

**Urban mobility and carsharing: Trends and threats on consumer behavior**

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*I want to thank family for their support, even moral and economic, for making me reach my objectives.*

*To my classmates and friends who made me enjoy this new experience and offer me their help.*

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## 1. Abstract

This research thesis tries to answer to one of the most concerning problems a great part of the world is facing: the sustainable mobility. Using the data collected by field studies, solutions are searched to provide a new way of mobility that doesn't harm the environment and aims for benefits of public and private enterprises and individuals.

The results determine the possible alternatives like carsharing services in order to minimize the actual problems and how this concern to the local administration policies regulated and how sharing economies start to have a significant cooperative role in day-to-day.

**Key words: environment, mobility, demographics, pollution, carsharing, consumer behavior, government policies.**

## 2. Introduction

During all my academical formation, I have been wondering multiple issues that concerned me about the company's evolution in a changing environment. There are major issues of how companies are able to earn and scale profit in a market where customer needs change every day and where new concepts appear with their development in the indicated market.

This dissertation drives to understand the concept of marketing that Philip Kotler has been analyzing trough years, marketers' objectives have been changing between ages. First, the idea was that companies were able to reach the « need » the customers had, and they will provide that desired item to customers. *“Marketing 1.0 is noted for reaching clients' minds”, (Kotler)* Companies just had to develop and create a new product and probably a huge number of potential customers would have bought it. *“1.0 companies do a good job, offer good quality products to people and generate earnings”. (Kotler)*. Those are the trends when a market that is not collapsed, but when competitors start to arrive and the market matures, marketers considered that they should have to study the customer needs deeper.

Companies can define and analyze their client databases in order to know them better. “Through these they study consumer behaviors and preferences in order to give them the best service possible.” (Kotler). Currently, selling products doesn't aim to sell products just in the best way possible but it also « to make the world a better place ». “Marketing is providing: product, service and value.” (Kotler). Marketers should preview most of customers wants before launching a new product/service.

During this abbreviation, there is where my point of research is directly focused on. There's a lot of market trends that suggest that new business models will recur to sharing economies and specially one sector has already started to move forward to it: The mobility. Nowadays, society is more and more concerned about the impact

of human footprint caused by actual means of transport and economic scenario. Governments start to act, citizens take good habits in order to reduce the waste and the most important concern: air pollution.

Air pollution is a major cause of premature death and disease and is the single largest environmental health risk in Europe (Lim et al., 2012; WHO, 2014, 2016a; GBD 2016 Risk Factors Collaborators, 2017; HEI, 2018), causing around 400 000 premature deaths per year. Governments and customers act on that, so marketers know that promoting corporate actions can develop their reputation.

The Corporate Social Responsibility (CSR) is the area where marketers are adopting measures to soft the effects caused by the manufacture and usage of the products. For example, Ford Motor Company, whose CSR compromise is to offer 13 models of electrical vehicles (EV) by 2020, already has developed an engine called "Ecoboost" focused on the effort of reducing GHG (greenhouse gases) emissions in all their dealerships in North-America use sail and solar PV systems as their principal energy source.

With this, it is clear that nowadays society concerns not just to obtain the product that will satisfy their needs. In this particular dissertation, mobility has been through an important revolution following the main: « Freedom of mobility » since petrol-powered vehicles won the war against electrical vehicles during the Industrial revolution and the mass production of these assets started to come out.

With this, main manufacturers designed their products trying to show comfort, design, brand status-quo and a long etcetera.

The matter now is that there a large number of vehicles in our streets. So that, this drives to traffic congestions that worsens the flexibility of mobility that these assets show.

Furthermore, the system has been focused in individual mobility, that is based on fossil fuels like petrol, which impacts on the atmosphere and is not sustainable for the environment.

For example, the oil spills, that occur frequently, cause irreparable harm to the oceans and cleanup tasks of these spills is very difficult and can take years to complete. However, the loss of marine life and the impact on animal and human health cannot easily be reversed.

Therewith, governments and local administrations take actions in this area trying to avoid high pollutant vehicles in the cities, like restricting the allowance of cars when anticyclonic weather conditions are given or aiming to renew the vehicular park and promoting the sales of hybrids and electrical vehicles (EV) with economical subsidies. EV technology is newer so more expensive than the conventional ones due to it is less introduced to mass production, so there's not a consistent escalation in costs for producers.

As well as there that technology is getting introduced into our every-day life's there's a large list of inconveniences in the present time: the higher cost compared with other technologies. One of the most successful alternatives that just appeared in the market in the recent years is the concept of "carsharing". With this, companies and individuals are facing the costly investments and most part of individuals can afford the usage, that it could be impossible if the investment was done individually.

All things considered, it is clear that public and private companies should be aware of what is going on in the actual market so that they can be able to react to furious competition they are going through.

After this short introduction to the research subject, the research question that this research has the aim to solve is: How costumers react by adapting to the use of new trending ways of mobility as carsharing services?



The paper begins with the explanation of sharing economies. This is followed by an explanation applied to “carsharing” services and the factors that aim this practice to become spread, in which analysis is based, basically giving an explanation about the problematics about actual transportation.

The remainder of the paper focus on the customer response to carsharing service usage focused in an experiment driven by a private corporate that offered a car-sharing fleet to their employees located between the different established head offices in 5 French cities. A survey was launched to see the user perceptions and figure it out the main worries that aim customers whether to use the service or not. Moreover, it includes the reaction on carsharing service usage to a « natural » experiment that was aimed by a public transportation outrage in the city of Toronto.

The study concludes with reflections on the simultaneous fissures and endurance of automobility produced by car sharing, and the opportunities for further practices that companies apply to the personal use.

### 3. Literature review/theoretical framework

#### 3.1. Concept

Sharing is a term which covers a large dynamic and diverse set of activities. There is, for example, a variety of items that are shared in our everyday life's: objects shared, including vehicles, houses, machinery and departments, and shared economies are based through a large list of business models, including practices like peer-to-peer, for profit or joint-ventures. (Dowling, Mallsen, Jennifer L.Kent, 2006)

This diversity in sharing practices and items is embraced by the range of disciplinary and theoretical perspectives through which they are understood. These include marketing (Belk, 2010), political economy (Martin, 2016) computer science and sociology (Coleman, 2013).

