ISCTE Business School
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THE IMPACT OF ELECTRIC VEHICLES ON THE TRANSPORTION SETOR

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Abstract

Due to the continuous useage of fossil fuels we are almost reaching a point of no return with catastrophic consequences in terms of climate change. With this issue in mind some companies, specifically in the automotive industry, have decided to go green with several BEV fleets which are changing and forcing cities to adapt to these changes and to the new APV options appearing with the purpose of enhencing and facilitate the mobility inside the cities. In this sense, the present investigation aims to estimate the impact and changes in the portuguese transportation sector, as well to assess the customer perception and identify the decision-making factors of an electric vehicle. An online questionnaire was used as a mean to collect the higher and broader number of respondents and its analysis was performed based on a qualitative analysis, hypothesis testing and correlations.

The results predict a growth of the APV in Europe and in Portugal along with average age of the Portuguese automotive car parc. It also expected a growth of the charging points infrastructure and the mobility options within the city. A BEV buyer usually considers itself as an ambitious person, seeking for new information about technology, sociable and always looking for ways to improve their life's and considers the running costs of an EV to be lower than a conventional car. Moreover, the Price and Autonomy are the two most valued factors in an EV and the Brand and Technology the least.

Keywords: BEV, APV, Electric Vehicle, Questionnaire, Mobility

JEL Classification:

L91 Transportation: General

Q55 Technological Innovation

Y40 Dissertations

Resumo

Devido ao uso continuado dos combustíveis fósseis, nós estamos a chegar a um ponto de não retorno com consequências devastadoras em termos de alterações climáticas. Com esta questão em mente, algumas empresas, especificamente da indústria automóvel, decidiram ser mais sustentáveis com o desenvolvimento de vários BEV nas suas frotas que estão a mudar e forçar as cidades a adaptarem-se a estas novas mudanças e ainda, às novas opções de APV que estão a aparecer com o objetivo de melhorar e facilitar a mobilidade dentro das cidades. Deste modo, a presente investigação serve para estimar o impacto e as mudanças no setor dos transportes em Portugal, bem como entender a perceção do comprador e identificar os fatores decisão num automóvel elétrico. Um questionário online foi efetuado de maneira a conseguir recolher o maior e mais variado número de inquiridos e a sua análise foi feita com base numa análise qualitativa, teste de hipóteses e correlações.

Os resultados preveem um crescimento dos APV na Europa e em Portugal juntamente com o crescimento da idade média do parque automóvel português. Também é esperado um aumento da infraestrutura de pontos de carregamento e das opções de mobilidade dentro da cidade. Uma pessoa que compre um BEV considera se uma pessoa ambiciosa, procurando informação nova sobre tecnologia, sociável, sempre tentando melhorar a sua vida e considera que os custos de manutenção de um automóvel elétrico são inferiores aos de um veículo convencional. Além do mais, o Preço e a Autonomia são os dois fatores mais valorizados num EV e a Marca e a Tecnologia os menos valorizados.

Palavras-Chave: BEV, APV, Veículo Elétrico, Questionário, Mobilidade

JEL Classification:

L91 Transportation: General

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List of Abbreviations

APV – Alternatively Powered Vehicles

ACEA – European Automobile Manufacturers' Association

BEV – Battery Electric Vehicle

CAGR – Compound Annual Growth Rate

ECV – Electrically Chargeable Vehicles

EU – European Union

EV – Electric Vehicle

ICE – Internal Combustion Engine

IQ – Investigation Question

HEV – Hybrid Electric Vehicles

PHEV – Plug-in Hybrid Electric Vehicle

US – United States

VIO – Vehicle in Operation

VW – Volkswagen

Chapter I – Introduction

1.1 Introduction

In this chapter it will be presented the topic of the dissertation along with an analysis of the context which induced the development of the objectives of this dissertation. As a result, this chapter will be divided into several sections which starts with a context analysis, followed by the general and specific objectives, the investigation questions and at last, the scope and structure of the dissertation.

1.2 Context Analysis

Nowadays, the energy sector emerges as a vital sector for the economy. The irrational use of energy has implications on the energy bill, therefore it is necessary to adopt policies that encourage the rational use of energy that are integrated with environmental policies. Internationally, all countries have witnessed a revolution in the energy sector. This revolution is due to the fluctuations in fossil fuel prices, climate changes, scarcity of energy sources and also because of the economic situation of countries which lead them to change their attitude towards future energetic questions.

The eminent exhaustion of primary energy sources, the energetic dependence on oil and the environmental impact that results from it, contributes to make different choices that rely on new energetic models for transportation which intend to better improve the quality of life of the populations and the reduction of the national energetic bill. The United States alone, consume 70% of all oil for transportation usage. From this transportation oil, 70% is used by passenger vehicles. Worldwide, an escalating middle class in India and China is triggering demand for passenger cars to surge, and with it, demand for oil. Hence the importance of alternative fuels. By 2020, there may be as many as 1.5 billion cars on the road, in contrast to 750 million in 2010 (Xue A., et al. 2015). The primary goal is to contribute for a sustainable transportation network, optimizing the advantages and integrate the renewable energies as an alternative to fossil fuels.

Over the last years, electrical vehicles, the so called EV's have been gaining progressively more importance because of the environmental burden associated with the

petrol engine cars. The main advantage related with this new typology of vehicles, relies on the fact that they produce zero emissions meaning that they run only on clean energy, which in the future, it is expected to come entirely from renewable energy sources. Another advantage of the EV's is their low running costs. Due to its efficiency it allows them to have much lower consumption values in comparison with combustion engine vehicles, plus these vehicles need less maintenance since they have fewer mechanical parts, they are more reliable, have better integrated technology and more advanced systems.

Despite they represent the best solution to answer the present concerns about global warming and the dependence on fossil fuels, electric vehicles still present a high acquisition cost resulting from the price to develop these technologies and the lack of available options, although the tendency of the prices is to decrease. On the other hand, one of the biggest issues concerning EV's is the low autonomy from the batteries, however, at this rate of development soon this will be no longer a problem, at least in city transportation. Until there, those who see this as an obstacle and still want to reduce their environmental impact, they can always opt for another type of vehicle such as the PHEV- Plug-in Hybrid Electric Vehicle.

The EV thematic is day by day more present in everyone's mind, even though there is still lot skepticism around it, the word is being spread just like the cars which are being increasingly sold, leaving the topic to a short-term mindset problem. The present dissertation seeks to assess the growth of EV's globally but specifically, on the national market measuring the future impact on the Portuguese automotive car parc. Furthermore, it also intends to assess the impact that the fossil fuels will suffer with this change and the consequent impact on the transportation sector. With the continuous development of these platforms associated with sustainability, many other new market segments and new business linked to mobility will be developed and improved, contributing to a sustained economic development.

Electric vehicles started to appear bringing something new to the table and finally there was a solution for those who didn't want to contribute to a world dependent on fossil fuels, even though there were several issues still concerning EV's. The EV's are presented these days as an option to certain mobility and transportation applications when looked with a concerted sustainable transport politic. Like it was said previously, one of the main

problems of EV's is the lack of battery autonomy meaning that the users of these electric cars are very dependent on their batteries and on charging points which are still scarce.

Car manufactures due to several factors that go from political to judicial actions had to start developing new car fleets fully electric and plug-in's, the so-called hybrids. These big investments and commitments from several companies are already having notable impacts on the options available to customers but especially, on EV car sales around the world since a lot of governments are offering benefits and incentives to those who opt for a green alternative transport, helping this way to counter the tendency. Attending to these matters, the main objective of this dissertation consists in assessing the impact of electrical vehicles on the transportation sector. This way we will try to forecast the evolution of a pressured and volatile market taking into account market shares and analyze the outcomes from the alternatives with a sustainable approach.

In order to fulfill the main objectives that were thought for this dissertation and to answer to the developed investigation questions it will be necessary to make a questionnaire with the purpose of assess who the new potential buyers of this segment are. This study intends to contribute and evaluate the impact of an energetic alternative for transportation which has as primary source the electricity, making it the main competitor against fossil fuels that are currently the core of the transportation sector over the globe. This impact on the transportation sector it could have many fields of study such as the cultural, economic or social scope, but in order to measure and evaluate the impact that this sector will suffer there is a need for some indicators in order to measure that impact and due to the fact that EV's will be the main transport mean it is essential to study the automotive car parc to try to estimate the impacts inherent with this change, which in this case, this impact will be specifically measured in Portugal.

1.3 General Objective

Having in mind the line of thinking previously presented that encourage the develop of this dissertation, it was set as the main objective of the investigation: Assess/Measure the impact of the Electrical Vehicles on the Transportation Sector, using the Portuguese automotive car parc as the main indicator for the research.

1.4 Specific Objectives

Resulting from the general objective there are some specific insights that the dissertation intends to aim which will all contribute to the concretization of the general objective. They are:

1- Analyze the growth of Electrical Vehicles;

2- Assess the descendent reliance on fossil fuels and the growth of green alternatives;

3- Estimate the impacts and changes on the transportation sector, more specifically on the Portuguese automotive car parc;

4- Assess the customer perception towards APV;

5- Identify the main aspects of an EV that are a decision-making factor for the consumer.

1.5 Investigation Questions

Taking into consideration the global objective and the specific objectives, the present dissertation will seek to answer the following investigation questions:

Question 1: Which impacts and changes should be expected in the Portuguese Car Parc?

Question 2: Is the customer perception a set back towards a change with a new transportation technology?

Question 3: In a car, which factors influence the most a consumer when buying an EV?

Investigation Question 1	Specific Objective 1,2 and 3
Investigation Question 2	Specific Objective 4
Investigation Question 3	Specifica Objective 5

Table 1 – Relation between Investigation Questions and Specific Objectives

1.6 Global Thesis Structure

In line with the proposed objectives above, the dissertation was developed under the following structure:

- **Chapter I – Introduction:** In this chapter it is presented the context of the investigation, the global objective along with the specific objectives, the formulated investigation questions and at last, the structure by which the dissertation is arranged.

- **Chapter II – Literature Review:** In this chapter, we have the bibliographic base that will allow the development of the research through the exposure of realistic scenarios and concepts that are related with the approached topic which will support the execution of the objective.

- **Chapter III – Methodology:** Here is where all the tools and processes used to collect information are described alongside with a representative workflow of the whole process. It is also in this chapter that the sample is defined, and a pre-test validation of questionnaire is performed.

- **Chapter IV - Data Analysis:** This chapter will be where the data collected from the questionnaire will be analyzed using some statistical techniques for a better comprehension of the results which will be then discussed and compared with the bibliographic support.

- **Chapter V – Conclusions:** Here is where the conclusions of the study will be presented, thus it will also be checked the validity and the fulfillment of the proposed objectives. Furthermore, limitations about the research results will also be exposed along with some recommendations and leads for possible future investigations concerning this topic.

Chapter II - Literature Review

2.1 – Introduction

In order to achieve the goals of this research and measure the impact of the EV's on the Portuguese car parc, a conceptual knowledge is required to support all the investigation. This way, the construction of a theoretical base aligned with the topic coverage is not only indispensable but fundamental for the purpose of this investigation.

The thematic of EV's is inherently associated with the protection of the environment, gas emissions and sustainable practices so, for that reason this chapter will start with the renewable transition. After, the market of EV's will be analyzed in a big picture and then more focused on Portugal since it is there the focus of the research. The chapter will end with a comparison between the Portuguese car parc and Europe's car parc enhancing the market opportunities that this new market segment will bring.

2.2 – Renewable Transition

The current paradigm of society stands on a point that if no actions are taken into consideration, we will reach a point of no return in terms of climate change and world sustainability. Nonetheless, we are step by step converging to a greener world powered and moved by renewable sources. Despite that, there is still a lot to change whether it is our daily life habits or businesses that sustain our local and global economy.

Transportation planning has a crucial and dominant role in a state, region or community's vision for its future (Block D. L., et al. 2017). It is mandatory that nations, countries and citizens start to adopt other options for mobility. The actual panorama that we live in is very much related and associated with the sustainability issue and renewable energy which leads people to be much more aware of the impacts that their actions and decisions have on the present and future. Consequently, for those reasons and others to be further analyzed, people, nations and countries are adopting and applying several measures and alternatives in order to counter face the previous tendency of the use of fossil fuels, specifically in the transportation sector.

García-Olivares (2018) says that transport is vital in the current globalized economy since it allows commercial trades, communication between populations and their citizens and

it is also responsible for being one of the main reasons of suburbanization in cities. He adds that the biggest challenges that the present world economy faces are energy security, sustainability, pollution and climate change impacts. Nowadays transportation relies a lot on fossil fuels, approximately 94% of total energy demand for transports is provided by oil only 1% by electricity at this phase, making the transportation sector responsible for more than 25% of world energy consumption (Juan A. A. et al. 2016).

Through a brief analysis of some indictors, some concerns about climate change immediately pop out. A renewable energy transition is urgently needed in order to avoid a catastrophic climate change, however for this transition to be successfully applied in the medium and long term, it would involve a major restructuring of infrastructure and an internationally coordinated policy action that would take between 40 and 50 years (Muñoz-Villamizar A. 2017).

Every country is a different situation because each country has its own resources and some of them have those resources in more abundance than others, making them more efficient to explore and consequentially leading to less costs of exploration. However, even though a renewable transition is necessary, an implementation of any kind of renewable energy would involve a substantial increase of raw material production which could turn into a challenge, mainly for the mining industry, if other economic or industrial sectors request for an added material production (Solé J. 2018).

On the other hand, according to Mersal (2017) building an ecocity might be the answer for solving those material demand products since the ecocity methodology does not rely on emergent new technologies, finding new revenue sources or even developing new concepts. An improved mean is already in our reach. The main goals of a sustainable city are to satisfy the basic needs and realize structures for human care such as mobility, creating barrier-free accessibility to transport networks and to provide the best conditions in terms of healthcare. The challenge here, which is appointed to be the main challenge in every main city, is the transportation sector. There are a lot of problems related with congestion, incomplete public transport networks, accessibility and the continuous increase of private vehicles that make a transition to a sustainable city more difficult to achieve without first changing the habits and the way transport in cities is approached. Block (2017), concludes

on his study that there is an urge for transportation system planning to be thoroughly harmonized with the planning struggles for electrical power systems.

(García-Olivares A. 2018) In a short term is very hard to change the mindset of people, change the way they are educated to use transports and the way they travel. This will be the most difficult part because in order to alter the habits of millions of people it takes a lot of years and a lot of investments so that people tend to be more aware of the actual panorama. However, some big companies are already moving towards this change investing a lot of money in research and development of EV's, some are even renewing their entire fleet into zero emission cars. Like any type of new transformative technology, EV's generate a diversity of powerful economic development challenges and opportunities. Despite the fact the electric vehicle market is still at an initial stage of development, it is set to redesign businesses, industries and communities all over the globe (Xue A., et al. 2015).

