Low Cost Taxis – An Environmentally Friendly Low Cost Transport. A Study made at the City of Lisbon, Portugal

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Abstract
This project, nesting in the entrepreneurism area, aims to develop an innovative road transport network for passengers (TAXI) at the city of Lisbon, Portugal, combining energy efficiency with the reductions of costs associated with the operation of the network.
This research highlights the importance of entrepreneurism and the role of the entrepreneur in the Portuguese economic conjuncture, showing its influences and contributes, as well as the main blockage factors to the creation of new ventures.
The research presents some means that encourages the practices of entrepreneurism and venture creation, through the demonstration of a legal investment solutions set, as well as managerial formation.
The analysis of the type of fuel that is used, leads us to conclude that the electric car is the most beneficial solution to passenger transportation. Nowadays, the most feasible solution, taking into account the economic conjuncture and the environment protocols, is the hybrid car transportation.
We checked that it is possible to create, using the electrical car, a road transport network for passengers (TAXI) at substantial lower costs for the driver, as well as for the passenger. Likewise, we also verified that it is possible to reduce the levels of pollutant gases emissions to near zero, without any loss of competitiveness in the exercise of the activity.

Keywords: Entrepreneurism, Taxi, Environmental friendly transport, electric car, zero gases emissions.

Introduction

The choice of an entrepreneurial project in the area of passenger transportation arises for two reasons:

• The importance of emphasizing environmental aspects, trying to find a sustainable and plausible solution to reduce CO_2 emissions in the urban environment;

• The attempt to change the current perspective of how prices are charged to passengers in passenger transportation of Lisbon (TAXI), finding alternative solutions to generate wealth.

The objective of the project is to evaluate and compare the different types of motor vehicles on the market, namely Gasoline, Diesel, Liquefied Petroleum Gas (LPG) or Natural Gas, Hybrid and Electric vehicles.

The choice of Lisbon for the implementation of a new concept of passenger transportation is obvious to someone who moves daily in Lisbon, given the size of the market, road traffic and passenger traffic registered every day. On the other hand, it is due to the growing environmental concern of State institutions, including the Municipality of Lisbon.

Literature review and research questions

Entrepreneurship is not a new phenomenon in history. It exists since the first innovative human action, in order to improve man's relationship with others and with nature (Dolabella, 2008), and is also seen in a perspective of uncertainty inherent to all human action (Miles, 1949 apud Kirzner, 1997).

Jean-Baptiste Say, who is considered "the father of entrepreneurship", associates entrepreneurs to innovation, and saw them as agents of change (Filion, 1999). We can say that the entrepreneurial spirit in man dates back to pre-history, from the invention of the wheel. In fact, the human species is entrepreneurial, and we can even consider that it is something that is born with Man (Dolabella, 2008).

However the word entrepreneurship goes beyond a mere invention, it refers to how to do things differently in the realm of economic life (Schumpeter, 1999). It is the manifest and willingness of individuals (on their own or in teams, within or outside existing organizations) in perceiving and creating new economic opportunities (e.g.: new products, new production methods, new organizational schemes and new market combinations) (Wennekers & Thurik, 1999).

Hart (2003) defines entrepreneurship as a process of starting and continuing to expand new businesses. In fact, entrepreneurship is defined as any attempt to create a new business or initiative that, whether in temporal or spatial context, influences the economy (GEM, 2004; Kirzner, 1997).

Entrepreneurship can play an important role in the global economy. Its absence in the theories of markets, companies, organizations and changes makes the understanding of the business landscape incomplete (Shane & Venkataraman, 2000).

Some authors argue that entrepreneurship has little contribution to economic growth and development, especially in poorer countries and might even be socially useless (De Meza & Southey, 1996; Shane, 2009; Naudé, 2011). Others argue that there is a positive interaction between economic growth and entrepreneurship as a business activity, and therefore that they are not an independent phenomena (Dejardin, 2000).

In addition, for the Global Entrepreneurship Monitor (GEM), entrepreneurship is itself a driver of employment and economic growth. The creation of new businesses implies an investment in the local economy, creating new jobs, promoting competitiveness and the development of innovative business tools (GEM, 2004a).

The European Commission, through the Green Paper program (European Commission, 2003), which encourages entrepreneurship in Europe, points out as important reasons for the practice of entrepreneurship: economic growth, job creation, competitiveness improvement, the use of individuals' potential and the exploitation of society's interests (for example, environmental protection, education and social security services, and production of health services).

Entrepreneurship has been considered as a strong driver of business development. Schumpeter emphasizes the entrepreneur's role as the main agent and responsible for the introduction and development of new technologies, contributing to the redesign or replacement of outdated processes and products. The entrepreneur is seen as an agent of change (Schumpeter, 1999), the agent that brings together all the means of production, taking advantage of opportunities with the prospect of profit, taking calculated risks. Entrepreneurship is then the ability to design and establish something from very little or almost nothing (Filion, 1999).

Entrepreneurship comes primarily through two types of impulses of economic nature (Baptista, Teixeira & Portela, 2008), the so-called "necessity" entrepreneurship and "opportunity" entrepreneurship (Ferrão, Conceição & Baptista, 2005).

