ELECTRIC CARS

Perception and knowlegde of the new generation towards electric cars

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Contents

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1.Introduction

Transportation has been and will always be a highly important sector in human life. People have been using vehicles in their everyday life to enjoy the convenience that is offered and the benefits obtained reaching your destination by car instead of using public transport. Transportation' community is growing bigger and much faster than the human population (Garling & Thogersen, 1999). According to Sperling (as cited in Garling & Thogersen, 1999), in 1950, there were 50 million vehicles on the world. Within approximately 50 years this amount rose up to 600 million and the predictions show that it will go further the 3 billion vehicles by 2050(Garling & Thogersen, 1999).

At the beginning of the evolution of passenger vehicles, the brands, manufacturers and customers were mostly worried about the speed, the acceleration-efficiency, the size, the design and the price. The conventional cars have been sold and used massively around the world without consumers and companies considering the consequences of the fuel consumption. The automobile though burdens the environment in many ways.

The massive use of conventional cars has led to the dependence on fossil fuels (Rolim et.al, 2012). The exploitation of fossils fuels brings up big environmental costs since it constitutes one of the major contributions to the greenhouse gas effect (Rolim et.al, 2012). The different means of transport cause almost 14% of global greenhouse gas emissions and as it is predicted it will reach the 50% by 2030 (Egbue & Long, 2012).The high percentages of carbon dioxide and the rest of climate-altering emissions threatens both the environment and the people (Garling & Thogersen, 1999). To limit the impact of these emissions cleaner fuels and fuel catalysts have been introduced to the conventional cars. Nevertheless, these measures have not managed to restrict the carbon dioxide emissions which contribute majorly to the greenhouse effect (Garling & Thogersen, 1999).

The aforementioned results and predictions of other researches indicate that a more sustainable transportation system is needed. Shifts in fuel characteristics or the provision of alternative energy sources can reduce the emissions and promote the substitution of conventional gasoline and diesel fuel. These concerns have necessitated the adoption and use of alternative fuel vehicles such as hybrid and battery electric vehicles. This thesis refers to the electric vehicles only (those electric cars which are 100% powered by electric battery). Electric cars operate by one or more electric motors which are powered by rechargeable electric batteries. Due to electric cars' ability to operate using clean energy sources, an alteration to electric cars contributes to an independent, cleaner and more secure energy future (Daziano, 2013).

If most of the drivers start using an electric vehicle instead of a conventional car a lot of benefits can arise such as the reduction of greenhouse gas emissions, of carbon dioxide and fog in the urban air and enhance the economic security in case of disturbances to oil production in the Middle East (Krause et.al, 2013).

According to Steinhiber et.al (2013) electric cars have been considered an upcoming technology over the last century. Still though have not managed to gain the trust of consumers and obtain big market share. The problems regarding alternative cars like the electric is that they have been recently introduced, are still under improvement and provide new characteristics and driving routines to the users (Rolim et. al 2012). Electric cars have to compete with the conventional cars which for so long have been covering the needs of peoples and have been established in their everyday life. Beside the benefits an electric car can offer, it still has some drawbacks that make it look inferior to the conventional car. Although improvements in energy efficiency have been made so as to achieve sustainability in personal transportation, low emission vehicles such as electric cars still present a lot of disadvantages that make their comparison with conventional car inevitable (Daziano, 2012). Present batteries' capacity do not offer unlimited driving range, instead they require long recharging times and high initial purchase price (Garling & Thogersen, 1999). Daziano (2013) agrees that technical issues such as driving range, cost and charging procedure cause uncertainty to potential customers. The main problem is that the initial costs of an electric car are much higher than those of a conventional car while in the long term this is not true. High purchase price, limited driving range, absence of recharging stations and the duration of recharging procedure are important deterring factors in the purchase of electric cars (Daziano, 2013). On the one hand electric cars deprive time and money (as it is perceived at first), on the other hand they offer inexpensive fuel, electric motors with bigger lifecycle than the internal combustion engine of the conventional cars and cheaper maintenance costs (Garling & Thogersen, 1999).

Sovacool and Hirsh (as cited in Steinhiber, et.al 2013) claim that the adoption of electric cars needs to overcome not only technical issues, like the range, but also social and political impediments. In line with Sovacool and Hirsh are the arguments of Rolim et.al (2012) who claim that technological improvements are not enough, changes in driving behavior are essential in order to achieve reduced energy consumption and emissions. The influence of alternative vehicle technologies on the driving behavior, environment and safety is still questionable though. Indicatively some socio-political impediments might be improper judgments regarding discount rates applied by governments' policies, future fuel savings and the natural resistance of humans to something new and unfamiliar. For that reason private investments and subsidies are needed to encourage consumer acceptance of electric cars in the automobile market (Daziano, 2013).

Governments having understood the benefits of the penetration of electric cars in the market, try to promote them via subsidies such as tax free purchases, free parking or permission to drive on the bus lines. Those incentives are applied under the belief that they will facilitate users driving experience and make electric cars more attractive. The most important incentive that governments should undertake though is the development of infrastructure, charging points and charging stations (MacLean as cited in Potoglou & Kanaroglou, 2007).

As described above, socio-technical criteria are the actual problems in the penetration of electric cars but there is one more crucial impediment that should be considered. The major problem with the popularity of electric cars is the fact that most of the people have little knowledge or no knowledge at all regarding the use of electric cars and this is why they are perceived as inadequate or end up to be less favorable compared to the conventional cars. People seem to be skeptical when they have to deal with unknown technologies and innovations that are not familiar with. Such new technologies are the electric vehicles. Thus it is crucial to understand how people perceive electric cars and how this perception will affect their decision making process towards buying an electric car.

Thus, the purpose of this research is not to measure and evaluate the actual problems electric cars have but to test the knowledge of people toward electric cars and how the latter is perceived. This brings us to the main research question of this paper which is how electric cars and their characteristics are perceived by young consumers.The main question is analyzed in the following section by testing different hypotheses deriving from the different attributes of the electric cars such as range, charging time and costs. Through these hypotheses, there is also an oppurtinity to see how these perceptions regarding specific characteristics might affect the purchase intention of these consumers.

The contribution of this study in the transportation field is attributed to the fact that the statistical analysis contains data collected via a survey conducted among students in the Erasmus University Rotterdam in the period of June 2016. The paper adds to the literature since it offers information regarding the perception the new generation has towards electric cars .The new generation between 18 and 30 are the future customers of electric cars and so the government policy makers and brand marketers could take advantage of these results and apply policies and marketing strategies to attract these potential clients.

The paper is structured as follows: Section 2 presents the background of electric cars, their history, how they operate and some basic technical information. In section 3 the theoretical framework explains all the factors that may affect the intention of customers to buy an electric car. Section 4 gives an insight to the questionnaire which leads to section 5 where the methodology and the dataset are explained. Section 6 presents the results from the statistical analysis and at the end section 7 includes the conclusions, limitations and some discussion.

2. Background:

2.1 History:

The very first experimental electric vehicles appeared in the USA, UK and Netherlands in the 1830s,as Hoyer (2008) mentions in his paper "The History of Alternative Fuels in Transportation'' .The first electric vehicle was manufactured in 1842 in Scotland(Garling & Thogersen, 2001). The power given to the vehicle to operate was sourced by a rechargeable lead battery. While around 4000 automobiles were produced in the United States in 1900, 38 % of them were electric which proves that the electric car trend was at its prime during this period. Electric cars had experienced their "golden age" in the 1920s (Westbrook as cited in Hoyer, 2008).This period was characterized by a lot of technological developments and improvements like networks of charging stations.

After a while though, the innovative battery technology was put off because oil became cheaper and more than sufficient. In this way electric vehicle lost ground due to the competitive conventional vehicles. In the 60s though, electric technology gained interest again since semiconductors were invented and various changes in motors and controllers were introduced (Sperling as cited in Garling& Thogersen, 2001).The increased popularity of electric vehicles in that period is also attributed to the fact that the first regulation regarding the environment was introduced.