The concept of "car sharing", is based on the "shared use of an object, as in this case a car, made from a metal bodyshell, technology and powered by fossil fuels (most of these) in an indirect relationship with other objects"(Hodder's, 2012) such as the infrastructures of a country (roads, bridges, etc.), gasoline, parking spaces and so on. This practice has been benefited from shared economies, which with the computer revolution have been brought to digitization, such as an object dependent on a code that accomplishes its function (transporting people from point "A" to another point "B") that is followed by the "process of accommodation" (Grosz, 2005) As Grosz described for the "material realm" that carsharing has:

*"life" of its own, characteristics of its own, which we must incorporate into our activities in order to be effective, rather than simply understanding, regulating, and neutralizing it from the outside. We need to accommodate things more than they accommodate us.'* Grosz (2005: 132)

Also, the carsharing is appeared as a symptom of the reconstruction of automobility. “Automobility is an autonomous, self-contained, non-linear system that extends all over the world, including cars, drivers, roads, petrol stations and many objects, as well as new technologies and signals.” (Urry, 2004)

Mobility is also related with several factors that approach it and they could help to define the ideal future of this system. This paper focuses on demography, economy and environmental protection as the main transcendental issues of the development of the mobility.

### **3.2. Factors**

#### **3.2.1. Demographic factors.**

Global population is expected to have an “increase in life expectancy” due to the “movement towards and active and healthy lifestyles” (Krzyzanowski, Kuna-Dibbert, and Schneider, 2005). This tendency is an essential dynamic for European societies (Eurostat 2015; World Health organization and the World Bank 2011). The expectations with mobility and logistics are a difficult issue to be sealed due to car driver’s population is likely to grow. On these, a more active mobility will come from those who will stay or move back to crowded urban areas. As a consequence, this will affect goods and services supply chain either in urban areas or rural areas, where the higher cost of mobility for elder population will be demanded. (Anderton et al.2015;Velaga, Beercroft, and Nelson 2012).

Another consideration to be taken in mind is the “migration long-distance flows”. These develops concrete patterns in the demand of transportability of good and persons between the countries where the migrants come from. (Asylum Statistic-Statics Explained 2014; Vasileva 2009).

Over the years, the means of transport used, the reasons for the journeys and their timetables, among other variables, are depending on certain social conditioning factors (Lucas, 2001). In this point, the importance of access to daily activities is underlined as it embraces different social groups.

Mobility models are subject to certain social characteristics such as the “incorporation of an individual into a social group, family structure and income level”. Kaufmann (2006) affirmed the existence of a link between the different models of mobility and lifestyles based on urban territories.

Related with these models, the classification starts between “central cities, metropolitan areas and suburban areas”. Cebollada (2006) makes a distinction between the “morphological characteristics and the supply of public transport”. For this, certain mobility trends are directly related with the geographical area.

Regarding the social structure, collective membership is an element to be taken into consideration in terms of the differentiation between mobility models, although these are defined on the basis of the objectives of each case under study.

Certain social sciences, such as geography, have shown an unequal interest in the study of the mobility patterns of the different groups since most of their studies are based on women, young people and the immigrant population.

As for the women's group, it is stated that there are “different roles attributed according to gender” (Sabaté et al., 1995) and with-it different models of mobility. On the one hand, while “women make more displacements near-by and tend to walk more and use collective transport”, in addition to having motives “closer to the domestic scenarios”.

On the other part, “men are used to travel farther”, use private transport and their “motives are more related to the work scenario”.

Apart from that, “young people form a group with different mobility patterns” derived from the use of alternative means to the car and the gradual process of access to its use is interpreted at the same time as its incorporation into the world of adults (Cebollada, 2008). An important emphasis is placed on the way young people moves, as this focuses on the “possibility of access to urban goods and services”, both during the day and at night (depending on their leisure activities).

The Joseph Rowntree Foundation has carried out studies in this sense and among them it is observed that, in the United Kingdom, the consequences in the levels of accessibility for the different activities and services of young people with little availability of car use, especially in the peripheral areas (Lucas et al., 2001). In other countries, the difficulties of young people access to certain job positions in industrial areas of activities such as training activities were highlighted.

The third group highlighted in the interest of social research is immigrants, especially those from third world countries. Studies done on mobility of this group remarks on “socio-cultural and linguistic barriers”, which act against them when they obtain a driving license that allows them “access to the daily use of the private vehicle”. With this, these populations “tend to settle in the central spaces of metropolitan areas with a high supply of public transport” and the difficulties of this group to access urban goods and services, “emphasizing the situation of being an immigrant and a woman” (Lucas et al., 2001).

As well as the relations with activities of the members of a household can indicate us the strategies that these follow to arrive at their place of work, study, purchases or leisure. Complying with different mobility needs, all of them interrelated. Recent guidelines have been provided with data on the mobility of “single men from those with families and from different types of families”. (García Palomares, 2008).

The establishment of mobility strategies within a domestic unit leads to changes in the supply of transport, modifying the behavior not only of the individual who will use

the new means of transport but also of the whole domestic unit. This has a “direct impact on mobility and transport policies”. (Carme Miralles-Guascgh, 2008)

Otherwise, the relations within the activities of the members of a household can indicate us the “strategies that these follow to arrive at their place of work, study, purchases or leisure”. Complying with different mobility needs, all of them interrelated (García Palomares, 2008).

Policies applied are guided towards the “inclusion of the “vulnerable groups” with the aim of giving “complete access to everyone in terms of transport”. (Martens 2012). Otherwise, the “digitalization of the new mobility is tending to create a new kind of exclusion, those who do not own a smartphone”. (Pauzié 2013).

### **3.2.2. Economic factors.**

Global economies deal with an important role shaping the demand of the mobility. There are some trends that there are clearly identified: “European GDP population should grow much slower than the rest of the world in average”. This will be directly consequence with an “increase of flows, mostly freights, that in Europe will drive to modified freight flows.” (ITF Transport Outlook 2017, 2017)

At individual level, economic growth usually turns into more mobility, as observed in the growth of tourism. (“Share of the European economy in a World GDP declines” (Bassanini and Reviglio 2011).

Another shift to take in consideration is the restructuration of working organization. “Working from home and partial work” should take a further position in the future. This affects mobility in a “reduction in rush hour traffic”. This reduction will drive to another kind of trips with other purposes far from commuting to work. Another consequence is the growing “demand of more flexible tickets of public transport”. (Jackson and Victor 2011; Bernardino, Vieira, and Garcia 2013)

Most countries base their economic growth on the aim to increase per capita income in order to eliminate poverty. For this, they use the resources of the environment.

Poverty eradication is a special feature of sustainable environmental development. First, “half of the population currently lives in rural areas depends on limited natural resources”. Second, the “income is another variable that conditions the movement of citizens”. It is considered that there is a direct relationship between the level of income and the possibilities of moving around with mechanical transport, while “low incomes reduce the space of the households” (Mendizábal, 1996).

An investigation that relates income, mobility and labor exclusion, confirms mobility as one of the “unattainable resources for certain groups”.

The impact of mobility is often seen as a “factor of unemployment” (Sánchez, 2004) and an element that hinders the search for work and restitutes the scope of the labor market (SEU, 2003, Cebollada, 2008).