2.3 – The EV's Market

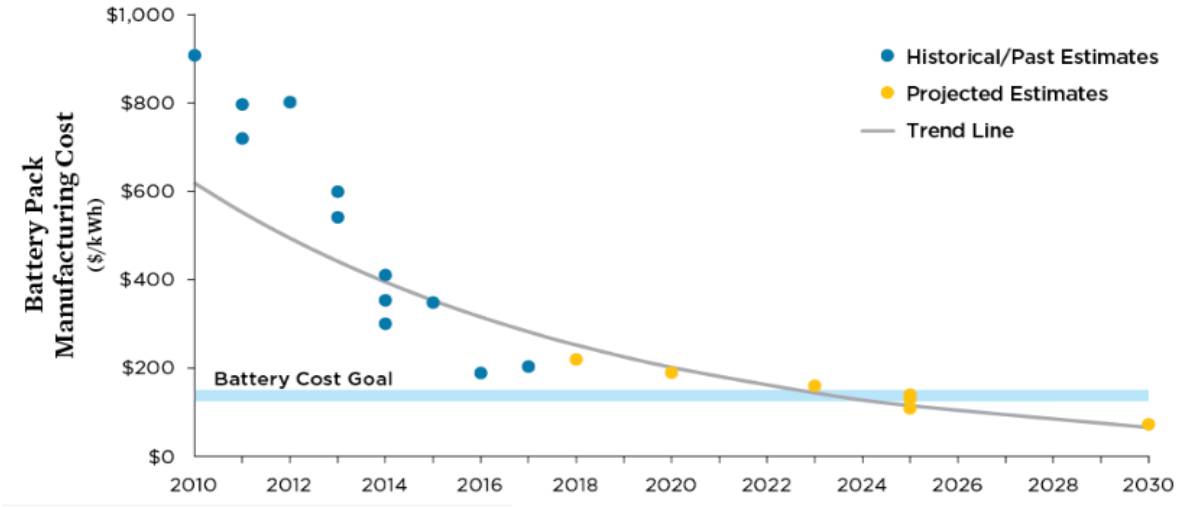
"Electric Vehicles are a promising technology for drastically reducing the environmental burden of road transport. More than a decade ago and more recently, they were advocated by various actors as an important element in reducing emissions of CO2, air pollutants and noise of particularly passenger cars and light commercial vehicles." (Grunig et al. 2011). Before the market of the EV's is analyzed it is important to understand the evolution of the automobile industry and why only now we are witnessing this change.

2.3.1 – History and Appearance of EV's

The first EV's were produced between 1828 and 1835 and they were small-scale electric cars. Then almost 70 years later, in 1901 appeared the first hybrid electric car and from here things would seem to develop in an ecological sustained way until around 1920 the cheap Texas crude oil was discovered which contributed to the decline of electrical vehicles. After that, it was only 50 years later around 1971, that electrical cars started to be heard again and it was with the first vehicle driven on the moon which ran on electricity. Consequently, this date set the next generation of electrical vehicles which encouraged many big and small automakers to explore alternative fuel vehicles. Despite having suffered some

drawbacks when compared with gas-powered cars in terms of range, the new regulations were set around 1990. Subsequently, things only improved, from the first mass produced hybrid car passing through the develop of a nation-wide charging infrastructure to the drop down of Electric Vehicle Batteries costs (graphic 1) which encourage the continuous production and development of new EV's increasing the batteries performance ("Timeline: History of the Electric Car", *no date*).

Graphic 1 - Electric Vehicle Battery Cost



2.3. Source: Accelerating US Leadership in Electric Vehicles, August 2017

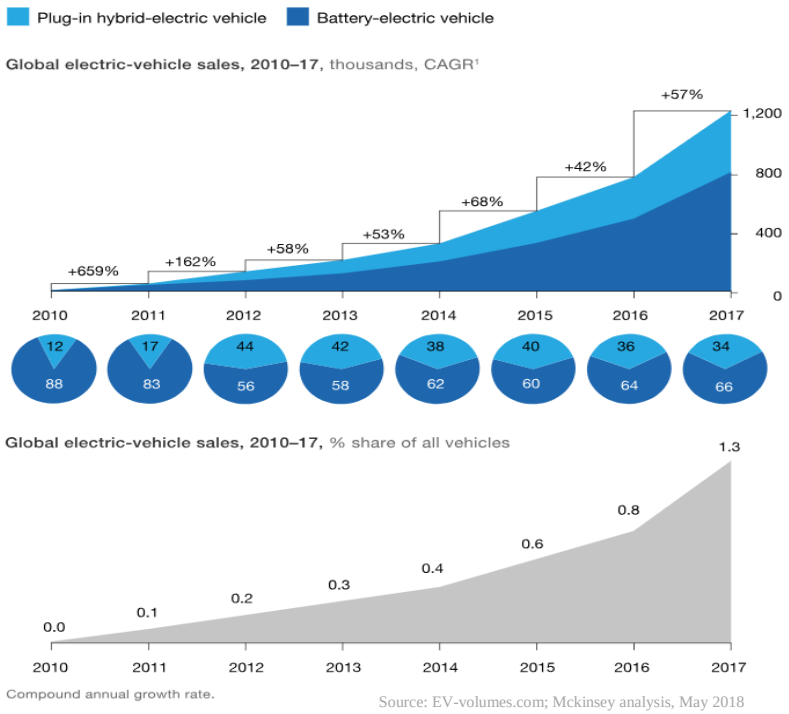
For the very first time, last year, the compound global sales of new EV's passed a million units and this number only tends to continue to grow since the big automakers all over globe are making hefty investments in this technology development reaching investment values of 90 billion dollars. From that investment, 52 billion in Germany, 21 billion in China and 19 billion form automakers in the U.S. (Lienert P., 2018). This can show the concern of car companies towards the market change and helps forecasting what the tendency of market will be.

By analyzing graphic 2, we see that growth has been quite exponential along with a high CAGR, meaning that the investments made would have grown with a high rate of return making this market very desirable for the many players in this industry. Nonetheless, the why we are only witnessing this exponential growth on sales mainly on the past couple years is due to the fact that many automakers had a late response towards the change and did not

predict that this change would happen so quickly. Until now, only some big car companies had invested in BEV and for that reason we are just now noticing this sky rocking evolution. In fact, by maintaining this current growth trajectory, EV producers would be able to almost quadruplicate the number of current EV's on the road by 2020, moving 4.5 million units, which is around 5 percent of the overall global light-vehicle market (Hertzke, et al. 2018). Furthermore, thanks to dropping battery costs and larger scale manufacturing, sales of EV's are expected to reach 11 million in 2025 and then 30 million in 2030 as they became advantageous over ICE (Lillian B., 2018).

From all the EV sales we can also state on the graphic 2 that in 2017, 66 percent of the sales were pure electric vehicles (BEV's) leaving the remaining 34 to the plug-in hybrid electric vehicles (PHEV). This may be explained by the fact that different regions of the globe have very distinctive powertrain preferences, which are influenced by regulatory actions, different customer choices, and the availability or not of some models (ibid).

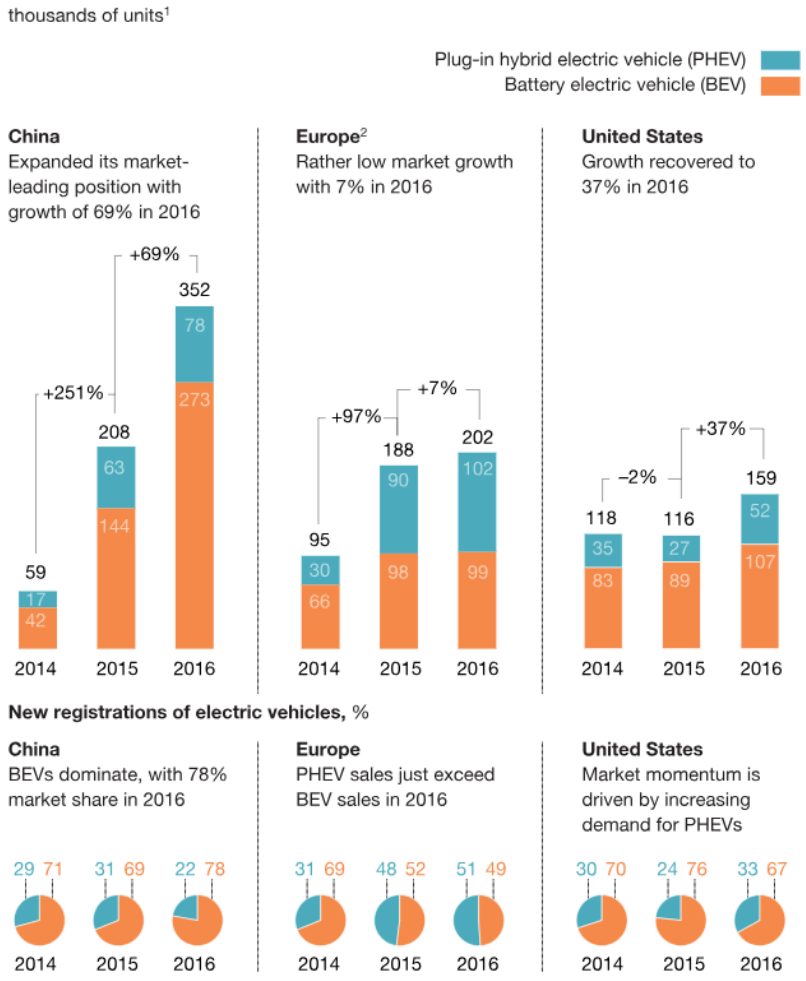
Graphic 2 - Global EV Sales



To support this differentiation between the dissimilar growths of BEV's and PHEV's in separate regions of globe, figure 1 shows explicitly in the three main EV markets the evolution of the new car registrations along with the shares of each type of vehicle from 2014

to 2016. It is clear that the China's market is the one leading electric vehicles sale having already passed the US market in total number of EV's in circulation (Hertzke P., et al. 2017). While China's and United States EV market is mainly dominated by BEV's, the market in Europe although separated by only two percentage points it is dominated by PEHV's. Once again, the influences of the regions, regulatory actions, and customer choice demonstrated.

Figure 1 - New Registrations of Electric Vehicles

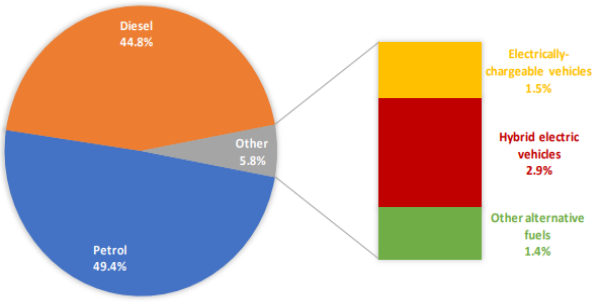


[1]Figures may not sum to 100%, because of rounding.
[2]Includes 11 key markets: Denmark, France, Germany, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, and United Kingdom.
Source: Mckinsey&Company, july 2017

One of the main reasons that helped to increase the sales of EV's was the number of electric vehicle models available to the consumers. In 2010, less than 10 years ago, there were only 6 different EV models for sale in North America. In 2017 this number scaled to 54 models available, which means that every year that passed around 7 new EV models

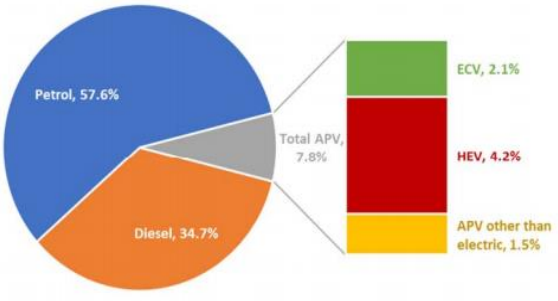
appeared in the U.S. market. From these 54 EV's, 25 are BEV, 26 PHEV and 3 fuel cell vehicles (Richter F., 2018). Changing the market, but still in the same scope, in the EU the scenario is quite the same. Since some automakers already decided to discontinue their fleets ran by diesel and committed to sell only petrol engines and EV's or PHEV, it is expected that the market shares of petrol engine cars increases, the diesel one's decreases and the APV should start getting some more market share, which can be illustrated bellow on graphics 3 and 4 where the fuel types of new car in the EU is compared (Smith J., L. 2018).

Graphic 3 - Fuel Type of New Cars in the EU, Q4 of 2017



Source: ACEA, AAA, March 2018

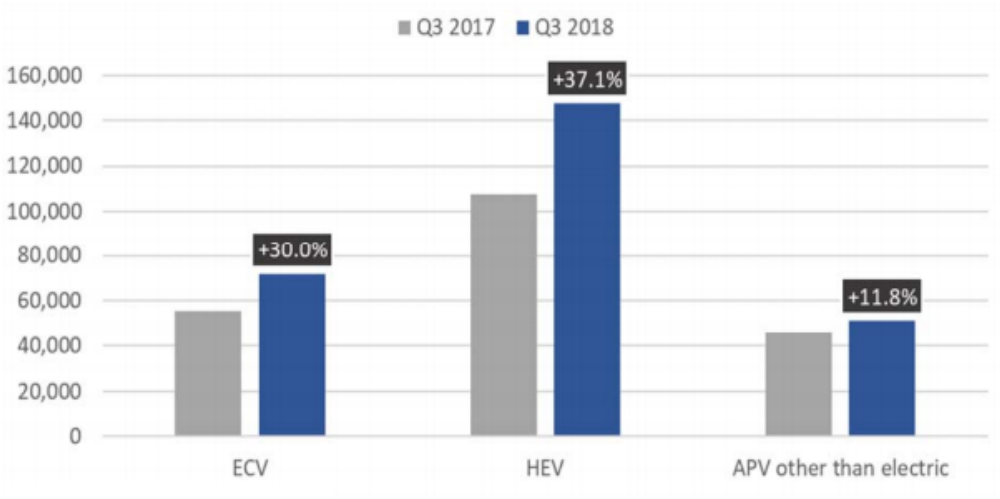
Graphic 4 -Fuel Type of New Cars in the EU, Q3 of 2018



Source: ACEA, AAA, November 2018

The improvement and development of cleaner transport vehicles is also a rising priority for European vehicle manufacturers (Lindstrõm M., et al. 2017). By analyzing both graphics above, we can state immediately a big change on the petrol and diesel percentages, which in only three quarters they have respectively increased 8,2% and decreased 10,1%. This means that in Europe, from the 19.6 million cars produced, more than 11 million cars ran on petrol (ACEA, 2018). Regarding the EV's, the discrepancy might not seem that big but when we are talking in millions the impact is much bigger, hence the fact that the EV's are an emerging market which started to see its growth not long ago and it is still on its early days. Looking at the graphic 4, we can state that the EV's grew about 1,9% in three quarters which translates in 372.400 new electrically powered vehicles.