"Necessity" entrepreneurship results mainly from the lack of employment opportunities or unfavorable conditions in the labor market. It is a social reaction to the lack of stable employment opportunities (GEM, 2004a). The individual, by being "pushed" to the creation of his own business, finds the solution for his survival (Ferrão et al., 2005).

Naudé (2011) argues that necessity entrepreneurship does not focus much in business creation and economic development, as its concern is of a more personal nature in an attempt to generate wealth.

On the other hand, the "opportunity" entrepreneurship appears from the detection and use of an innovative new business idea (Ferrão et al., 2005). It is usually developed by individuals who have greater personal skills and capabilities of economic nature, whether rooted in the individual (personality, attitudes, self-esteem, etc.), whether acquired at work or through training and education (skills, knowledge and experience) (Man & Lau, 2005). Statistically, in the vast majority of countries "opportunity" entrepreneurship is greater than the new business creation arising from necessity (GEM, 2004a).

In a simplified definition, opportunities are no more than situations in which new goods, services, raw materials and organizing methods can be marketed and sold above their cost of production (Casson, 1982 apud Shane & Venkataraman, 2000).

Ducker cited by Shane and Venkataraman (2000), describe three different categories of opportunities: (1) creation of new information, as in the invention of new technologies; (2) exploitation of market inefficiencies, as happens over time and geography; (3) reaction to the changes, as with political, legislation, or demographic changes.

Individuals with greater entrepreneurial capacity, more information on products, markets, processes and technology, and with lower risk aversion, anticipate more easily a particular business opportunity that will be potentially lucrative (Portela, Hespanha, Nogueira, Teixeira & Baptista, 2008). The individual should play a proactive role to better identify and recognize the opportunities, and thus individual and situational differences can influence this recognition process (Ardichvili, Cardozo & Ray, 2003).

However, the concept of entrepreneurship in a broader perspective is not only about creating new businesses (Antončič & Hisrich, 2001).

If, on the one hand, there are entrepreneurial strategies that seek new opportunities by creating new organizations, we find the existence of that search for opportunities in existing organizations (Figure 1). Once the surrounding environment is constantly changing, opportunities may arise not only as a new design but also as a reformulation of what already exists (Plummer, Haynie & Godesiabois, 2007).

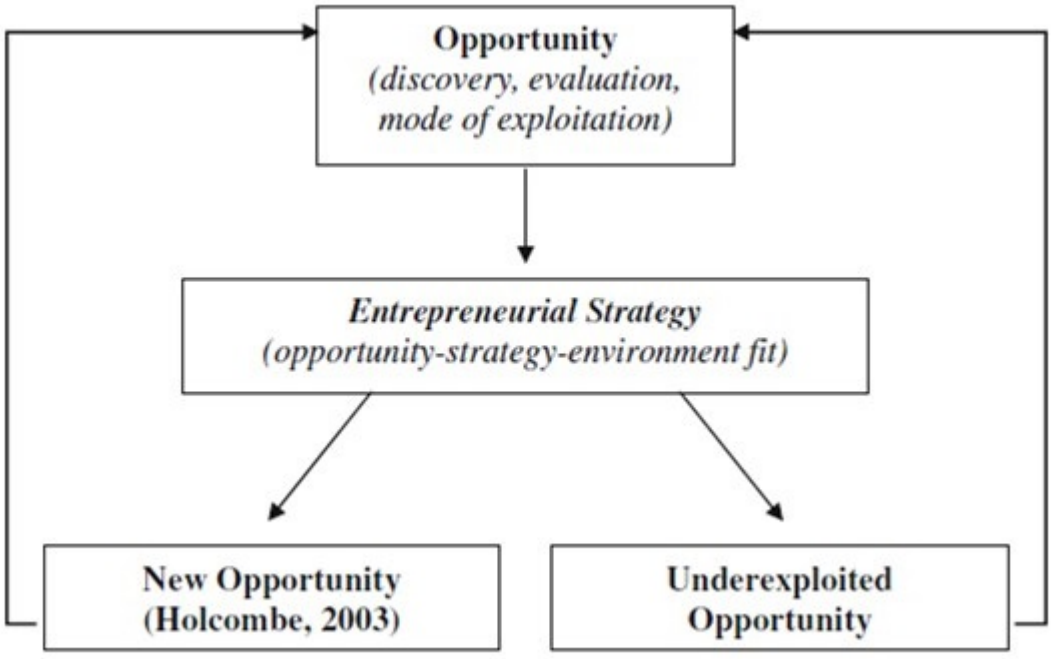

Figure 1: Basic Structure of Business Process
Source: Plummer et al., 2007

Entrepreneurship thus assumes an important role within organizations, finding new solutions to meet the challenges of the moment (Antončič & Hisrich, 2001), and is part of the management function within existing companies (Hitt, Ireland, Camp & Sexton, 2001). In a study by Stevenson and Jarillo (1990), entrepreneurship is seen as a process in which individuals within organizations do new, and out of the ordinary, things in search of new opportunities.