Income also influences in the place of residence, so the “quality of public transport is a variable of urban land income” (Miralles, 1997). Thus, “areas with a less developed transport network have lower housing prices than in other areas with similar characteristics”.

A study (Avellaneda, 2007) exposed a case in Latin America where low-income families who live in miserable conditions in the old quarters of cities and are reluctant to move to places in better sanitary conditions (even offered by public institutions) located in the peripheral areas “alleging that in the center of cities it is not necessary to make large journeys to access goods and services”.

Moreover, Motorization indices are also related to income, indicating that “low-income groups have less possibility of using a car”, in the Metropolitan Region of Barcelona (Spain) it is observed that municipalities with lower income levels have the lowest level of registered vehicles (Cervero et al., 2002).

With this, the relationship between income and mobility, with a restriction of access to goods and services can be read as a “limitation of the right to the city” (Cass et al., 2005).

### **3.2.3. Environmental protection factors.**

The impact of the means of transport it can be divided in two effects with a broad difference. Disputations divide the impact effects of each ones (AAE, 2005), that we can classify in “mechanic”(private and collective) and “no mechanic” (on foot and bicycles).

These last ones have an insignificant effect if we compare them to the first ones, who are the “main responsible of the energy consummation, atmospheric, acoustic pollution and the fragmentation and occupation of the territory” (Maddison et al. 1996). “Transports sector” is one of responsible of the major energy consumption that with a global focus can reach the “50% of the total energy consumed”. (CIC-CyP,2003). After the plane, “road transport is the one which more energy consumes”. From this point of view, the “less efficient means of transport is the private vehicle, especially those with larger engines”.

Furthermore, the great part of the energy needed comes from non-renewable resources, as well as fossil fuels derived from petrol and this dependence is expected to increase in the future with a growth in global energy consumption of 2% per year. Likewise, the “pollutant gas emissions that directly come from the private vehicles represent the 44,5%” of all the emissions caused by the means of transport, “far away from the ones generated by bus (6,2%) and the train (1,5%)” (IPCC, 2008).



Considering the acoustic pollution, “road traffic is the principal source in European cities” (80%). The “rising motorization of the cities drives to more surface employment to build various infrastructures” that allow the flow of vehicles. Between 1990 and 1998, in the European Union (UE), more than 30.000 ha (hectares) of ground classified for agricultural use were used to build diverse road infrastructures, especially for highways construction. (AAE, 2001). They also interrupt other flows (movements of flora and fauna).

There are also interruptions in natural dynamics and flows, as these “infrastructures become barriers” (both due to their physical impact and the intensity of traffic) and “interrupt the movement and propagation of species”, mostly affecting fauna (AAE, 2001).

There are other factors in addition to those already referenced in terms of environmental aspects, such as sustainability, as in the case of socio-territorial variables, these are interpreted with the “costs derived from mobility and transport, as the effect it has on climate change”. These costs go beyond the economic costs (as it would be named by the neoclassic intellectuals), there are also social and “environmental costs”. (Whitelegg, 1997). The economic costs include both direct (fuel, repairs) and indirect (depreciation of vehicles, taxes, etc.) operating costs.

Regarding the social costs, all those that affect society are taken into consideration, such as “traffic accidents, the loss of the ability of the child and elderly population to travel and the restriction of users to a certain public space and time used”. (EEA, 2005)

To face with these costs, there are different factors to take consideration. First, most of them are encouraged by policies and other related to the management of the climate change consequences. (EEA, 2005)

In order to raise awareness about environmental protection, strict regulations are taken. Mobility has a huge impact on the environment and this is confronted by the

administration with the application of strategic policy goals looking forward to the decarbonization (Pachauri and Meyer 2014; Anderton et al.2015).

Economies are focusing in adapting to the context in the main of “sustainable consumption” culture. The proliferation of this new way of thinking bring either citizens and companies to apply social and environmental rules and approaches as: “corporate responsibility (RSC), circular economy and life cycle assessment”. (Petersen et al. 2009).

These elements are required for the management of logistics as well as it concerns to the “channels of food consumption that need short supply chains” (Blanke and Brudick 2005; Coley, Howard and Winter; 2009; Miesterling, Samaras and Schweiver 2009; Kulak et al. 2015; Dablanc et al. 2016).

From the energy supply factors, policy goals support a “movement towards energy efficiency and renewable energies” and end up depending on fossil fuels (European Commission 2011; Harrison 2013).

The dependence of this limited material is expected to be placed by biofuels and more electricity production. (Pachauri and Meyer 2014).

To sum up, there is a straight evidence that proves that the “impact of the transport on the climate change is direct and significant”. Extreme weather worsens transportation systems of road, rail and aviation. (Doll, Klug and Enei 2014). One advantage considered would be the “North-West passage for freight between Europe and Asia due to global warming” (Anderteton et al.2015).

To face this, empirical evidence is provided in this dissertation in order to prove that carsharing services could be an intermediate solution to some of the factors described.

#### 4. Methodology/empirical study: quantitative analysis

This dissertation uses the concept of *carsharing*, as it can be defined when of a “single car is used by several individuals”. This concept differs with *carpooling*, “where several persons use the same car at the same time”. Carsharing offers the ability to benefit from the usage of a private car without facing all the inconvenient. (Sylvain Fleury et al, 2016)

Concerning the cost of personal car usage, some studies (*e.g. Attali & Wilhite, 2001; Tuan Seik, 2000*) show that “carsharing is less expensive that private car usage”. Using this way of transport also derivates with “shorter-distances traveled with personal vehicle”, causing a double effect.

Other issue to have in consideration is that carsharing has the “ability to substitute between 1 and 6.5 personal cars in average terms” (Millard-Ball, 2005). Carsharing usage is also related with the “less frequency of trips driven by impulses” (Zheng et al. 2009), this concept makes the users “increase awareness of conscience of the cost per journey and the consequent planification”.

Several studies were conducted in Singapore and California showing that in the first area the carsharing user profiles were ranged by the majority of middle-income married men, aged between 30-39 years, living in household averages size 4.2 persons.

In the second area considered for the study, the average was 37.7 years in average and the average household of 2.02 people. (Millard-Ball, 2005)

The demographic effect was consolidated with the files due to the study was based in a major majority of woman asked in the second survey and that the study was conducted between the university staff of a university in California. With this, it is shown that the data is different in terms of “commuting distance and gender” (more women were the car-sharers) (Zhou, 2012). The only factor that remained considerably constant was the age.

