaptive cruise control, and blind spot detection, which aim to reduce accidents. Furthermore, the representative of *Insurance Company B* stated that "due to the high voltage stored, one would expect that there would be an increase in the number of claims, but since most EVs are in the top range in terms of safety and driving assistance, one would hope that the increase in fire claims would be balanced out due to the added driving assistance included in such vehicles." When this participant was asked whether the insurance company has ever experienced claims related to EVs, s/he stated that they had not experienced

any abnormal claims other than normal collisions. The representative of *Insurance Company C* also said that as a company, they have received claims related to EVs but only in terms of the standard motor insurance rather than the additional coverages offered to EVs. Furthermore, the participant representing *Insurance Company D* explained that the buyers of EVs tend to be young, earning a better than average income, and are better-educated persons who tend to have a better claims experience than the average. This may lead to misinterpretation of statistics showing that EVs have fewer claims than ICE vehicles. The representative of *Insurance Company A* stated that it is too early when asked whether their company has experienced any claims related to EVs.

Theme 3: Risk Characteristics in EVs

When the participants were asked whether their company considers insuring EVs riskier than petrol and diesel vehicles, two out of the participants (*Insurance Companies B* and *D*) do not consider insuring EVs more dangerous than petrol and diesel vehicles. The representative of *Insurance Company D* stated that "while an EV or PHEV can suffer damage to the main battery which is absent in an ICE vehicle, the same can be said for the damage to the fuel tanks and system in ICE vehicles which are absent in EVs." Moreover, the representative of *Insurance Company A* stated that "it is still too early to have a clear picture of the impact EVs will have." On the contrary, according to its representative, *Insurance Company C* considers insuring EVs riskier than petrol and diesel vehicles because "fire experienced on EVs may take days to be put out, unlike conventional vehicles." The theme of risk characteristics in EVs was narrowed down to two sub-themes, Electrical Risks and Third-Party Bodily Injury Related to Charging Cables.

Electrical Risks

The participant representing *Insurance Company B* stated that "electrical risks are naturally more prevalent in EVs than ICE engines" when asked what risks s/he considers different in EVs

when compared to ICE vehicles. Furthermore, this participant explained that EVs have a risk of overvoltage since they need to be plugged in. The statements put forward by this participant show that s/he believes EVs are more prone to electrical risks than ICE vehicles. Moreover, the representative of *Insurance Company D* indirectly mentions “damage to the battery while charging caused by lightning” as one of the risks associated with EVs. Still, this representative explained that the standard motor policies provide coverage for this risk, and “there is little need or value in specifying them.”

Third-Party Bodily Injury Related to Charging Cables

The representative of *Insurance Company C* stated that third-party bodily injury claims are likely to increase with more EVs on the road, mainly due to the cables required to charge EVs. This can lead the injured individual to open a complaint and sue the car's owner for damages. The representative of *Insurance Company D* explained that EVs policies specify that they offer cover to liability arising from charging cables, including when someone trips over the cables. This statement indirectly shows that charging cables can be considered one of the risks attached to EVs. However, this participant explained that this risk is covered under the standard motor policies, and "there is little need or value in specifying them."

Theme 4: Uptake of EVs

The theme of EV uptake was derived when the participants were asked whether they saw a correlation between the low percentage of EVs in Malta and the risks associated with EVs. All four participants stated that they do not see any correlation between the low rate of EVs in Malta and the risks associated with EVs. All four participants said that the low percentage of EVs in Malta is mainly attributed to other factors, out of which two sub-themes were derived, Price and Lack of Charging Points.

Price

The participant representing *Insurance Company D* stated that the low percentage of EVs in

Malta is mainly due to the price required to buy an EV. Purchasing an EV is costlier than ICE vehicles. Furthermore, the representative of *Insurance Company C* explained that the percentage of EVs in Malta is low because people think EVs are more expensive to buy, run and maintain. However, this participant believes this mentality will slowly change, and people will be more willing to purchase an EV even in light of the government's grants to people buying an EV. On the other hand, the participant of *Insurance Company B* stated that the percentage of EVs in Malta is low because the grants offered by the government have been only out for a few months. Furthermore, the participant representing *Insurance Company A* believes that the "take-up will increase when it makes economic and practical sense to switch to EVs."

Lack of Charging Points

Lack of charging points was identified as one of the reasons why the percentage of EVs in Malta is low by the participants representing *Insurance Companies B* and *D*. However, the participant representing *Insurance Company B* believes that as time goes by, an ICE vehicle will become more expensive to buy when compared to an EV, and with the implementation of more charging pillars across the Maltese islands, the number of EVs on the Maltese roads will increase substantially. Furthermore, the participant representing *Insurance Company D* explained that the low percentage of EVs in Malta is attributed to “the lack of charging infrastructure for those not having a garage or drive in their home.”

Theme 5: Costlier to Repair

The theme of costlier to repair was derived from the responses provided by the participants when asked whether EVs will increase the number of insurance claims and whether EVs are riskier than ICE vehicles. References made by the participants to the severity of claims are incorporated under this theme because all responses provided refer to the costs required to repair EVs. All the participants in this research study agreed that the costs to repair EVs, both parts and labour, will increase compared to ICE vehicles. The representative of *Insurance Company B* explained that the repair costs of EVs will increase because these types of cars

have added safety and driving assistance compared to ICE vehicles. Furthermore, this participant stated that service standards must be maintained due to the extended battery warranty, which continues to increase the price. Moreover, the representative of *Insurance Company D* believes that EVs are costlier to repair since few repairers are experienced in such a field, which will affect the repair cost. Furthermore, this participant continued explaining that repair times can be time-consuming as the battery needs to be disconnected and reconnected once the work is over due to safety and damage issues. Also, evidence shows that replacement parts may be harder to source and are generally less cost-effective. Yet, this participant explained that as a company, they have "retained the same pricing model for EVs and do not charge more." On the other hand, the participant representing *Insurance Company A* mentioned that training personnel to work on EVs is considered a risk in EVs rather than ICE vehicles. Lastly, the participant representing *Insurance Company C* stated that even though the number of claims will remain stable, with no excessive increase, the costs to repair EVs, both parts and labour, will increase compared to ICE vehicles.

