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Viability of Free-floating Carsharing from the Consumers' Perspective

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Wien, Juli 2013

Áron Lékai

Preamble

"A developed country is not a place where the poor have cars.
It's where the rich use public transportation."

Gustavo Petro
Mayor of Bogota, Colombia

Here, I would like to take the opportunity and thank everybody, who in some way supported the completion of this thesis.

I would like to thank Prof. Franz Wirl and the Members of the Chair of Industry, Energy and Environment of the University of Vienna for their supervision and support.

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Finally, I would like to thank all my family and friends, who supported me during the completion process.

[1] www.nextendweb.com

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Table of Abbreviations

FFCS .... Free-floating Carsharing
CS...................................... Traditional Carsharing
CSO .... Carsharing Organization (Service Provider)
bcs .... Bundesverband Carsharing
ecs .... European Car Sharing Association
IPO..................................... Initial Public Offering
M&A .... Mergers and Acquisitions
NPO .... Non-profit Organization
SUV .... Sport Utility Vehicle
TCS.................................... Traditional (Station-based) Carsharing
VKT.................................... Vehicle kilometers travelled

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1. Introduction

This chapter describes the problem setting of the thesis, while trying to answer the question: why is carsharing an issue at all? In the beginning, the main objective of the thesis will be declared; at the end of the chapter the thesis structure will be introduced.

This thesis has a **double objective**. On the one hand, it tries to give a **'whole picture'** about free-floating carsharing, this relatively new mobility service, by summarizing its characteristics and structuring the influence factors of the business. On the other hand, it tries to **provide a guideline** for the potential customers, by estimating: under what conditions does it worth using such service. In order to reach these goals, the most recent findings of the scientific literature were collected (confronting the various aspects); moreover the real-world example of the Viennese free-floating carsharing service: car2go was deeper analyzed, thus providing primary results about its usability/viability from the consumers' point of view.

First, we have to find an answer for the following questions:

- Why became carsharing a new mobility trend?
- What were the consumers' needs that reinvented carsharing recently?
- What is the contribution of carsharing in solving these issues?

One major driver in the popularity of carsharing could be the **cost issue** (increased living and car ownership expenses). This can be best illustrated by the fact that today the average age of new-car buyers in Germany increased to around fifty years (sueddeutsche.de, 2013); while we can assume that the basic needs of people towards transportation didn't change significantly in the last decades. Ergo, once again (like in the pre-war era), owning a car turned out to be an unaffordable 'luxury' for many people. This resulted in the new wave of **'collaborative consumption'**, where consumers reach higher 'efficiency' (e.g. lower costs) by using the service of specialized firms, who *"enable a sharing of goods across their consumer base"* (Obradovits, 2011 p. 1).

Hence, the collaborative consumption is caused by the increased costs of ownership, while it was triggered (became possible) by the technological innovations of the internet, wireless communication, GPS navigation, etc.

Carsharing is the 'collaborative answer', instead of the traditional way of vehicle ownership, because the mobility needs of the users can be 'just as well' satisfied by making cars just 'accessible' for the people; in this sense, ownership is not a prerequisite. Basically, it is a **'renting or buying'** decision of the consumer; however, as we will see in the following chapters, a lot of different influence factors need to be taken into consideration, when making this decision.

The best analogy to illustrate free-floating carsharing is, if we describe it as a **'modern, automated, self-driven taxi service'**, which can provide higher efficiency (e.g. lower costs), by eliminating the most expensive cost element, the human capital from the process (e.g. the taxi drivers).[2]

Besides the cost issue, another major driver in the popularity of carsharing could be the general **inefficiency of private cars[3]**, which contributes to the well-known mobility and environmental crisis of the world. The extent of this effect however will not be considered in this thesis, because as we will see in the following chapters, the environmental consciousness is an underlying usage motive only for a marginal segment of the people (e.g. the 'green' subculture); most of the consumers decide only based on their utilitarian and convenience needs.