Given that the market is increasingly competitive, companies require their professionals to have entrepreneurial attitudes and characteristics (Dolabella, 2008). These characteristics play a necessary role in the development and growth of the various business sectors (Pasquini, Rodrigues, Vendrame, Sarraceni & Ribeiro, 2009), not only by the creation of new projects, but also by the creation of other innovative activities and guidelines, such as: developing new products, services, technologies, administrative techniques, competitive strategies and positioning (Antončič & Hisrich, 2001).

In an attempt to clarify the explanation, Figure 2 shows the entrepreneurial process in existing organizations, defined as "Intrapreneurship".

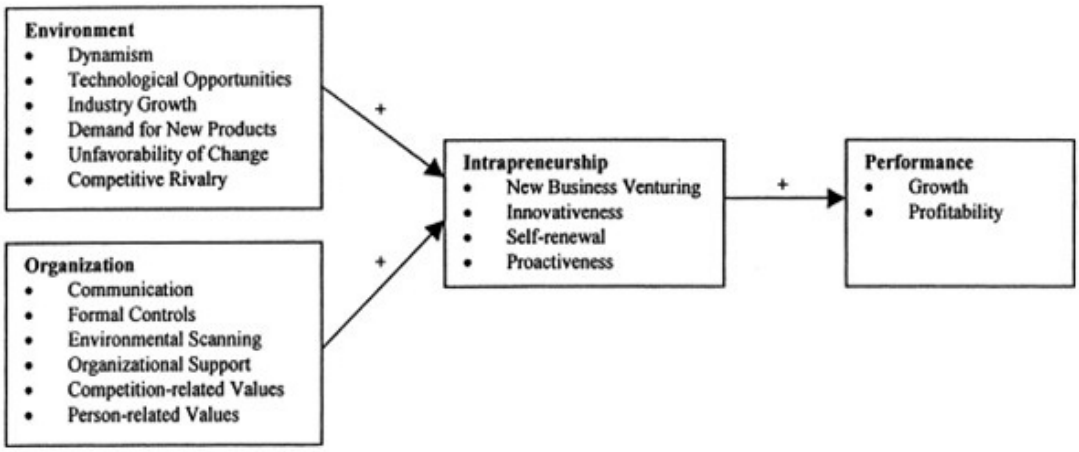

Figure 2: Intrapreneurship model and direct effects
Source: Antoncic & Hisrich, 2001

New firms are a key element for technological development and balance of markets, through new and more technologically advanced investments, exploring new business opportunities and a more efficient use of resources (Statistics Portugal, 2007).

For Wood (2011) entrepreneurship initiatives allow to develop opportunities to generate revenues, which are needed to help stimulate the economy. Simultaneously, at the social level, new companies can play an equally important role in job creation.

The entrepreneur is the one who presents his ideas to the market, and given the uncertainty and obstacles, makes decisions about the location, manner and use of resources and methods (Wennekers & Thurik, 1999). It is a creative person, marked by the ability to set and achieve goals, where his views serve as motivation to achieve success (Filion, 1999). The entrepreneur is someone who can identify, grasp and seize an opportunity, turning it into a successful business. The entrepreneur is basically a

person who sees the change as the norm and explores it as being an opportunity (Pasquini et al., 2009).

Entrepreneurs' behavior, attitude, belief, intelligence, knowledge and skills are essential to respond and resolve the demands he sets to himself (Bonnstetter, 1999). Given adverse conditions, it is in the best configuration of these characteristics that entrepreneurs find ways that allow them to take advantage of their ideas (United Nations, 2004).

The entrepreneur is the person who takes risk, by investing his own money. It is also the agent that brings together all the means of production (e.g.: product, investment, wages, rents, etc.) in order to obtain profit, power and prestige (Baumol, 1990). Entrepreneurship is the result of the strategic merge of analytical and creative intelligence and successful practice, and what makes it different is his success, so the entrepreneur not only needs to create product or services ideas, he is also demanded to come up with the type of product or service (Sternberg, 2004).

Entrepreneurs are people who feel the opportunities before others, take risks and act proactively, taking the uncertainty of operating in new markets, they develop new products and form innovative mechanisms or processes to provide services. Entrepreneurs are important agents of economic growth, marketing new products, new production methods, new methods of exploration and innovations that stimulate economic activity (Ferreira, 2009).

Schumpeter (1999) considers the innovative role of the entrepreneur as a determinant of economic development. By creating new forms and combinations of the using knowledge and capital, it is the entrepreneur who runs and changes the economic order.

The entrepreneur also has certain behavioral traits and some attitudes that drive his action. For Filion (1999) the entrepreneurial action is based on four key factors: the vision, energy, leadership and relationships within the market. Dornelas (2001) goes further and considers that entrepreneurs are individuals who make a difference. They are people dedicated to work, passionate about what they do, builders of their own destiny, independent, dynamic and determined, with a leadership capabilities above the ordinary. Possessors of knowledge, planning very well every step of a business, who know how to exploit the opportunities, who take calculated risks and create added value for society seeking solutions that improve people's lives.

The entrepreneur has some special characteristics, with differences among them. There are some entrepreneurs who create and manage a business with the main objective to get profit and growth, and others whose main objective is personal promotion (Carland, Hoy, Boulton & Carland, 1984).