Graphic 5 - Alternative Powered Vehicles in Q3 in the EU



Source: ACEA, AAA, November 2018

On graphic 5 we can observe that both ECV and HEV grew more than 30% in only one year. *"Demand for alternatively-powered cars in the European Union continued to post strong growth (+29.7%), mostly driven by the strong performance of battery (+37.4%), hybrid (+37.1%) and plug-in hybrid electric vehicles (+24.5%)"* (ACEA, 2018). Although the EV's market share it's still low, at this rate of evolution with the manufactures ramping up production capacities, combined with the discontinuation of several manufactures to continue to produce diesel powered engines, in a near future it is expected that the EV's market share will soon reach two-digit figures. In fact, by 2040 "some 60 million EV's are projected to be sold, equivalent to 55% of the global light-duty vehicle market." (BNEF, 2018).

2.3.3 - Portugal EV's Market context

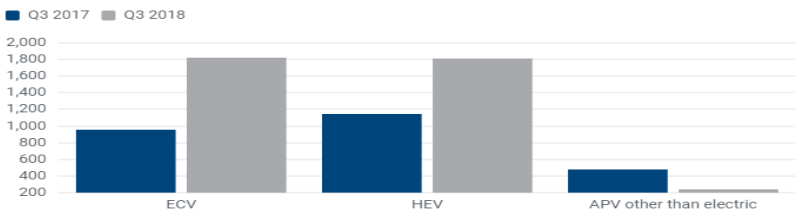
In Portugal, the situation matches the global paradigm since it is also witnessing a consistent annual increase on EV sales. The market is not as big as in other countries, although the growth it is already notable. In 2018, by analyzing the graphic 6, the sales in the third trimester were around 1800 vehicles which represents an increase of almost 400% when compared to the third trimester of 2016 which was around 400 ECV's. This shows the impressive rate of growth that EV's are getting and this large growth rate is due to the incentives on buying this type of vehicles and due to the low number of ECV's and size of the market, therefore the discrepancy is very evident.

Graphic 6 - Number of ECV's Sold in Portugal by Trimester

Source: ACEA, 19/11/2018

Supporting this evident growth of the EV's market there's the graphic 7 representing the passenger car registrations in Portugal, comparing the quarter 3 of 2017 with the quarter 3 of 2018. From this graphic we can state that the growth of the APV's has declined, on the other hand, the HEV's grew around 57.4% when compared with the same period of the previous year. Looking shorter in time, the growth of ECV's from the third quarter of 2017 to the third quarter of 2018 suffered an increase of 90.1% (ACEA, 2018). This data shows that Portugal is also experiencing what is the emergence of a new market, and this continuous growth should be emphasized in the future since by 2025 it is expected a market potential of about 25 million units with more than 400 models available (Frost & Sullivan, 2018), allowing the customer to have better and more diversified options which will all together boost the growth of the market.

Graphic 7 - New passenger car registration in the EU by alternative fuel type, in Portugal



Source: ACEA, 08/11/2018

Contrary to what happens in many other European countries, where the PHEV claim the biggest increment, in Portugal, both PHEV and EV grow in a similar way, at the same rhythm. The PHEV and EV's already represent 3% of the market share in Portugal (Carvalho S., 2018).

2.4 - Automotive Car Parc

The term « Parc » is the European terminology used for all registered vehicles within a defined geographic region and it has as definition, VIO – all vehicles in operation. (Hedges & Company, 2014). The global vehicle population in 2016, stood at 1.32 billion cars and trucks which doubles the VIO in 1996, meaning an increase of 4.6% from the prior year (Petit S., 2017).

(ACEA, 2018) In 2017, were produced about 98.9 million motorized vehicles globally with China being the country with the highest share of produced vehicles. In fact, China has now surpassed the United States by being home to more than 300 million vehicles whereas the U.S. have a car parc of around 268 million vehicles, and its growth will only continue to rise since China's car per capita is much lower leaving a lot of room to this number to expand (Chesterton A., 2018).

Nonetheless, in order to the dissertation and the data itself becomes more accurate and precise leading to consistent inferences, this research will have its study focus only on the European Union car parc.

2.4.1 – Europe's Car Parc

According to ACEA (2018) 24% of all passenger cars produced worldwide are made in Europe, which is around 19.6 million cars. This value has decreased and increased over the years reaching nowadays the highest value so far. Furthermore, this continued increase over the past couple years of the production without a renovation/shut down of the "old" car fleet is leading to the continuous growth of the car parc. "The EU passenger car fleet grew by 5.7% over the last five years" (ACEA, 2018), with the number of vehicles on the road going from 243 to 257 million (table 1). To put this into perspective, per every 1,000 inhabitants there are 587 cars.

From 2015 to 2016 the average passenger cars growth variation was 2% which represents an increase of more than 5 million passenger cars in use, only in the EU. Apart from Latvia, all countries had a positive variation which means that all countries of the EU except from Latvia, augmented their fleet.

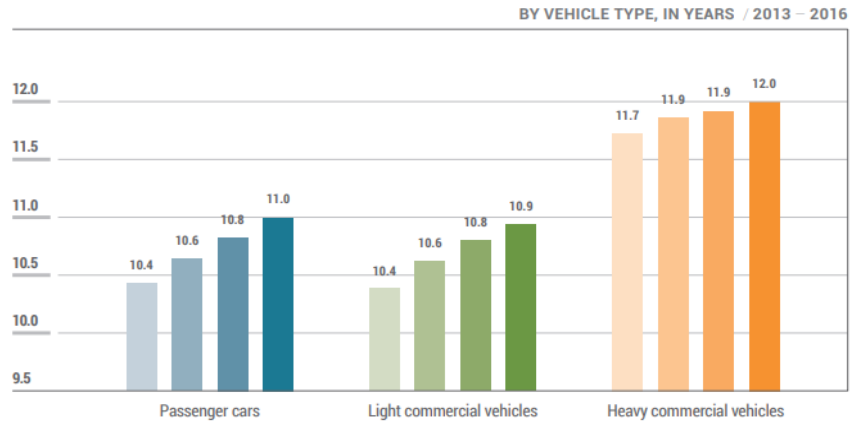
Table 2 - Vehicles in use in Europe – Total Vehicles

	2012	2013	2014	2015	2016	%change 16/15
Austria	5,010,283	5,075,639	5,139,421	5,201,750	5,288,596	1.7
Belgium	6,183,942	6,241,017	6,328,169	6,425,839	6,538,095	1.7
Croatia	1,598,381	1,595,647	1,624,590	1,662,490	1,724,267	3.7
Czech Republic	5,403,947	5,501,892	5,614,994	5,847,361	6,119,478	4.7
Denmark	2,709,497	2,730,684	2,780,902	2,849,905	2,936,247	3.0
Estonia	694,489	719,703	754,189	783,131	816,206	4.2
Finland	2,968,004	2,985,879	3,007,744	3,028,333	3,048,059	0.7
France	38,138,000	38,200,000	38,407,000	38,567,670	38,651,953	0.2
Germany	46,538,124	47,014,699	47,647,581	48,427,094	49,285,424	1.8
Greece	6,218,035	6,192,499	6,190,701	6,199,759	6,235,761	0.6
Hungary	3,437,219	3,501,230	3,579,786	3,687,078	3,821,432	3.6
Ireland	2,229,029	2,268,722	2,302,123	2,356,901	2,409,983	2.3
Italy	41,999,986	41,776,186	41,893,839	42,241,934	42,862,046	1.5
Latvia	704,943	721,416	747,711	765,335	753,373	-1.6
Lithuania	1,947,997	2,031,444	1,210,487	1,254,204	1,295,630	3.3
Luxembourg	383,467	394,405	402,297	412,750	422,291	2.3
Netherlands	9,214,000	9,207,000	9,237,528	9,396,413	9,528,197	1.4
Poland	22,022,275	22,734,532	23,450,536	24,261,232	25,329,863	4.4
Portugal	5,807,100	5,753,200	5,747,500	5,781,700	5,824,700	0.7
Romania	5,266,680	5,503,408	5,764,023	6,065,901	6,408,904	5.7
Slovakia	2,138,684	2,198,463	2,272,506	2,367,911	2,461,598	4.0
Slovenia	1,198,349	1,205,856	1,221,964	1,247,935	1,284,382	2.9
Spain	27,480,341	27,154,604	27,114,855	27,462,976	28,026,696	2.1
Sweden	5,018,189	5,074,641	5,180,716	5,279,391	5,398,128	2.2
United Kingdom	35,760,901	36,282,603	37,113,358	38,219,610	39,240,439	2.7
EUROPEAN UNION	**280,071,860**	**282,065,369**	**284,734,520**	**289,794,603**	**295,711,748**	**2.0**

Source: ACEA Report: vehicles in use, 2018

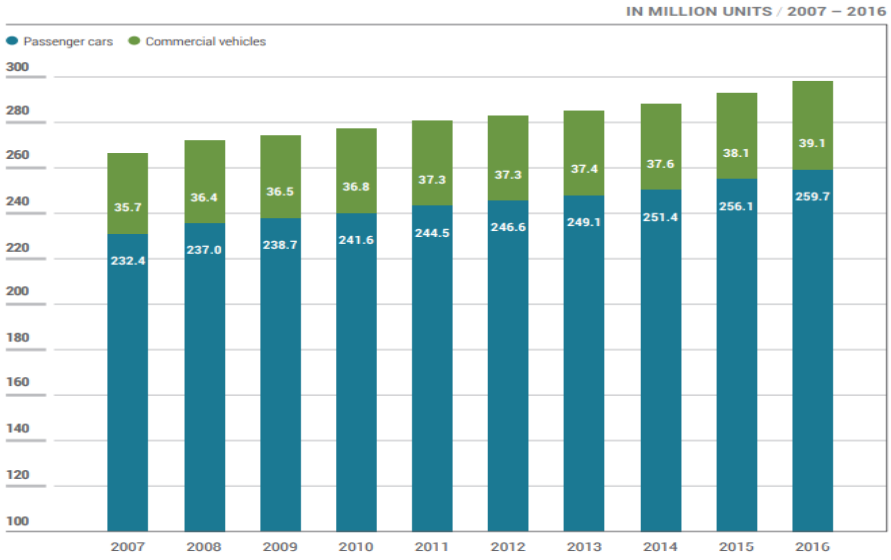
However, the continuous growth of the car fleet also makes the average age of the cars increase. The graphic 8 shown below, illustrates the growth of the average age in the EU which tells us that year after year the EU vehicle fleet is getting older reaching in 2016 an average age for passenger cars of 11 years, for light commercial vehicles 10.9 years and for heavy commercial vehicles 12 years. There are much more passenger cars as seen in graphic 9 than any other vehicle category, meaning that most of the cars responsible for this aging of the vehicle fleet belong to citizens. In other words, there will be an increasingly need from the fleet operators to consider their populations driver profile when planning what type of fuel better suits the needs of their drivers, attending to the benefits from a financial perspective (Ryan A., 2018).

Graphic 8 - Average Age of EU



Source: HIS MARKIT - The automobile industry pocket guide 2018/2019

Graphic 9 - EU Vehicle Fleet: Size and Distribution



Source: OICA, HIS MARKIT - The automobile pocket guide 2018/2019

2.4.2 – Portuguese Car Parc

According to ACEA Portugal has more than 5.8 million cars in use. Through the analyses of the table 2 presented below, Portugal has seen its commercial vehicles in use, which includes light commercial vehicles up to 3.5 tonnes, medium and very heavy commercial vehicles over 3.5 tonnes and buses, decreasing since 2012. On the opposite side, the passenger cars in use have been increasing since 2013, which reflects Europe's tendency demonstrated on graphic 9. Although the negative variation from the total commercial vehicles is bigger than the positive variation of passenger cars, the variation from the total vehicles in use is positive in 0.7%. This is due to the fact that the amount of passenger cars

in use its much higher when compared to the commercial vehicles, so that, a similar percentage in variation will have a much bigger effect on the passenger cars achieving this way a positive variance of the total vehicles in use.

Table 3 - Vehicles in use in Portugal

		2012	2013	2014	2015	2016	%change 16/15
-Total comercial vehicles	Portugal	1,310,100	1,273,200	1,251,500	1,243,700	1,224,700	-1.5
-Passenger cars	Portugal	4,497,000	4,480,000	4,496,000	4,538,000	4,600,000	1.4

Source: ACEA Report: vehicles in use, 2018

When compared with the EU average age of fleet, Portugal is situated above in every vehicle category (ACEA, 2018). It is 1,5 years older on average than the EU passenger cars, 2,2 years older on average concerning light commercial vehicles and 2,8 years older on average than the medium and heavy commercial vehicles of the EU. Looking at table 3 it is noticeable a considerable difference between the cars after 2007 and before, leaving about 61% of the total Portuguese passenger cars with more than 10 years old. The same happens with the light commercial vehicles and the medium and heavy commercial vehicles with about 68% and 65% respectively, also with more than 10 years old making Portugal a country with the majority of vehicles in use above 12 years old which can also turn into an opportunity with the introduction and consolidation of the APV's.

Table 4 - Vehicles in use by age in Portugal

Year of first registration	2016	2015	2014	2013	2012	2011	2010	2009	2008	2007	>10 years	Total	(in years)
Portugal	192,358	176,379	144,526	117,995	118,400	177,144	240,195	177,531	232,366	213,493	2,809,613	4,600,000	12.5

Source: ACEA Report: vehicles in use, 2018

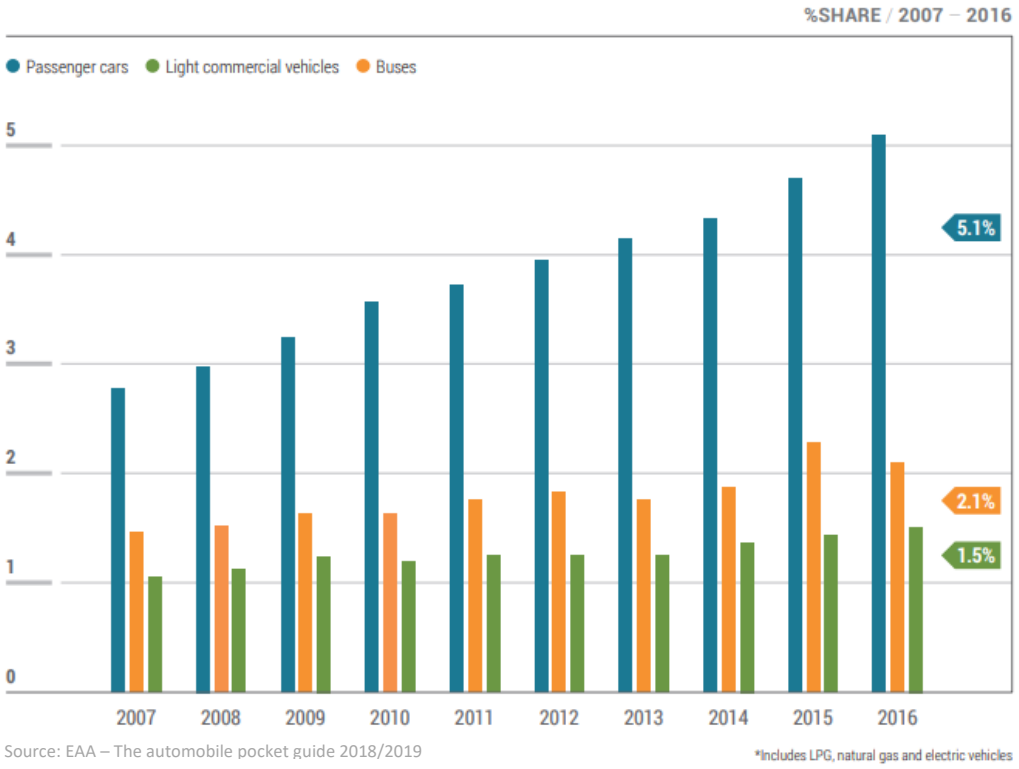
2.5 Conclusions

The EV's market is in continuous expansion and it is predicted to reach a stock of 18.7 million EV's by 2030, exciding annual sales of 3.5 million vehicles which will be more than 20 percent of the annual sales in 2030 (Cooper A. et al. 2018). Furthermore, it took more than 8 years to reach a million EV sales and the next million is expected to be in less than 3 years, around 2021.