4.4 Discussion

4.4.1 Adjustments Undertaken by Maltese Insurance Companies to Accommodate EVs

As discussed in Chapter 2.2, research shows that EVs introduce new types of danger, which can put their users at risk due to the high voltage equipment in these vehicles (Kjosevski *et al.,* 2017). These features can also be dangerous when the vehicle is parked and not being used. Panasiewicz (2015) explained that while an EV is parked, the battery remains on, leading to an electrical fault or electric malfunction. Due to this factor, the risk of an electric shock increases. Furthermore, Sun *et al.* (2020) found that EVs carry an element of overcharging, which may pose another threat. Since the type of batteries used in EVs is lithium-ion which is considered to be highly explosive, they require more attention when it comes to their disposal (Panasiewicz, 2015). In addition, EVs may be subject to theft and vandalism due to the use of

copper in EVs (Jones *et al.,* 2020). Some of the representatives of the insurance companies stated that EVs are riskier than ICE vehicles. The risks mentioned by two or more of the participant insurance companies were electrical risks and third-party injury related to charging cables. One of the participants mentioned the battery's disposal as a risk. However, the representative of *Insurance Company D* stated that "while an EV or PHEV can suffer damage to the main battery which is absent on an ICE vehicle, the same can be said for the damage to the fuel tanks and system in ICE vehicles which are absent in EVs." Furthermore, the participant representing *Insurance Company B* stated that even though EVs carry with them a risk of overvoltage because they have to be plugged in during the charging process, this factor does not impact the coverage provided because the battery of an ICE vehicle works relatively the same but using a conventional charger which poses similar risks as those of an EV. Therefore, there is not much difference between an EV and an ICE vehicle regarding coverage. Moreover, the representative of *Insurance Company D* stated that "the only value of having a separate EV policy was in marketing'', because their standard motor insurance policy offers the same coverage provided by insurance companies with a specific EV insurance policy.

As explained in Chapter 4.3, only *Insurance Company C* has a specific EV motor insurance policy. On the contrary, *Insurance Company A* offers different rates and additional specific cover to EVs due to its battery and any third-party liability related to plug-in cables under its conventional policy. Unlike *Insurance Company C*, this insurance company adjusted its standard motor insurance to include different rates and additional specific cover for EVs. However, when comparing the EVs insurance policies of *Insurance Companies A* and *C* with the policies of Aviva, Automobile Association, and Admiral (insurance companies which were referred to in Chapter 2.1), one would find that all these insurance companies offer a similar level of coverage for EVs.

On the other hand, the insurance policy offered by *Insurance Company B* covers any type of vehicle, irrespective of whether it is an EV or an ICE vehicle because both cars pose battery risks. Therefore, *Insurance Company B* does not have a specific insurance policy on EVs or has amended its standard motor insurance policy because, as stated by its representative, "the policy never excluded EVs. It caters for EVs as much as it caters to ICE/PHEVs." Furthermore, as explained by the participant representing *Insurance Company D*, the company s/he represents offers the same coverage provided by the insurance companies who offer insurance policies specifically for EVs. Therefore, there is no need to have a separate insurance policy specifically for EVs.

Even though research on how insurance companies should adapt to address the risks associated with EVs is minimal, the participants' responses above show that insurance companies in Malta have adjusted differently to the increase of EVs on the roads in Malta and the risks associated with EVs are acceptable. Some insurance companies prefer to continue offering the standard motor insurance policy without having an insurance policy dedicated to EVs because the standard motor insurance policy caters to the needs of EVs. The representative of *Insurance Company D* stated that even though damage to charging cables and the battery may be considered specific to EVs, the standard motor insurance policy already covers these needs, and there is little need to specify them. However, since research on EVs is quite limited, research in the long term should be carried out to analyse the frequency and severity of claims on a yearly basis. *Insurance Companies A* and *C* explained that even though the number of claims will more or less remain stable, with no excessive increase, the costs to repair EVs, both parts and labour, will increase compared to ICE vehicles. The representative of *Insurance Company B* agreed that EVs would increase repair costs due to the added safety and driving assistance found in these types of cars and the service standards which need to be maintained due to the extended battery warranty, which continues to increase the price.

Moreover, the representative of *Insurance Company D* stated that information on this subject matter is still limited; however, the number of claims lodged is not likely to increase because EVs include particular features to reduce accidents.

4.4.2 The Low Percentage of EVs in Malta and the Attitudes of the Maltese Population Towards EVs

More than three-fourths (83.823%, 342) of the participants in this research study were very familiar or familiar with the term EV, and only 5.147% (15) of the participants were slightly familiar or not familiar with this term. To further analyse this, the Kruskal-Wallis test was used to test whether there is a significant difference between the statement of familiarity on the concept of EVs across gender. The test revealed that there is a significant difference across the 3 categories of gender (Male, N=246; Female, N=161; Other, N=1). Therefore, the statement of familiarity on the concept of EVs is not the same across gender (test statistics K.W; p=0.001). Another Kruskal-Wallis test was conducted to test whether there is a significant difference between the statement of familiarity on the concept of EVs across age. The test revealed that there is no significant difference across the age groups (18-30, N=131; 31-45, N=153; 46-60, N=96; 61-75, N=27; 76+, N=1) and the statement of familiarity on the concept of EVs is the same across age (test statistics K.W; p=0.134). Therefore, the familiarity on the concept of EVs was not affected by the demographic of age but was affected by the demographic of gender.

According to the latest statistics published by NSO, out of 414,669 cars on the road in Malta, only 11,544 were EVs (NSO, 2022b). The results gathered from the online survey showed that only 30.882% (126) of the participants owned an EV. These percentage figures show that most of the participants do not own an EV. Moreover, only 33.333% (136) of the participants stated that they would consider buying an EV in the next two years, with 25.980% (106) said that they would think about purchasing an EV but not within two years, 8.578% (35) are not interested in

buying an EV, and 3.676% (15) do not know. Similar results were obtained in the research study carried out by Lewicki *et al.* (2021) where 13% stated that they would change their vehicle, 62% would not change their vehicle, while 25% were undecided. To further analyse the levels of EVs adoption, a regression analysis was conducted in order to test the levels of EV adoption in relation to gender, age, and household size. Figure 17 illustrates the four independent variables in relation to the dependent variable on the levels of EVs adoption. This figure shows that the p-values of the demographic characteristics; gender, and age, are less than the 0.05 level of significance whilst the p-value of the demographic characteristic, household size, is more than the 0.05 level of significance. This shows that gender and age matter when compared to the levels of EVs adoption. Similar to the variable of hosuehold size, the statement of 'How often do you use your vehicle' resulted in a p-value greater than 0.05 level of significance. Therefore, household size and the statement on travel behaviour can be deemed as not fit for the model since their outcome turned out to be insignificant. Hence, these independent variables can be removed from the model. Furthermore, the R^2 came equal to 0.078 which means that this model only explains 7.8% of the variability of the statement on the levels of EVs adoption.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	2.389	.371		6.444	<.001
	D1. Gender	.334	.107	.153	3.112	.002
	D2. Age	-.233	.059	-.199	-3.955	<.001
	D4. Household Size	.050	.046	.054	1.083	.279
	S1. How often do you use your vehicle?	-.065	.055	-.059	-1.198	.232

a. Dependent Variable: Q4. If you were to purchase a car within 2 years, would you be willing to purchase an EV?