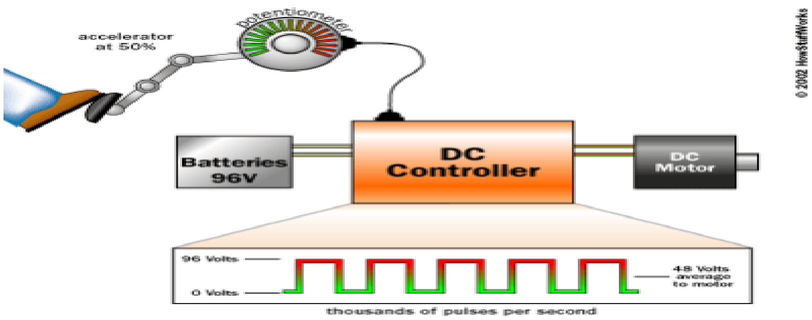
The Air Quality Act of 1967 toward vehicle emissions that was applied in the United States, in combination with the oil crises in 70s and 80s helped the development of electric vehicles to move further. Determining factor though in the investment of electric vehicles was a strict command from the California Air Resources Board, which demanded that all manufacturers should sell a big amount of zero emissions vehicle (Garling & Thogersen, 2001).The defined percentage of zero emissions vehicle began at 2% in 1998, increased to 5% in 2001 and was doubled by 2003 (Garling & Thogersen, 2001).

When the Zero Emission Act was dismissed, partial zero emissions cars started being of more preference and this is when Toyota developed hybrid cars (Toyota Prius) which have both electric and combustion engines (Helmers & Marx, 2012). The increasing popularity of hybrid cars led to a parallel increasing interest in the electric cars in general. Adjacent to the hybrid cars, 100% electric cars are powered exclusively by an electric motor. Another peculiarity of the 100% electric car compared to the hybrid is the car size. On the one hand battery size must grow so as to offer bigger capacity and consequently longer range but this affects the total weight of the car .In the future electric cars are planned to be mainly small or medium-size cars. The sizes are defined this way because the weight restricts the range of operation and also because bigger cars require bigger batteries which increases the cost of the battery and at the end the initial purchase price of the electric car (Helmers & Marx, 2012).

2.2 Technical characteristics:

Larminie and Lowry (as cited in Helmers & Marx, 2012) refer to three basic parts of a battery electric vehicle which are the electric battery, the electric motor and a motor controller (picture 1). As observed above, the technology of electric cars is not a new unknown technology but has been in our disposal for over than 110 years (Helmers & Marx, 2012). As a matter of fact, the technical structure of the electric cars is simpler than of conventional cars. Its simplicity is attributed to the fact that there is no starting , exhaust or lubrication system , most of the electric cars are automatic and in some cases a cooling system is not necessary. Helmers & Marx (2012) describe "The battery charges with electricity either when plugged in the electricity grid via a charging device or during braking through recuperation''. The charger constitutes a substantial component in the whole charging procedure due to its efficiency that can vary between 60% and 97%, wasting 3% to 40% of the grid energy as heat. The third basic component of the electric car, the motor controller provides variable power to the electric motor. Following, the electric motor converts the electric energy into mechanical energy and gives push to the car (Helmers & Marx, 2012). In other words, the batteries give power to the controller which in turn delivers it to the motor. Then the accelerator pedal catches on a pair of potentiometers (variable resistors) that "tell" the controller how much power it has to give. When the car is not moving the controller gives zero power and full power when the driver pushes the accelerator pedal and the car begins to move. (Source: http://auto.howstuffworks.com/electric-car2.htm, accessed in June 2016)

Picture 1: Inside of an electric car.



A simple DC controller connected to the batteries and the DC motor. If the driver floors the accelerator pedal, the controller delivers the full 96 volts from the batteries to the motor. If the driver take his/her foot off the accelerator, the controller delivers zero volts to the motor. For any setting in between, the controller "chops" the 96 volts thousands of times per second to create an average voltage somewhere between 0 and 96 volts.

2.3 Electric Cars in 2016: a short overview

As it has been already pointed out, the necessity of introduction of alternative electric vehicles derives from the lack of fuel resources , from the greenhouse gas emissions that keep rising and the noise pollution. The reasons for the implementation of alternative fuel vehicles are mainly environmental concerned and this emphasizes the importance of this implementation.

Until now the most common alternative fuel cars are the electric vehicles. Electric vehicles is the general category of these alternative fuel vehicles and the sub-categories are battery electric vehicles(BEVs) or else called pure-electric vehicles that operate on electric power, hybrid electric vehicles (HEV) that have both internal combustion engine (ICE) and electric battery and hydrogen fuel cell electric vehicle (FCEV). According to Tom Denton (2015) ,in 2015 the sales of electric vehicles were increasing and evidence show that this growth will continue. In 2014, more than 75.000 evs were registered in the EU.The largest increases were noted in UK , Germany and France.

The purpose of electric vehicles production is to cut down the energy size and power for fuel consumption and obtain the demanded energy from carbon free energy sources like fuel cell (Bayindir et.al, 2011). The major characteristics of the three different types of electric vehicles are given at the table below (Table 1).

Hybrid electric vehicles can be also categorized into three different types, the series hybrid electric vehicles (SHEV), the parallel hybrid electric vehicles (PHEV) and the combination of series and parallel hybrid electric vehicles. As Bayindir (et.al, 2011) describes in his paper, in PHEV the mechanical and electrical power output are connected in parallel to drive the transmission of energy. If the requested power is bigger than the output power of ICE, the electric motor starts operating and in combination with ICE they supply the demanded power to the transmission. If the requested power is smaller, then the power left is used to charge the battery.

Conventional Hybrids , that have both a gasoline engine and electric motor cannot be plugged in and recharged. Their batteries are recharged when braking while kinetic energy is converted into electricity. (Source: http://blog.ucsusa.org/josh-goldman/comparing-electric-vehicles-hybrid-vs-bev-vs-phev-vs-fcev-411, accessed in May 2016)

Plug in-hybrid electric vehicles differ from conventional hybrids in that they can be plugged into an outlet to recharge the battery.The superiority of plug-in hybrid electric vehicles compared to the conventional hybrids is that the can substitute electricity from the grid for gasoline. For instance, the 2014 Chevy Volt can drive 38 miles before the gasoline motor starts working.

Pure-electric vehicles operate solely with electric power via on-board batteries that are charged when plugged into an outlet or charging station. The battery can be charged either when plugged in the electric grid via a charging device or during braking through recuperation(Helmers & Marx, 2012). Examples of pure-electric cars are the Nissan Leaf which was launched in 2010, Fiat 500e and Tesla Model S. These models have achieved longer driving ranges in comparison with PHEVs and produce zero gas emissions. The fact that pure-evs do not have a gear box it makes users feel they drive an automatic car. The BEVs at the present offer a range of up to 80 miles per charge with the exception of Tesla which can offer 200 miles driving distance on a single charge. Battery technology though improves all the time and at some point BEVs will be able to offer a wider range and attract more customers.

Fuel cell electric vehicles (FCEVs) have only an electric motor like a BEV but the way energy is stored differs. FCEVs do not recharge battery but they store hydrogen gas in a tank . The combination of hydrogen and oxygen from the air produces electricity in the fuel cell which in turn powers the electric motor which powers the whole vehicle at the end. Like BEVs there is no production of tailpipe since the only byproduct is water. The biggest pron of this type of vehicle is that since they do not need recharging, the refilling with hydrogen lasts around 5 minutes at a filling station. (Source:http://blog.ucsusa.org/josh-goldman/comparing-electric-vehicles-hybrid-vs-bev-vs-phev-vs-fcev-411, accessed in May 2016)

Consequently the options among different types of electric vehicles are many and the industries like Toyota and Tesla have been in strong competition on which one will offer the best envirnomental friendly car with Toyota focusing on fuel cell hybrids and Tesla on pure- electric cars. The competition is justified since the market of electric cars seems promising according to IDTechEx that claims that the global sale of hybrid and 100% electric cars will be increased to $185 billion in 2025 . (Source:http://www.idtechex.com/research/reports/future-technology-for-hybrid-and-pure-electric-cars-2015-2025-000393.asp, accessed in May 2016)

Table 1 : Major characteristics of electric vehicles (Bayindir et.al, 2011)

Type's of EVs	Battery EVs	Hybrid EVs	Fuel cell EVs
Propulsion	Electric motor drives	Electric motor drives Internal combustion engine	Electric motor drives
Energy system	Battery Ultracapacitor	Battery Ultracapacitor ICE generating unit Integrated starter generator	Fuel cells Need battery/ultracapacitor to enhance power density for starting.
Energy sources and infrastructure	Electric grid charging facilities	Gasoline stations Electric grid charging facilities (for plug-in hybrid)	Hydrogen Hydrogen production and transportation infrastructure
Characteristics	Zero emission Independence on crude oils High energy efficiency High initial cost Commercially available Relatively short range	Very low emission Long driving range Higher fuel economy as compared with ICE vehicles Dependence of crude oils Complex Commercially available	Zero emission or ultra low emission High energy efficiency Independence on crude oils Satisfied driving range High cost Under development
Major issues	Battery and battery management High performance propulsion Charging facilities	Managing multiple energy sources Dependent on the driving cycle Battery sizing and management	Fuel cell cost Hydrogen infrastructure Fueling system

3. Theoretical Framework:

3.1

As observed above, the technology of electric cars is not a new unknown technology but has been in our disposal for over than 110 years (Helmers & Marx, 2012). The fact though, that electric cars have not managed to earn the trust of people and their market share is still at low levels, leaves them with the innovation label and all the consequences this characterization has, until now. There have been numerous researches that tried to prove why this technology is not yet adopted and what policy makers should do in order to promote electric cars in the market but there is not yet a clear answer on which factors are actually those who affect significantly the intention of consumers to buy electric cars.