Moreover, in terms of percentage, the passenger cars are the ones that represent the highest share percentage of alternative powered vehicles, being also the segment that has been growing the most as described on the graphic 10. This, particularly in Portugal since consumers are buying more new cars year on year (table 3 above) and approximately 79% of

its car parc is composed by passenger cars, represents a big market opportunity for a fleet renovation weather in terms of aged vehicles or a transition to EV's.

Graphic 10 - Share of Alternative Powered Vehicles per Segment



Nonetheless, some studies through inquiries and research have identified some key figures that influences the decision-making process when buying a new car, the respective impact of the factors and the consumer concern factors regarding a Battery Electric Vehicle. Weve (2017) identifies as influencers of a decision aspects like the look of the car, the brand, the size, its safety and emissions. On the other hand, (Deloitte, 2014) Deloitte orders the following factors, the price/value of the vehicle, vehicle features, type of engine, type of vehicle, model and brand from most relevant to least, respectively. However, specifically looking at BEV's, since most of the consumers are not familiarized with the thematic and are few compared to the many that never experienced or even driven a BEV. Deloitte (2018) after performing a study, stated that the greatest concerns towards a BEV are the driving range, cost/price premium, lack of electric vehicle charging infrastructure, time required to charge and safety concerns regarding battery technology.

As said previously above on the Renewable Transition topic, the most difficult part of this transition process will be to change people's habits. By 2020, 40% of new car buyers will be from millennials, of which 88% do their car purchase research through the internet (Bannister, K., 2017) meaning that the perception that the consumer has from the product will be much more different than it was before. More effort will have to be put from the automakers in order to build innovative vehicles that address the gaps in the market and these more innovative vehicles, the large majority will pass through the EV's which are the ones bringing more advanced and new innovative technology to the industry along with bold designs and more efficient vehicles.

2.6 Critical Analysis

Despite Garcia-Olivares stated that, the most difficult part of this transition would be the change of mindset and that it would take several years, this process is moving fast. More than it was maybe predicted to. In fact, today in Portugal, for each 100 cars sold 5 are electric leading to a growth of sales from the homologues previous year of 168% making a total of 3378 EV's sold (Nunes F., D., 2018). To put this into perspective, on the seven previous years there were sold in Portugal "only" 3669 EV's. So, what does motivate people into buying this type of vehicles and why would they opt for an EV instead of a petrol engine car? These two questions are essential for development of the next chapter since they show what influences people into making their choices. This will be further addressed in the methodology chapter with a questionnaire which could be the key for better and more accurate predictions, to profit for automakers, sustainability for countries and the world and for the consumers satisfaction.

Some known city capitals like Athens, Mexico City, Madrid and Paris already pledged to ban diesel vehicles form their city centers by 2025 (BBC, 2018) while other capitals set some different measures for the same year, even though they commit to stop diesel sales or petrol and some even promise both. Likewise, Denmark introduced a legislation that banned new diesel cars from entering the Danish capital in 2019. From Cities to Brands, some major players in the automotive industry such as Volkswagen, Porsche and Toyota already signaled they will move away from diesel technologies, plus Volkswagen and

Porsche are part of the VW Group which is owner of many other car brands which suggests these other brans from the group might follow the same course soon.

This slow progressive path to a zero-emissions transportation system, is getting closer and closer and the first fuel to see its end is expected to be the diesel. Looking at ACEA's quarterly reports presented above, it is showed that the EU diesel market share had decreased while the APV's market share did the opposite. This tendency will continue and spread allowing space for other free emission engines to proliferate such as the APV. Juan A. A. (2016), says that only 1% of electricity is used to power the transportation sector while 94% comes from oil. This data will soon change since the oil will be less used with the emergence of the EV's, although with this type of vehicles the electricity dependency will be also higher, so it is very important that along with this growth, as Block (2017) stated, comes a structured network of charging infrastructure systems beside the necessary transportation planning in the cities. Failing to do so, it might lead costumers to opt for petrol engine vehicles since the infrastructure is already built and there are still not so many restrictions about these engines.

Chapter III - Methodology

3.1 -Introduction

The present chapter will be the link between the literature review and the results expected which are the answer to the investigation questions. It will start with a description of the chosen design method, followed by the definition of the sample, the pre-test validation which ensures the quality of the questionnaire and at last, a workflow of the methodology showing the steps made from the beginning to the end of the methodology process.

3.2 Methodology Research Design

In order to answer the investigation questions the qualitative approach was chosen since it was better suited for the thematic, although the data was treated using the quantitative approach in terms of interpretation. Furthermore, in this case the questions made in the questionnaire are opinion questions where the goal is to try to understand the motivations of a certain sample and to perceive and interpret the tendencies around it whereas the quantitative approach is used to quantify a problem and understand its size. Having this mindset in mind a series of questions were developed to seek answers for the investigation questions.

The questionnaire starts with the basic general information with the purpose of defining the sample. After this sample characterization the respondent will finally start to answer some questions that will help solving the investigation questions presented below. Hence noticing that different profiles have different tendencies so, these questions are very important in the way that will help provide guidelines about the target that electric vehicles are attracting.

IQ 1. - Which impacts and changes should be expected in the Portuguese Car Parc?

It starts with the "Basic Information" section where the sample is defined followed by "Mobility" section where several questions are made regarding the preferences of the respondents. They are directed for fuel type preferences, the age of their own vehicles, the willingness to buy a new car or the way which the respondents dislocate themselves from one place to another on their daily routines. The goal in this section is mainly trying to assess how is the current relation between market/consumer perception and through the data

received make a forecast of the impacts that should be expected specifically in the Portuguese car parc.

IQ 2. - Is the customer perception a set back towards a new technological road transportation change?

To answer to this investigation question comes the section called "Consumer Behavior and Preference Analysis" which has two questions that first, intend to assess the psychological and sociological determinants that characterize the behavior of the respondent and second, a functional analysis that will tell how volatile are the respondents towards the electric vehicles topic.

IQ 3. – In a car, which factors influence the most a consumer when buying an EV?

Like the previous investigation question, the answer to this one is also in the same section and seeks to know from the several critical factors encountered, how important are they for the respondent and from those factors which of them is the most and the least important, aiming to see this way what does the respondent values more in a car.

3.3 Sample Definition

When performing a questionnaire for a study there is a need to gather a big quantity of answers in order to the study to have a bigger impact whereas in this case, due to the dissertation being developed in a short period of the time it was necessary to come up with a sample and define it:

Who? - In order to achieve the highest number of answers the questionnaire was spread via social media. Since there is not a specific target to the study, it was only a matter of choosing the tool with the biggest range possible to achieve the higher number of respondents and to make the study more plausible.

When? – The data collection period was set between the 8th of March of 2019 and 15th of April of 2019.

Where? – Due to the fact that the chosen tool used to spread the questionnaire was the social media it makes it not possible to define a geographical perimeter since anyone can access the questionnaire from any part of the world if they have internet connection.

3.4 Pre-Test Validation

The pre-test was realized by sending the questionnaire to a restrict number of persons in order to acknowledge which flaws would be perceived by the respondents before sending the official version. After the trial and followed by the feedback of the respondents, some changes were necessary to be made. As main changes we can denote some semantic errors that were corrected, a few alterations in some questions such as adding the option "other" allowing this way the respondents to have the possibility to express themselves and giving their own opinion which doesn't limit the answers. The last main change was the removal of two questions that were not directly linked with the literature review. Subsequently, after this process the questionnaire was finally ready to be spread out.

3.5 Methodology Workflow

Since the steps that were made in order to make the methodology were already described above, it is only necessary now to present a workflow of how the whole process works.

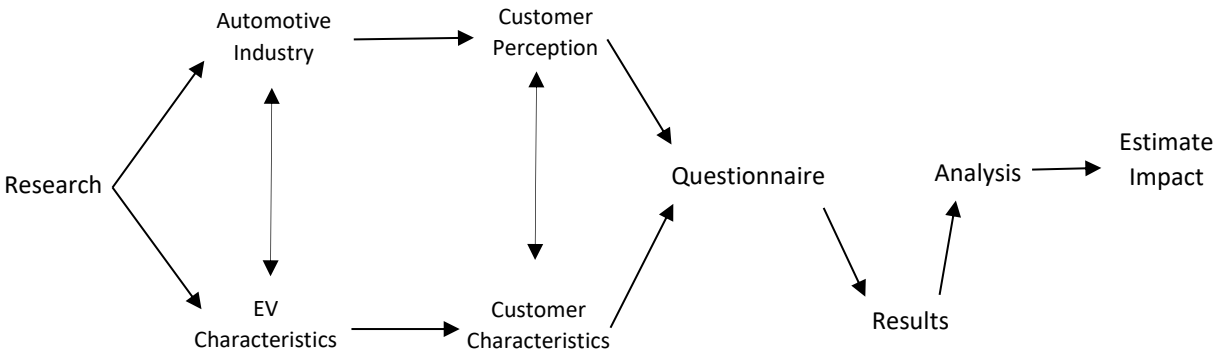


Figure 2 - Process Workflow

Chapter IV – Data Analysis

4.1 Introduction

In this chapter, the results from the questionnaire will be statically analyzed individually per section and in some section with the help of a statistical software called SPSS. Afterwards the results will be interpreted and compared with the literature review data followed by the conclusion.

4.2 Statistical Analysis

4.2.1 Sample Characterization

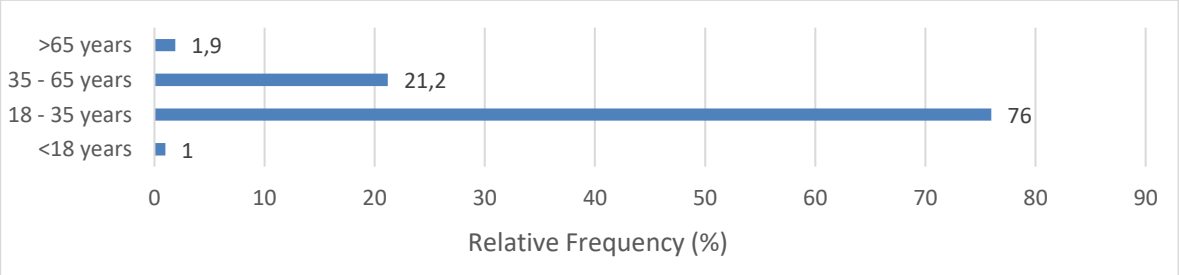
To characterize the sample, the independent variables "Gender", "Age", "Nationality", "Studies", and "Driving Experience" were used.

Regarding the independent variable "Gender", the data collected was close to be even among the two categories, with 52,9% of questionnaires answered by men and 47,1% responded by women.

The graphic 11 represents independent variable "Age" according to the four age groups considered for the study. The group with the highest percentage of elements in the sample is the "18 - 35 years" (76,0% of answers), as expected by the channels which the questionnaire was spread. The next big group was "35 – 65 years" (21,2% of answers) followed by age groups ">65 years" and "<18 years" both with less than 2% of answers.

Due to a small number of answers in age groups ">65 years" and "<18 years" the variable was altered for the purpose of statistical analysis. Category "<18 years" was aggregated to a new category named "35 years or below" and category ">65 years" was also aggregated into a new category named "35 years or above", resulting in two groups for this variable.

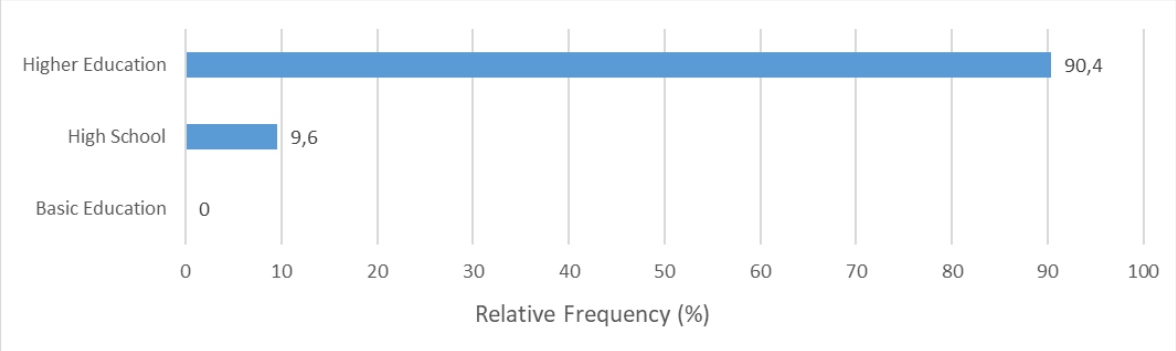
Graphic 11 - Sample Characterization of Age



The independent variable "Nationality" was evaluated with two possible situations which were "Portuguese" and "Other". Although it had two options, the one with almost the totality of the answers was "Portuguese" which characterizes 91,7% of the sample.

The independent variable "Studies" examined three types of education levels: "Basic Education", "High School" and "Higher Education". As shown in graphic 12, most of the sample is characterized by a "Higher Education" education level (90,4% of answers) leaving the rest of the answers to the "High School" education level (9,6% of answers).