Figure 17: Regression Analysis on the Levels of EVs Adoption

All of the four participants of the insurance companies do not see any correlation between the low percentage of EVs in Malta and the risks associated with EVs. Furthermore, less than half of the participants in the online survey strongly agreed or agreed with these statements put forward related to risks associated with EVs that are;

1. EVs introduce new type of danger due to high voltage electric equipment that is present in these types of vehicles.

2. There is a risk of electric fault when EVs are parked because the battery is always on.

3. EVs are more prone to cyber-attacks because they are considered as a more connected mobility solution.

These findings show that the low percentage of EVs in Malta is not due to the risks associated with EVs. In fact, the representatives of the insurance companies stated that the low percentage of EVs in Malta is mainly attributed to other factors, such as purchase price and lack of charging points. One of the representatives of the insurance companies even mentioned the lack of solutions on how individuals without a garage can charge their EV. These factors were also pointed out by the participants of the online survey for the general public. Additionally, the barriers pointed out in the research study were also identified in several research studies conducted across European MSs and consulted in Chapter 2.3.

The purchase price was considered by 65.931% (269) of the participants in this research study as the factor that would influence them 'very much' when purchasing an EV. Moreover, 21.569% (88) of the participants stated that the purchase price affects them 'very' when purchasing an EV. These two percentage figures show that the purchase price was considered to be the factor that would influence 87.5% (357) of the participants ‘very' or 'very much' when purchasing an EV. On the other hand, only 2.941% (12) of the participants stated that purchase price would

not influence them at all or slightly influence them when purchasing an EV. Some of the participants representing the general public said that the purchase price to buy an EV is currently too expensive. The purchase price should be lowered to make EVs more affordable because "it's easy to find a cheap 2nd hand car at around 5k, but that can't be said for an EV". Research carried out over the years in several European MSs also found that buying an EV is expensive. Berkeley *et al.* (2018), Vrösch (2018), Bienias *et al.* (2019), Pisani (2020), and Lewicki *et al.* (2021) found out the purchase price to buy an EV is too expensive and is hindering the participants from purchasing an EV. A financial subsidiary was identified as a motivation to buy an EV by 26% of the participants in the research study carried out by Bienias *et al.* (2019). In this research study, 62.990% (257) of the participants stated that government incentives would influence them 'very much' when purchasing an EV. Moreover, 19.607% (80) of the participants noted that government incentives influence them 'very' when purchasing an EV. Therefore, while 3.922% (16) of the participants stated that government incentives would not influence at all or slightly influence them when buying an EV; 82.597% (337) of the participants considered government incentives as a factor that would affect them 'very' or 'very much' when purchasing an EV.

Furthermore, most of the participants in the research studies consulted in Chapter 2.3 were also concerned about the long charging time required to charge an EV and the lack of charging stations where you can charge your vehicle. In this research study, 66.422% (271) of the participants chose the recharging time as the factor that would influence them 'very' or 'very much' when purchasing an EV. On the other hand, 23.039% of the participants stated that this factor would influence them 'moderately' if they would buy an EV. Less than 10% of the participants stated that recharging costs do not influence them or slightly influence them when purchasing an EV. Regarding charging infrastructure, 71.082% (290) of the participants stated that this factor would influence them 'very' or 'very much' when purchasing an EV. Less than 15% of the participants stated that charging infrastructure would not influence or slightly

influence them when purchasing an EV. On the other hand, 81.618% (333) of the participants in this research study chose charging costs as the factor that would influence them 'very' or 'very much' when purchasing an EV. Less than 10% (6.617%, 27) of the participants stated that charging costs would not influence or slightly influence them when purchasing an EV.

Additionally, safety was identified by 83.333% (340) of the participants as the factor that would influence them 'very' or 'very much' when purchasing an EV. Less than 10% (5.882%, 24) of the participants stated that safety would not influence them or slightly influence them when purchasing an EV. Safety concerns were also pointed out by the participants in Zaunbrecher *et al.*'s (2014) study, who stated that EVs look like plastic cars and accidents with EVs as more dangerous. The battery of an EV was considered a factor that would influence 82.108% (335) of the participants in this research study 'very' or 'very much' when purchasing an EV. Less than 10% (5.882%, 24) of the participants stated that the battery range would not influence or slightly influence them when purchasing an EV. The battery range of an EV was considered one of the main concerns amongst the participants participating in different research studies carried out across European MSs. In this research study, the battery range was considered the 6th factor that would influence the participants 'very much' when buying an EV. On the other hand, 59.559% (243) of the participants considered speed/performance to influence them 'very' or 'very much' when purchasing an EV. Moreover, 27.941% (114) stated that this factor would affect them ‘moderately’, while 12.5% (51) stated that this factor would not influence at all or slightly influence them when purchasing an EV.

Maintenance costs were identified as the third factor that would influence the participants 'very much' when purchasing an EV. 84.068% (343) of the participants stated that this factor would influence them 'very' or 'very much' when purchasing an EV. On the other hand, less than 5%

(4.657%, 19) of the participants stated that this factor would not influence them or slightly influence them when purchasing an EV. Research carried out by Pisani (2020) found that maintenance costs are expected to be lower than the costs of an ICE vehicle since the cars have fewer parts that can break alone. Some of the participants in this research study stated that the prices of the battery and parts should be reduced because they are pretty expensive. Furthermore, Pisani (2020) stated that the barriers attached to EVs would be balanced by the low operating and fuel costs needed to maintain an EV. However, 73.774% (301) of the participants in this research study stated that fuel costs would influence them 'very' or 'very much when purchasing an EV. Less than 15% (11.029%, 45) of the participants stated that this factor would not influence them at all or influence them slightly when purchasing an EV.