The success or failure of the business depends heavily on the competence of the person (Capaldo, Iandoli & Ponsiglione, 2004). An entrepreneur should be a permanent student, have a great capacity to share information, be transparent, have a high propensity to work, take risks and be receptive to error.

According to Ruth (2006), an entrepreneur should be able to do, i.e., to have "management skills". The creative spirit must not be destroyed due to bad financial decisions, wrong investments or defective budgets. Knowing how to make a business plan can be a useful tool for the implementation of projects, but education should not influence their skills, nor change the entrepreneurial intentions of individuals (Graevenitza, Harhoffa & Weberd, 2010).

Miraldes and Garcia (2009) also emphasize this idea, claiming that having good ideas is not enough. An entrepreneur, more than having the capacity to implement his ideas, needs to know who will buy it (identify the target client), check if such target is able to purchase the product, and set the price that will be charged.

The entrepreneur keeps a high level of awareness of the environment in which he lives, using it to detect business opportunities, and should have an attentive attitude towards his surrounding environment. He needs to continually learn, not only about what happens in his environment to detect opportunities, but also about what he does to act properly on a given situation (Filion, 1999).

The impact and the size of the exploited opportunity, which determines its expected value, depend greatly on its characteristics. For example, a cure for lung cancer will have a greater dimension than a solution to the need to create meals in a particular high school (Shane & Venkataraman, 2000). The entrepreneur, by exploring an opportunity, should believe that the expected profit will be sufficient to offset the costs, loss of leisure time, and the associated uncertainty (Kirzner, 1997).

A study conducted by the Statistics Portugal (2007) points out as some of the main motivations for the establishment of new businesses in Portugal, the prospect of making more money, and the desire for new challenges. Most of the new entrepreneurial actions require some funding and support, an issue that has been identified as one of the most significant determinants for the low initiative rates and growth of new companies, both in creation (size of the initial investment) and survival (resources required for business growth in the early years) (Ferrão et al., 2005).

In this study were identified the following research questions:

• Is it possible to exist a TAXI model that reduces CO_2 emissions in Lisbon?

• Is it possible to exist a TAXI model, in Lisbon, that reduces the price paid by passengers?

Methodology

Based on the literature review presented above, we can consider that entrepreneurship becomes somewhat important for any economy. Its value is transversal, both the concept of creating new companies or activities, and in the implementation and development of an innovative concept within the existing companies. The goal remains the same, to introduce in the market something innovative and with added value.

This project also aims to be transversal either in implementing a new "brand" in the market, and in exploring this innovation in the existing structure. The project has the purpose to achieve two main objectives:

• First, the environmental concern that is, try to reduce CO_2 emissions (and other polluting components) in the TAXI network of Lisbon.

• Second, the concern with customers, which is, try to reduce the price paid by passengers using a TAXI.

As the two goals assume a change in the system in place, its implementation can be transversal (changing or creating a new passenger transport system).

Concerning the reduction of gas emissions, the goal involves the change of vehicles (TAXI) currently circulating in Lisbon, by others whose CO_2 emissions are substantially lower.

Concerning the price reduction for the passengers, the goal is based on the substantial reduction in the cost of fuel. The research provides a comparison between different vehicles, those powered by gasoline, Diesel, Liquefied Petroleum Gas (LPG) or Natural Gas, Hybrid and Electric.

This analysis aims to realize to what extent the reduction in the cost of fuel compensates the initial investment, and assess the possibility of reducing the price charged to passengers.

Costs with vehicle maintenance (mechanics, tires, cleaning, etc.) were not taken into account, since all have similar costs, except for the electric car that has an additional cost with batteries.

Therefore, it becomes crucial to develop a detailed analysis of mobility in the city of Lisbon, of the legislation applicable to transportation by TAXI, of pollutant emissions statistics and of the respective protocol policies, which allow us to answer the two research questions listed above.

Results analysis and discussion

In a comparative analysis on the population density in Portugal, we easily conclude that the Lisbon Metropolitan Area (LMA) is without any doubt the area with greatest population concentration (26.4% of national concentration) and largest commuting. It means that LMA is where the daily movements between place of residence and place of work or study are higher.

The city of Lisbon is of course the destination of most commuters, both workers and students (Figure 3).