Most of the researches so far have focused on the actual factors that deter the increase in the market share of electric cars and try to suggest policies regarding these results. The most important thing though in the penetration of electric cars to the automobile market is to understand potential customers' needs and more specifically to understand why they seem to think that electric cars cannot cover those needs. The lack of faith in the electric car technology might derive from the little knowledge and misperceptions people have about the operation and characteristics of the electric cars.

As mentioned above, electric cars are still considered an innovation since they are not widely spread, their technology is under question and still a lot of their characteristics need to be developed. As Petschnig et.al (2014) claim, people firstly form an attitude regarding an innovation, in our case electric cars, and then they decide if they are going to adopt or this innovation. Their results show how important these perceptions are in the purchasing decision of an electric car because these are who create negative or positive feelings about the innovation.

Krause et.al (2013) in agreement with Petschning about the importance of the perceived characteristics of electric cars conducted a survey in order to test how much people know about electric cars. Almost 95% of their respondents provided wrong answers to basic questions regarding electric cars and 75% of them were not able to recognize the benefits an electric car can offer. In addition, many of them were not informed about government policies and incentives applied to promote the purchase of electric cars. The results of this survey showed that misperceptions regarding the purchase and maintenance costs affected the intention of buying an electric car significantly (Krause et. al, 2013). What they seemed to be more aware of is the purchase price and what they were least familiar with was the maintenance costs.

Schuitema et.al (2012) agrees that the future of electric cars relies on how consumers perceive them. People hesitate when new technologies like electric cars appear because they do not have any or have little experience with them and are afraid to lose the convenience and familiarity they have developed with the conventional cars.

Burgess et.al (2013) discusses also the fact that people have low understanding of the electric cars. Like Krause et.al (2013), Burgess et.al (2013) found via a survey that people knew they do not have enough knowledge about electric cars, how the driving experience could be, what the benefits and the costs are. They also found that negative misperceptions lead to a negative intention of buying an electric car. The most common feeling that people have, as commented above, is that electric cars are inferior to conventional cars especially in performance. The characteristics of the performance that are considered are the perceived range, speed, acceleration and charging procedure. Furthermore, the association of electric cars with small vehicles and underdeveloped technology causes anxiety about safety and reliability. This uncertainty is attributed to the fact that people are used to the dominant technology of conventional cars and leads to unwillingness in investing in the new technology of electric cars (Burgess et.al, 2013).

Consequently, considering the importance of perceptions of electric cars, the purpose of this research is to study how the new generation between 18-30 years old perceives electric cars regarding their social and hedonic attributes, how much knowledge they have regarding the instrumental characteristics of electric cars and how these perceptions affect their rounabout the range, the purchase and maintenance costs, the charging procedure and infrastructure, the design, size, acceleration-performance and the financial incentives of governments.

It is important to be mentioned that the fact that this paper studies the perceptions of new generation towards electric vehicles offers to policy makers more recent information about the situation of the market and the beliefs and intentions of potential customers . New generations might be the future customers of electric cars and their opinion towards them is of high importance. Some of the findings might be the same as in the past but since society changes all the time , there are definetely some additional information that should be taken into consideration . For instance , over the last years due to strong job competition almost everyone obtains a master degree in order to be a more competitive candidate . Thus, considering the increase in the education level of this generation compared to the previous one , it can be assumed that the more educated people are those more aware of the electric cars ‘attributes might be . Someone who is around their 60s now, might have been reluctant to adopt a new technology like electric cars while their children who are surrounded by environmental sustainability information and innovation projects are more open to adjust to a new technology.

Nevertheless, it should be mentioned that the environment of electric cars is very dynamic and the conditions change all the time. Manufacturers make efforts to introduce new models more efficient, cheaper and more attractive to the customers which results to the production of new models of electric vehicles very fast. Only two months ago , Tesla released the new model 3 which offers a better range of 215km per charge , in the most affordable price by now of 35.000$ without even the incentives (Source:https://www.tesla.com/model3,accessed in July 2016).Electric vehicles , despite their environmental contribution have been characterized and actually are expensive to obtain regarding the initial purchase price . With the new model, Tesla changes one of the most important obstacles for buying an electric car and if the survey of this paper is conducted after 2017 when the new model will have been already in the market , then different answers may be given. Thus , the information deriving from this paper is accurate for the present and based on the condintions known until now but might not be applied two years later and may be considered out of date. The dynamic environment of electric cars makes it important and neccesary, new researches and surveys to be conducted very often in order to have a clear and recent image of the market.

3.2 Range:

Despite the fact that researches have shown that the limited range of electric cars is enough to satisfy the needs of a considerable amount of people, many car buyers still tend to choose cars with higher possible range (Franke & Krems, 2013). Some possible explanations for this purchasing intention could be the misinformation regarding the actual mobility needs (Kurani et.al as cited in Franke & Krems, 2013), the comparison of electric cars with the conventional cars and their maximum offered range (Kurani et.al as cited in Franke & Krems, 2013), the insecurity about the limitation in range (Nilsson as cited in Franke & Krems, 2013) and at last the fact that people have not driven cars with restrained range mobility (Kurani et.al as cited in Franke & Krems, 2013).

But what is the actual available range of an electric car? First we should define the range as the maximum distance that can be covered by a full battery charge (Daziano, 2012). Pearre (as cited in Franke & Krems, 2013) argues that the optimal range of an electric car is 100 miles per charge. The actual problem with the range though is when it is in its optimal level. In order for a battery of an electric car to be charged , a substantial amount of energy and limited natural resources are needed which has an impact on the environmental contribution of the electric car. (Mcmanus as cited in Franke & Krems, 2013). If manufacturers want to achieve higher available range then they have to increase the capacity of this range which in turn brings higher purchase price and loses the advantage of being affordable and cost-effective compared to the conventional cars (Neubauer as cited in Franke & Krems, 2013). Consequently, the optimal range for electric vehicles ends up to be the lowest satisfactory range (Franke & Krems, 2013).

A variety of researches has been conducted so as the appropriate electric car range to be decided. Most of them have been based on the travel behavior of European citizens and their range needs. The majority of these researches agrees that the 100 mile range is enough. Since the electric cars lack in acceptance and marketability it should be taken into consideration that the optimal range reckons not only on the range needs but also on the clients preferences and familiarity with the electric cars.

Kurani et.al (1994) came up with three new decision factors regarding the limited range. The first one is the “safety buffer” which refers to peoples’ need to leave at least 20 miles of range on the vehicle at all times Kurani et.al (1994). The second one relates to the “routine activity space” which consists of the places of the activities the families reach on everyday basis such as commuting to work Kurani et.al (1994). The last factor is called “critical destination” and refers to the furthest reachable distance someone driving the electric car expects to be available in case of an emergency or for main activities related to their lifestyle (Kurani et.al ,1994) .

The unfamiliarity of people with electric cars plays a crucial role in their successful development. A majority of people has still a little knowledge and understanding towards the electric cars (Burgess Et.al, 2013). Their lack of understanding leads to the creation of false perceived inadequacies such as the reduced range (Burgess Et.al, 2013). A lot of people are not willing to buy an electric car because they are afraid that the available range will not be enough and it will be incapable of satisfying their needs. In line with Burgess et.al (2013) are the findings of Hoen & Koetse (2014) who argue that the driving range is one of the most important factors that influence the consumers behavior. To emphasize the importance of a sufficient range of the electric cars, a UK survey showed that 70% of 500 consumers were afraid that the charge of the electric car would finish faster than expected and they would not be able to reach their destination (Bunce et.al, 2014).