Potential “market niches” were highlighted for “special communities”, like university users, and that early adopters of car-sharing use (30%) gave up private car usage looking for a combination of this main and combined public transport. (Shaheen, 2001)

On psychological aspects a study (Schaefers 2013) revealed that car-sharing users are driven by “value seeking” (economies), “commodity” (ease-to-use), “lifestyle” (pleasure of driving that particular car) and “environment” (friendliness of the service). Farther studies (Shaheen & Rodier 2005) revealed three trends. First, car-sharing “adapters aim to take new adventures”. Second, “they don’t considerate their own vehicle a difficulty”. Third, they are “aware with the environment”.

The most influential non-psychological factor found was the “difficulty to park between the user residence and the workplace”. The following one, is the distance of the location that they could manage to leave the car. The principal criteria is the “ease to use”.

Another factor beyond distance that has been taken into consideration is flexibility (Shaheen, 2001). The strategy proposed by the author is to reduce the cost of the system, which could be replaced by a propulsion of alternative fuels of carsharing fleets and tax incentives.

Another author (Zhou, 2012) compared different communities of car sharing and was able to prove that the usage was significantly higher in universities than in other scenarios where incentives were shown, such as an offer for 8 hours of free parking in a campus area.

Shaheen and Novick (2006) analyzed what makes carsharing users use the system and in a longitudinal study found that the final intention of users to use the service was 33%, but 78% of them had also driven the vehicles or watched a video.

After the study, it could be shown that “user satisfaction showed high values of customer satisfaction”, “more than 60% of users said they were very satisfied”, “60% with refueling and 44% with the reservation and booking system”. The biggest “inconvenience observed was insurance coverage”, followed by the “fear of sharing a car”. According to their interviews this “fear” can be contrasted through the “establishment of a system of ratings and feedback”. (Shaheen, Mallery and Kingsley, 2012)

All these studies are related among consumers but he did not find any relevant about the companies.

Corporate carsharing refers to the “use of a fleet of vehicles belonging to a company that can be used by employees for their business trips”(Schröder & Wolf, in press). In this case, financial considerations become more relevant as in this case the users (employees) would not pay for the usage of the service.

The change of conception of carsharing can be changed through the “proliferation of campaigns” about the practice (Schröder and Wolf). The paper also focused on the psychological factors that determines the use of carsharing, adding the factor of “environmental friendliness” as one of the principal’s “eco-friendly” factors to intervene with people behavior (Schröder & Wolf, in press). The service of car-sharing service already existed in the analyzed company but it was not available for all the employees.

#### **4.1. Acceptability models and UTAUT (Unified Theory of Acceptance and Use of Technology) vs the TAM (Technology Acceptance Model)**

Some theoretical models have been developed to describe the acceptance of technology and its determinants. (Davis, 1989; Davis, Bagozzi & Warshaw, 1989)

Current use can be predicted by measures of intended use as well as measures of “perceived usefulness” and “ease of use”. (Henderson & Divett, 2003)

The TAM (Technology acceptance Model, Davis, 1989) summarizes the links between received utility, perceived ease of use, and intended use but this model has been criticized for years because it does not consider social or organizational variables like social influence and facilitating conditions.

Social influence refers to the “degree to which individuals think they can use the system while respecting their social group norms whilst giving a positive image of themselves”. Facilitating conditions refers to the “degree with which individuals think they are provided with a favorable context and the resources they need to help them use the system. The UTAUT included “moderating factors relating to the individuals features and their past experiences like sex, age, experience, volutariness of use”.

It has also been proved that “TAM wasn’t powerful enough to explain significant part of the variable intentions to use, whereas UTAUT explains a 70% of the variance”. (Venkatesh et al. 2003)

With this, “UTAUT appears to be a solid theoretical framework to access to the physical determinants to use innovations”. (Venkatesh et al. 2003)

#### **4.2. The goal of the present study**

The goals of the present study were to “analyze the regression weight of the UTAUT applied to corporate carsharing and to study the role of environmental friendless in the intentions use of the service”. (Sylvain Fleury et al, 2016).

#### **4.3. The method.**

A questionnaire was sent to 2504 employees of a telecommunications company using a carsharing service in France, this company was chosen because it has a large sample with the same structure.

The fleet consisted of “100 vehicles spread over two regions (Brittany and Ile de France) in France, namely 5 cities: Paris, Saint-Denis, Arcueil, Lannion and Rennes”.

Of the “2504 respondents, 259 responded to the questionnaire (80% male and 20% female), representing a 10.3% response rate. The survey covered ages from 21 years to 65% and the average age 47.5 years. Of the total, 228 were users of the service”.

For this experiment, the “surveys were sent by e-mail, in which no reminder was sent and the users were not obliged to use the service either”. The other alternatives taken into consideration were that “employees could access an assigned vehicle”. Some incentives for this experiment were applied, such as the fact that “employees could access fleet vehicles any day, any hour and with no mileage limit”. Once the user has finished his trip, another user can use the same car.

“Respondents claimed to travel 3377 kilometers on average per year for professional purposes. The lowest value was 0 and the highest was 50000.”

The survey was provided over the internet. On the first page of the survey the questions were about the individual characteristics of the user (sex, age) and information about their modes of travel. On the next page respondents were asked to say five words or expressions related to carsharing. Finally, respondents were asked about the rating they would give to 28 elements on visual scales scoring from 0 to 100 using five dimensions adapted by the UTAUT models (Venkatesh et al. 2003); modes of behavior, expectations of functioning, expectations of effort, social influence and conditions of facilitation.

Based on the results of Schaerfers' (2013), the measure of environmental friendliness was added. Participants could write comments beyond the scores.

The data can be seen in the attached table.

**Table 1**

List of items used; these items were translated from their French versions.

<i>Performance expectancy</i>	
1	I would find the carsharing service useful for my business travel
2	I would find carsharing useful for my business travel
3	I would find the carsharing service useful in a professional context
4	Overall, using carsharing helps me saving time for my business travel
<i>Effort expectancy</i>	
5	I would find simple to use the carsharing service for my business travel
6	The car-sharing service seems simple to use in a professional context
7	Practicing carsharing appears easy to me for my business travel
8	It seems easy to practice carsharing for my business travel
<i>Social influence</i>	
9	People who influence my behavior think that I should use carsharing for my business travel
10	People who are important to me think that I should use carsharing in a professional context
11	My company encourages me to adopt an environmental friendly behavior by using a carsharing fleet of vehicles for my business travel
12	People who are important to me think that I should use carsharing for my business travel
<i>Behavioral intention</i>	
13	I intend to use the carsharing service in the next 6 months for my business travel
14	I would recommend to use the carsharing service to my colleagues in a professional context
15	In a professional context, as soon I am able, I will use the carsharing service
16	I plan to use the carsharing service each time I need it for my business travel
<i>Facilitating conditions</i>	
17	Carsharing is compatible with my job in a professional context
18	Carsharing is compatible with the way I like to work in a professional context
19	Cardriving with a shared vehicle makes changes in the way I organize work for my business travel
20	Cardriving with a shared vehicle is compatible with my habits for my business travel
21	I have the resources necessary to use the carsharing service for my business travel
22	Assistance is available in case of difficulties with the carsharing service for my business travel
23	I have the knowledge necessary to use the carsharing service for my business travel
24	Assistance is easy to obtain in case of difficulties with the carsharing service in a professional context
<i>Perceived environmental friendliness</i>	
25	For my business travel, driving a shared vehicle matches my expectations in terms of ecology
26	I think carsharing is an ecological means of transportation in a professional context
27	Practicing carsharing is an environmental friendly behavior for my business travel
28	I think carsharing is a means of protecting the environment in a professional context



Table 1: List of items used; these items were translated from their French versions

#### 4.4. Results

The number of times participants used the carsharing service over a 6-month period averaged 9.18 times and the average distance travelled was 3483.15 kilometers.