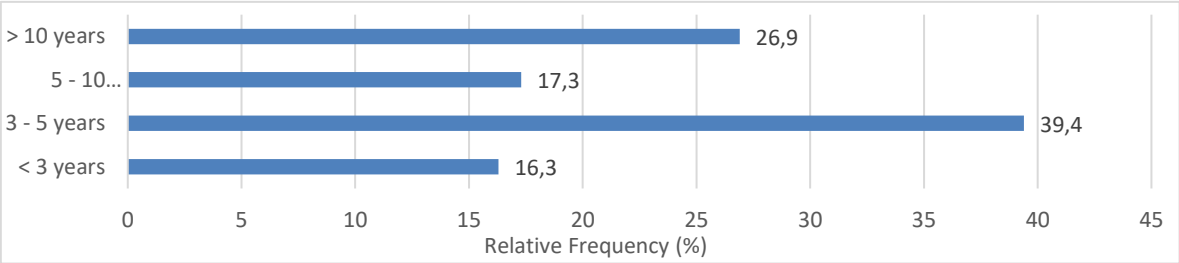
Graphic 12 - Sample Characterization of Studies



Due to the lack of observations in the "Basic Education" group, the variable was also altered. The categories "Basic Education" and "High School" converged into a new category designated as "High School or bellow", leaving the variable with only two categories.

The independent variable "Driving Experience" was analyzed in four types of experience: ">3 years", "3-5 years", "5-10 years" and ">10 years", as presented in graphic 13. The ">10 years" is the second most representative category of the sample (26,9% of answers) after "3-5 years" category (39,4% of answers). The categories "5-10 years" and "<3 years" are only 1% apart from each other, being the first "5-10 years" (17,3% of answers).

Graphic 13 - Sample Characterization of Driving Experience



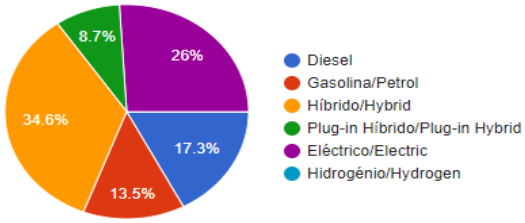
4.2.2 Sample Profile

Here the answers from the questionnaire will be linked between each other in order to try to define what type of people did answer it and at the same time, analyze if there is a pattern among the answers given by most of the respondents.

Starting with the mobility part on the first question regarding the vehicle ownership, 72,1% of the respondents claim to possess a car and from these car owners around 44% have a car with and age equal or superior to 10 years. When asked to non-car owners to answer the same question having into consideration a relative's car as referential, we get 41,3% of respondents with a vehicle with 10 to 20 years old and 14,4% with cars with more than 20 years. About the vehicle swap frequency, around 39% of the respondents have admit to change cars each 5 to 10 years and 45% said only over 10 years. Since the topic here is mobility, the sample was asked to answer which transport do they use the most on a daily basis to which almost 60% responded "Car" followed by the "Train" and "Bus" with 15,4% and 14,4% respectively. The sample was also asked which methods they use when they want to buy a new vehicle and about 44,2% prefers only to make an online research while the majority 51,9% not only does the online research but also goes to the dealership.

On the second part of the mobility section the questions made to the sample had more to do with the sensibility towards green alternative transports. The first question was about an electrical car experience and the majority of the sample, about 61,5%, answered no meaning that more than half of the sample never tried a BEV. When asked about the intention of buying a car in the next 5 years, 53,8% answered "yes", which is more than half of the respondents. About the choice fuel type for a new hypothetical vehicle purchase, 69,3% opted for green alternative fuels being 34,6% for hybrids, 26% for electric vehicles and 8,7% for plug-in hybrids. The remain answers were spread between diesel and petrol with 17,3% and 13,5% respectively.

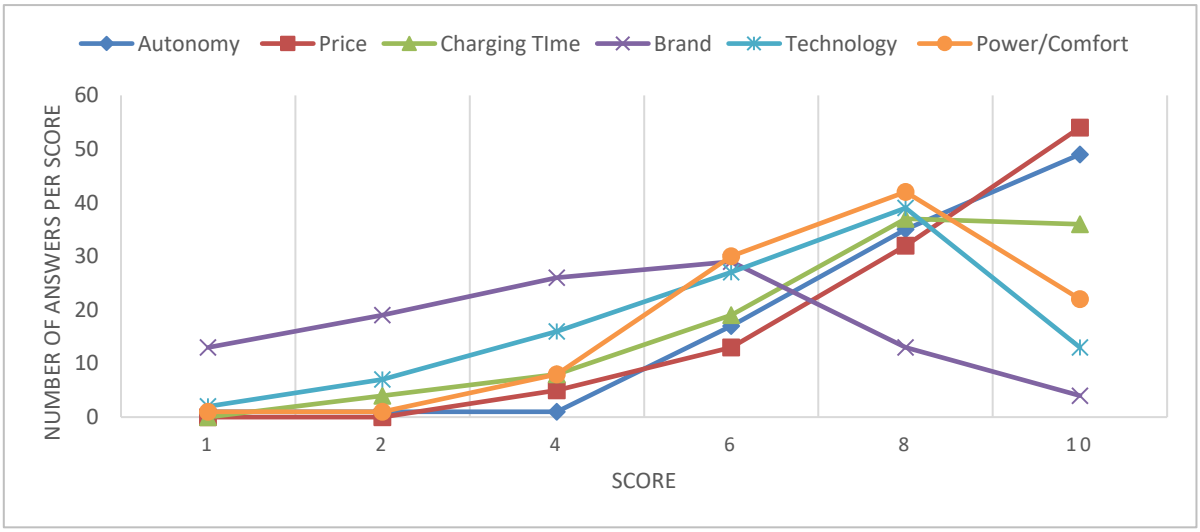
Graphic 14 - Fuel preferences



Linking the answers of the BEV car experience and these answers we observe that from the respondents that have experienced a BEV, 72,5% chose a green alternative fuel and from those who never tried a BEV 67,2% chose a green alternative fuel. Although the sample is not big enough to compare the data more thoroughly it is fair to assume that people that have had a BEV experience are more willing to opt for an EV car instead of a diesel or petrol engine car. To end this section, it was asked if an alternative electric transport would be an option to which 77,9% of the respondents answer "Yes, at a lower cost" meaning that the individuals are still not willing to pay the current prices which are at the moment still above the majority of the non-electric transports.

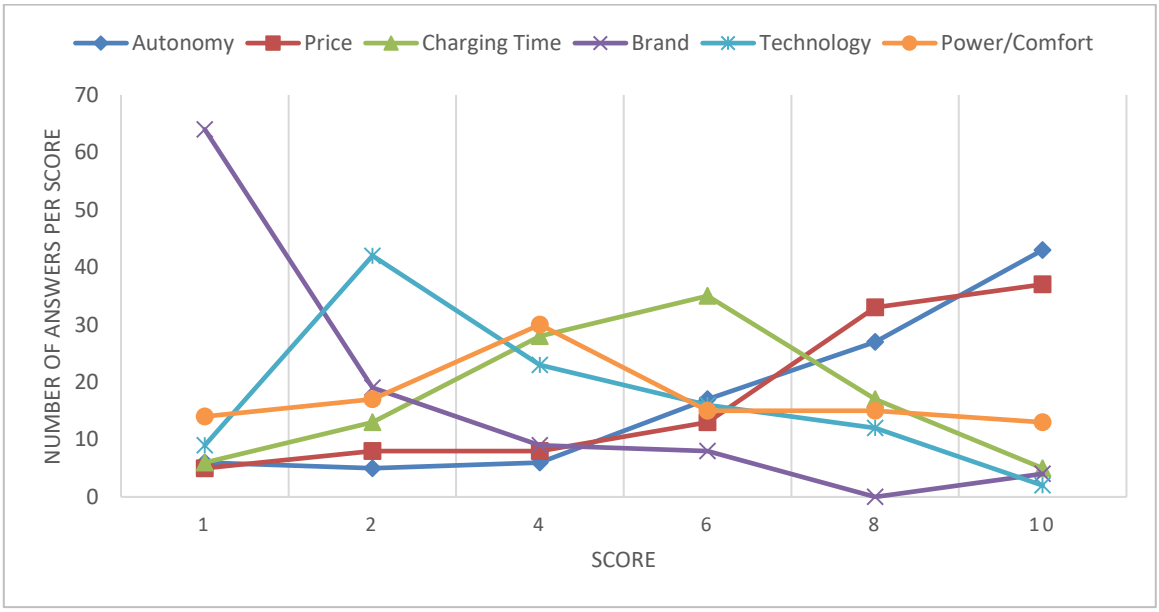
The following two graphics they both represent the preferences of the sample towards some of the most important critical factors encountered in a BEV car although they differ in importance and relevance. First, the respondents were asked to evaluate each factor with a score without any restrictions in terms of prioritizing the choice. In graphic15 we can observe a sequence on the factor preferences which starts with the Price, then the Autonomy followed by the Charging Time, Power/Comfort, Technology and Brand. Hence noticing that the factors Price/Autonomy and /Technology/Power/Comfort had very similar scores among the respondents. Despite this result, the fact that the sample was small it made some of the lines look similar between them being difficult in some cases to clearly come up with a conclusion since the amount of data collected could show more disparate results between the factors. This way, in order to avoid this kind of situations and to be able to proper analyze and

Graphic 15 - Critical Factors Importance



conclude clearly which of the factors were indeed more important in the respondents eyes, the same question was asked but this time, the sample was required to give one and only one score to each factor allowing this way, to see which factors were prioritized to the detriment of others. Through the graphic 16 analysis, we get a clear view over the graphic lines which ensures a proper distinction between the various factors, starting with most valued factor among the respondents, the Autonomy followed by the Price, Charging Time, Technology and at last the factor that was least appreciated among answers, the Brand. Straight away we can tell which factors have more influence in an individual regarding its car preferences.

Graphic 16 - Critical Factors Importance



At last the respondents were asked, if it was the case, to provide some more factors that they would take as well into consideration along with the previous given factors and some of the inputs provided did not relate with BEV car characteristics but with its sphere of action such as, the price of charging the car electrically, financial benefits towards the purchase, the charging point infrastructure or the taxation. Nonetheless, other factors directly related with the vehicle were also pointed such as the battery cell longevity and battery warranty which are the core of a BEV.

4.3 Factorial Analysis

In this point is where we start deepen the knowledge given by the data previously collected and to do so, the statistical software SPSS was utilized along with several tests and measurements in it, in order to perceive if the data is reliable and truth worthy for the development of the study.

After running the Factorial Analysis algorithm in the SPSS, we get several outputs which all give different, relevant and detailed information. The first output is the Correlation Matrix which enables to summarize a large amount of data where the goal is to see the correlation between variables. The values vary from 1 to -1 which are both the strongest possible correlation coefficients. Positive correlations mean that the variables move in the same direction meaning that they directly influence each other, on the other side, the negative correlations mean that the variables move in opposite directions.

After the correlation matrix follows the Bartlett and KMO tests. These tests ensure that the factorial analysis is proper and adequate allowing to verify if there is a sufficiently strong correlation for the factorial analysis to be applied. Here, two hypotheses are tested:

H_0: the correlation matrix is an identity matrix, there is insufficient correlation between the variables. The analysis is not adequate.

H_1: the analysis is adequate because there is a significant correlation.

The Bartlett test says that if the value of *p-value* is lower than the significance level of 0,05 we should reject H_0.

Following the Bartlett test comes the KMO test which measures the applicability of the factorial analysis use in the data set. Lower values mean that the sample is too small being inadequate for this tool. In order to the analyses to be considered possible for the case, the test must reach values $\geq 0,5$.

The next test is about the communality matrix which tells the percentage of variability explained in each variable when grouped into a factor. This value should be always superior to 0,6. When bellow this value it should be removed from the test. Nonetheless, some

variables may stay with values bellow 0,6 depending on the importance that the variable has for the study.

4.3.1 Sample Characterization and Psychological and Sociological Analysis

The purpose of the choice of these variables for the correlation matrix in this section was to define and understand the sample both psychological and sociological as individuals and to match its characteristics with its behavior finding this way the connection between them.

Starting with the positive correlations, by observing the table 4 below we can denote a couple correlations such as A1 and C1 with a coefficient of 0,271 between the variables "Gender" and "I regularly seek information about the latest consumer technology" and A1 and C3 with a coefficient of 0,276 between the variables "Gender" and "I keep up-to date with consumer technology by reading newspapers/magazines, websites or relevant TV shows". Regarding negative correlations there are several that stand out, like A2 and C5 with a coefficient of -0,407 between the variables "Age" and "I'm a very ambitious person setting high standards and expectations for myself", A2 and C6 with a coefficient of -0,236 between the variables "Age" and "I'm always looking for ways to alter my life to make it better" and also A5 and C6 with a coefficient of -0,280 between the variables "Driving experience" and "I'm a very ambitious (…)".

Table 5 – Sample Characterization and Psychological and Sociological Correlation Matrix[a]

		A1. Gender	A2. Age	A3. Nationality	A4. Studies	A5.Driving Experience	C1. I regularly seek information about the latest consumer technology	C2.I often socialize with people from a large variety of different backgrounds	C3. I keep up-to-date with consumer technology by reading newspapers/ magazines, websites or relevant TV shows	C5. 'Im a very ambitious person setting high standards and expectations for myself	C6. I'm always looking for ways to alter my life to make it better	C7. Compulsive behavior usually governs my purchasing decisions
Correlation	A1. Gender	1.000	-.123	.048	.019	-.149	.271	-.050	.276	.043	-.004	.070
	A2. Age	-.123	1.000	-.094	-.286	.732	-.002	-.114	.012	-.407	-.236	-.162
	A3. Nationality	.048	-.094	1.000	.056	.128	.239	.056	.082	.095	.162	.069
	A4. Studies	.019	-.286	.056	1.000	-.325	-.070	.049	-.123	.133	.038	-.173
	A5.Driving Experience	-.149	.732	.128	-.325	1.000	-.060	-.078	-.060	-.280	-.111	-.097
	C1. I regularly seek information about the latest consumer technology	.271	-.002	.239	-.070	-.060	1.000	.183	.576	.099	.128	-.038
	C2.I often socialize with people from a large variety of different backgrounds	-.050	-.114	.056	.049	-.078	.183	1.000	.179	.244	.368	.082
	C3. I keep up-to-date with consumer technology by reading newspapers/magazines, websites or relevant TV shows	.276	.012	.082	-.123	-.060	.576	.179	1.000	.020	.171	.037
	C5. 'Im a very ambitious person setting high standards and expectations for myself	.043	-.407	.095	.133	-.280	.099	.244	.020	1.000	.491	.172
	C6. I'm always looking for ways to alter my life to make it better	-.004	-.236	.162	.038	-.111	.128	.368	.171	.491	1.000	.148
	C7. Compulsive behavior usually governs my purchasing decisions	.070	-.162	.069	-.173	-.097	-.038	.082	.037	.172	.148	1.000

a. Determinant = .082

About the Bartlett's and the KMO test they both were positive. Bartlett's showed a significance level below 0,05 meaning that H_0 is rejected and the matrix is not an identity matrix. On the KMO's test although the value was above required for the feasibility of the analysis with a value of 0,593 is considered a poor score which might be explained by the size of the sample.