Here, it shall be just mentioned that theoretically carsharing can contribute to reduce the aforementioned inefficiency, through reduced vehicle ownership; reduced vehicle kilometers travelled; reduced greenhouse gas emissions; reduced parking demand in urban areas; reduced monthly transportation costs; and

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[2] Of course, this comparison is a great simplification of the reality; however, if taxi service would be cheaper, the proposed 'rent or buy' decision would rather be 'vehicle ownership or taxi'.
[3] Cars stand still 23 hours a day on average (Dorn and Gabert, 2010 p. 55); 10% of all traffic accounts for just search for a parking spaces in some cities (Shoup, 2006 in Firnkorn and Müller, 2011); 15% of all trips are shorter than one kilometer, which is only a 10-15 minutes walking distance (Dorn and Gabert, 2010 p. 59)

through the effect that it usually promotes a 'healthy' way of mobility. (Shaheen et al. 2012) On the other hand, as we will see it in chapter 4, these positive effects can turn out to be indeed negative ones, if using different service configurations (e.g. too big fleet, or too cheap pricing compared to public transportation, etc.). All in all, the aggregate environmental friendly character of carsharing (especially of the novel free-floating carsharing) has not dependably been proven yet.

Moreover, the popularity of carsharing is on the rise, because of its ability to capture the changing needs of the **younger generations**.[4] [5] Besides the cost issue mentioned earlier, there is a notable segment of the consumers (especially in the younger generations), who find vehicle ownership a burden (high responsibility, effort of maintenance, etc.); while carsharing provides them a more suitable alternative, since they can adapt it much easier to their existing mobility behaviors (reduced effort and responsibility).

All in all, we can set the following criteria: carsharing can only be considered as a 'step forward' in the **efficiency improvement** process of transportation, if it simultaneously can (Fliegner, 2002 p. 23):

- Reduce the disadvantages of private vehicles
- Extend the advantages of private vehicles
- Be available (affordable) for a broad population.

Based on these introductory ideas (**chapter 1**), the structure of the thesis will build up as follows. In **chapter 2** the definition, subtypes and main parameters of the carsharing services will be described (car2go of Vienna in more detail). Moreover, a quick history and industry overview will be provided as well. The various aspects of mobility behavior (especially of the potential carsharing customers) will be discussed in **chapter 3**, focusing on the underlying usage motives of free-floating carsharing customers. After that, **chapter 4** tries to provide a balance, comparing

[4] In Germany, the number of young households without car increased from 20% to 28% between 1998 and 2008. (economist.com, 2012)
[5] The average annual VKT of young people is decreasing drastically; moreover they get their driver's license only at an older age, which has long-term consequences: those, who learn how to drive in their late 20-s, drive 30% less than those, who learn in their teen ages. (economist.com, 2012)

the positive and negative aspects of carsharing, while **chapter 5** is discussing the prerequisites of success, all the factors that are necessary for a carsharing service to reach profitability. In the primary research chapter (**chapter 6**), the key elements of usability/viability are analyzed based on the real-world example of car2go Vienna. The cost saving potential, the degree of vehicle availability and the appropriate fleet size will be estimated respectively, which are of key importance from the customer's point of view. Finally, in **chapter 7**, some general conclusions will be drawn based on the findings of the thesis; and some conjectures will be made about the future of free-floating carsharing.

2. What is Carsharing?

This chapter will introduce the concept of carsharing. The definitions and the characteristics of the subtypes will be presented, as well as a vague history and industry overview. The last part of this chapter introduces the details and specific conditions of the car2go service in Vienna.

All services are described by the term carsharing (“organisiertes Autoteilen” in German) that provide **short-term access to a fleet of shared vehicles without ownership**. (Schaefers, 2013 p. 69) It is a new type of mobility service, which according to Duncan is a relatively inexpensive alternative *“…for those with occasional need of private transportation.”* (Duncan, 2011 p. 363) Somewhat sensationalized: *“It combines the benefits of a private vehicle while avoiding the burdens of vehicle ownership.”* (Shaheen, 1999 in Schaefers, 2013 p. 69)

It is a membership-based service, which requires preregistration at a service provider (CSO), thus the terms and conditions of the usage are regulated in a contract. (It is crucial to agree upon usage liabilities in advance, to provide credit card access for the CSO, and to control the validity of the driver’s license.)