In terms of acceptability, the sample was separated between users and non-users of the carsharing fleet (228 and 31 respectively). In general, the carsharing service was well received by users, with a median score of 70 points (74.84 on average) out of 100. Only 5.02% of participants rated the service below 50 points.

The Wilcoxon test (signed-rank) was used for comparisons between users and non-users, revealing significant differences between behavioral intentions ( $p=.0008$ ), effort expectations ( $p < .001$ ) and ease of installation ( $p = .012$ ). However, there was no significant difference in performance expectations, social influence, or environmental friendliness.

The image of carsharing was pronounced by the participants of this study, which are in the attached figure (Figure 1), showing two terms related to the same notion: expectations of effort. Not all the participants agreed on the difficulty/simplicity of carsharing, but all thought that “ease of use” is the “main dimension to be considered

for the use of this service”. However, other concepts such as environmental awareness were rarely mentioned.

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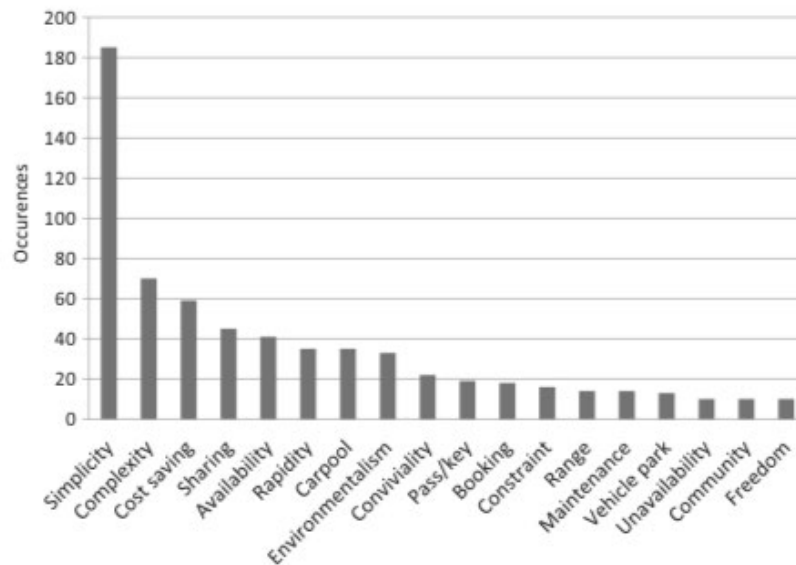


Figure 1: Words associated with carsharing

After doing the reliability analysis (Table 2), aiming to find out the internal consistency of all the dimensions, there was one element that failed to correlate. In this case it is about the dimension of the facilitation conditions as little correlation was found with the other elements of the dimension.

Constructs	Cronbach's alpha
Performance expectancy	.893
Effort expectancy	.952
Facilitating conditions	.888
Social influence	.842
Behavioral intentions	.898
Perceived environmental friendliness	.937

Table 2: Internal consistency of the six assessed psychological dimensions

All concepts that are part of Cronbach alpha's analysis show a high value so all concepts were consistent.

To sum up, the performance expectancy was affected by the participants who used the service because they thought it was useful and easy to use, and in less importance if it was an ecological mean of transport.

## **5. Methodology/empirical study: Qualitative data analysis**

The recent rise of carsharing has created a transportation alternative for city residents. The study attempts to explain how carsharing interacts with public transport systems as well as its exponential growth.

Taking advantage of a malfunction in the public transport service of the city of Vancouver (Canada), a study estimates a potential substitutability of "carsharing" for transit through data collected by the company that has the most extensive in the city, in this case the company car2Go. Car2Go is a subsidiary of Daimler, which in May 2018 operated in 23 cities located in 8 countries (Justin Tyndall, 2018).

Previous studies have discussed that "carsharing and public transport can operate as part of an integrated network" (Constain, Ardon & Habib, 2012; Shaheen, Schwartz & Mipyewski, 2004). The availability of a service of carsharing allows those who have given up owning a private vehicle to have an "alternative available when public transport is not able to meet their needs" and that is the main objective of the study.

The study focuses on free access fleets, single use carsharing systems. They permit the user to rent a vehicle anywhere and leave it in a geographical area allowed by the provider, usually close to the user's home, so journeys do not usually end where they started.

During the afternoon and night of November 24, 2013, a large part of the public transportation system of the city of Vancouver stopped working due to a malfunction. This incident provoked a natural experiment that served to consistently and

adequately estimate the users of the system who replaced public transport for car-sharing. The use of the system increased considerably due to the breakdown. (Justin Tyndall, 2018).

### 5.1. Related Literature

It is curious how the carsharing interferes with other means of transport. The premise found is that carsharing users use this platform when public transport infrastructure does not meet their needs.

Some studies have recognized the strong synergy that exists between public transport and carsharing. (Shaheen et al. 2004) placed carsharing in a “position between public transport and private vehicle ownership”.

A study (Cervero, Golub, and Nee (2007)) made a link between the adoption of car-sharing trips and those made with public transport, showing in the city of San Francisco a 29% of the completed survey data referred to trips that were made by the carsharing fleet could have been made by public transport.

Constant et al. (2012) noted that round trips are sometimes made by carsharing fleets when service is low. Transportation agencies are interested in knowing how carsharing and transit interact.

The results of Huwer’s (2004) survey between carsharing programs efforts and public transport agencies was used to demonstrate that carsharing is a “complement to public transportation”, as it allows “traffic users to expand the range of their mobility” without having to purchase a private vehicle.

OShahenn, Chan and Micheaux (2015) state that in spite of being a complementary service to the public transport , it can also be a rival. Depending on the context of the user’s journey, “carsharing can be easily substituted by public transport.”

In addition to this, Clewlow (2016) showed that carsharing users are more likely to use public transport.