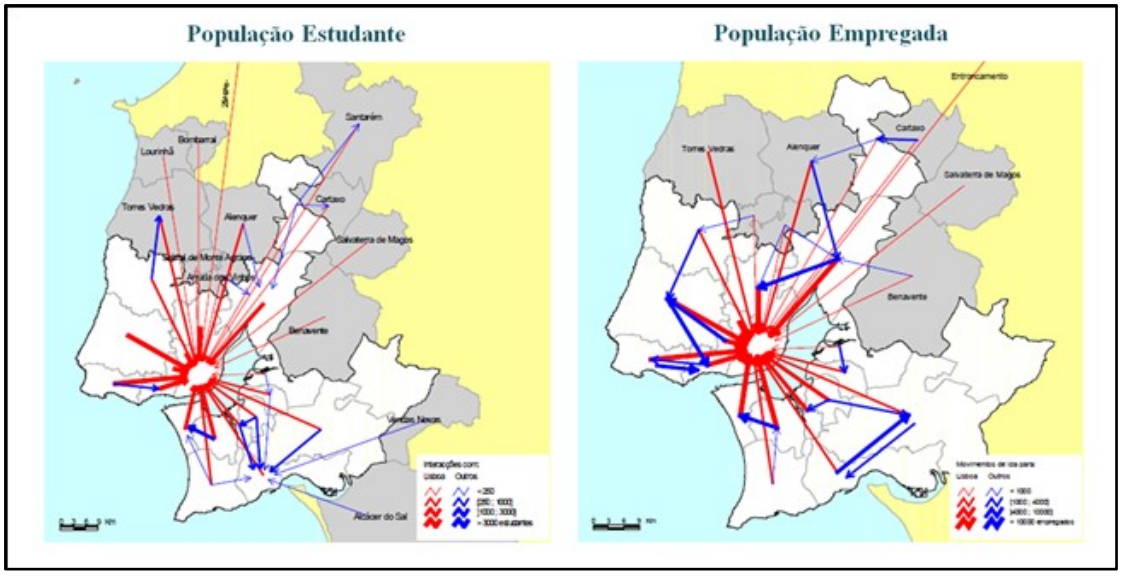

Figure 3: Major student and employed population movements, in the Lisbon Metropolitan Area in 2001
Source: Instituto Nacional de Estatística, 2003

Analyzing in detail the most popular means of transportation, we can see some significant changes comparing the years 1991 and 2001 (Figure 4).

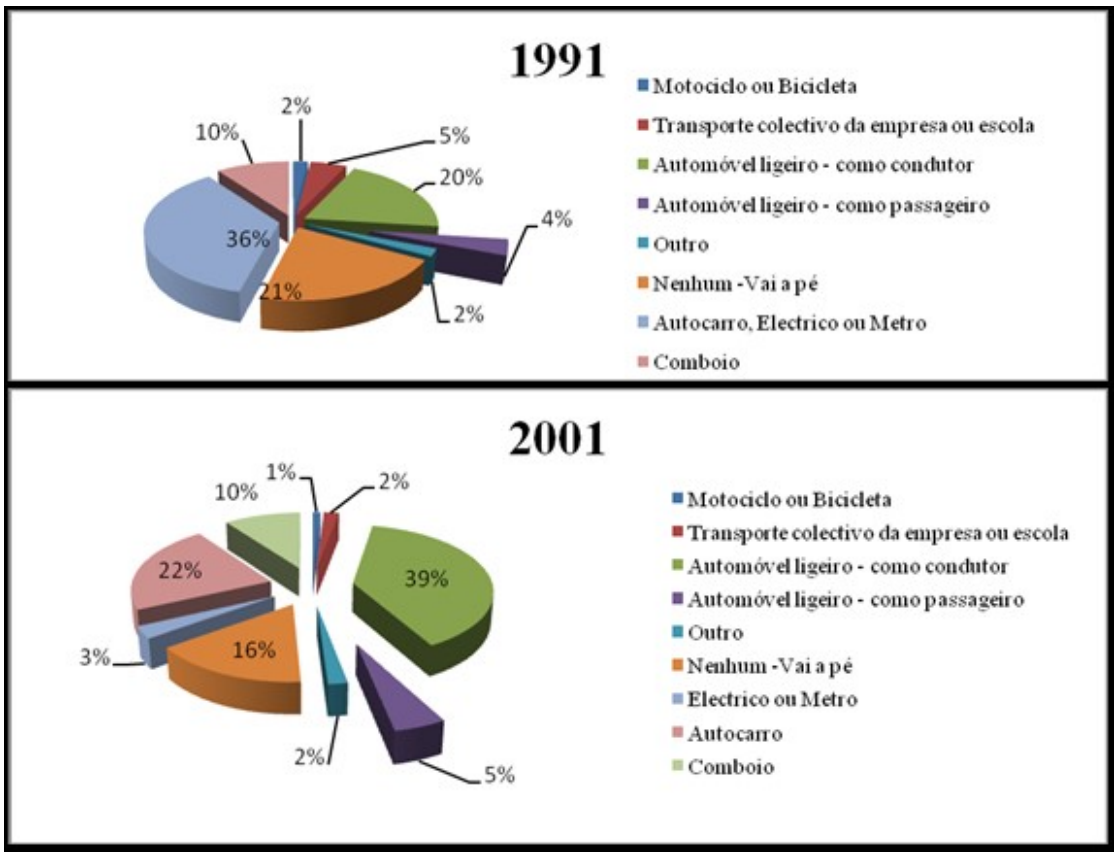

Figure 4: Main modes of transportation used by individual active residents in LMA, 1991 and 2001
Source: Instituto Nacional de Estatística, 2003

The most prominent aspect is the increase in the use of private transportation (passenger car - as a driver) in detriment of using public transportation (bus, tram and subway). Also worth noting, the slight increase in the use of transportation by TAXI (passenger car - as a passenger), although not very significantly.