There are **three main branches** of carsharing:

1. Traditional (stationed-based) carsharing
2. Free-floating (one-way or on-demand) carsharing
3. Peer-to-peer (p2p, neighbor-to-neighbor, or personal vehicle) carsharing

In the **traditional subtype**, the cars are located in predefined-stations, from where they can be taken after a vehicle reservation process for an arbitrary time. After the rental, they must be returned to the departure station, where the payment will be usually calculated based on a time- and distance-based tariff. Moreover a monthly membership fee is usually charged as well.

Primal is its **'pay-as-you-drive'** character of the **free-floating subtype**, which usually has no fix/monthly costs, thus allowing a much more flexible usage, without any commitment from the customer side. Here the vehicles are 'floating' de-central, within a pre-defined operation area, not bounded to a fix station (GPS-based, real-time information on vehicle availability); they can be parked at any public parking places inside the operation area. This characteristic provides the key-advantage of this subtype, namely the FFCS can be used for **one-way trips** (different departure and destination locations), supports **spontaneous rides** (reservation in advance is only an option); but on the other hand, it also makes the FFCS a complement form of public transportation (which is considered as a disadvantage from an ecological perspective). However, *"A free-floating system probably feels closest to owning a private car as is possible"* (Firnkorn, 2012 p. 1669), which sentence grabs best the reason of its popularity. The table below collects the main FFCS characteristics in comparison with some other transportation modes.

Table 1: Comparison of Transportation Modes

	Rent-a-car	**Taxi**	**Traditional Carsharing**	**Free-floating Carsharing**
Availability				
Location	central	in front of house possible	de-central	de-central (in front of house possible)
Extra Time Needed to Use	more than an hour	~ 5-15 min.	~ 30-45 min.	~ 5-15 min.
Availability during the day	during office hours	24/7	24/7	24/7
Minimum rental time	1 day	-	1 hour	-
Usage Restriction	driver's license, age restriction possible	-	membership, driver's license	membership, driver's license
One-way Rides	sometimes possible	yes	no	yes
Costs				
Pricing System	time- and sometimes distance-based	base tariff, time- and distance based	time- and distance-based, monthly fee	time-based
Usage Behavior				
Average Duration	one-more days	less than an hour	a couple of hours, sometimes 1-2 days	less than an hour
Average Distance	more than 100 km	less than 10 km	20-100 km	less than 10 km

Source: Based on Dorn and Gabert (2010, p. 8)

The third subtype, the **peer-to-peer carsharing** relies not on a commercial fleet, but on the existing vehicles of the private owners.[6] Here, the CSO can save the investment of buying cars (which is the biggest expense element of course). The service operator functions rather as an intermediate agent between the private vehicle owners (supply) and those in need of private transportation (demand). The incentive of car owners to participate is that they can usually keep 60-65% of the rental fee. This subtype can rather be described as a bottom-up community movement (past reinvented, check history later!), where the ecologically conscious neighbors share a vehicle among each other. The biggest disadvantage of this subtype is the trust (better put: the **lack of trust**), which is needed, if someone wants to rent out his automobile[7]. The emotional connection to the cars (a person may be more likely to rent out his home than his automobile), and the **moral hazard issue**, which applies from both sides (carefulness of driving and maintenance history are private information, no incentive to be careful) hinders the success of this service significantly. Furthermore, p2p carsharing does not motivate people to sell their cars, since they can make money with it. In conclusion, unless this system can somehow motivate people to give high effort (solving the moral hazard issue), and thus increases trust, the p2p carsharing will remain a **marginal service** mostly in the 'green' customer segment. (Shaheen et al., 2012 p.77)

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[6] Various hybrid business models of p2p carsharing exist, a detailed description can be found in Shaheen et al., 2012.

[7] Especially relevant in case of an 'unattended access', where the parties do not even meet each other.