This perception makes them choose conventional cars over electric so as to enjoy the security and convenience the first offer (Bunce et.al, 2014).

Neumann et.al (2011) conducted a survey in Berlin where they interviewed people about their perception towards electric cars before and after having a 3 month driving experience with electric cars. Before driving the electric car, most of the participants were afraid that the limited range would be a barrier in their mobility. After the three month driving experience more than 94.3 % of the participants supported that 140-160 km is enough for everyday needs. The estimation of users regarding the range of electric cars is 150 km. When they were asked to suggest an optimal range they claimed that 200km is insufficient, 200km and more is sufficient and 250km is the optimal level. (Neumann et.al, 2011) Other results show that 80% of everyday mobility can be covered with electric car and electric cars were not characterized as less flexible than conventional cars. If cargo and passenger capacity were bigger then even more trips around 90% could be covered by electric cars (Neumann et.al, 2011). Krogh et.al (2014) also studied the performance of electric cars compared to the conventional cars. The authors support like the rest the advantages of electric cars regarding the environmental contribution and cost-efficiency but they also mention some important drawbacks such as the available range.

According to Krogh et.al (2014), a conventional car has a range of 500-600km while the range of electric cars is 150-200km and in order to fully charge may take more than an hour compared to gasoline. In order to test if the limited range of an electric car affects the individual mobility, the authors compare the relative frequency of directions of a specific length (Krogh et.al, 2014). The study shows that the trajectories for 99% of the electric cars and for 90% of the conventional cars are less than 50km. Since these trajectories are comparable, the limited range of electric cars does not seem to be a substantial problem Krogh et.al (2014).This result though does not prove that electric cars can satisfy all the demands of users. An argument is that an electric car can fully satisfy your requirements if you can commute to and from work without recharging during the day (Krogh et.al, 2014). The authors compared the everyday total distance driven for electric and conventional cars. The results showed that only a small percentage of the respondents would be able to cover the everyday total distance days with an electric car, since the rest of the respondents had to cover longer total distances than the electric car can cover without recharging (Krogh et.al, 2014). Daziano (2012) also emphasizes the importance of understanding the clients ‘assessment of electric cars driving range. Consumers’ insecurity regarding the limited range constitutes an important obstacle in their decision to buy an electric car.

Hypothesis 1: People who assume low range levels are less willing to purchase an electric car.

3.3 Recharge and Recharging Times:

The driving range which is analytically described above and constitutes an important factor in the decision making of purchasing an electric car is directly linked with the charging time and the charging facilities available. Since the recharging of an electric car is an unfamiliar concept for many drivers, the complexity of the knowledge in the recharging characteristics of electric cars comprises an obstacle in the battery electric car market. There are a lot of different types of batteries for different electric cars and a variety of recharging outlets with varied costs depending on the location, time and the size of electrical service (Kurani et.al, 1994). In houses, where the lifestyle requires only the available distance that an electric car can offer, there is no need for extra recharging station facilities since the home recharging is enough (Kurani et.al, 1994). Reckoning on trip patterns and time pressure of the drivers, and also on their opinion towards gasoline stations, home recharging is a substantial benefit for potential buyers.

The concern of buyers regarding the available range is linked also to the high recharging times. According to Daziano (2012) the duration of recharging a battery of an electric car with standard outlets may take 8 to 16 hours and the fact that there are not so many available recharging stations make things more complicated. On the contrary the abundance of gas service stations and the extremely fast refueling time gives a competitive advantage to the conventional cars (Daziano, 2012). Nevertheless Kurani et.al (1994) found out in their study that charging times might be an obstacle but not as important as the range . The households tested in their research were more vulnerable to the available range than the recharging time. Most of them would rather solve the problem of optimal range rather than decreasing charging time.

The difference between conventional and electric cars is how energy is stored in order for the vehicle to operate and the actions required transmitting power to the vehicle. Electric cars use electrical energy to operate and this energy is stored in batteries while a conventional car uses liquid fuel which is stored in a compact fuel tank (Bunce et.al, 2013). When you want to power an internal combustion engine (conventional car) you just have to visit a petrol station and in few minutes its full but electric cars have to be plugged in to external electricity supply. Electric cars' charging procedure takes more time than refueling a conventional car but the benefit it offers is that it can be recharged overnight at home and the cost of this consumed energy is included in the domestic electric supply (Bunce et.al, 2013). The operating costs of electric cars are cheaper for a standard range of 100 miles compared to petrol or diesel that will cover the same distance (Bunce et.al, 2013).

The challenge here is that potential customers need to adjust to new behavior and routines regarding the recharging procedure, like how often they should do it and when (Bunce et.al, 2013).In a survey of 500 UK consumers as cited in Bunce et.al (2013), 70 % of the participants claimed that the procedure of recharging their car would be inconvenient and that it would prevent them from of driving as far as they wanted. The important thing that should be mentioned here is that these percentages come from drivers that have not driven an electric car. The electric car drivers on the other hand acknowledge a lot of advantages toward the charging procedure. Forty participants in South England, after using an electric car for one week they characterized the recharging procedure as “Straightforward “ and convenient and emphasized the importance of being able to charge it at home (Graham Raw as cited in Bunce, 2014). These findings were supported by another trial of Franke and Krems(as cited in Bunce ,2014) were 71% of drivers that had an experience driving electric cars for six months preferred recharging than refueling at a gas stations and 87% of them agreed that the recharging procedure was easy. Electric car drivers also supported that they had substantial saving from powering an electric car compared to refueling a conventional cars (Graham Raw as cited in Bunce, 2014). Not only positive reactions though appeared when the participants tried the electric cars. Some of them called the recharging time as “dead time” which deprived their flexibility and spontaneity that a conventional car offers (Graham Raw as cited in Bunce, 2014).

As far as the recharging stations are concerned, their lack constitutes also an important barrier to the use of electric cars. In the Smart survey (2010) participants argued that needed better and more public charging infrastructure in order to be more positive towards buying an electric car and that governments should invest more in this improvement. In Grahams' survey those who worried about the charging facilities were afraid that these garages are not accessible .These participants shared the same worries as those in Turrentine's survey (as cited in Bunce, 2014) but when the latter experienced driving electric cars for three months they realized that they did not have any reason to worry about it since only 4.8 % of the charges was operated in public charging station.

Hypothesis 2: High expected charging time would lead to an increased probability of not buying an electric car.

3.4 Costs (purchase and maintenance)

Delucchi & Lipman (2001) in their study "An Analysis of the retail and lifecycle cost of battery-powered electric vehicles" found that if the market of electric cars wants to succeed in promoting them, they have to provide cost-competitive electric cars in comparison with the conventional cars, which means that batteries should have lower production cost and longest duration. Critics claim that battery-powered electric cars (BPEV) can be very costly and they need subsidies or other kinds of promotion in order to be more attractive to clients. Various studies have shown that that BPEVs appear to cost much more than conventional cars in the short-term, but according to other studies BPEVs' costs can reach comparable levels of costs with the conventional cars very fast. Future predictions suggest that BPEVs' purchase costs and lifecycle costs will exceed those of conventional cars (Dixon & Garber as cited in Delucchi et.al, 2001). In line with this prediction is the results from Sierra's research (as cited in Delucchi et.al, 2001) which support that the purchase prices of electric cars will be kept at very high levels through 2010.

The cost levels of the battery both if it is referred to the first placement or to a replacement are directly linked with the initial purchase cost of the electric car. Consequently the higher this cost the higher the initial purchase price and also the insurance and registration costs (Delucchi et.al, 2001). As Daziano (2013) argues, high levels of purchase prices and high maintenance costs like the replacement of batteries are important deterring factors for the attraction of customers towards electric cars.

Electric cars present low operating costs compared to conventional cars because the price of electricity is usually lower than petrol's price (although this is not always the case , since the price of petrol is not stable). Maintaining an electric car is also cheaper than maintaining a conventional car but the initial purchase cost of the first needs at least 10 years to balance with the initial and ownership cost of a conventional car (Faria et.al, 2012). Caulfield (2010) also concluded in his research that the car price is one of the most important factors in the car purchase decision making process. The biggest percentage of respondents in his survey agreed that electric cars are cheaper to run compared to conventional cars, especially when considering the fuel cost.