Under the Framework Directive of Air Quality, stipulated by the European Commission, all Member States shall take measures to ensure that they plans and programs for the "Air Quality Improvement" are developed and implemented in areas where pollutant levels are greater than the limit value (Diário da República, 2007).

For proper compliance with the European and national protocols, the Portuguese State and, in particular, the Lisbon Municipal Council (CML, 2009) have adopted some measures to promote, implement and encourage the reduction of greenhouse gas emissions, such as the commitment, through partnerships with competent authorities, to promote the use of vehicles with clean technology locally (electric vehicles, natural gas, hydrogen and compressed air), with the implementation of charging points for electric vehicles, the commitment to put Portugal as a reference country in the field of sustainable mobility development, and restrictions on the access to certain areas of Lisbon, the so-called Reduced Emissions Zones (REZ).

Features and specifications of the vehicles studied

As mentioned above, the comparative analysis is made with five different vehicles (Gasoline, Diesel, LPG, Hybrid and Electric). The choice of the vehicles was carried out taking into account certain requirements that were identical within vehicles, such as the cost of initial investment (with the exception of the LPG vehicle), factory characteristics, new vehicles (0 kilometers), identical luggage capacity and similar dimensions (with 5 seats). The data collected will form the basis for future conclusions, especially fuel consumption and CO_2 emissions to the atmosphere.

The characteristics and specifications of the vehicles studied are shown in Tables 1 to 5.

Gasoline - Mercedes-Benz B 180 Blue EFFICIENCY	
Features	
Power	122cv / 90kW
CC	1595 cc
Carrying capacity	486 L
Places	5
Investment	
Initial investment	21.524,76 €
Taxes	2.983,44 €
VAT	5.636,89 €
Final price	30.145,09 €
Consumption and CO2 emissions	
Combined consumption	6,2 L/100km
CO2 emissions	138 g/km

Table 1: Gasoline - Mercedes-Benz B 180 Blue EFFICIENCY
Source: Authors

Diesel - Mercedes-Benz B 180 CDI Blue EFFICIENCY	
Features	
Power	109cv / 80kW
CC	1796 cc
Carrying capacity	486 L
Places	5
Investment	
Initial investment	22.327,26 €
Taxes	4.335,41 €
VAT	6.132,41 €
Final price	32.795,08 €
Consumption and CO2 emissions	
Combined consumption	4,6 L/100km
CO2 emissions	115 g/km

Table 2: Diesel - Mercedes-Benz B 180 CDI Blue EFFICIENCY
Source: Authors

LPG - Chevrolet Aveo BI-FUEL 4 Ls 1.2	
Features	
Power	62cv/84kW – 81cv/60kW
CC	1206 cc
Carrying capacity	350 L
Places	5
Investment	
Initial investment	9.481,40 €
Taxes	429,17 €
VAT	2.279,43 €
Final price	12.190,00 €
Consumption and CO2 emissions	
Combined consumption (Gasoline)	5,5 L/100km
Combined consumption (LPG)	7,2 L/100km
CO2 emissions	130 g/km
CO2 emissions	116 g/km

Table 3: LPG - Chevrolet Aveo BI-FUEL 4 Ls 1.2
Source: Authors

We assume that the Chevrolet Aveo will use 90% of LPG fuel, and only 10% gasoline (mainly to start the engine and in emergency situations).

Hybrid - Toyota Prius	
Features	
Power	99cv
CC	1798 cc
Carrying capacity	446 L
Places	5
Investment	
Initial investment	21.649,63 €
Taxes	1.493,15 €
VAT	5.322,84 €
Final price	28.465,62 €
Consumption and CO2 emissions	
Combined consumption (Gasoline)	3,9 L/100km
Electric consumption	Auto Recarregável
CO2 emissions	89 g/km
CO2 emissions (electric)	0 g/km

Table 4: Hybrid - Toyota Prius
Source: Authors

Electric - Nissan LEAF	
Features	
Power	80kW
CC	-
Carrying capacity	330 Litros
Places	5
Investment	
Initial investment	29.260,16 €
Taxes	0 €
VAT	6.729,84 €
Final price	35.990,00 €
Consumption and CO2 emissions	
Electric consumption	24 kWh
Autonomy	175 Km
CO2 emissions (electric)	0 g/km
CO2 emissions (indirect)	1,687 g/km

Table 5: Electric - Nissan LEAF
Source: Authors

It is estimated that the batteries installed in the electric vehicle has a life span (100%) of 5 years or 160,000 km. After reaching that number, the battery only reaches a loading capacity and autonomy of 80% of the original.

A Taxi, in a concrete definition of the word, means “A car that carries passengers to a place for an amount of money that is based on the distance traveled” (Merriam-Webster’s online dictionary [online], 2016). It is a public mean of passenger

transportation, and is equipped with a taximeter that calculates and charges the traveled distance, and the time of occupation of a vehicle.

The operation of a TAXI service has some tax benefits in the replacement of old vehicles for new ones, either at the time of purchase or in the circulation tax.

Therefore, we can calculate the purchase price of new cars intended to perform TAXI service (Table 6).