2.1. Industry Overview

The history of carsharing started as a bottom-up community movement to enable cost savings for its users. The first CSO was founded in Zürich, Switzerland 1948, under the name SEFAGE ('Selbstfahrergenossenschaft'), which was a citizen initiative in a time, when the masses couldn't afford the luxury of owning a car. Due to the sudden economic boom of the post-war era, carsharing lost its relevance until the 1970s, when it was reinforced with an environmental friendly character, and became an 'alternative solution' to overcome the mobility and environmental crises; became a desired tool of de-motorization. However, the viability of these early age carsharing services was hindered by the manual processes of reservation, billing, key exchange (lockbox), etc. that are fully automated today. (Koss, 2002 p. 56)

The **first free-floating service** was the 'Procotip', which operated in Montpellier, France 1971-1973. Here the cars had to be taken to predefined stations around the city centre, but they were not bounded to fixed stations, thus the service allowed for one-way rides. The example of Porcotip can provide us useful experience, because some poor **planning mistakes** in the business model led to a financial fiasco just two years after the launch. The first mistake of the management was that they used a tariff based on travelled distance, which resulted in shorter rides than previously planned, and gave no incentive for the customers to drive the car back to the stations (people parked the cars often at their homes for a longer period). The second mistake, which should have been controlled, is that the car stations were too centrally located (around the city centre), which increased the burden of the customers taking the cars back to the stations.[8] (Keller, 2000 p. 13)

Today the carsharing industry is only active in North America and Western Europe (with a few exception e.g. in Singapore or Mexico); while the 'home' of

[8] On the other hand Procotip was a pioneer in technology: cars were supplied with a 'Tip-Meter', which operated with tokens and let the car run only when people paid enough tokens.

traditional carsharing is still Switzerland.[9] The industry recently entered in its commercial mainstream phase, although it is far from a level yet, where it could deliver significant aggregate benefits for the public. There are too few customers just yet; a significant effect on the aggregate mobility behavior is barely measurable. (Duncan, 2011 p. 363) The industry is best characterized today by its heterogeneity and instability. Big players with financial strength entered the market recently, which are currently influencing the events the most.[10]

A couple of players are visible on the graph below. Next to the big players, numerous NPOs, and publicly owned projects are struggling with survival as well. M&A and bankruptcies are everyday occasions, as the consolidation of the industry is currently happening.[11]

Graph 1: Carsharing providers

An illustrative example of the industry is the story of **Zipcar**, which was founded in 2002, then covering the East-coast of the US. In 2007, it merged with Flexcar, and with the help of many other contract- or equity-based co-operations, it reached nationwide coverage. Their IPO happened in 2011; while they acquired the Austrian Denzel Mobility CarSharing GmbH in 2012 (which is just one of the examples of their international expansion). Lately, in March 2013 they were acquired by the Budget Avis Group rent-a-car giant. As it can be seen, the future of the carsharing industry is very foggy yet; a deeper forecast can only be inaccurate and redundant from our point of view.

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[9] The market leader Mobility Carsharing was founded in 1987; today it has more than 100,000 customers and around 2600 vehicles.

[10] Car manufacturers: Daimler→car2go, BMW→DriveNow, Citroën→Multicity, VW→Quicar, Ford→Ford2go; Public transportation providers: Deutsche Bahn→Flinkster, Rental car service providers: Avis Budget Group→Zipcar, Europcar, Sixt, Hertz, Enterprise, etc.

[11] E.g. in Berlin, Germany the three major players offer a fleet of 2250 vehicle in total (1200 car2go, 700 DriveNow, 350 electric vehicles by Multicity), which is an unbeatable competition for the smaller players. However, the average user signs up parallel for multiple services, thus increasing convenience and reaching a very high availability rate.

2.2. Introducing car2go

Daimler's free-floating carsharing system car2go is available in Vienna since December 2011. Currently it uses 600 identical gasoline-driven Smart cars in an operating area of approximately 120 km^2. The service has around 35,000 members (in January 2013); the average rental distance is around 5-10 km, and the cars are rented around 4-8 times per day on average. (wienerzeitung.at, 2013)

After a sign-up for the service (one-time fee: 19 EUR), a membership-card (chip-card reader behind the windshield), and a personal PIN number are used to start/end a rental. GPS-based real-time information helps to locate the vehicles via smartphone or desktop internet, while the in advance reservation is only a helpful option (30 minutes before the ride possible). The communication system during a ride is an integrated touch-screen with navigation software and an in-car phone, which enables contacting a hotline support 24/7.