The results of this survey indicate that when the potential customers have to choose between electric and conventional cars, their emphasis is mostly given on the reductions of fuel costs compared to other reductions such as the reduction of pollutants. In agreement with Caulfield (2010) come the findings of Potoglou & Kanaroglou (2007) who support that possible customers take sensible decisions and they prefer low-cost cars. Potoglou & Kanaroglou (2007) who examined household attitudes (United States) towards electric car purchase found that households would pay extra so as to benefit from short-or long term savings. More specifically, they were willing to pay 500-1200 to save 100$ in annual maintenance costs and 2200-5300$ to save 1000$ in annual fuel costs. A complementary approach is that purchase price and running costs are considered as the instrumental attributes that will have an impact on the potential adoption of electric cars (Schuitema et.al, 2013). The noticeable thing here is that the perception of these attributes is extremely strong.

Schuitema et.al (2012) conducted a research in order to make clear how the perception of drivers towards the car attributes influences their decision over buying an electric car. The main results of the study showed that instrumental attributes such as purchase price and running costs are substantial since they are linked with other attributes, that will be defined in the following paragraph, coming from the ownership and use of electric cars(symbolic attributes) and others such as the pleasure of driving (hedonic attributes).

Hypothesis 3a: Those who believe that the maintenance cost of an electric car is higher than of a conventional car will have a negative opinion towards buying an electric car.

Hypothesis 3b: Those who expect long term cost savings from the use of an electric car (via low maintenance costs compared to a conventional car) will be more positive about purchasing an electric car.

3.5 Hedonic attributes:

Beside the instrumental attributes that influence the purchase intention, important role play also the symbolic and hedonic attributes which are presented in the aforementioned research of Schuitema et.al (2012).It is presented that potential customers who believe that a pro-environmental self identity suits their self-image seem to be more positive about buying an electric car. The motive to adjust to new technologies depends on clients' innovativeness, which is their propensity to obtain new products from a specific category as soon as they appear in the market and before the majority of other consumers (Schuitema et.al, 2012). Hedonic innovativeness is one of the categories we are interested in this section and is the emotional experience coming from the utilization of new technologies and the feeling obtained from it such as happiness and satisfaction (Dittmar as cited in Schuitema et.al ,2012).

In addition,symbolic innovativeness plays also an important role in the adoption of electric cars and it refers to the social identity that it is mirrored from the custody of new technologies (Dittmar as cited in Schuitema et.al, 2012). Both categories are strongly linked to the car use and ownership. Self image congruency (Sirgy as cited in Schuitema et.al, 2012) offers an important explanatory theory in the understanding of different perceptions of electric cars' attributes. Evidence has shown that self-image congruency can justify customers' preferences for a car brand, a car purchase decision and happiness with the new asset (Kressmann, Erickes & Jamal as cited in Schuitema et.al, 2012).For instance, someone with an intense car-authority identity is more expected to find electric cars more appealing since they can be characterized as having the newest and more progressive technology. Nevertheless the same category considering the barriers of electric cars like range & performance may hesitate to invest in buying an electric car (Schuitema et.al, 2012).

Another promoting factor could be the pro-environmental identity the purchase of an electric car gives you. Such identities will enhance your social image and how you are perceived by others because this choice ponies up the sustainability of road transport. Thus hedonic attributes play an important role in decision making process of buying an electric car (Schuitema et.al, 2012). Consequently, purchasing an electric car gives you the chance to build a social identity and can provide a social benefit either you are a strong car-authority person or a pro-environmental. So these types of people are more likely to be positive towards the purchase of an electric car.

Generally the results of this research show that the intention of purchasing an electric car is stronger if consumer perceives the hedonic and symbolic attributes of electric cars positively.

In line with this study is the research of Petsching et.al (2014) who claim that the innovation image may affect consumers' decision to accept this innovation (Kleijnen as cited in Petsching et.al, 2014). The authors agree with other theories which support that social prestige comprises s a crucial factor in the decision making process of adopting an innovation (Rogers as cited in Petsching et.al, 2014). Regarding high ecological innovations, the symbolic status and image are substantial attributes. In their analysis the authors conclude that the perceived innovative characteristics encourage or discourage positive or negative attitude respectively towards the adoption of electric cars. As Modhal (as cited in Egbue & Long, 2012) agrees, half of the Americans are "technology pessimists", which means they oppose to technology. Sovacool & Hirsch (as cited in Egbue & Long, 2012) also say that most of the potential customers when they try to make choices they "stick to notions of tradition and familiarity" instead of supporting new technology.

Hypothesis 4: Positive symbolic characteristics linked with the ownership of an electric car enhance the intention of customers to buy one.

3.6 Overview of the hypotheses

In the theoretical framework four hypotheses that are summed up at the table below (Table 2) were formed. During the survey, respondents were asked different questions regarding their beliefs/ expectations or knowledge towards electric cars' operation and characteristics. More specifically, the questions asked in the survey in order to test the hypotheses were the following. The question "What is according to your expectation the average range of an electric car today?" gave the respondents six different options for answers starting from low levels (up to 100km) until high levels of range (more than 400 km). Those who chose low expected levels of range will be added in a regression model with the decision intention as a dependent variable and give us results about the relationship between these two variables and how this expectation affects the purchase intention. The same procedure was also applied for the second hypothesis and one question for the expected charging time was included in the survey. The two sub-hypotheses on the third hypothesis are related to the costs savings or expenses from the use of electric cars. One of the components of the costs deriving from electric cars is the maintenance costs. In order to check how respondents perceive these costs they were asked in the survey if they think that the maintenance of electric cars costs more than for conventional cars. Like in the previous case , the variable of the maintenance costs will be added in the regression model with the decision variable and the results will show the nature of this relationship. Among the reasons of why someone would consider buying an electric car, cost efficiency was given as an option. Depending on the proportion of the respondents who chose this answer, assumptions can be obtained about the influence of cost efficiency on the purchase intention. At last, there was one more question asking respondents about which qualities they associate with the ownership of an EC and the results will be also tested in the regression model with the decision variable.

Table 2 : Overview of the hypotheses

	HYPOTHESES
H1	Low expected range levels lead to a negative purchase intention towards ECs
H2	High expected charging time leads to a negative purchase intention towards ECs
H3a	Higher expect maintenance costs of electric cars lead to a negative purchase intention towards ECs
H3b	Long term expected cost savings from the use of electric cars lead to a positive purchase intention
H4	Positive symbolic characteristics linked with an electric car lead to a positive purchase intention.

4. Methodology

4.1 Data Collection

The data was collected through a survey distributed among my social network and the 228 responses that were collected were from highly educated people between the ages of 18 to 35. The questionnaire (Appendix A) consisted of 14 questions (including personal characteristics) related to the characteristics of electric cars and tested the knowledge and familiarity of respondents with the electric car technology.

4.2 Statistical Analysis

Considering that the response variable “dec” is a dichotomous variable the appropriate model is either a logit or probit regression model in order to express the probability of deciding to purchase an electric car or not.With OLS regression when the response variable is a binary variable this model is called a linear probability model and it is used to describe conditional probabilities.But, the errors deriving from the linear probability model violate the homoskedasticity and normality of errors assumptions of OLS regression, thus concluding to invalid standard errors and hypothesis tests. In the first effort of applying the logit or logistic model the results appear to be abnormal and could not be interpreted . This problem may be due to the fact that when the survey was conducted the qualitrics survey tool recoded automatically the values 1 and 2 to the binary variables(own,exp & dec) for yes and no respectively. Thus ,stata recognized these variables as polytomous rather than dichotomous variables and consequently the appropriate way to test their relationship was via a multinomial logistic regression (Source: http://www.ats.ucla.edu/stat/stata/dae/logit.htm, accessed in July 2016)

Table 3: Description of the variables

Name	Description
own	Binary variable=1 if respondent owns a car; 2 otherwise
exp	Binary variable=1 if respondent has even driven an electric car;2 otherwise
dec	Binary variable=1 if respondent would consider buy an electric car ;2 otherwise
posdec	Categorical variable icluding the reasons why the respondent would consider buying an electric car (1-10)
negdec	Categorical variable including the reasons why the respondent would not consider buying an electric car (1-12)
qual	Categorical variable with the qualities associated with the electric car (1-7)
range	Categorical variable with the expected average range (1-6)
emi	Categorical variable with the Co2 emissions produced by electric cars (1-6)

chargh	Categorical variable with the expected charging time (1-5)
maint	Categorical variable=1 If the respondent thinks that the maintenance of an ev costs more than of a conventional car ; 2 if they think the opposite ; 3 if they think it costs the same
age	Categorical variable with the age of the respondent seperated in two groups of age ,18-24 & above 24 years old
gender	Binary variable=1 if respondent is a male;2 otherwise
Origin	Categorical variable with the continents of origin (1-5)
education	Categorical variable with the education level (1-3)