Additionally, insurance costs were identified by 74.510% (304) of the participants as the factor that would influence them 'very' or 'very much' when purchasing an EV. On the other hand, less than 10% (5.882%, 24) of the participants stated that this factor would not influence them at all or slightly influence them when purchasing an EV. Moreover, some of the participants in this study noted that insurance costs related to EVs should be lowered. Furthermore, environmental concerns were not considered an important barrier that would impact the participants from purchasing an EV by the participants in Giansoldati *et al.* (2020) study. In this research study, 68.138% (278) of the participants stated that environmental issues would influence them 'very' or 'very much' when purchasing an EV. Less than 15% (12.255%, 50) of the participants stated that this factor would not influence or slightly influence them when purchasing an EV.

Lastly, car tax was identified as a factor that would influence 74.508% (304) participants in this research study 'very' or very much' when purchasing an EV. Less than 10% (8.333%, 34) of the participants stated that this factor would not influence or slightly influence them when

purchasing an EV. On the other hand, less than half of the participants (46.078%, 188) stated that the resale value is the factor that would influence them 'very' or 'very much' when purchasing an EV. Moreover, 33.578% (137) of the participants stated that this factor would influence them 'moderately' when purchasing an EV.

Furthermore, Friedman's Two-Way test was used to test whether there is a significant difference between car tax, charging costs, charging infrastructure, environment issues, fuel costs, government incentives, insurance costs, maintenance costs, purchase price, recharging time, resale value, safety, and speed/performance. Therefore, this test was mainly used to analyse the different factors that can potentially influence the purchase of EVs. The test revealed a significant difference across the factors (test statistic F.T.W; p=0.000). Furthermore, the statistical analysis revealed that purchase price, government incentives, and maintenance costs obtained the highest mean rank of 8.454, 8.098, and 7.930, respectively. Therefore, as discussed in Chapter 4.2, the three most influential factors that gained the highest responses from the participants were indeed purchase price, government incentives, and maintenance costs.

Additionally, three regression analyses were conducted to analyse whether the independent variables; gender, age, household size, and statement on travel behaviour have an impact on each of the following dependent variables; purchase price, government incentives, and maintenance costs. Figure 18 illustrates the four independent variables in relation to the dependent variable, purchase price. This figure shows that the p-values of the demographic characteristics; gender, age, and household size, are greater than the 0.05 level of significance. Therefore, this outcome shows that none of the analysed demographics make a difference when compared to how purchase price influences individuals when purchasing an EV. On the

other hand, the statement ‘How often do you use your vehicle’ resulted in a p-value lower than 0.05 level of significance, which means that it has an impact when compared to how purchase price influences individuals when purchasing an EV. Therefore, the demographic characteristics of gender, age, and household size can be deemed as not fit for the model since their outcome turned out to be insignificant. Furthermore, the $R^{\wedge 2}$ came equal to 0.046,which means that this model only explains 4.6% of the variability of purchase price.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.419	.296		11.564	<.001
	D1. Gender	.133	.086	.078	1.554	.121
	D2. Age	.005	.047	.005	.105	.916
	D4. Household Size	.061	.037	.084	1.673	.095
	S1. How often do you use your vehicle?	.153	.044	.175	3.507	<.001

a. Dependent Variable: S12. Purchase Price

Figure 18: Regression Analysis on Purchase Price

Figure 19 illustrates the four independent variables in relation to the dependent variable, government incentives. This figure shows that the p-values of the demographic characteristics; gender, and household size, are greater than the 0.05 level of significance, while the p-value of age is lower than the 0.05 level of significance. This shows that only age matters when it comes to how government incentives influence individuals when purchasing an EV. Similar to gender and household size, the statement of ‘How often do you use your vehicle’ resulted in a p-value lower than 0.05 level of significance. Therefore, gender, household size, and the statement on travel behaviour can be deemed as not fit for the model since their outcome turned out to be insignificant. Hence, these independent variables can be removed from the model. Furthermore,

the $R^{\wedge 2}$ came equal to 0.029, which means that this model only explains 2.9% of the variability of government incentives.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	4.131	.326		12.670	<.001
	D1. Gender	-.118	.094	-.063	-1.246	.214
	D2. Age	.143	.052	.143	2.767	.006
	D4. Household Size	-.016	.040	-.020	-.400	.689
	S1. How often do you use your vehicle?	.043	.048	.045	.890	.374

a. Dependent Variable: S9. Government Incentives

Figure 19: Regression Analysis on Government Incentives

Figure 20 illustrates the four independent variables in relation to the dependent variable, maintenance costs. This figure shows that the p-values of the demographic characteristics; gender, and age, are less than the 0.05 level of significance, while the p-value of the household size is more than the 0.05 level of significance. This shows that gender and age have an impact when compared to how maintenance costs influence individuals when purchasing an EV. Similar to gender and age, the statement of 'How often do you use your vehicle' resulted in a p-value lower than 0.05 level of significance. Therefore, only household size can be deemed as not fit for the model since its outcome turned out to be insignificant. Hence, this independent variable can be removed from the model. Furthermore, the $R^{\wedge 2}$ came equal to 0.050, which means that this model only explains 5.0% of the variability of maintenance costs.

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	3.688	.318		11.593	<.001
	D1. Gender	.224	.092	.121	2.427	.016
	D2. Age	-.104	.050	-.105	-2.063	.040
	D4. Household Size	.029	.039	.037	.733	.464
	S1. How often do you use your vehicle?	.110	.047	.116	2.341	.020

a. Dependent Variable: S11. Maintanance Costs

Figure 20: Regression Analysis on Maintenance Costs

Based on the information provided in the online survey, more charging stations and government incentives are required to encourage more residents in Malta to purchase EVs. Furthermore, 48.039% (196) and 48.529% (196) of the participants stated that more knowledge on how to charge EVs at home/work and how EVs function is required. Moreover, some of the participants in this study said that solutions should be found to charge EVs for those who do not have a garage. Also, the participants mentioned price affordability, introduction of bans and penalties on ICE vehicles and incentives on electric bills, adequate infrastructure, and improved product development when asked what should be done to encourage more residents in Malta to purchase an EV. Some of these motivations were also pointed out in Bienias *et al.* 's (2019) study. Moreover, financial subsidiary to lower the financial burden was identified by 26% of the participants in this research study. This factor was followed by free parking zones, exemption from excise tax, extended warranties, and access to charging stations.