One major advantage of car2go lies in its simple and uniform **pricing system** (check graph on the next page). The time-based tariff costs 0.29 EUR/min[12], all-inclusive.[13] The operator takes care about all the other incurring costs: gasoline, full-casco insurance[14], winter tires, annual highway stickers, maintenance and cleaning costs; moreover the public parking spaces in Vienna are also prepaid and are included in the rental fee. This time-based tariff is ideal to avoid rush hours and traffic jams; while is high enough compared to the public transportation fares.

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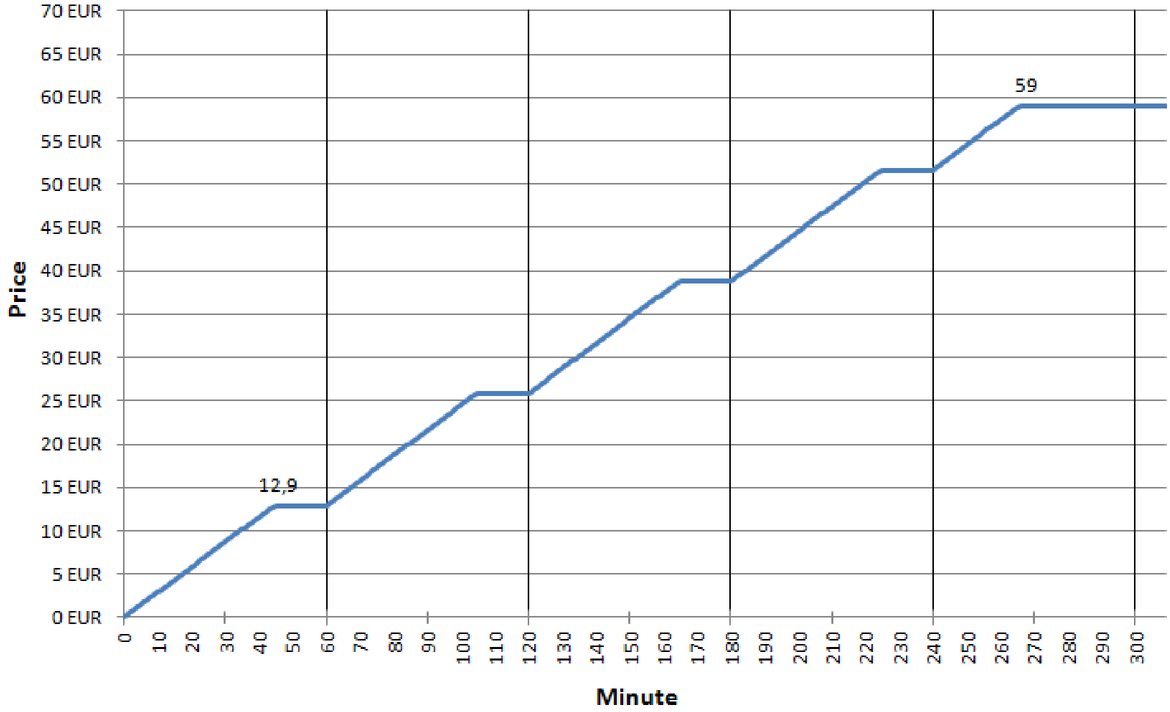
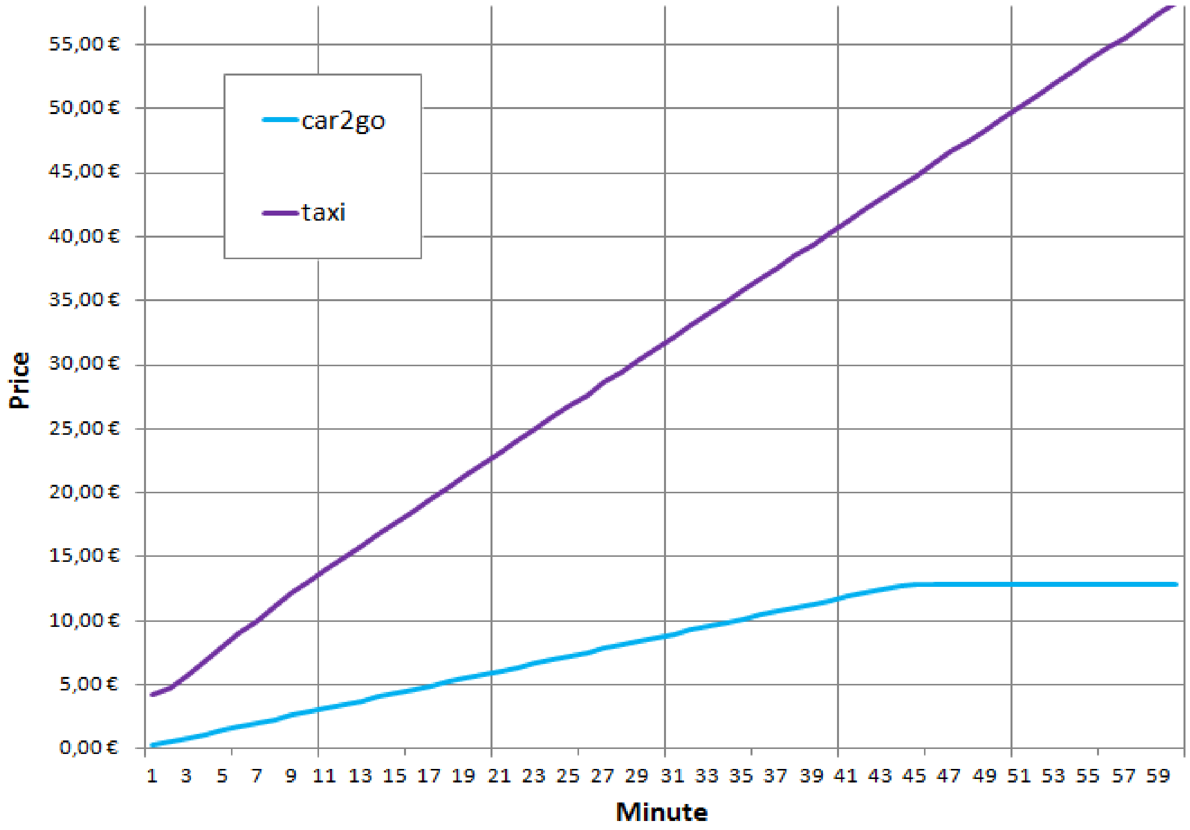
[12] Max. 12.9 EUR/hour; max. 59 EUR/day
[13] Some surcharge applies when going abroad or to the airport with the car. Penalty fees apply, when violating the terms of usage. For further information check: www.car2go.com/en/wien
[14] Currently, the liability of the customer is 500 EUR.