5. Results

Figure 1: Descriptive statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
dec					
no	220	.1363636	.3439569	0	1
range					
up to 200km	215	.3116279	.4642396	0	1
up to 300km	215	.1674419	.3742412	0	1
up to 400km	215	.0883721	.2844977	0	1
more than..	215	.0325581	.1778912	0	1
i do not ..	215	.2651163	.4424252	0	1
exp					
no	222	.9009009	.2994703	0	1
emi					
5g/km	212	.254717	.4367333	0	1
50g/km	212	.1179245	.3232821	0	1
90g/km	212	.0141509	.1183926	0	1
130g/km	212	.004717	.0686803	0	1

up to 400km	215	.0883721	.2844977	0	1
more than..	215	.0325581	.1778912	0	1
i do not ..	215	.2651163	.4424252	0	1
exp					
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5g/km	212	.254717	.4367333	0	1
50g/km	212	.1179245	.3232821	0	1
90g/km	212	.0141509	.1183926	0	1
130g/km	212	.004717	.0686803	0	1
i do not ..	212	.3207547	.4678714	0	1
chti					
4 hrs	211	.3317536	.4719627	0	1
8hrs	211	.3981043	.4906713	0	1
12hrs	211	.1279621	.334842	0	1
i don't k..	211	.0853081	.2800039	0	1
maint					
no	210	.3380952	.4741915	0	1
the same	210	.1809524	.3858986	0	1
own					
no	222	.3423423	.4755658	0	1

5.1 Demographics

The amount of respondents was 228 highly educated people from 18 to 35 years old. Regarding the demographics, 55.98% were male respondents, 76.02% above 24 years old and the majority of the sample 94.26 % were from Europe while the rest 5.74 % was almost equally from the rest of continents All the respondents were highly educated with at least a bachelor degree. More specifically, 31.10 % owned a bachelor degree, the majority 61.72% had a master degree and the rest was at a PhD level(Appendix B).

5.2 Purchase Intention

In order to assess how the experience from driving an electric car affects their purchase intention, there was a relevant question in the survey that showed that only 9.95 % of the sample has tried driving an electric car in contrast to the huge number of 90.05 % who have never driven an electric car .So as to have a more complete image of the sample there was also a question in the survey of whether the respondent owned a car or not. 65.61 % had a car on their own and compared to the small percentage of experience with an electric car, it may be assumed that a high percentage does not own an electric car (Figure 1).

In the question of whether the respondent would consider buy a electric car in the future or not, the majority, 86.81%, declared that they would. The high percentage of positive reaction to this question may indicate that the lack of experience with an electric does not influence the purchase intention, at least not negatively but later on regression analysis will show the relationship between these two variables. In the survey flow after respondents were asked if they would consider buying an electric they were also asked for which reasons they would decide to buy or not an electric car. From the group of people who were positive in buying an electric car, the two main reasons for buying an electric car were the cost efficiency and environmental responsibility with 34.95% and 48.92% respectively. (Appendix B). The noise reduction option was not chosen at all which indicates that this characteristic of electric cars does not play an important role on the decision making or it might be that people are not completely aware about this attribute. While in the positive decision group there was a clear distinction between the two aforementioned reasons, in the negative decision there seems to be a bigger variety in the reasons why someone from the respondents would not consider buying an electric car. (Appendix B) In detail, the 26.67% attributed their negative decision to the range (maximum distance that can be covered with a fully charged battery) of electric cars which is smaller compared to the conventional cars. Other important reasons were the charging time, the lack of charging infrastructure/facilities and the efficiency as well as other reasons that were specified by the respondents such as the inability of electric cars to provide a fun and entertaining driving experience.

5.3 Perceptions & Expectations

Regarding the knowledge and familiarity of respondents with the electric cars most of them (30.84%) assumed that the average range of an electric car is up to 200 km which shows that towards the range attribute their perception is close to reality condidering that the available range changes all the time to the developing technology. The interesting thing is that another substantial amount, 26.64 % of the respondents declared that they do not know the expected range (Figure 1). Although their expectation regarding the range was not far from reality, the results that the range attribute is the most deterring factor for respondents for buying an electric car shows that the actual range electric cars can offer is not satisfying for a substantial percentage of our sample .

On the question of which qualities respondents associate with the electric cars the most common association among the sample was the environmental friendly quality and it comes in agreement with the fact that environmental responsibility was the greatest reason for buying an electric car according to the survey. The second quality that collected more answers was the technological development (Appendix B). The nature of the electric car and they way it is promoted and marketed leads to both of the aforementioned qualities and it is reasonable to be the first that comes in respondents mind.

The whole purpose of the production of electric cars was to reduce the CO2 emissions and contribute to the sustainability of transportation sector.The question about the CO2 emissions of electric cars received varied distribution on the answers. The majority of the sample (32.23 %) declared that they do not know what these emissions might be. Other big percentages were noted in the first and second option of the question that were 0 g/km and 5 g/km CO2 emissions respectively (Appendix B). The actual emissions of CO2 from the electric cars is 0g/km and this is the most important technological development and attribute of this type of alternative vehicles. Nevertheless , only 28.44% of the respondents was aware of this information while approximately the same percentage (25.59%) said that the emissions were 5 g/km. A reason for these results might be that the respondents did not take into account the note that the survey refers to 100% electric cars , fact that might have led to a confusion with hybrid cars whose emissions are around 5 g/km. What may be assumed from this result is that people although they are willing to buy an electric car mainly for environmental reasons they seem to lack in knowledge towards electric cars' actual environmental contribution.

6. Discussion -Hypotheses

During the literature review and the discussion of previous researches regarding electric cars' characteristics and people's perception and knowledge towards them, four hypotheses were formulated and tested after the data was collected . The first hypothesis was that people who assume low levels of range like up to 100km or up to 200km will have a negative purchase intention for electric cars is rejected. When running the multinomial logistic regression the results show that there is a significant and negative relationship between the range and the negative purchase intention at a 10% level of significance (Figure 2) which means that if the range is increased the probability of not buying an electric cars decreases. In Figure 3 though , where the options of the expected range are tested with the decision probability no significant relationship is presented. What can be assumed from here is that respondents are aware (via their social network or media) that the major drawback of electric cars is the limited range and this is why they rate it as the most deterring factor for buying an electric car (Appendix B) and also affects their intention to buy one but in reality they do not seem to know or have experienced which level of range is sufficient for their mobility and this is probably the reason why no specific option has a significant relationship with the response variable.

Figure 2: Multionomial logistic regression between decision and expected range .

VARIABLES	(1) yes	(2) no
o.range	-	
o._cons	0 (0)	
range		-0.203* (0.120)
Constant		-1.222*** (0.402)
Observations	215	215

Figure 3 : Multinomial Logistic regression between the decision and the different categories of expected range.

VARIABLES	(1) yes	(2) no	(3) yes	(4) no	(5) yes	(6) no
range = 2, omitted	-		-		-	
range = 3, omitted	-		-		-	
range = 4, omitted	-		-		-	
range = 5, omitted	-		-		-	
range = 6, omitted	-		-		-	
o._cons	0		0		0	
	(0)		(0)		(0)	
range = 2, up to 200km		0.205		0.205		0.205
		(0.631)		(0.631)		(0.631)
range = 3, up to 300km		0.223		0.223		0.223
		(0.700)		(0.700)		(0.700)
range = 4, up to 400km		0.803		0.803		0.803
		(0.749)		(0.749)		(0.749)
range = 5, more than 400km		-13.52		-13.52		-13.52
		(815.7)		(815.7)		(815.7)
range = 6, i do not know		-1.057		-1.057		-1.057
		(0.801)		(0.801)		(0.801)
Constant		-1.833***		-1.833***		-1.833***
		(0.539)		(0.539)		(0.539)
Observations	215	215	215	215	215	215

Regarding the second hypothesis that high expected charging time would lead to an increased probability of not buying an electric car is neither rejected nor accepted. In Figure 4, no significant relationship is presented between decision probability and any option of the expected charging time. Consequently , charging time does not seem to influence the purchase intention not at least at a significant level.

Figure 4 :multinomial logistic regression between decision and charging time.