Moving on to communalities test, the variable "My friends and family would say I was a cosmopolitan person" was removed from the test not only because it had a value below what is acceptable but also because its existence was not compromising the reliance of the study, so the factorial analysis was run again this time without the variable, as displayed in the image bellow.

Table 6 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.593
Bartlett's Test of Sphericity	Approx. Chi-Square	245.901
	df	55
	Sig.	.000

In terms of variance, from this analysis 5 components were obtained with variance above 1 meaning that these components explain in this case nearly 72% of the variability in the original 11 variables. The short number of answers might have led to this result, nonetheless the complexity of this data could be reduced by using these components, with only a 28% loss of information.

Table 7 - Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.537	23.061	23.061	2.537	23.061	23.061	2.178
2	1.860	16.913	39.975	1.860	16.913	39.975	1.834
3	1.394	12.675	52.650	1.394	12.675	52.650	1.802
4	1.133	10.297	62.947	1.133	10.297	62.947	1.212
5	1.004	9.131	72.078	1.004	9.131	72.078	1.188
6	.744	6.760	78.838				
7	.695	6.319	85.156				
8	.565	5.136	90.293				
9	.498	4.527	94.819				
10	.359	3.265	98.084				
11	.211	1.916	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 8 – Communalities Test

Communalities

	Initial	Extraction
A1. Gender	1.000	.524
A2. Age	1.000	.812
A3. Nationality	1.000	.901
A4. Studies	1.000	.656
A5.Driving Experience	1.000	.825
C1. I regularly seek information about the latest consumer technology	1.000	.727
C2.I often socialize with people from a large variety of different backgrounds	1.000	.440
C3. I keep up-to-date with consumer technology by reading newspapers/magazines, websites or relevant TV shows	1.000	.722
C4. My friends and family would say I was a cosmopolitan person	1.000	.464
C5. 'Im a very ambitious person setting high standards and expectations for myself	1.000	.618
C6. I'm always looking for ways to alter my life to make it better	1.000	.580
C7. Compulsive behavior usually governs my purchasing decisions	1.000	.786
C8. Making sure I always make the correct decision is something that is important to me	1.000	.420

Extraction Method: Principal Component Analysis.

4.3.2 Sample Characterization and Critical Factors Analysis

Following the same line of thought, we get another correlation matrix but this time referring to preferential factors for the sample in a electric vehicle car, this way through the correlation analysis it will tell which factors are more or less influenced by the characteristics of the individuals.

Table 9 - Sample Characterization and Critical Factors Correlation Matrix[a]

		A1. Gender	A2. Age	A3. Nationality	A5.Driving Experience	E1.Autonomy	E2.Price	E3.Charging Time	E4.Brand	E5. Technology	E6. Power/Confort
Correlation	A1. Gender	1.000	-.123	.048	-.149	-.041	-.053	-.110	.093	.244	-.057
	A2. Age	-.123	1.000	-.094	.732	.215	.022	.054	-.141	-.147	.013
	A3. Nationality	.048	-.094	1.000	.128	-.106	.007	.017	-.015	.255	.232
	A5.Driving Experience	-.149	.732	.128	1.000	.227	-.032	.076	-.216	-.090	-.003
	E1.Autonomy	-.041	.215	-.106	.227	1.000	.245	.449	.031	.039	.191
	E2.Price	-.053	.022	.007	-.032	.245	1.000	.301	.005	-.052	.117
	E3.Charging Time	-.110	.054	.017	.076	.449	.301	1.000	.220	.197	.289
	E4.Brand	.093	-.141	-.015	-.216	.031	.005	.220	1.000	.585	.206
	E5.Technology	.244	-.147	.255	-.090	.039	-.052	.197	.585	1.000	.370
	E6. Power/Confort	-.057	.013	.232	-.003	.191	.117	.289	.206	.370	1.000

a. Determinant = .094

Looking at table 8 above and starting with positive correlations, there are some relevant coefficients among the variables worth mentioning such as A1 and E5 with a coefficient of 0,244 between the variables “Gender” and “Technology”, A2 and E1 with a coefficient of 0,215 between the variables “Age” and “Autonomy”, E1 and E2 with a coefficient of 0,245 between the variables “Autonomy” and “Price”, E1 and E3 with a coefficient of 0,449 between the variables “Autonomy” and “Charging Time”, E4 and E5 with a coefficient of 0,585 between the variables “Brand” and “Technology” and E4 and E6 with a coefficient of 0,206 between the variables “Brand” and “Power/Comfort”. The more relevant negative correlations found were A2 and E4 with a coefficient of -0,141 between the variables “Age” and “Brand”, A2 and E5 with a coefficient of -0,147 between the variables “Age” and “Technology” and A5 and E4 with a coefficient of -0,216 between the variables “Driving Experience” and “Brand”.

On the Bartlett’s test the result was a value of significance under 0,05 meaning that the H_1 is accepted meaning that there is correlation between the variables which makes the data useful for the study. About the KMO’s test the result is also positive in the way that exceeds the minimum value accepted. Although the value 0,544 is low, the usage of this technique is still considered to be proper for the study analysis.

Table 10 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.544
Bartlett's Test of Sphericity	Approx. Chi-Square	234.165
	df	45
	Sig.	.000

Moving to the communalities test the variable "Studies" was removed from the table due to fact it had a value bellow 0,6 and because it was considered not to be relevant for the correlations in study. On the other side, the variables "Gender", "Price" and "Power/Comfort" were left due to its importance in the correlations matrix in terms of information given.

Table 11 – Communalities Test

	Initial	Extraction
A1. Gender	1.000	.335
A2. Age	1.000	.833
A3. Nationality	1.000	.807
A5.Driving Experience	1.000	.874
E1.Autonomy	1.000	.613
E2.Price	1.000	.523
E3.Charging Time	1.000	.656
E4.Brand	1.000	.682
E5.Technology	1.000	.809
E6. Power/Confort	1.000	.562

Extraction Method: Principal Component Analysis.

Table 12 - Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.180	21.802	21.802	2.180	21.802	21.802	1.775
2	2.074	20.738	42.540	2.074	20.738	42.540	1.857
3	1.358	13.581	56.121	1.358	13.581	56.121	1.873
4	1.079	10.795	66.916	1.079	10.795	66.916	1.400
5	.944	9.444	76.360				
6	.713	7.134	83.494				
7	.639	6.387	89.881				
8	.474	4.739	94.620				
9	.325	3.252	97.872				
10	.213	2.128	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

In terms of variance, from this analysis there were obtained 4 components with variance above 1 meaning that these components explain in this case nearly 67% of the variability in the original 10 variables. The short number of answers might have led to this result, nonetheless the complexity of this data could be reduced by using these components, with only a 33% loss of information.

4.3.3 Mobility and Functional Analysis

The purpose of correlating the mobility part with the functional analysis was with the intention of evaluating if the past of a person in terms of vehicle history, as a driver and if their habits do influence future decisions specially when it comes to a segment that is for some completely new.

By analyzing the table 14 we can also observe some positive and negative correlations worth denoting. As positive there's B1 and D2 with a coefficient of 0,235 between the

variables "vehicle Ownership " and "I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging", B6 and D2 with a coefficient of 0,261 between the variables "Electric Car Experience" and "I think I can fulfil (…)", B7 and D1 with a coefficient of 0,262 between the variables "Swapping car in the next 5 years" and "Electric cars are relatively more expensive to purchase but can pay for themselves in fuel costs", D1 and D3 with a coefficient of 0,368 between the variables "Electric cars are relatively (…)" and "I would value the ability to refuel my car from home", D4 and D8 with a coefficient of 0,546 between the variables "Electric cars don't offer enough performance" and "I think electric cars would be complicated to use", D5 and D7 with a coefficient of 0,555 between the variables "I would feel relatively less safe in an electric car" and "Electric cars are less reliable than conventional cars" and D6 and D9 with a coefficient of 0,456 between the variables "I think it would be easier for me to find places to plug in an electric car" and "I consider the current electric vehicles charging points infrastructure to be enough". Looking at the negative correlations worth mentioning we have B1 and D8 with a coefficient of -0,138 between the variables "Vehicle Ownership" and "I think electric vehicles would (…)", B3 and D5 with a coefficient of -0,169 between the variables "Vehicle swap frequency" and "I would feel relatively (…)", B3 and D8 with a coefficient of -0,225 between the variables "Vehicle swap frequency" and "I think electric cars would (…)", B8 and D8 with a coefficient of -0,262 between the variables "Vehicle fuel choice" and "I think electric cars would (…)".

Table 13 - Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	2.939	16.329	16.329	2.939	16.329	16.329
2	2.199	12.217	28.546	2.199	12.217	28.546
3	1.757	9.762	38.308	1.757	9.762	38.308
4	1.632	9.065	47.373	1.632	9.065	47.373
5	1.539	8.552	55.924	1.539	8.552	55.924
6	1.110	6.165	62.090	1.110	6.165	62.090
7	1.000	5.553	67.642			
8	.891	4.952	72.594			
9	.802	4.453	77.047			
10	.718	3.989	81.037			
11	.612	3.399	84.435			
12	.556	3.092	87.527			
13	.479	2.658	90.185			
14	.454	2.524	92.709			
15	.387	2.152	94.861			
16	.367	2.039	96.899			
17	.282	1.569	98.468			
18	.276	1.532	100.000			

Extraction Method: Principal Component Analysis.

Table 14 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.618
Bartlett's Test of Sphericity	Approx. Chi-Square	415.492
	df	153
	Sig.	.000

Table 15 - Mobility and Functional Analysis Correlation Matrix[a]

		B1. Vehicle Ownership	B2. Age of vehicle owned	B3. Vehicle swap frequency	B4. Daily transport used	B5. Process of buying a car	B6. Electrical car experience	B7. Swapping car in the next 5 years	B8. Vehicle fuel choice	D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	D3. I would value the ability to refuel my car from home	D4. Electric cars don't offer enough performance	D5. I would feel relatively less safe in an electric car	D6. I think it would be easy for me to find places to charge an electric car	D7. Electric cars are less reliable than conventional cars	D8. I think electric cars would be complicated to use	D9. I consider the current Electric Vehicles charging points infrastructure to be enough	D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle
Correlation	B1. Vehicle Ownership	1.000	-.037	.060	.044	-.093	.051	-.060	-.148	.027	.235	.202	-.080	.006	.051	-.042	-.138	.016	.016
	B2. Age of vehicle owned	-.037	1.000	.296	.106	.060	-.010	.065	-.103	-.053	-.138	.003	-.037	.016	-.097	.071	-.053	-.209	.065
	B3. Vehicle swap frequency	.060	.296	1.000	.211	.109	.104	.302	.031	-.024	.065	-.013	-.146	-.169	-.005	-.107	-.225	-.133	-.050
	B4. Daily transport used	.044	.106	.211	1.000	.167	.115	.007	.140	.005	.082	-.118	.030	-.060	-.084	.032	.023	-.059	.133
	B5. Process of buying a car	-.093	.060	.109	.167	1.000	.123	.203	.099	-.006	-.117	-.133	.080	-.060	.130	-.025	-.001	.123	-.103
	B6. Electrical car experience	.051	-.010	.104	.115	.123	1.000	.098	-.099	.036	.261	.171	.143	.114	-.056	.147	.099	.166	.094
	B7. Swapping car in the next 5 years	-.060	.065	.302	.007	.203	.098	1.000	.139	.262	.001	.099	.035	-.070	.128	-.094	-.098	.016	.175
	B8. Vehicle fuel choice	-.148	-.103	.031	.140	.099	-.099	.139	1.000	.237	.008	.056	-.151	-.077	.206	-.134	-.262	.006	.101
	D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	.027	-.053	-.024	.005	-.006	.036	.262	.237	1.000	.050	.368	-.053	.047	.388	-.116	-.059	.152	.388
	D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	.235	-.138	.065	.082	-.117	.261	.001	.008	.050	1.000	.217	-.198	.065	.080	-.064	.079	.267	-.083
	D3. I would value the ability to refuel my car from home	.202	.003	-.013	-.118	-.133	.171	.099	.056	.368	.217	1.000	-.068	-.107	.204	-.167	-.193	-.065	.345
	D4. Electric cars don't offer enough performance	-.080	-.037	-.146	.030	.080	.143	.035	-.151	-.053	-.198	-.068	1.000	.471	-.045	.533	.546	.178	.070
	D5. I would feel relatively less safe in an electric car	.006	.016	-.169	-.060	-.060	.114	-.070	-.077	.047	.065	-.107	.471	1.000	.070	.555	.542	.268	.044
	D6. I think it would be easy for me to find places to charge an electric car	.051	-.097	-.005	-.084	.130	-.056	.128	.206	.388	.080	.204	-.045	.070	1.000	-.037	-.085	.456	-.040
	D7. Electric cars are less reliable than conventional cars	-.042	.071	-.107	.032	-.025	.147	-.094	-.134	-.116	-.064	-.167	.533	.555	-.037	1.000	.517	.105	.066
	D8. I think electric cars would be complicated to use	-.138	-.053	-.225	.023	-.001	.099	-.098	-.262	-.059	.079	-.193	.546	.542	-.085	.517	1.000	.320	-.008
	D9. I consider the current Electric Vehicles charging points infrastructure to be enough	.016	-.209	-.133	-.059	.123	.166	.016	.006	.152	.267	-.065	.178	.268	.456	.105	.320	1.000	-.250
	D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle	.055	.065	-.050	.133	-.103	.094	.175	.101	.388	-.083	.345	.070	.044	-.040	.066	-.008	-.250	1.000

a. Determinant = .013

Table 16 - Communalities Test

	Initial	Extraction
B1. Vehicle Ownership	1.000	.407
B2. Age of vehicle owned	1.000	.518
B3. Vehicle swap frequency	1.000	.635
B4. Daily transport used	1.000	.702
B5. Process of buying a car	1.000	.487
B6. Electrical car experience	1.000	.477
B7. Swapping car in the next 5 years	1.000	.522
B8. Vehicle fuel choice	1.000	.606
D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	1.000	.682
D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	1.000	.685
D3. I would value the ability to refuel my car from home	1.000	.652
D4. Electric cars don't offer enough performance	1.000	.650
D5. I would feel relatively less safe in an electric car	1.000	.621
D6. I think it would be easy for me to find places to plug-in an electric car	1.000	.675
D7. Electric cars are less reliable than conventional cars	1.000	.641
D8. I think electric cars would be complicated to use	1.000	.693
D9. I consider the current Electric Vehicles charging points infrastructure to be enough	1.000	.761
D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle	1.000	.763

Extraction Method: Principal Component Analysis.