Graph 2: Pricing system of car2go in Vienna



In comparison with the Viennese central/regulated **taxi** tariff, the car2go is highly competitive, as it can be seen on the graph on the next page. (For the detailed taxi tariff check appendix 1) The purple line on the graph below includes the Viennese taxi tariff on workdays, during daytime. The base, time- and distance-based tariff elements are transformed into a per-minute price, using a conversion rate of 25 km/h, which is the average speed of the cars in Vienna according to the Magistratabteilung 18. (Trunk, 2010 p. 13) Moreover, the purple line does not account for the extra fee, which applies when booking a taxi via phone; this scenario would shift the line more upwards (which is most of the case).

Graph 3: Taxi versus car2go



3. Usage Motives

In this chapter, the question must be answered: what are the usage motives of the carsharing customers? In the first part, it will be described: how do people make their transportation decisions in general? In the second part the carsharing customers will be analyzed: who are the customer base for carsharing, what are their behavior patterns and motivations of using carsharing (traditional or free-floating service respectively)?

The simple answer is: people choose the transportation mode, which **maximizes their utility**, which would provide them the maximum benefit from the available set of modes. The utility factors that need to be maximized can be grouped into two main categories according to Keller, 2000 p. 25:

- **'Quality' of the ride itself:** travel time, travel cost, travel experience: subjective factors e.g. safety, comfort, fun, design
- **External influence factors:** reliability of the transport mode, frequency (in a temporal sense), availability (in a geographical sense), integration into a network.