VARIABLES	(1) yes	(2) no
charging time = 2, omitted	-	

charging time = 3, omitted	-	
charging time = 4, omitted	-	
charging time = 5, omitted	-	
o._cons	0 (0)	
charging time = 2, 4 hrs		-0.588 (0.871)
charging time = 3, 8hrs		-0.392 (0.845)
charging time = 4, 12hrs		0.128 (0.919)
charging time = 5, i don't know		0.357 (0.960)
Constant		-1.609** (0.775)
Observations	211	211

The 3rd a hypothesis claimed that those who believe that the maintenance cost of an electric car is higher than of a conventional car will have a negative opinion towards buying an electric car. In Figure 5 it is observed that there is no significant relationship between the decision intention and the expectations regarding the maintenance costs , so the hypothesis cannot be rejected or accepted.

Figure 5: Multionomial logistic regression between decision and maintenance.

VARIABLES	(1) yes	(2) no
maintenance costs = 2, omitted	-	
maintenance costs = 3, omitted	-	
o._cons	0 (0)	
maintenance costs = 2, no		-0.394 (0.464)
maintenance costs = 3, the same		-0.470 (0.595)
Constant		-1.670***

		(0.273)
Observations	210	210

The 3rd b hypothesis was that "those who expect long term cost savings from the use of an electric car will be more positive about purchasing an electric car". From the descriptive statistics appendix B it can be observed that cost efficiency for those who were positive in buying an electric car , was the second more popular option after the environmental contribution with 34.95 %. Consequenlty the 3rd b hypothesis is accepted.

In the fourth hypothesis was claimed that positive symbolic characteristics linked with the ownership of an electric car enhance the intention of customer to buy one of them.Taken into consideration the options from the question that received most responses (Appendix B) which are the environmental friendly and technological development qualities , a multinational logit regression is run with the probability of buying an electric car as the response variable . The results show no significant relationship between any of the qualities given and the response variable (Figure 6) . Respondents may consider the symbolic attributes of electric cars as an advantage of electric cars but it does not seem to play a crucial role on their purchase intention .

Figure 6: Multinomial logistic regression between decision and quality.

VARIABLES	(1) yes	(2) no
qual = 2, omitted	-	
qual = 3, omitted	-	
qual = 4, omitted	-	
qual = 5, omitted	-	
qual = 6, omitted	-	
qual = 7, omitted	-	
o._cons	0 (0)	
qual = 2, technological development		-0.174 (0.587)
qual = 3, innovation		0.171 (0.675)
qual = 4, modern		1.212

		(1.251)
qual = 5, conservative		1.212
		(1.251)
qual = 6, safety		-15.82
		(2,356)
qual = 7, no particular quality		1.500
		(0.947)
Constant		-1.905***
		(0.253)
Observations	215	215

Figure 7: Multinomial logistic regression between response and all the explanatory variables.

VARIABLES	(1) yes	(2) no
ownership of a car = o,	-	
experience with ec = o,	-	
range = o,	-	
CO2 emissions = o,	-	
charging time = o,	-	
maintenance costs = o,	-	
qual = o,	-	
age = o,	-	
gender = o,	-	
origin = o,	-	
edu = o,	-	
o._cons	0	
	(0)	
ownership of a car		0.834*
		(0.492)
experience with ec		-2.018***
		(0.651)
range		-0.325**
		(0.149)
CO2 emissions		0.0926
		(0.109)
charging time		0.310
		(0.221)

maintenance costs		-0.152
		(0.321)
qual		-0.0216
		(0.149)
age		0.512
		(0.594)
gender		-0.721
		(0.515)
origin		0.00831
		(0.303)
edu		-0.101
		(0.397)
Constant		1.033
		(2.097)
Observations	210	210

7.Conclusion and recommendations

7.1 Summary of the research findings

The purpose of this research was to collect information regarding people's knowledge and perception towards electric cars and how consequently these perceptions affect their purchase intention.In contrast with previous researches such as the one conducted by Krause et.al (2013) where it was concluded that a big percentage almost 95 % of the sample gave wrong answers to basic questions regarding electric cars , the respondents here seem to be more aware of electric cars' attributes.Indicatively, the majority of respondents answered right regarding the range and the charging time of an electric car.On the contrary though, when respondents were asked about the CO_2 emissions most of them declared that they do not know the answer. More specifically the majority of the respondents (30.84%) assumed correctly the available range of electric cars and a relatively big percentage (26.64%) of them declared that they do not know about it. The two more common associated qualities with the electric cars were the environmental contribution and the technological development which is in line with what the electric car automobility represents. As already mentioned a sad discovery was that most of the respondents were not aware that the emissions of CO_2 from electric cars are 0g/km and this is something that policy makers should take into consideration since it is obvious that the biggest advantage of 100% electric cars is not widely spread and known.

During the analysis it was observed that out of the 11 explanatory and control variables only three variables had a significant relationship with the response variable. Nonwithstanding the results of other researchers like Neumann et.al (2011) who argued that those who have an experience with electric cars form positive attitude towards electric cars' attributes , this paper shows the exact opposite that the lack of experience with an electric car had a positive influence on the purchase intention while the ownership of a car increased the probability of not buying an electric car (Figure 7). The fact that the lack of experience with ECs increases the positive purchase intention indicates that people who have driven an electric car have probably not being satisfied or became more aware of its drawbacks.

What can be assumed from these results is that respondents when they were given the reasons for buying or not buying an electric car they probably got affected by the common thought and gave answers regarding what the rest of the the sample would answer or what is more commonly known and heard in the society in general. Nevertheless their answers indicate that the limited range still remains the most important drawback in the electric cars technology and comes in line with Burgess et.al (2013) who concluded that people are not willing to buy an electric car because there are afraid that the available range is not enough. The rest indicators such as charging time , maintenance costs, emissions, associated qualities did not give any significant results. As Kurani et.al (1994) argued charging time might be an obstacle but is not as important as the range and this might be the reason why in this research there is no significant relationship between the decision and the charging infrastracture. have a slight impact on their purchase intention and can constitute contributing factors. Potoglou & Kanaloglou (2007) declared in their research that possible customers would pay extra for a short or long term savings or that high maintenance costs constitute dettering factors for the adoption of ECs according to Daziano (2013). In this paper, although the sample was almost equally distributed between those who assumed that maintenance costs of electric cars are more expensive than of conventional cars and those who assumed the opposite, no significant relationship appeared also here between the perception regarding maintenance costs and the decision variable.Cost efficiency might be the second most important reason for buying an electric car according to the sample, but yet the range is the one factor that affects the most the purchase intention of customers. In disagreement with previous researches,which support that positive associated qualities with electric cars influence positively the purchase intention, come the results of the relationship between symbolic characteristics and the decision intention here. Despite the fact that only 2.34% of the sample did not assocciate electric cars with any quality, during the analysis the quality variable presented an insignificant relationship with the probability of buying an electric car.

In addition, the personal characteristics of the respondents,when added in the model as control variables (Figure 7) , did not play any role in the formation of the decision so it can be assumed that the market power of electric cars depends on their technical characteristics, especially range, rather than other exogenous factors.Thus, policy makers and automanufacturers should put even more effort than they already have so as to improve the technology and create competitive models that will attract some of the faithful customers of conventional cars or even new drivers that want to start their driving experience with modern and environmental friendly vehicles .

7.2 Recommendations

As it can be observed from the aforementioned results and conclusions , range remains the most important and determinant factor in the purchase intention of potential customer. No matter how important other attributes of electric cars are considered , range will always come first to the list and the rest components will be contributive.As so ,while manufacturers keep trying to introduce new technologies in order to increase the available range and improve the general perfomance of electric cars , policy makers or governments who want to promote electric cars so as to contribute to environment's protection should organize campaigns or activities that will inform people and societies about electric cars' benefits and characteristics and help them understand that the available range is already sufficient for their needs. As shown in the analysis for example, people were not aware that 100% electric cars have zero CO_2 emissions and this is attributed to a lack of proper advertising from the related companies.

Charging infrastracture might not seem a significant factor now in the analysis because the range anxiety overcomes the rest of deterring factors but at the point where auto-industries will have managed to provide the desirable range then the charging facilities will start to be considered as a big issue. Governments should be already prepared and create the appropriate environment and facilities in order to welcome an increase in the electric cars' market.