4.5 Chapter Conclusion

The findings of this research study show that the chosen insurance companies have adjusted differently to the increase of EVs in Malta. In fact, only of the participant insurance companies has a separate insurance policy for EVS. On the other hand, the low percentage of EVs in Malta

is not due to the risks attacked with EVs but due to other factors. The purchase price, government incentives and maintence costs were identified as the three most factors that would influence the participants very much when purchasing an EV. Furthermore, more than three-fourths (78.676%, 321) of the participants stated that more charging infrastucture is required in Malta to encourage more residents to purchase an EV.

CHAPTER 5: CONCLUSION AND RECOMMENDATIONS

5.1 Main Findings

The information gathered from the online survey and the open-ended questionnaires helped the researcher to answer the research questions established in Chapter 1.4 as follows:

1. How did Maltese insurance companies adjust their policies to be able to insure EVs?

Findings show that two of the insurance companies offer only the standard motor insurance policy and provide coverage for both ICE vehicles and EVs, while another insurance company offers different rates and additional coverage under the standard motor insurance policy. Only one of the representatives stated that its insurance company offers an insurance policy specifically for EVs. The EV insurance policy provides additional coverage for different circumstances such as electric overload damage due to lightning strikes and short circuits, animal bites on the drive battery resulting in damage, scrappage costs after an accident, and decontamination costs, amongst others. The breakdown assistance services offered by this same company were also changed. All the representatives of the insurance companies stated that the frequency of claims related to EVs is not likely to increase, but the cost to repair these vehicles will be higher.

2. How should Maltese insurance companies which do not have an EV policy adapt to address the risks associated with EVs?

Findings of this study show that some of the participant insurance companies offer the same insurance policy irrespective of whether it is an EV or an ICE vehicle because both cars pose battery risks. Furthermore, these same companies offer the same coverage provided by the insurance companies that offer insurance policies specifically for EVs. Therefore, there is no need to have a separate insurance policy specifically for EVs. Moreover, the representative of one insurance company stated that having an insurance policy, particularly for EVs, is like having an insurance policy for petrol vehicles and another for diesel vehicles. The only purpose of having a separate EV insurance policy is marketing. Therefore, it does not make sense to

have a separate EV insurance and is not considering offering an EV insurance policy in the next two years.

3. What are the attitudes of the Maltese population about transitioning from a petrol/diesel vehicle to an EV?

The findings of the survey show that even though 83.823% (342) of the participants were 'familiar' or 'very familiar' with the term EV, only 28.431% (116) own an EV. The purchase price, government incentives, and maintenance costs were the three most factors identified by the participants that would influence them 'very much' when purchasing an EV. Safety, charging costs, and battery range were also identified by more than half of the participants as the factors that would influence them 'very much' when purchasing an EV. Even though the consulted literature stated that EVs might bring with them new risks, mainly due to high voltage electrical equipment that is present in the vehicle (Kjosevski *et al.,* 2017), less than one-fourth (24.265%, 99) of the participants strongly agreed or agreed that EVs bring new types of danger due to high voltage electrical equipment. Furthermore, only 17.157% (70) of the participants strongly agreed or agreed that there is a risk of electrical fault when EVs are parked because the battery is always on. Moreover, only 25.245% (103) of the participants strongly agreed or agreed that EVs are more prone to cyberattacks because they are considered a more connected mobility source. These percentage figures show that the participants in this research study do not consider EVs risky.

The percentage of participants willing to buy an EV in the next two years amounts to one-third (33.333%, 136) of the participants. On the other hand, 25.980% (136) of the participants stated that they would think about purchasing an EV but not within the next two years while 8.578% (35) indicated that they are not interested in buying an EV. Lastly, more than three-fourths

(78.676%, 321) of the participants stated that more charging stations are required in Malta to encourage more residents to purchase an EV, followed by more government incentives, awareness of how EVs function, and knowledge on how to charge EVs. Price affordability, bans and penalties on ICE vehicles, adequate infrastructure, incentives on electric bills, and improve product development were listed by the participants as other factors which can be improved to encourage more residents in Malta to purchase an EV.

4. What correlation can be established between the low percentage of EVs in Malta and the risks associated with them?

All insurance companies' representatives do not see any correlation between the low percentage of EVs in Malta and the risks associated with EVs. These participants stated that the low percentage of EVs in Malta was due to other factors, which were also put forward in the survey held amongst the public. Moreover, less than half of the participants strongly agreed or agreed with the statements on risks associated with EVs, showing that they do not consider these vehicles riskier in terms of high voltage, electrical fault, and cyberattacks.

5.2 Significance of the Study

In view that research in Malta on this subject matter is limited to date, this research study can help the concerned stakeholders to take the necessary actions, particularly related to the purchase price, government incentives, and maintenance costs, to encourage more residents in Malta to purchase an EV. Also, the feedback put forward by some participants can help the concerned stakeholders improve the product and service they provide to their customers to ensure that the clients receive the best service possible.

Furthermore, through this research study, one is to understand that if an insurance policy does not offer an insurance policy specifically for EVs, this does not mean that the respective

insurance company does not insure EVs. However, insurance companies in Malta have adjusted differently to EVs. Moreover, this research study can help insurance companies to take onboard the suggestion put forward by the participants that the insurance costs should be more affordable.

5.3 Further Studies

Further studies are required in this area in view that research on this subject matter in Malta is still limited. Further studies should focus on:

1. The pricing methods currently used in Malta. One of the representatives of the insurance companies stated that the pricing methods do not accurately estimate the vehicle risk. Therefore, more focus should be given to the engine performance and the cost of repairs rather than the value and the engine size to accurately price the vehicle risk.

2. The frequency and severity of claims related to EVs in the long term.

3. The infrastructure required in Malta and other small countries to handle the increase in electricity demand due to the increase in EVs.