Looking at the table displayed bellow, on the Bartlett's test it shows that the significance level test was inferior to the 0,05 meaning that we reject H_0 and we accept the alternative hypothesis H_1. On the KMO's test the value encountered was 0,618 which is a mediocre value within the KMO measures, nonetheless it is superior to 0,5 meaning that the test is feasible.

About the communalities, the variables "Age of vehicle owned" and "Process of buying a car" were removed from the table due to the fact that they both prensent values below 0,6 and both do not represent important and reliable information for the integraty of the study. On the ther hand, the variables "Vehicle Ownership" and "Electric Car Experience" were mantained in the table because of its relevance and correlation with other variables.

In terms of variance, from this analysis there were obtained 6 components with variance above 1 meaning that these components explain in this case nearly 62% of the variability in the original 11 variables. The short number of answers might have led to this result, nonetheless the complexity of this data could be reduced by using these components, with only a 38% loss of information.

4.3.4 Functional and Critical Factors Analysis

Here we will correlate the main factors of an EV to be considered with a functional analysis that translates into a section of the questionnaire which was meant to perceive the mentality of the sample towards Electric Vehicles. By analyzing the results, we get a better perception of the sample allowing to see which factors with which type of mindset have a more positive direct influence on the sample, as well as negative.

From the table 16 we observe some positive correlations worth mentioning such as E1 and D3 with a coefficient of 0,305 between the variable "Autonomy" and "I would value the ability to refuel my car from home", E2 and D2 with a coefficient of 0,226 between the

variable “Price” and “I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging”, E3 and D3, with a coefficient of 0,248 between the variable “Charging Time” and again “I would value (…)”, and last but not the least, E4 and D5 with a coefficient of 0,234 between the variable “Brand” and “I would feel relatively less safe in an electric car”. As negative correlations that stand out there’s E1 and D2 with a coefficient of -0,235 between the variable “Price” and “I think I can fulfill (…)”, E2 and D4 with a coefficient of -0,347 between the variables “Price” and “Electric cars don’t offer enough performance” and E1 and D9 as well as E3 and D9 with a coefficient of -0,174 and -0,180 between the variables “Autonomy” and “I consider the current Electric Vehicles charging points infrastructure to be enough” and “Charging time” and “I consider the current Electric (…)” respectively.

Moving to next the test, the Bartlett’s and KMO test, the significance level achieved on the first was below 0,05 which rejects the H_0 meaning that there is significant correlation between the variables therefore, the analysis is adequate for the study. The second test reached a value of 0,651 being above 0,5 which means the analysis is possible. However, although the value is bigger than 0,5 it is considered mediocre, this is due to the small size of the sample.

Table 17 - KMO and Bartlett's Test

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.651
Bartlett's Test of Sphericity	Approx. Chi-Square	461.487
	df	120
	Sig.	.000

Table 18 - Total Variance Explained

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings[a]
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	2.983	18.643	18.643	2.983	18.643	18.643	2.857
2	2.372	14.823	33.466	2.372	14.823	33.466	1.916
3	1.885	11.783	45.249	1.885	11.783	45.249	1.768
4	1.720	10.748	55.997	1.720	10.748	55.997	1.814
5	1.324	8.274	64.271	1.324	8.274	64.271	2.049
6	1.111	6.943	71.214	1.111	6.943	71.214	1.486
7	.786	4.915	76.129				
8	.628	3.926	80.054				
9	.593	3.706	83.760				
10	.487	3.046	86.806				
11	.436	2.722	89.529				
12	.397	2.482	92.011				
13	.362	2.260	94.271				
14	.339	2.117	96.389				
15	.293	1.828	98.217				
16	.285	1.783	100.000				

Extraction Method: Principal Component Analysis.

a. When components are correlated, sums of squared loadings cannot be added to obtain a total variance.

Table 19 - Functional and Critical Factors analysis Correlation Matrix[a]

		D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	D3. I would value the ability to refuel my car from home	D4. Electric cars don't offer enough performance	D5. I would feel relatively less safe in an electric car	D6. I think it would be easy for me to find places to plug-in an electric car	D7. Electric cars are less reliable than conventional cars	D8. I think electric cars would be complicated to use	D9. I consider the current Electric Vehicles charging points infrastructure to be enough	D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle	E1.Autonomy	E2.Price	E3.Charging Time	E4.Brand	E5. Technology	E6. Power/Confort
Correlation	D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	1.000	.050	.368	-.053	.047	.388	-.116	-.059	.152	.388	.120	.063	.056	.016	.033	.064
	D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	.050	1.000	.217	-.198	.065	.080	-.054	.079	.267	-.083	-.235	.226	-.024	-.043	-.044	-.056
	D3. I would value the ability to refuel my car from home	.368	.217	1.000	-.068	-.107	.204	-.167	-.193	-.065	.345	.305	.262	.248	-.093	.028	.158
	D4. Electric cars don't offer enough performance	-.053	-.198	-.068	1.000	.471	-.045	.533	.546	.178	.070	.099	-.347	.007	.147	.036	-.045
	D5. I would feel relatively less safe in an electric car	.047	.065	-.107	.471	1.000	.070	.555	.542	.268	.044	-.035	-.076	.008	.234	.054	-.044
	D6. I think it would be easy for me to find places to plug-in an electric car	.388	.080	.204	-.045	.070	1.000	-.037	-.085	.456	-.040	.138	.153	.004	.065	.047	.106
	D7. Electric cars are less reliable than conventional cars	-.116	-.054	-.167	.533	.555	-.037	1.000	.517	.105	.066	.046	-.187	-.069	.129	.019	-.149
	D8. I think electric cars would be complicated to use	-.059	.079	-.193	.546	.542	-.085	.517	1.000	.320	-.008	-.016	-.147	-.013	.168	-.031	-.213
	D9. I consider the current Electric Vehicles charging points infrastructure to be enough	.152	.267	-.065	.178	.268	.456	.105	.320	1.000	-.250	-.174	.034	-.180	.129	.016	.014
	D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle	.388	-.083	.345	.070	.044	-.040	.066	-.008	-.250	1.000	.165	-.071	.085	-.010	.048	-.080
	E1.Autonomy	.120	-.235	.305	.099	-.035	.138	.046	-.016	-.174	.165	1.000	.245	.449	.031	.039	.191
	E2.Price	.063	.226	.262	-.347	-.076	.153	-.187	-.147	.034	-.071	.245	1.000	.301	.005	-.052	.117
	E3.Charging Time	.056	-.024	.248	.007	.008	.004	-.069	-.013	-.180	.085	.449	.301	1.000	.220	.197	.289
	E4.Brand	.016	-.043	-.093	.147	.234	.065	.129	.168	.129	-.010	.031	.005	.220	1.000	.585	.206
	E5.Technology	.033	-.044	.028	.036	.054	.047	.019	-.031	.016	.048	.039	-.052	.197	.585	1.000	.370
	E6. Power/Confort	.064	-.056	.158	-.045	-.044	.106	-.149	-.213	.014	-.080	.191	.117	.289	.206	.370	1.000

a. Determinant = .009

Table 20 - Communalities Test

	Initial	Extraction
D1. Electric cars are relatively more expensive to purchase but can pay for themselves in lower fuel costs	1.000	.722
D2. I think I can fulfill all my transport needs with an electric car that has a range of 100 miles before recharging	1.000	.801
D3. I would value the ability to refuel my car from home	1.000	.652
D4. Electric cars don't offer enough performance	1.000	.697
D5. I would feel relatively less safe in an electric car	1.000	.657
D6. I think it would be easy for me to find places to plug-in an electric car	1.000	.780
D7. Electric cars are less reliable than conventional cars	1.000	.649
D8. I think electric cars would be complicated to use	1.000	.718
D9. I consider the current Electric Vehicles charging points infrastructure to be enough	1.000	.784
D10. I consider that a weak charging point infrastructure is a conditioning towards buying an Electric Vehicle	1.000	.793
E1.Autonomy	1.000	.764
E2.Price	1.000	.679
E3.Charging Time	1.000	.677
E4.Brand	1.000	.713
E5.Technology	1.000	.791
E6. Power/Confort	1.000	.516

Extraction Method: Principal Component Analysis.

About the communalities test, although there's a variable with value under what is considered the acceptable, which is the variable "Power/Comfort" it represents a critical factor with a considerable importance for the study, being this way kept for the integrity of the study.

In terms of variance, from this analysis there were obtained 6 components with variance above 1 meaning that these components explain in this case nearly 71% of the variability in the original 11 variables. The short number of answers might have led to this result, nonetheless the complexity of this data could be reduced by using these components, with only a 29% loss of information.

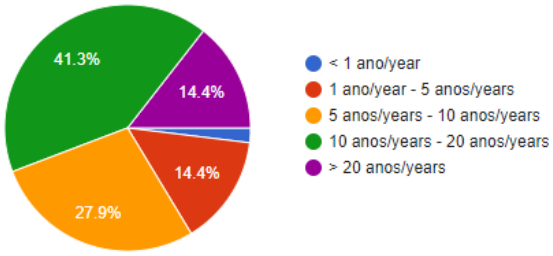
4.4 Results Interpretation

By observing the results obtained with the questionnaire we can denote some tendencies that go along with the global market direction such as the growth of EV sales. From the study performed, although 61,5% of the respondents have never tried a BEV, more

than 68% of respondents when asked about the fuel preference for their next vehicle they said that they would opt for an APV instead of a petrol engine car which goes accordingly with ACEA's graphics 3 and 4 tendency. Not only will the number of the EV's in Portugal tend to go up but also the number of vehicles registered since more than 50% of the sample will buy a new car in the next 5 years which corresponds with ACEA's data displayed on graphic 6 and graphic 7. Hence noticing that even though about 61,5% of the sample never experienced a BEV, about 67% still opted for an APV meaning that the information is getting spread, therefore the experience is not entirely correlated with the fuel choice of the buyer, it might also have to do with the individuals awareness and possibly its sense of being more environmental friendly.

Another tendency that is occurring in the EU and that Portugal is no exception to it, is the continuous growth of the vehicles ages. On table 3 is shown the average age of the vehicles in Portugal and its about 12,5 years which is already above the EU average age. The results obtained from the questionnaire reinforce this tendency since 55,7% of the respondents or their relatives, own a car older than 10 years leaving only about 14% of the respondents with a car between the age of 1 and 5 years. This conjuncture combined with a delayed car swap frequency will only increase the average age of the Portuguese car parc, furthermore without any program to incentive the dismantling of the cars, the car parc will only tend to grow bigger and older.

Graphic 17 - Vehicle Age



Since in 2020 about 40% of the new car purchases will be from millennials, it is very important to follow their evolution in terms of behavior and the way they process information. From that percentage, 88% will make their car purchase research through the internet (Bannister, K., 2017) therefore, it was necessary to understand how people nowadays

tend to make their car purchase research. From the data collected, which is composed by 77% of the sample being below 36 years old and about 23% above 35 years old, there is an evident tendency for the end of the concessionaries in a medium-short term period. From the respondents under 36 years old, only 3 use the concessionary, 37 the internet and the remaining 40 use both research approaches. With respondents above 35 years old the results reiterate with only 1 respondent using only the concessionary, 9 the internet and the remaining 14 use both approaches. It is clear through the data analysis that the tendency here is the use of online tools instead of the traditional concessionaries.

Graphic 18 - Research approach when buying a new vehicle

Regarding the factorial analysis and starting with the table 4 there are some correlations between several variables that go along with the desire of a better lifestyle and transportation practicality in a city such as, the positive correlation between “Gender” and “I regularly seek information about the latest consumer technology” meaning that both genders try to be updated in terms of technology awareness. Also, the variable “Age” with the variables “I’m a very ambitious person setting high standards and expectations for myself” and “I’m always looking for ways to alter my life to make it better” have a negative correlation which indicates that older persons will have less expectations and standards about their life’s therefore, a transition to a BEV even though it might make their life easier, taking into consideration the several benefits related to them, it will be a challenge for many. Following this idea of making life better and easier, on table 14 there is a negative correlation between B8 and D8 which shows that the respondents tend to associate the different types of fuel and BEV to a more complicated usage. There are several types of BEV’s which can make people confused the different functions of each one, therefore being this a new technology, for the many skeptical people it will endure the renewable transaction process.

On table 8 there is a correlation that shows a link between the factor “Brand” the factor “Power/Comfort” of the vehicle, indicating that there is a certain notoriety associated with some brands which in the EV market, are the ones that took the first step into this new market and started developing their infrastructure. These companies, being the first ones to make the move, they have had practically the whole market share thus, through the years they developed more efficient and capable technology and increased their gap between other competitors that entered later the market.

4.5 Conclusion

Hence noticing, although the values in the correlation matrix values are not close to the maximum possible value of the coefficient, they are very important indicators to have in consideration because they represent some of the most relevant correlations from a sample that was not big enough for the amount of variables in consideration for the study. Even though some values are low, the study was thoroughly examined assuming the highest values from the several tests as being strong in terms of the information that they provide.

Chapter V – Conclusion

5.1 Introduction

In this chapter, the main conclusions obtained from this investigation are summarized, in order to respond to the formulated research questions and assess the fulfilment of the specific objectives. From the questionnaire analysis, some possible future scenarios will be described along with recommendations concerning a smooth implementation of a BEV infrastructure network in Portugal. Moreover, the limitations of this research as well as some leads for future investigations will be approached.

5.2 Answers to the Research Questions

5.2.1 Question 1

The first research question is "Which impacts and changes should be expected in the Portuguese Car Parc?". This research question goes towards the first three specific objectives described in the introduction chapter.

Starting by analyzing each specific objective, the first one was to analyze the growth of the EV's which, by combining the results obtained from the questionnaire with the data available, it is expected that the EV's will continue to grow a lot in these coming years both in Europe and in Portugal. The number of new BEV registered only grew in the past couple years and most of the sample plans to buy a car in the next 5 years. Since this majority will also opt for a greener alternative type of vehicle, the growth of EV's, specifically in Portugal, it is set to continue to thrive. Moreover, with this increase of the EV's circulation in Portugal, the electric-vehicle charging infrastructure should be reinforced and the way energy is supplied and consumed should be also a concern since with a fleet of APV's, mostly BEV's, it will be hard to control the charging peaks of the vehicles which can damage the power grid.

The objective that follows has to do with the descendent reliance on the fossil fuels and the growth of green alternatives and through the data analysis given by ACEA the tendency of the fossil fuels consumption is to decrease, allowing room for the ascendant green alternatives. Thus, in the study performed, most of the respondents opted for a green alternative transport for their life or daily basis transportation.