Le Vine, Lee-Gosselin, Sivakumar and Polak (2014) created and measured a model capable of measuring access to alternative means of transport in which they had highlighted relevance. The results obtained by the model in the city of London showed that “carsharing systems can reduce the number of subscribers to transport services by 1.2%”. Derrible and Kenedy (2010) added that the “potential of carsharing services” to supply the demand “depends relatively on the robustness of the transport network”

Such as Kepapstoglou and Karlafts (2009) said that when "operational disruptions" occur in certain cases such as when a rail transport line needs to be covered by buses, called "bridging" due to its limited scope. With the carsharing services they provide a new form of "bringing" in a constant way, with “high flexibility but with a limited capacity”.

On the long term, “carsharing services may influence in the way the considerations that are established between owning a vehicle and mobility”. (Cervero et al., 2007; Firnkorn & Müller, 2011, 2015; Kent & Dowling, 2013; Martin & Shaheen, 2011; Mishra, Clewlow, Mokhtarian, & Widaman, 2015).

“Substitution effects” between carsharing and other alternative models are “determinate by the capacity of uncomplying a trip though transit will make determinate the users between public transit or vehicle ownership”. The “existence of the service makes the transit critical situations less grave” and making the “use of transit more desirable” (Cercero et al.2007; Constait et al. 2012; Huwer 2004;Martin &Shaheen, 2011). Carsharing services and public transport may be able to provide an unbridged mobility network without the necessity of private vehicle ownership. There weren't any longer studies abording this matter.

## 5.2. Carsharing transit in Vancouver

Vancouver is a city located in Canada that counts with 631,000 inhabitants and counting with the metropolitan region about 2.6 million. The public transport infrastructure is covered by a light rail system called Skytrain. Skytrain counts with 53 stations that gives service to the inhabitants in the metropolitan area. The Skytrain system covered around 119 million passengers in 2015 (Vancouver's transit operator). According to statistics over 119 million passengers used Skytrain services whilst 230 million decanted for the bus (City of Vancouver, 2016).

Statics for residents in Vancouver showed that a 27% of the trips were made using public transport, while a 50% were made by private transportations vehicles (including carsharing). (City of Vancouver, 2016).

Vancouver carsharing services supply is composed by 4 major programs: Zipcar, Modo, Evo and car2go. The firsts one based in round-trip fixed location systems whilst the latter two are one-way, free-floating systems. Car2go is the greatest provider, counting with a fleet of 1250 during the period that has been studied. It is also the largest system in terms of membership.

The vehicles provided by car2go are mostly two-seats Smart Car vehicles. During a pilot project they decided to allow 5-passenger models, like a presented model as the Mercedes Benz B-Class. During the time the study was applied this model just represented a 1.5% of the total fleet. (Car2Go data, 2016)

The clients of car2go carsharing services are able to make a reservation of a car when it's not already reserved by someone else. The smartphone application enables the ability of making reservations for a period within 30 minutes till the car is taken. The clients are charged per minute and a flat-free per each trip.

Costs range from 1 CAD base rate and 0.41 CAD per minute of usage. In addition, users must be members before booking a car, in which subscription they are asked for different documentation, such as a valid driver's license.

### **5.3. 24th November transit outage**

This day is where an experiment was formed in a natural manner in which this study has been based. On November 24th, the SkyTrain collective transport system suffered a breakdown, due to a free lane that was stored next to the tracks had been unhooked due to vibrations and fell on the route of the tracks. Next, a train that was in circulation hit the loose piece as it passed, damaging the electrical infrastructure and leaving six stations without service. The repairs began immediately but the traffic was not restored between 2:30-11 pm. The “breakdown affected the financial district of the city of Vancouver during rush hour”. The “Millennium Line and “Expo Line were affected” while Canada Line was not (J. Tyndall, 2016).

As commented at the beginning of this section, “this incident created a natural experiment in which it could be observed how the behavior of users of public transport services responded to a service failure” (J. Tyndall, 2016). During this period of time an anomalous use of carsharing services was observed as a response to this breakdown.

### **5.4. Data**

The study shows a unique and detailed data capture of the locations of the vehicles, car2go has an "Application programming interface" (API) that is able to show in real time and accurately all the vehicles available for lease. A vehicle is available for hire

when it is parked and not reserved by a customer. The data taken by the API focused on the months of November and December 2015. (J. Tyndall, 2016).

The average interval between requests was 7 minutes and 38 seconds. The analysis was limited from 5 a.m. to midnight every Tuesday in November and December. The eight days of data collection included 1,097,640 observations on vehicles, forming part of the 1180 API requests. (J. Tyndall, 2016).

As a result of the “increased use of car2go, there is less availability of the total fleet of available vehicles”. The “median number of available cars was 930, between a range of 620 and 1142”. (J. Tyndall, 2016).

Connecting IDs through the “API requests allowed access to the construction of trip level data” so that a vehicle that has been parked long enough, as long as there is no error in the system, is counted as a single trip when the vehicle has been parked and immediately rented again. (J. Tyndall, 2016).

On the other hand, the “local weather also influenced the collection of data where a little rain was observed during 7 of the 8 control days”, where coincidentally “no precipitation was recorded on the 24<sup>th</sup>”. 30% of the observations were recorded when there was some amount of rain. (J. Tyndall, 2016).

## 5.5. Method

The analysis carried out considered that the number of users could vary with time, thus data was taken every Tuesday, starting from the month of November 2015 to December 2015. “November 24 was used as the treatment period while the other established dates were used as a valid control group”. (J. Tyndall, 2016).

In figure 2, the number of available vehicles can be seen during the afternoon and evening of the appointed days where on the 24<sup>th</sup> a clear decrease in the number of vehicles can be seen. At 5 p.m. on the 24<sup>th</sup>, there was not any car available among



the 250 meters of the affected stations. Meanwhile, on average, 54 vehicles were available in the same geographical areas on the control days. The difference was consistent with the fact that there were more vehicles in use at the time of the breakdown. (J. Tyndall, 2016).

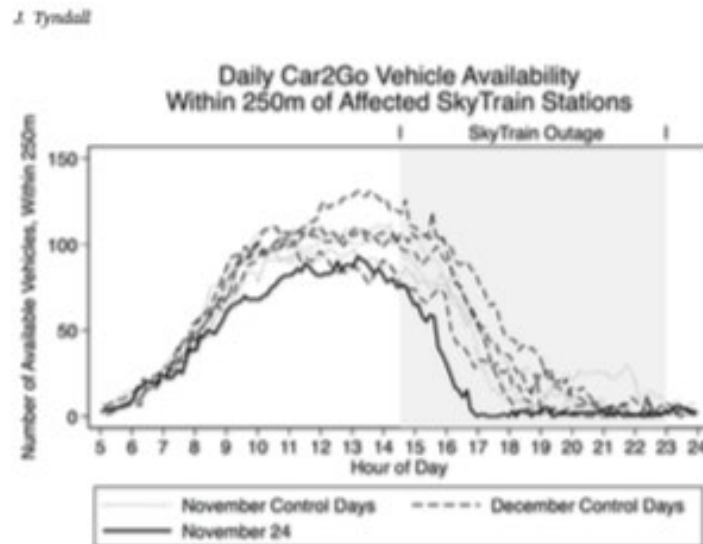


Figure 2: The figure plots vehicle availability close to affected stations, with a separate line for every day in the data set (J. Tyndall, 2016).