7.3 Limitations and suggestions for further research

Despite the fact that this research was carefully prepared, I should acknowldege its limitations and shortcomings. At first, the type of questions that were distributed to the sample might not have been the most appropriate type in order to gather accurate information. The questions had multiple answers and the respondents were able to choose only one of the given options (Appendix A) fact that might have affected the results in a way that respondents might have been manipulated to choose the most obvious answer or leave aside other answers that they would also consider important. If the questions were open ended , respondents might have given completely different answers that could change the results of the research. For instance in the question “Which is the most deterring factor for buying an electric car ?” the first answer-option was the range and it is the option that gathered the more responses. It is reasonable for the sample to choose the most obvious answer since probably the limited range of electric cars has been widely known to a great majority of people . If they were asked though to write down three reasons why they would not buy an electric car , the range option might not have come up to their minds but instead something less obvious but more important for them. The problem with open ended questions was practical because the time available for the completion of the research was not enough for the answers of the open questions to be gathered and tested. Future researchers could use the same questionnaire but with open questions and compare these with the future results and notice if it affects the results.

Furthermore , the size of the questionnaire had to be small in order to be more appealing to the respondents and become easier to collect as many answers as possible. Due to the restriction in the size of the survey some questions were not included. For example, respondents were asked about the expected charging time but they were not asked anything about their knowledge regarding the charging facilities. Of course, this lack was not only due to restricted size but also to practical obstacles. The respondents were from all over the world since the questionnaire was distributed via social media to students of Erasmus University and the charging facilities in every country might have great differences, so the results deriving from this kind of question would not be relative.

As far as the methodology is concerned , the model of choice to get the results was not the most appropriate. To be more accurate , the response variable was a binary categorical variable with categorical explanatory variables. The response variable “dec” was binary with 2 option yes and no as given answers. Considering the response variable as a dichotomous variable a logistic regression should have been applied but due to the fact the answers of the questionnaire were already recoded with specific values given from the Qualtrics survey tool , the Stata programma could not recognize the response variable as a dichotomous categorical but as a polynomous categorical variable and this is why the regression model that was used was a multinomial logistic regression. Any effort made to change the recoded values of the variables affected the relationship between response and explanatory variables and in the fear of the violation of the results, the aforementioned model was preferred.

Appendices:

Appendix A: The questionnaire

Q1 Do you own a car?
- ❍ Yes
- ❍ No

Q2 Have you ever driven an electric car?
- ❍ Yes
- ❍ No

Q3 Would you ever consider buying an electric car in the future?

- ❍ Yes
- ❍ No

Answer If Would you ever consider buying an electric car in the future? Yes Is Selected

Q4 Which is the most important reason for buying an electric car?
- ❍ Cost efficiency
- ❍ Environmental responsibility/concern for future generations
- ❍ Noise reduction
- ❍ Increase in gasoline prices
- ❍ Subsidies (tax reduction,free parking, HOV /Bus lanes
- ❍ Openness to innovation/ early adopters
- ❍ Correspondence to your social prestige (status)
- ❍ Peer pressure (influence by your social circle)
- ❍ Smooth driving perfomance
- ❍ Other.Please specify: ____________________

Answer If Would you ever consider buying an electric car in the future? No Is Selected

Q5 What is the biggest deterring factor for buying an electric car?
- ❍ Range (maximum distance that can be covered by a fully charged battery)
- ❍ Lack of variety in models (Design & Brands)
- ❍ Initial purchase cost
- ❍ Maintenance cost
- ❍ Charging time
- ❍ Lack of charging infrastructure-facilities
- ❍ Size
- ❍ Complexity (how difficult it is to understand the use)
- ❍ Insecurity for the new technology
- ❍ Efficiency (General performance on the road)
- ❍ Acceleration (How fast it goes from 0- 100 km)

Other. Please specify: ____________________

Q6 Which of the following qualities would you associate the most with an electric car?
- ❍ Environmentally friendly
- ❍ Technological development
- ❍ Innovation
- ❍ Modern

❍ Conservative
❍ Safety
❍ No particular quality

Q7 What is, according to your expectations, the average range of an electric car today?
❍ Up to 100 km
❍ Up to 200 km
❍ Up to 300 km
❍ Up to 400 km
❍ More than 400 km
❍ I do not know

Q8 The combustion of fossil fuels, such as gasoline and diesel, to transport people and goods is the second largest source of CO2 (carbon dioxide) emissions which causes the greenhouse effect. Electric cars seem to be the solution to this problem as they can reduce these emissions. How much do you expect the CO2 emissions of electric vehicles to be?
❍ 0 g/km
❍ 5 g/km
❍ 50 g/km
❍ 90 g/km
❍ 130 g/km
❍ I do not know

Q9 On average, how long do you think it takes to fully charge an electric vehicle?

❍ 1/2 hour
❍ 4 hrs
❍ 8 hrs
❍ 12 hrs
❍ I do not know

Q10 Do you think that the maintenance of an electric car is more expensive than the maintenance of a conventional car?
❍ Yes
❍ No
❍ The same

Q11 What is your age?

❍ 18-24
❍ Above 24

Q12 What is your gender?
❍ Male
❍ Female

Q13 What is your origin?

- ❍ Europe
- ❍ North America
- ❍ South America
- ❍ Asia
- ❍ Africa
- ❍ Australia

Q14 What is your education level at the moment?

- ❍ Bachelor
- ❍ Master
- ❍ Phd

Appendix B: More Descriptive Statistics

Ownership of a car:

Answer	%	Count
Yes	65.61%	145
No	34.39%	76
Total	100%	221

Experience of driving an electric car:

Answer	%	Count
Yes	9.95%	22
No	90.05%	199
Total	100%	221

Decision of buying an electric car:

Answer	%	Count
Yes	86.30%	189
No	13.70%	30
Total	100%	219

Reasons for buying an electric car:

Answer	%	Count
Cost efficiency	34.95%	65
Environmental responsibility/concern for future generations	48.92%	91
Noise reduction	0.00%	0
Increase in gasoline prices	7.53%	14
Subsidies (tax reduction,free parking, HOV /Bus lanes	2.69%	5
Openness to innovation/ early adopters	3.23%	6
Correspondence to your social prestige (status)	0.54%	1
Peer pressure (influence by your social circle)	0.00%	0
Smooth driving perfomance	1.08%	2
Other.Please specify:	1.08%	2
Total	100%	186

Reasons for not buying an electric car :

Answer	%	Count
Range (maximum distance that can be covered by a fully charged battery)	26.67%	8
Lack of variety in models (Design & Brands)	6.67%	2
Initial purchase cost	0.00%	0
Maintenance cost	6.67%	2
Charging time	16.67%	5
Lack of charging infrastructure-facilities	10.00%	3
Size	0.00%	0
Complexity (how difficult it is to understand the use)	0.00%	0
Insecurity for the new technology	0.00%	0
Efficiency (General performance on the road)	13.33%	4
Acceleration (How fast it goes from 0- 100 km)	6.67%	2
Other. Please specify:	13.33%	4
Total	100%	30

Associated qualities with the use of electric cars:

Answer	%	Count
Environmentally friendly	64.49%	138
Technological development	16.82%	36
Innovation	9.35%	20
Modern	1.40%	3
Conservative	1.40%	3
Safety	4.21%	9
No particular quality	2.34%	5
Total	100%	214

Expected average range:

Answer	%	Count
Up to 100 km	13.55%	29
Up to 200 km	30.84%	66
Up to 300 km	16.82%	36
Up to 400 km	8.88%	19
More than 400 km	3.27%	7
I do not know	26.64%	57
Total	100%	214

Expected charging time:

Answer	%	Count
1/2 hour	5.71%	12
4 hrs	33.33%	70
8 hrs	39.52%	83
12 hrs	12.86%	27
I do not know	8.57%	18
Total	100%	210

Expected CO2 emissions:

Answer	%	Count
0 g/km	28.44%	60
5 g/km	25.59%	54
50 g/km	11.85%	25
90 g/km	1.42%	3
130 g/km	0.47%	1
I do not know	32.23%	68
Total	100%	211

Expected maintenance costs:

Answer	%	Count
Yes	47.85%	100
No	33.97%	71
The same	18.18%	38
Total	100%	209

Age of the respondent:

Answer	%	Count
18-24	23.92%	50
Above 24	76.08%	159
Total	100%	209

Gender of the respondent:

Answer	%	Count
Male	55.98%	117
Female	44.02%	92
Total	100%	209

Origin of the respondent:

Answer	%	Count
Europe	94.26%	197
North America	1.44%	3
South America	0.48%	1
Asia	1.44%	3
Africa	1.44%	3
Australia	0.96%	2
Total	100%	209

Education level of the respondent:

Answer	%	Count
Bachelor	30.81%	65
Master	61.61%	130
Phd	7.58%	16
Total	100%	211

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