4. How the product specifications of EVs can be improved to meet the needs of their customers.

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APPENDICES

Appendix 1: Questions of the Online Survey

Background Information

1. Gender * [Mark only one oval]

- ◯ Male
- ◯ Female
- ◯ Other

2. Age * [Mark only one oval]

- ◯ 18-30
- ◯ 31-45
- ◯ 46-60
- ◯ 61-75
- ◯ 76+

3. Are you currently living in Malta? * [Mark only one oval]

- ◯ Yes
- ◯ No

4. Household Size * [Mark only one oval]

- ◯ 1
- ◯ 2
- ◯ 3
- ◯ 4
- ◯ 5
- ◯ 6
- ◯ 7 or more

Driving Licence Ownership

5. Do you have a driving licence? * [Mark only one oval]

- ◯ Yes
- ◯ No

Car Ownership

6. Do you own a car? * [Mark only one oval]

- ◯ Yes
- ◯ No [Skip to Question 9]

7. Do you own an Electric Vehicle (EV)? * [Mark only one oval]

◯ Yes
◯ No

Travel Behaviour

8. From a scale of 1-5 (5 being daily), how often do you use your vehicle? * [Mark only one oval]

	1	2	3	4	5	
Never	◯	◯	◯	◯	◯	Daily

Familiarity with the Concept of EV

9. From a scale of 1-5 (5 being very familiar), how familiar are you with the term Electric Vehicle (EV)? * [Mark only one oval]

	1	2	3	4	5	
Not familiar at all	◯	◯	◯	◯	◯	Very familiar

Factors Influencing the Purchase of EVs

From a scale of 1-5 (5 being very much), how would each of the following factors influence you when purchasing an EV?

10. Battery Range * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

11. Car Tax * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

12. Charging Costs * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

13. Charging Infrastructure * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

14. Environment Issues * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

15. Fuel Costs * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

16. Government Incentives * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

17. Insurance Costs * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

18. Maintenance Costs * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

19. Purchase Price * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very Much

20. Recharging Time * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

21. Resale Value * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

22. Safety * [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

23. Speed/Performance [Mark only one oval]

	1	2	3	4	5	
Not at all	◯	◯	◯	◯	◯	Very much

Associated Risks with EVs

From a scale of 1–5 (5 being strongly agree), how much do you agree with the following statements.

24. EVs introduce new types of danger due to high voltage electric equipment that is present in these types of vehicles. * [Mark only one oval]

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

25. There is a risk of electric fault when EVs are parked because the battery is always on. * [Mark only one oval]

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

26. Wireless charging infrastructure can help overcome the problem of theft and vandalism attached with EVs. * [Mark only one oval]

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

27. EVs are more prone to cyberattacks because they are considered as a more connected mobility solution. * [Mark only one oval]

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

Levels of EVs Adoption

28. If you were to purchase a car within 2 years, would you be willing to purchase an EV? * [Mark only one oval]

- ◯ I already own an EV
- ◯ I would consider buying an EV
- ◯ I would think about purchasing an EV, but not within 2 years
- ◯ I am not interested in purchasing an EV
- ◯ Do not know

29. For those who do not own an EV, from a scale of 1-5 (5 being strongly agree), if gasoline prices were to increase in the next 2 years, would you consider shifting to an EV? * [Mark only one oval]

	1	2	3	4	5	
Strongly Disagree	◯	◯	◯	◯	◯	Strongly Agree

30. What should be done to encourage residents in Malta to purchase an EV? * [Check all that apply]

- ◯ More government incentives
- ◯ More awareness on how EVs function
- ◯ More charging stations
- ◯ More knowledge on how to charge EVs at home/work
- ◯ None of the above
- ◯ Other _____

Appendix 2: Questions of the Questionnaire for Insurance Companies that have an EV insurance policy

1. What is your role in the company?
2. How long have you been working in this role?
3. Does your company offer an Electric Vehicle (EV) insurance policy?
4. How long has your company been offering an EV insurance policy?
5. How did your company adjust its motor insurance policy to start accommodating EVs?
6. Briefly give an overview of what your company's EV insurance policy entails.
7. What are the main differences between regular car insurance and an EV insurance?
8. What factors would you list that would distinguish your company's EV insurance policy from other insurance companies?
9. Do you think EVs will increase the number of claims? Please elaborate.
10. Has your company ever experienced claims relating to EVs? If yes, can you provide any data related to claims per year, costs per year, etc.
11. Does your company consider insuring EVs riskier than petrol/diesel vehicles? Please elaborate.
12. What risks would you consider different in EVs when compared to petrol/diesel vehicles?
13. In your opinion, is there any correlation between the low percentage of EVs in Malta and risks associated with EVs? Please elaborate.
14. Does your company offer any discounts on insurance premium when it comes to EVs?
15. Other comments.

Appendix 3: Questions of the Questionnaire for Insurance Companies that do not have an EV insurance policy

1. What is your role in the company?
2. How long have you been working in this role?
3. Does your company offer an Electric Vehicle (EV) insurance policy?
4. If your company does not offer an EV insurance policy, please elaborate.
5. Do you consider insuring EVs riskier than petrol/diesel vehicles? Please elaborate.
6. What risks would you consider different in EVs when compared to petrol/diesel vehicles?
7. In your opinion, is there any correlation between the low percentage of EVs in Malta and risks associated with EVs? Please elaborate.
8. Is your company considering offering an EV insurance policy within the next 2 years in view that the push for EVs is increasing both on a national and an international level?
9. If your answer to the previous question was No, please elaborate.
10. What kind of policy would your company consider offering?
11. What changes does your company need to undergo to start offering its clients an EV insurance policy?
12. Do you think EVs will increase the number of claims? Please elaborate.
13. Other comments.

Appendix 4: Information Sheet and Consent Form for Insurance Companies

1st March 2022

Information Letter

Dear Sir/Madam,

My name is Liandra Borg, and I am a student at the University of Malta, presently reading for a Master of Science in Insurance and Risk Management. I am presently conducting a research study for my thesis titled "The Impact of Electric Vehicles on the Maltese Insurance Market and the General Public"; this is being supervised by Dr Jonathan Spiteri. This letter is an invitation to participate in this study. Below you will find information about the study and about what your involvement would entail, should you decide to take part.

The aim of my dissertation is to understand (i) how Maltese insurance companies are adjusting their insurance policies to respond to the uptake of Electric Vehicles (EVs); (ii) the attitudes and perceptions of the Maltese population towards the transition to EVs and the barriers that are holding them from purchasing an EV; and (iii) if there is a correlation between the risks associated with EVs and the low percentage of EVs in Malta. Any data collected from this research will be used solely for purposes of this study.

Should you choose to participate, you will be asked to complete an open-ended questionnaire which should not take you more than 20 minutes to complete. Your responses will assist the researcher in understanding how Maltese insurance companies are adjusting their policies to respond to the uptake of Electric Vehicles (EVs).

Data collected will be treated anonymously and only I, Liandra Borg, will have access to the data, which shall be stored on a secure drive.