	Gasoline	Diesel	LPG	Hybrid	Electric
Normal	30.145,09€	32.795,08€	12.190,00€	28.465,62€	35.990,00€
TAXI	27.576,34€	29.062,30€	11.662,12€	26.629,04€	35.990,00€

Table 6: Acquisition Cost Differences
Source: Authors

Taxi transport in the city of Lisbon

In order to compare the different costs of fuel (gasoline, diesel and LPG) of TAXI vehicles in Lisbon, an average of the prices in the last quarter of 2013 was made. Concerning the cost of electricity the tariff in the simple regime of EDP for 2013 has been taken into account. The collected data were:

Gasoline 95 to 1.563 € / L

Diesel - € 1.439 / L

LPG - € 0.785 / L - The calculation took into account the spending of 90% in LPG system and 10% in the gasoline regime.

Hybrid - € 1.563 / L (referring to the price of gasoline 95).

Electric - € 0.1679 / kWh - Amount corresponding to the tariff of electricity in 2013 (€ 0.1365 + VAT 23% per kWh).

A study conducted by the Institute of Mobility and Land Transport (IMTT) (Instituto da Mobilidade e dos Transportes Terrestres, 2006) weighting the number of TAXI by the working days in a week, concluded that there is an average daily supply (vehicles in circulation) of about 3100 vehicles in the city of Lisbon.

Tables 7 to 10 discriminates some relevant data for later comparison. All data was taken from the same study on the conditions of transportation in TAXI in Lisbon, prepared by IMTT. Also, note that some data have been updated for purposes of comparison.

Number of vehicles	3.103
Kms traveled/year	235.028.694
Kms traveled year/by TAXI	75.743
Kms traveled/day	643.914
Kms traveled day/by TAXI	208

Table 7: Kilometers travelled (totals)
Source: adapted from IMTT, 2006

	2005	2011 (Updated data)
Liters consumed/year	18.507.515	18.507.515
Fuel expenses/year (€)	17.378.557	26.632.314

Table 8: Total consumption
Source: adapted from IMTT, 2006

NOx	235
Particles and hydrocarbons	24
CO	118
CO_2	49.600
NOx – 1gr / Km	
Particles and hydrocarbons – 0,1 gr / Km	
CO – 0,5 gr /Km	
CO_2 – liters consumed * 2,68 = Kg	

Table 9: Gas emissions (Ton. / Year)
Source: adapted from IMTT, 2006

Services/day (weighted average)	16
Service hours number (weighted average)	17

Table 10: Daily service hours
Source: adapted from IMTT, 2006

CO_2 emissions comparison

The computed values presented in Table 11, result from the combination of CO_2 emission values (depending on the specifications of the models presented above), the number of kilometers/year traveled by a TAXI vehicle, and the total of 3103 cars. The analysis should be done separately, assuming that all TAXI vehicles use the same type of fuel.

	CO_2 emissions by TAXI	CO_2 emissions from 3103 TAXIS
Current values	16 ton.	49.600 ton.
Gasoline	10,5 ton.	32.510 ton.
Diesel	8,7 ton.	27.091,67 ton.
LPG (combined) (1)	8,91 ton.	27.657,06 ton.
Hybrid	6,76 ton.	20.966,60 ton.
Electric (2)	0,13 ton.	397,39 ton.

Table 11: CO2 emissions estimate of TAXI vehicles in a year (ton.)
Source: adapted from IMTT, 2006

(1) – Combined values of CO2 emissions (10% related to Gasoline and 90% to LPG).
(2) – CO2 emission values in the production of electricity by EDP (2006 values), since the car itself does not produce any polluting gas.

Fuel cost comparison

Table 12 displays the liters consumed and the cost of the different types of fuel. The "current values", referred to in the table, take into account the consumption close to 8 liters per 100 km, representative of the majority of the current TAXI fleet. The values computed in vehicles powered by LPG/Gasoline refer to the use of 90% LPG and 10% gasoline used mainly at the start and in case of emergency. The computation for the vehicle powered exclusively by electricity is based on the kWh necessary to travel 208 km.

	Kms/day	Fuel spent (day)	Daily cost	Annual cost
Current values	208	16,34 Litros	23,51 €	8.581,39 €
Gasoline	208	15,81 Litros	24,70 €	9.016,61 €
Diesel	208	9,57 Litros	13,77 €	5.024,64 €.
LPG/Gasoline	208	14,98 / 11,44 Litros	12,37 €	4.514,42 €
Hybrid	208	8,11 Litros	12,68 €	4.626,94 €
Electric	208	28,5 kWh	4,79 €	1.748,10 €

Table 12: Annual cost of fuel comparison
Source: Authors

Table 13 shows that annual savings are considerable in case the vehicle is powered by electricity, about 80% less than what is currently spent. Out of curiosity, and in the possibility of replacement of an old Diesel vehicle with a newer range, we see a possible reduction of 46% in fuel spending.