However, identifying this difference leads to some impediments due to “causal identification”. The breakdown occurred at rush hour, so the “time was considered an important value to be considered”.

The difference of available cars between the hours that the breakdown took place, both on the day of the incident and on the control days, is given. The “data showed a number of 38 vehicles that were no longer available compared to the same hours when the breakdown took place” and when it did not. “The availability of vehicles during the breakdown was 36% compared to the same hours on control days”. (J. Tyndall, 2016).

As for the unusual demands during those control days that were recorded, causes other than the breakdown was considered, such as Schmöller et al (2015) regarding

the presence of rain. A regression model was therefore estimated in order to calculate the effect of the breakdown on public transport.

The first equation showed a basic regression where:

$$V_{dh} = \beta_0 + \beta_1 \Omega_{dh} + \psi_d + \phi_h + R_{dh} + \varepsilon_{dh}$$

*Equation 1*

"V denotes the number of available vehicles,  $\Omega$  is an indicator variable for whether the observation was made during the transit service outage, and  $\psi$  and  $\phi$  are fixed effects for day and hour of day respectively. R is a dummy variable capturing the presence of rainfall. The parameter of interest is  $\beta_1$ , which captures the partial effect of the outage on vehicle availability. " (J. Tyndall, 2016).

The second equation had the advantage of providing information about the intensity of the partial effect when it had been modified a little (including day and time):

$$V_{dh} = \beta_0 + \sum_{h=14}^{22} \beta_h (\psi_{d=Nov.24} \times \phi_h) + \psi_d + \phi_h + R_{dh} + \varepsilon_{dh}$$

*Equation 2*

The last equation shares with the first one definition but it recorded the trip data instead of the availability of the cars, allowing to estimate the source of the error that could occur in the booking platform:

$$B_t = \beta_0 + \beta_1 \Omega_t + \psi_t + \phi_t + R_t + \varepsilon_t$$

*Equation 3*

An error was considered if it was the case that a vehicle was parked and rented again between the same observations, counting just one trip when two were done.

It was also considered that in the presence of growing demand, some Car2Go employees intervened to displace the number of cars available, although the effect was small in comparison to the change in market demand and would be within the availability levels of the vehicle fleet.

## 5.6. Results/discussion

	Citywide	Citywide	Within 250 m	Within 250 m
	(1)	(2)	(3)	(4)
Transit Outage	-75.431** (20.005)	-43.722** (7.901)	-39.064** (3.925)	-9.174** (2.851)
Precipitation (dummy)		-17.078** (2.983)		-3.712** (1.043)
Const.	934.806** (3.956)	1008.115** (5.923)	50.897** (1.724)	14.458** (1.761)
Hour Fixed Effects?	N	Y	N	Y
Day Fixed Effects?	N	Y	N	Y
Obs.	1180	1180	1180	1180
	.035	.898	.053	.947

Significance levels: \* : 5% \*\* : 1%. Newey-West standard errors in parenthesis.

Table 2: Partial Effect of Transit Outage on car2go Vehicle Availability

In the first column of the attached graph, it can be seen that on “average 75 cars were no longer available in the city when the sample was taken”. On the other hand, the breakdown occurred during the afternoon peak hour so that the estimate can be modified by this fact since “at peak time there will always be fewer cars although there is a malfunction in the train service or not”. (J. Tyndall, 2016).

In the second column it is possible to observe the fixed effects of the day when the observation was made. A fictitious variable was added to represent the presence of rain in the study. Schmöller et al. (2015) suggest that the use of carsharing tends to

be more frequent when this phenomenon occurs. In the short period of time given in the study, the presence of rain only gives tentative data. After establishing controls, there were 44 fewer cars than expected. The result is significant.

In average terms, between 2:30 pm and 11 pm, only 3.7% of the vehicles available within 250 m of one of the stations that was closed due to the breakdown. That means that the reduction of 44 vehicles implies that there would only be approximately two cars available within 250 m of the affected stations. The regression estimates this number till nine for those areas in average terms. This means a strong rise in demand in the surroundings of the affected stations. So it is clear that the breakdown increased the demand for vehicles, particularly in nearby stations.

The capacity of car2go to satisfy the demand of the users affected by the breakdown can be estimated by calculating the number of vehicles rented per hour that the system recorded as a response to the breakdown and the number of trips made as a consequence of the same cause. With this, “the breakdown lasted 8.5 hours and the additional vehicle-hours recorded by car2go were 372” (J. Tyndall, 2016).

Trip lengths are recorded starting when the vehicle disappears from the API, considering that the “duration of the trip occupies the driving time, as well as the time between booking and the time that the user takes to get to the car” (J. Tyndall, 2016).

On the day of the breakdown, “the average travel time was 27.3 minutes, which was consistent with the company's recorded average of approximately 30 minutes”. (J. Tyndall, 2016).

In terms of the number of trips there were “817 trips provided by the company during the breakdown, an anomalous amount in terms of the system normally recorded”.

The highest deficit occurred “between 5pm and 6pm when there were 115 fewer vehicles than expected”, representing “9% of the total fleet”. In response to the traffic collapse, the alternative specialization showed a total of “394 additional vehicle-

hours that the company provided, resulting in 865 additional trips. The estimate differs with the equation by only 5.9%". (J. Tyndall, 2016).