Participation in this study is entirely voluntary; in other words, you are free to accept or refuse to participate, without needing to give a reason. You are also free to withdraw from the study at any time, without needing to provide any explanation and without any negative repercussions for you. Should you choose to withdraw, any data collected from your interview will be erased as long as this is technically possible (for example, before it is anonymised or published), unless erasure of data would render impossible or seriously impair achievement of the research objectives, in which case it shall be retained in an anonymised form.

If you choose to participate, please note that there are no direct benefits to you. Your participation does not entail any known or anticipated risks.

Please note also that, as a participant, you have the right under the General Data Protection Regulation (GDPR) and national legislation to access, rectify and where applicable ask for the data concerning you to be erased. All data collected will be stored in an anonymised form for two years after completion of the study.

A copy of this information sheet is being provided for you to keep and for future reference. Thank you for your time and consideration. Should you have any questions or concerns, please do not hesitate to contact me by e-mail liandra.borg.18@um.edu.mt you can also contact my supervisor via email: jonathan.v.spiteri@um.edu.mt.

Sincerely,

Liandra Borg

liandra.borg.18@um.edu.mt

Dr Jonathan Spiteri

jonathan.v.spiteri@um.edu.mt

Participant's Consent Form

"The Impact of Electric Vehicles on the Maltese Insurance Market and the General Public."

I, the undersigned, give my consent to take part in the study conducted by Liandra Borg. This consent form specifies the terms of my participation in this research study.

1. I have been given written and/or verbal information about the purpose of the study; I have had the opportunity to ask questions and any questions that I had were answered fully and to my satisfaction.
2. I also understand that I am free to accept to participate, or to refuse or stop participation at any time without giving any reason and without any penalty. Should I choose to participate, I may choose to decline to answer any questions asked. In the event that I choose to withdraw from the study, any data collected from me will be erased anonymously.
3. I understand that I have been invited to participate in an open-ended questionnaire in which the researcher will require insurance representatives to complete the questionnaire in order to investigate how insurance companies are adjusting their policies to respond to the uptake of electric vehicles (EVs). I am aware that the open-ended questionnaire will take approximately 20 minutes. I understand that the open-ended questionnaire is to be conducted in a place and at a time that is convenient for me.
4. I understand that my participation does not entail any known or anticipated risks.
5. I understand that there are no direct benefits to me from participating in this study.
6. I understand that, under the General Data Protection Regulation (GDPR) and national legislation, I have the right to access, rectify, and where applicable, ask for the data concerning me to be erased.
7. I understand that all data collected will be stored in an anonymised form within 2 years of completion of the study.
8. I have been provided with a copy of the information letter and understand that I will also be given a copy of this consent form. I have read and understood the above statements and agree to participate in this study.

Name of participant: _____

Signature: _____

Date: _____

Liandra Borg

liandra.borg.18@um.edu.mt

Dr Jonathan Spiteri

jonathan.v.spiteri@um.edu.mt

Appendix 5: Information Sheet and Consent Form for Participants in the Survey

Dear participant,

I am a student at the University of Malta, reading for a Masters in Insurance & Risk Management. Currently I am carrying out a research study for my dissertation, entitled ''The Impact of Electric Vehicles on the Maltese Insurance Market and General Public'' under the supervision of Dr Jonathan Spiteri.

The aim of my dissertation is to understand (i) how Maltese insurance companies are adjusting their insurance policies to respond to the uptake of Electric Vehicles (EVs); (ii) the attitudes and perceptions of the Maltese population towards the transition to EVs and the barriers that are holding them from purchasing an EV; and (iii) if there is a correlation between the risks associated with EVs and the low percentage of EVs in Malta. For the purpose of this study, only individuals who are in possession of a driving licence as well as residing in Malta may participate in this survey. I would like to kindly invite you to participate in this short survey which its estimated completion time is of 5 minutes.

Should you agree to participate, I guarantee that:

1) You will not be asked to enter any sensitive information that may identify you and your anonymity throughout this research is guaranteed. Only I, Liandra Borg, will have access to the data, which shall be stored on a secure drive. All data will be stored for a maximum of two years before being destroyed.

2) All information provided in this survey will be used solely for the purpose of this dissertation. Your responses will assist in the development of new knowledge and insights related to Electric Vehicles (EVs).

3) Participation is entirely voluntary, and you are free to quit the survey at any moment and for no reason. All data collected prior to quitting the survey will be deleted from records. You are free to withhold your responses or close the window at any time. Many of the questions are also compulsory to respond.

4) There is no deception in the data collection of this questionnaire, and no risks (either physical or otherwise) are foreseen.

5) Your rights under the General Data Protection Regulation (GDPR) and the Malta Data Protection Act 2018 to access, rectify, and where applicable erase your data from records will be upheld at any time, upon request.

Your participation and time to contribute to this research are greatly appreciated.

Should you require any information or clarifications, please do not hesitate to contact me via email on liandra.borg.18@um.edu.mt

Sincerely,

Liandra Borg

By clicking 'Next' to continue, you are consenting to take part in this study.

Appendix 6: Data Codes

Question 1: Gender

1 = Male

2 = Female

3 = Other

Question 2: Age

1 = 18-30

2 = 31-45

3 = 46-60

4 = 61-75

5 = 76+

Question 3: Are you currently living in Malta?

1 = Yes

2 = No

Question 4: Household Size

1 = 1

2 = 2

3 = 3

4 = 4

5 = 5

6 = 6

7 = 7 or more

Question 5: Do you have a driving licence?

1 = Yes

2 = No

Question 6: Do you own a car?

1 = Yes

2 = No

Question 7: Do you own an Electric Vehicle (EV)?

1 = Yes

2 = No

Question 8: From a scale of 1-5 (5 being daily), how often do you use your vehicle?

1 = Never

2 = Rarely

3 = Occasionally

4 = Frequently

5 = Daily

Question 9: From a scale of 1-5 (5 being very familiar), how familiar are you with the term Electric Vehicle (EV)?

1 = Not familiar at all

2 = Slightly familiar

3 = Somewhat familiar

4 = Familiar

5 = Very Familiar

From a scale of 1-5 (5 being very much), how would each of the following factors influence you when purchasing an EV?