The last specific objective related with this research question has to do with the estimated impacts and changes on the Portuguese automotive parc and the conclusion is that the average age will only tend to grow older due to fact that the majority of the sample already has a car older than 10 years and a large group of the sample only swaps car after 10 years of usage. However, the next car to be purchased by them is more than likely to be BEV indicating a shift on the market and in the composition of the Portuguese Car Parc. Nonetheless, without a mechanism to incentive the dismantling of the vehicles the automotive parc will only grow without a proper replacement.

Summing up, the impacts that should be expected is an increase of the APV in circulation either in Europe and in Portugal, a growing infrastructure of charging points and green alternative mobility options available and an increase of the average age of the Portuguese Car Parc.

5.2.2 Question 2

The second research question is "Is the customer perception a set back towards a change with a new transportation technology?". This research question goes towards the fourth specific objective described in the introduction chapter.

The objective for this research question was to assess the customer perception towards APV which the questionnaire allowed to check. In order to answer to this, two different analysis were performed, a psychological and sociological analysis and a functional analysis. On the first one, the purpose was to try to define the profile of someone who would possibly buy an EV and from the answers gotten, we can describe the sample as sociable, seeking for new information about technology, ambitious about their life's and always looking for ways to improve it. They are not moved by a compulsive buying behavior, instead they try to make sure that they make the correct decision.

Through the functional analysis made in the questionnaire there's evidence that they find the EV's safe, easy to use, reliable, and with good performance indicators. Although they are more expensive than conventional cars, the sample agrees that it compensates with the low running costs, specially when it comes to fuel. Furthermore, the fact that the EV's can be fueled at home is something valorized by the sample however, there is need for the

development and growth of the charging points infrastructure since it represents a key factor for the majority when considering buying an EV.

In general terms, the respondent's perception about the APV is positive, despite being a recent subject for the many, the sample showed no aversion to them. The only two downsides were related with the weak charging points infrastructure and the low autonomy of some BEV. Hence noticing, despite most of the sample had never tried an EV there was no reluctance showed regarding the topic.

5.2.3 Question 3

The third research question is "In a car, which factors influence the most a consumer when buying a car?". This research question goes towards the fifth specific objective described on the introduction chapter.

Here the purpose was to identify the main factors that are decision-making factors for the consumer and to do so, the sample was asked to score several factors encountered that are taken into consideration during the process of buying a car. These factors were more focused on factors found on an EV, such as the Charging Time, Price, Power/Comfort, Autonomy, Brand and Technology. Firstly, they were asked to just to score the factors and then to hierarchize them from best to worse. Both questions had similar results, especially when it comes to the most valued factors for the consumer the respondents preferred the autonomy and price and the least ones were the brand and technology.

Although the factors selected for this study came from the outputs given by Weve (2017) and a study from Deloitte above in the literature review, the respondents were given an option to express if it was the case, other factors that they would consider equally important to which few answered. The ones that responded, talked about important factors that were not approached in this dissertation but can be found on the Limitations of the dissertation.

Remembering once again that most of the sample did not experienced an EV, the perception and the nature of this answers and preferences might differ after the experimentation is done. Nonetheless, from the study performed it was possible to determine the factors that influenced the most this sample when buying a car.

5.3 - Limitations

The present dissertation was conducted through a study of The Impact of Electrical Vehicles in the Transportation Sector with a focus in the Portuguese Automotive Car Parc, wherefore the limited number respondents to the main and only investigation tool used made the obtained results limited by the sample size and lack of randomness.

The channel used to disseminate the questionnaire was the internet which was the one that offered a broader range with more capabilities of reaching people regarding the time considered for this part of the process. However, by using such method as the internet, the sample turned out to be quite similar in terms of age, therefore the study might be influenced by a younger age group possibly misleading some of the conclusions.

About the study itself there were some factors equally or more important than the ones presented here that were not included in the questionnaire neither in the dissertation due to the more technical scope involved because some of the factors are still not implemented or even taken into consideration by the majority of the electrical vehicle buyers such as the battery cell longevity, battery warranty and the electricity price of the charging points infrastructure.

Since the BEV are powered by batteries that have a certain life spam period, being the “motor” of the car, it is essential, when making an investment to have in consideration how long will the battery last, alongside with the warranty associated. Regarding the charging points, for now they are free of charge but in a near future the plan is to add some fees to its usage making it a cost to consider because like any other car, the autonomy and the fuel consumption differs from vehicle to vehicle. Furthermore, the prices and information about this have still not been put available for the public by the car companies since these topics and particularly the price of the electricity in the charging points should be somehow regulated.

The relevance of this study may also be affected since there isn’t a lot of actual, actualized and thoroughly detailed data about the EV’s market and its sphere of action among the several other industries that it impacts. Since it is a relatively new market still considered

in a low stage of development with huge improvements year after year which makes it harder to encounter proper, relevant and precise information about the automakers, the third parties and the impacts and outcomes of the market.

5.4 – Leads for Future Investigations

Since all the obtained results, conclusions and recommendations are limited to the sample size, one of the recommendations for future research lies in the possibility of expanding the size of the sample by seeking to collect data for longer periods of time. Also, in order to have a more random and a broad variety of answers it would be interesting to explore other means to gather information apart from the online questionnaires such as interviews or hand delivered questionnaires to people involved in the car industry, schools and companies.

Apart from the questionnaires where are questions are made, sometimes the perception and the image that people often associate with these new types of vehicles is often a product of marketing, media and sometimes opinionmakers. This way, engaging some type of discussion between APV owners and people that never tried one and that have mixed feelings or even people that are not into these type of vehicles at all, could be also be way to obtain some useful data.

It would be also interesting to make a questionnaire before and after experimenting an EV just for a drive or to lend the EV for a small period and evaluate this way if any perception or desire have changed towards BEV appreciation. Of course, this would involve another type of resources to be able to make this in a larger scale, but the results obtained could be very enriching for the study’s purpose.

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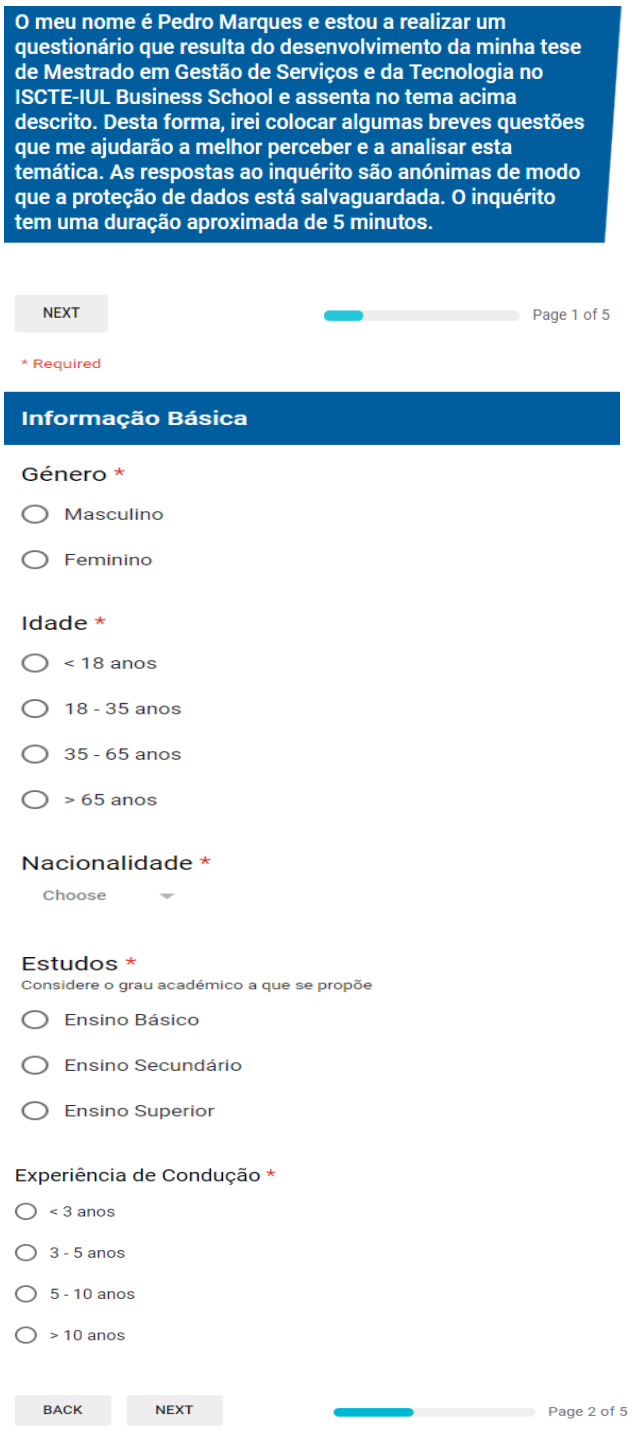
Chapter VII – Appendix

7.1 – Questionnaire used for the data collection



O meu nome é Pedro Marques e estou a realizar um questionário que resulta do desenvolvimento da minha tese de Mestrado em Gestão de Serviços e da Tecnologia no ISCTE-IUL Business School e assenta no tema acima descrito. Desta forma, irei colocar algumas breves questões que me ajudarão a melhor perceber e a analisar esta temática. As respostas ao inquérito são anónimas de modo que a proteção de dados está salvaguardada. O inquérito tem uma duração aproximada de 5 minutos.

NEXT

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* Required

Informação Básica

Género *

- Masculino
- Feminino

Idade *

- < 18 anos
- 18 - 35 anos
- 35 - 65 anos
- > 65 anos

Nacionalidade *

Choose

Estudos *

Considere o grau académico a que se propõe

- Ensino Básico
- Ensino Secundário
- Ensino Superior

Experiência de Condução *

- < 3 anos
- 3 - 5 anos
- 5 - 10 anos
- > 10 anos

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* Required

Mobilidade - Part1

Preferências

1. Possuo um veículo próprio? *

- ◯ Sim
- ◯ Não

2. Que idade tem o veículo mais antigo que possuo? *
Se não possuir nenhum, considere o de um familiar

- ◯ < 1 ano
- ◯ 1 ano - 5 anos
- ◯ 5 anos - 10 anos
- ◯ 10 anos - 20 anos
- ◯ > 20 anos

3. Com que frequência costumo mudar de veículo? *
Se não possuir nenhum veículo, considere o da resposta anterior

- ◯ < 1 ano
- ◯ 1 - 2 anos
- ◯ 2 - 5 anos
- ◯ 5 - 10 anos
- ◯ > 10 anos

4. Qual destes meios de transporte uso com maior frequência no meu dia-a-dia? *

- ◯ Autocarro
- ◯ Bicicleta
- ◯ Carro
- ◯ Metro
- ◯ Mota
- ◯ Other: _____

5. Aquando da compra de um veículo, realizo primeiro uma pesquisa online onde retiro a informação que necessito ou desloco-me a um concessionário? *

- ◯ Pesquisa online
- ◯ Desloco me a um concessionário
- ◯ Ambos
- ◯ Other: _____

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* Required

Mobilidade - Part2

6. Já alguma vez experienciei um Veículo Eléctrico? *

- ○ Sim
- ○ Nã

7. Nos próximos 5 anos, penso em comprar um carro novo ? *

- ○ Sim
- ○ Não

8. Se comprasse um carro hoje, optaria por um veículo movido a: *

- ○ Diesel
- ○ Gasolina
- ○ Híbrido
- ○ Plug-in Híbrido
- ○ Eléctrico
- ○ Hidrogénio
- ○ Other: _____

9. Se tivesse um meio de transporte eléctrico alternativo, considerá-lo-ia? *

- ○ Sim, a um custo inferior
- ○ Sim, a um custo superior ou inferior
- ○ Não

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* Required

Análise comportamental e preferencial do consumidor

10. Determinantes Psicológicas e Sociológicas *

	Discordo Totalmente	Discordo	Não concordo nem discordo	Concordo	Concordo Totalmente
Costumo regularmente procurar informação sobre as novas tecnologias de consumo	○	○	○	○	○
Socializo regularmente com várias pessoas de diferentes áreas	○	○	○	○	○
Mantenho-me atualizado às tecnologias de consumo através jornais/revistas, websites ou programas de televisão	○	○	○	○	○
Os meus amigos e família diriam que eu sou uma pessoa cosmopolitana	○	○	○	○	○
Sou uma pessoa ambiciosa que coloca padrões e expectativas elevadas para mim	○	○	○	○	○
Estou sempre à procura de maneiras de alterar a minha vida para melhor	○	○	○	○	○
O comportamento compulsivo normalmente descreve as minhas decisões de compra	○	○	○	○	○
Ter a certeza de que tomo sempre as decisões corretas é algo importante para mim	○	○	○	○	○

11. Análise funcional *

	Discordo Totalmente	Discordo	Não concordo nem discordo	Concordo	Concordo Totalmente
Veículos Eléctricos são relativamente mais caros mas compensam com menos custos de combustível	○	○	○	○	○
Eu acho que consigo preencher todas as minhas necessidades de transporte através de um veículo eléctrico com 150km de autonomia	○	○	○	○	○
Eu valorizaria a capacidade de poder atestar o meu carro em casa	○	○	○	○	○
Veículos Eléctricos não oferecem performance suficiente	○	○	○	○	○
Eu iria me sentir menos seguro num veículo eléctrico	○	○	○	○	○
Eu acho que seria fácil para mim encontrar lugares para carregar um véiculo elétrico	○	○	○	○	○
Veículos Eléctricos são menos fidedignos do que os carros convencionais	○	○	○	○	○
Eu acho que os veículos eléctricos seriam mais complicados de usar	○	○	○	○	○
Eu considero a atual infraestrutura relativa a postos de carregamento de Veículos Eléctricos suficiente	○	○	○	○	○
Eu considero que uma fraca infraestrura de postos de carregamentos de veículos eléctricos seja uma condicionante à compra de um Veículo Eléctrico	○	○	○	○	○

12. Aqui encontram se alguns fatores críticos ponderados aquando da compra de um Veículo Eléctrico. Por favor, avalie os seguintes fatores quanto à sua importância para si. *

1 - Menos Importante ; 10 - Mais Importante

	1	2	4	6	8	10
Autonomia	○	○	○	○	○	○
Preço	○	○	○	○	○	○
Tempo de Carregamento	○	○	○	○	○	○
Marca	○	○	○	○	○	○
Tecnologia	○	○	○	○	○	○
Potência/Conforto	○	○	○	○	○	○

13. Por favor, ordene os fatores apresentados previamente consoante a relevância que têm para si. *

1 - Menos Relevante ; 10 -Mais Relevante

	1	2	4	6	8	10
Autonomia	○	○	○	○	○	○
Preço	○	○	○	○	○	○
Tempo de Carregamento	○	○	○	○	○	○
Marca	○	○	○	○	○	○
Tecnologia	○	○	○	○	○	○
Potência/Conforto	○	○	○	○	○	○

14. Se houver algum fator que considere igualmente importante e que não esteja representado nas questões anteriores, por favor indique qual.

Your answer

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