*J. Tyndall*

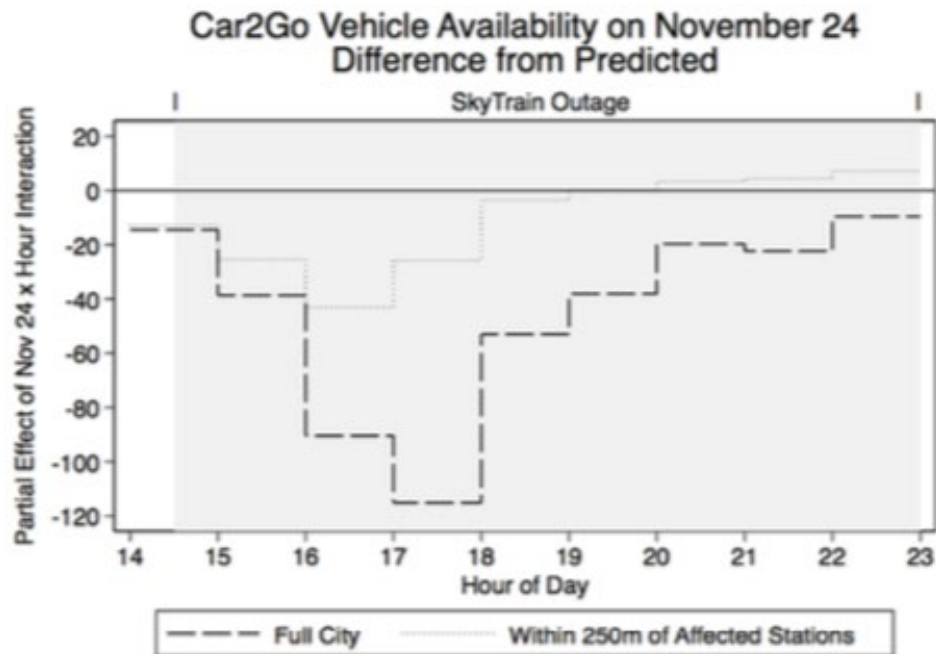


Fig.3. The figure plots the estimated vehicle deficits during the outage.

Figure 3 shows the decrease in the number of vehicles available, the beginning of the graph starts with the start time of the breakdown. It can be seen that as well as the number of available cars decreased in the areas near the affected Skytrain stations, the decrease spreaded to the stations beyond the nearby ones.



Figure 4: Skytrain stations in Vancouver affected by November 24 service outage(J. Tyndall, 2016).

In Figure 4, you can see the effect of "bridging" in the stations of VCC-Clark Station, Renfrew Station, and Nanaimo Station, whose are the most likely to continue the journey home within the un-affected line. (J. Tyndall, 2016).

"In the absence of the breakdown on November 24th at 5pm, the possibility of the same "bridging" trip was only 0.02. During the breakdown," this trip was 8 times more likely to be made, with a probability of 0.16%". (J. Tyndall, 2016).

The significant evidence found is that "bridging" trips were replaced by trips with the carsharing service. (J. Tyndall, 2016).

## 6. Conclusions and recommendations

As well as this dissertation showed, there's a consistent evidence that car-sharing services are an alternative to take into consideration to deal with nowadays global transportation troubles specially for the high cost of the structure that is carried by big corporates, making the transition affordable for the major part of the customers.

The adaptation of the customers to this service instead of promoting the use of a private vehicle was contrasted in all the data given in the studies referred before.

These studies focused on the impressions and the value that the customer is expecting to receive from the service and their behavior in front of it when their main alternative has a breakdown in the infrastructure, in this particular case rail transportation.

Concerning the commented study of the carsharing fleet experiment in a corporate (Sylvain Fleury, Ariane Tom, Eric Jamet, Elsa Colas-Maheux), it can be concluded that all UTAUT have an effect on the behavioral intentions of employees who were surveyed unless social influence. Social influence (Venkatesh et al, 2003) has shown to have an impact only after a certain period of service usage. In this particular case, given that the fleet of vehicles was already available in the company before the study was conducted, the "lack of this variable can be justified because the employees were already aware of it".

On the other hand, participants considered that the service is easy to use if the conditions of use allow it, with the facilitation conditions having an enormous impact on the study.

Another trend that was considered as an indirect impact was shown by environmental friendliness on behavioral intentions, measured by performance expectations. Proving that carsharing is a practice that is best viewed as an environmentally friendly service. Users used to consider the service to be useful if it was easy to use and environmentally friendly.

The expectation of effort was the most important factor in both direct and indirect terms, given the words that participants mentioned at the beginning of the questionnaire. They rarely wrote that they would use the service "when it works better" and said "there are too many logistical problems".

The sections with the highest scores were facilitation conditions, expectations of effort and behavioral intentions.

Others suggested that an explanatory video would have been appreciated by first-time users, such as announcing the resources that would be saved by the use of that service.

Regarding the natural experiment that took place during a public transport outage in the city of Vancouver (Justin Tyndall, 2016), it can be proved that a carsharing free-access services fleets provide an alternative to conventional means of transport and show a certain synergy with public transport.

The study described above has shown how common users of public transport replace public transport with carsharing trips when there are expected complications in the transport network. According to the data obtained, it has been observed that "carsharing services are capable to fill the gaps in the public transport network". As a prove of this, the availability of the carsharing fleet was considerably reduced at points where the transport line broke down.

One possibility considered during the study, was that various economic incentives can be given to users to encourage them to leave vehicles near areas where there are peaks in demand, as well as for those who need the service and at that time there is a lot of demand (like the rising prices of asking for an Uber where there's high demand, for example in a Saturday night).

However, users of carsharing fleets think that the "scale-up" of this system is limited because taking care of a bigger structure will bring a higher amortization cost to the fleeting companies.

One of the practices that has grown strongly has been to place carsharing fleets parking near public transport stations in order to increase the stocking of vehicles and take advantage of the synchronization between these two systems.



Cervero et al. (2007), Constain et al. (2012), Sioui, Morency and Trépanier (2013) and Tyndall (2017) observed in their studies that despite the “affordable cost of car-sharing, the urban population rates reported with low incomes participated marginally”. So, this could lead to effects only by “sub-populations”.

Bieszcat and Schiwieterman analyzed the current situation in how the government encourages this kind of services, observing how the tax rate is much higher than in other services.

Policy makers should be aware of this and give incentives to promote this practice in order to reduce the uprising number of vehicles that already are in the streets causing congestions, slowing down the flow of the transit and dropping pollution to the atmosphere, that as we have seen it’s a major cause of premature death in the major cities.

With this, it can be said that carsharing seem to be that it has just arrived to our days and its effects are a consistent proof for its permanence in the mobility market, even though some actions should be taken by actors to improve the service.

## **7. Implication for future research**

As well as studies provided are recent, there’s not a large amount of data available concerning certain effects of carsharing service usage. Future research could focus on the government policies applications in order to make carsharing usage affordable for all individuals without facing the creation of sub-groups because of the income level.

Moreover, there’s evidence that proves that carsharing vehicle fleets powered by fossil materials tend to have higher pollution emissions in the starting phase of the trip due to the fleet engines are always starting and stopping (phase when most of pollutant gases are dropped) not like a vehicle in the long run and the engine already heated. So that, in order to obtain a deeper study on the environmental friendliness this has to be compared with the latter electrical powered carsharing fleets.

Future work also includes the creation of a data base comparing the amount of emissions for the disposal (from manufacturing till the end of the product life) to the final client of these items and the comparison with others ways of transport like walking or bike as well as other practices like “carpooling”, concerning factors and effect.

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