Question 10: Battery Range

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 11: Car Tax

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 12: Charging Costs

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 13: Charging Infrastructure

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 14: Environment Issues

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 15: Fuel Costs

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 16: Government Incentives

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 17: Insurance Costs

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 18: Maintenance Costs

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 19: Purchase Price

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 20: Recharging Time

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 21: Resale Value

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 22: Safety

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

Question 23: Speed/Performance

1 = Not at all

2 = Slightly

3 = Moderately

4 = Very

5 = Very Much

From a scale of 1-5 (5 being strongly agree), how much do you agree with the following statements.

Question 24: EVs introduce new types of danger due to high voltage electric equipment that is present in these types of vehicles

1 = Strongly Disagree

2 = Disagree

3 = Undecided

4 = Agree

5 = Strongly Agree

Question 25: There is a risk of electric fault when EVs are parked because the battery is always on

1 = Strongly Disagree

2 = Disagree

3 = Undecided

4 = Agree

5 = Strongly Agree

Question 26: Wireless charging infrastructure can help overcome the problem of theft and vandalism attached with EVs

1 = Strongly Disagree

2 = Disagree

3 = Undecided

4 = Agree

5 = Strongly Agree

Question 27: EVs are more prone to cyberattacks because they are considered as a more connected mobility solution

1 = Strongly Disagree

2 = Disagree

3 = Undecided

4 = Agree

5 = Strongly Agree

Question 28: If you were to purchase a car within 2 years, would you be willing to purchase an EV?

1 = I already own an EV

2 = I would consider buying an EV

3 = I would think about purchasing an EV, but not within 2 years

4 = I am not interested in purchasing an EV

5 = Do not know

Question 29: For those who do not own an EV, from a scale of 1 - 5 (5 being strongly agree), if gasoline prices were to increase in the next 2 years, would you consider shifting to an EV?

1 = Strongly Disagree

2 = Disagree

3 = Undecided

4 = Agree

5 = Strongly Agree

Question 30: What should be done to encourage residents in Malta to purchase an EV?

1 = More Government Incentives

2 = More awareness on how EVs function

3 = More charging stations

4 = More knowledge on how to charge EVs at home/work

5 = None of the above

6 = Other

Appendix 7: SPSS Calculations

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
D1. Gender	420	1	3	1.41	.497
D2. Age	420	1	5	2.04	.929
D3. Residence	420	1	2	1.00	.049
D4. Household Size	420	1	7	3.25	1.166
Q1. Do you have a driving license?	419	1	2	1.03	.160
Q2. Do you own a car?	408	1	2	1.02	.147
Q3. Do you own an EV?	408	1	2	1.69	.463
S1. How often do you use your vehicle?	399	1	5	4.39	.968
S2. How familiar are you with the term EV?	408	1	5	4.41	.928
S3. Battery Range	408	1	5	4.27	.954
S4. Car Tax	408	1	5	4.12	1.084
S5. Charging Costs	408	1	5	4.27	1.018
S6. Charging Infrastructure	408	1	5	4.02	1.233
S7. Environment Issues	408	1	5	3.96	1.225
S8. Fuel Costs	404	1	5	4.06	1.155
S9. Government Incentives	408	1	5	4.40	.922
S10. Insurance Costs	408	1	5	4.16	1.007
S11. Maintanance Costs	408	1	5	4.36	.924
S12. Purchase Price	408	1	5	4.49	.858
S13. Recharging Time	408	1	5	3.93	1.087
S14. Resale Value	408	1	5	3.38	1.158
S15. Safety	408	1	5	4.31	.950
S16. Speed/Performance	408	1	5	3.68	1.072
S17. EVs introduce new types of danger due to high voltage equipment that is present in these types of vehicles	408	1	5	2.75	1.187
S18. There is a risk of electric fault when EVs are parked because the battery is always on	408	1	5	2.41	1.171
S19. Wireless charging infrastructure can help overcome the problem of theft and vandalism attached with EVs	408	1	5	3.37	1.172
S20. EVs are more prone to cyberattacks because they are considered as a more connected mobility solution	408	1	5	2.77	1.145
Q4. If you were to purchase a car within 2 years, would you be willing to purchase an EV?	408	1	5	2.26	1.075
S21. If gasoline prices were to increase in the next 2 years, would you consider shifting to an EV?	302	1	5	3.74	1.220
Valid N (listwise)	290				

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of S2. How familiar are you with the term EV? is the same across categories of D1. Gender.	Independent-Samples Kruskal-Wallis Test	<.001	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Independent-Samples Kruskal-Wallis Test

S2. How familiar are you with the term EV? across D1. Gender

Independent-Samples Kruskal-Wallis Test Summary

Total N	408
Test Statistic	29.379[a]
Degree Of Freedom	2
Asymptotic Sig.(2-sided test)	<.001

a. The test statistic is adjusted for ties.

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distribution of S2. How familiar are you with the term EV? is the same across categories of D2. Age.	Independent-Samples Kruskal-Wallis Test	.134	Retain the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Independent-Samples Kruskal-Wallis Test

S2. How familiar are you with the term EV? across D2. Age

Independent-Samples Kruskal-Wallis Test Summary

Total N	408
Test Statistic	7.031[a,b]
Degree Of Freedom	4
Asymptotic Sig.(2-sided test)	.134

a. The test statistic is adjusted for ties.

b. Multiple comparisons are not performed because the overall test does not show significant differences across samples.

Nonparametric Tests

Hypothesis Test Summary

	Null Hypothesis	Test	Sig.[a,b]	Decision
1	The distributions of S4. Car Tax, S5. Charging Costs, S6. Charging Infrastructure, S7. Environment Issues, S8. Fuel Costs, S9. Government Incentives, S10. Insurance Costs, S11. Maintanance Costs, S12. Purchase Price, S13. Recharging Time, S14. Resale Value, S15. Safety and S16. Speed/Performance are the same.	Related-Samples Friedman's Two-Way Analysis of Variance by Ranks	.000	Reject the null hypothesis.

a. The significance level is .050.

b. Asymptotic significance is displayed.

Related-Samples Friedman's Two-Way Analysis of Variance by Ranks

S4. Car Tax, S5. Charging Costs, S6. Charging Infrastructure, S7. Environment Issues, S8. Fuel Costs, S9. Government Incentives, S10. Insurance Costs, S11. Maintanance Costs, S12. Purchase Price, S13. Recharging Time, S14. Resale Value, S15. Safety, S16. Speed/Performance

Related-Samples Friedman's Two-Way Analysis of Variance by Ranks Summary

Total N	404
Test Statistic	529.462
Degree Of Freedom	12
Asymptotic Sig.(2-sided test)	.000