	Annual fuel cost	Possible annual savings
Current values	8.581,39 €	
Gasoline	9.016,61 €	(435,22 €)
Diesel	5.024,64 €.	3.556,74 €
LPG/Gasoline	4.514,42 €	4.066, 97 €
Hybrid	4.626,94 €	3.954,44 €
Electric	1.748,10 €	6.833,28 €

Table 13: Possible savings with fuel
Source: Authors

Considering the number of services per day (on average), coupled with the number of kilometers traveled on each trip, and using the price list stipulated by law, we easily calculate the value gained in passenger transportation (Table 14).

Number of trips per day	16
Estimated Kms per trip	13,00 kms
Price charged per trip (1)	7,75 €
Total revenue per day	124 €
Total revenue per year	45,260 €

Table 14: Gross Revenue by TAXI
Source: Authors
(1) – Value calculated according to the Tariff System TAXI 2013

Taking into account the values calculated in Table 14 we can determine the annual balance of the TAXI services (Table 15).

	Fuel expense	Revenue	Annual profit
Current values	8.581,39 €	45.260,00 €	39.659,43 €
Gasoline	9.016,61 €	45.260,00 €	36.243,39 €
Diesel	5.024,64 €	45.260,00 €	40.235,36 €
LPG/Gasoline	4.514,42 €	45.260,00 €	40.745,58 €
Hybrid	4.626,94 €	45.260,00 €	40.633,06 €
Electric	1.748,10 €	45.260,00 €	43.511,90 €

Table 15: Annual balance between expenditure and revenue (by TAXI)
Source: Authors

Final considerations

Table 16 shows the required number of trips and working days to recover the investment made in the acquisition of any type of vehicle.

	Number of trips required	Number of working days
Current values	3.558	222
Gasoline	3.750	234
Diesel	1.505	94
LPG/Gasoline	3.436	215
Hybrid	3.669	229

Table 16: Number of days required to recover the initial investment
Source: Authors

Transportation in an electric vehicle is the alternative that may offer greater advantages with certain costs. Despite showing some noticeable drawbacks, focusing on this type of mobility can become quite plausible. The disadvantages are primarily based on the low autonomy of the vehicle, which requires replenishment more than once per day.

After obtaining the analyzed results, we can see that there are no major differences in the acquisition price of new vehicles for the TAXI service, with the exception of the LPG vehicle. In fact, the return on investment of a LPG vehicle is much faster compared to others, whose time required recovering the acquisition investment is quite identical.

Concerning the cost of fuel, we find that the electric vehicle is advantageous when compared to the other vehicles examined. Despite having a slightly higher acquisition cost and an additional cost with battery replacement (after traveled 160,000 kilometers or after 5 years), the charging cost is quite advantageous.

While we can conclude that the idea of electric TAXI vehicles would be a good solution for Lisbon, there may still be some significant obstacles, namely the lack of charging infrastructures. Additionally, it may still be premature to bet on this technology, as it is quite recent and there are still no guarantees of reliability for a service as demanding as TAXI.

Collected data show that replacing the existing fleet with a newer fleet (same range) substantially reduces the costs of fuel and CO_2 emissions. Disregarding the electric vehicle, the hybrid vehicle is the offering better in reducing the costs of fuel and CO_2 emissions. The LPG vehicle can also be taken into account, as its acquisition price is much lower compared to others.

Conclusions and recommendations

After completion of this project we can draw some conclusions regarding the objectives proposed initially, being able to state that:

• Entrepreneurship can be a solution and a strong booster of the Portuguese economy, especially in times of crisis;

• There is a clear intention of the Portuguese Government and in particular of the Lisbon Municipal Council, to reduce greenhouse gas emissions. The laws and protocols already approved somehow limit the use of more polluting vehicles;

• In a TAXI service, costs associated with fuel can become less bearable, taking into account the means available today (vehicles that consume 8L/100km);

• The TAXI service in electric vehicles may be a plausible solution, although it may have some reservations, particularly with the implementation costs of charging infrastructures;

• The concept of electric TAXI can still offer some resistance in its implementation, so that hybrid vehicles can be a good option (considering consumption and CO_2 emissions), without major structural changes;

• The scenario of price reduction for passengers only becomes feasible amending current legislation (legal requirement), or being a transportation company other than TAXI (without State intervention) and necessarily giving up the associated advantages (e.g.: circulation in exclusive "bus" lanes).

To conclude, and in response to the first research question, we can say that there are TAXI models (those running on LPG, the hybrid and the electric models) that reduce CO_2 emissions in Lisbon.

In response to the second research question, we can also say that there is a TAXI model (that powered by electricity) that can decrease the price paid by passengers.

As a final recommendation, based upon data presented above, we can say that the choice of electric vehicles is the one that will best serve both the environment because it yields zero CO_2 emissions, and the consumer because it is the only one whose annual fuel cost will allow to reduce the price paid by passengers.

However, as we are dealing with a new technology, there are several restrictions that prevent its immediate adoption, the main one being the short battery life, (vehicle autonomy), which would always imply more than one daily charge. Moreover, as there are still no charging infrastructures across the country, trips out of the Lisbon area would be very problematic, or even impossible.

As a proposal for future studies, including the analysis of costs considered to be constant in this project (for example, staff costs, maintenance costs and the evolution of energy prices) will enrich the approach and allow greater detail, thus a conclusion based on a higher number of data and information.

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