On the other hand, the **constraints of the people** have to be considered in the decision process as well (Keller, 2000 p. 27):

- **Objective constraints:** personal budget, available variety of modes, time constraints (office hours, etc.) necessity of cooperation with others (friends, family), prerequisites (driver's license, etc.)
- **Subjective constraints:** limited information[15], individual personality, values[16] and habits[17]

[15] People with a private car use taxi and rent-a-car more often, because they value convenience more, or simply because they are unfamiliar with the timetable of the public transportation. (Firnkorn, 2012 p. 1668)
[16] As mentioned earlier in chapter 2: vehicles generate emotions and personal attachments (related to the need for beauty, possession, freedom and self-realization): People are more likely to rent out their homes than their automobiles.
[17] Mobility patterns also change during the lifetime of the people. (Fliegner, 2002 p. 23) On the other hand, the individuals' needs and desires e.g. for comfort do not change with their constraints.

This decision model of transportation illustrates well the complex network of influence factors that play a role in the person's decision about mobility. According to Fliegner, 2002 p. 26: from a psychological point of view, people make a conscious decision (mostly from routine), when it comes to mobility. It is not an isolated decision, but a part of our complex behavior pattern, related to our cultural orientation. This is why our subjective experiences matter just as much as the objective factors: a positive car-free experience can trigger de-motorization, writes Fliegner, 2002 p. 59; which message translated to carsharing means that a (positive) **personal experience** is the best way to make the people change their old mobility behaviors.

However, only those people count as a **carsharing customer base**, who are objectively fitted to the service. Carsharing is suitable only for those, *"who can adapt carsharing in their travel patterns without changing it significantly and can reach money savings with it."* (Duncan, 2011 p. 366) Estimating the real size of this group is a true challenge, because the behavior patterns are extremely hard to quantify due to the many special life situations. Thus, the aim of this chapter can only be to present the many influence factors that a decision maker has to take into consideration about carsharing.

Based on Duncan, 2011, we can define four major customer segments, who **economically** could be **suitable for** (traditional) **carsharing**:

1. Those who don't own a private vehicle[18]
2. Those who drive only a few kilometers annually (People with low vehicle kilometers travelled can reach cost savings with carsharing.)
3. Those who need a car only occasionally, but drive more because the fix car costs make this economically prudent (The more people drive their car, the lower the kilometer unit cost gets.)
4. Those who find vehicle ownership a burden.

[18] 41% of the households in Vienna: although, the majority of them do not have a driver's license.

On the other hand, a household is **demographically** most probably **not suitable** for carsharing, if it belongs to the following groups (Duncan, 2011):

- Households with small children (high number of necessity/compulsory rides to kindergarten, issue of the child car seat, etc.)
- Households with cars manufactured before 1973 (old-timers are not just a transportation tool for their owners)
- Households with a light truck or a SUV (premium price for a utility: comfort, speed, etc. that only such cars can provide)
- Households with more car than drivers.

As these groups have **no incentive to minimize their travelling costs**, they probably won't put down their own private vehicles and take up carsharing instead. In general, the only people who can accommodate carsharing are those with a rational user orientation towards private vehicles. Another demographic prerequisite of suitability is that the household has to be located in an **urban/metropolitan area**, because a rural household (even living in the suburbs) requires most likely a private car to satisfy its mobility needs.[19] Duncan estimates that – in the San Francisco Bay (Urban) Area, if assuming for perfect vehicle availability – both economically and demographically, only about 6% of the vehicles and 9% of the households are suitable for traditional carsharing. (Duncan, 2011 p. 377)

This is a rather poor result for the traditional carsharing, although we have to consider a much bigger **customer base for the free-floating carsharing**, due to its higher flexibility and ease of use. Also Dorn and Gabert, 2010 p.78 found that the two most desired characteristics by the people are the free-floating feature (one-way rides, independence from parking stations) and a simple tariff system. Since the FFCS doesn't require a commitment from the customer (no fix costs); it allows a much more flexible usage, more **'like a modern taxi service'**[20] (so, it is a highly likely scenario that people with an SUV would also use FFCS occasionally).

[19] Not to mention that a carsharing service can only be viable in a metropolitan area (see chapter 5)
[20] This comparison will be deeper elaborated in the conclusions. (see chapter 7)

After investigating the **underlying motivational patterns of free-floating carsharing** users, Schaefers, 2013 found that the usage motives can be allocated into four main groups, which are the following[21]:

1. **Value seeking/Thriftiness** (utilitarian motive): money saving potential
2. **Convenience** (utilitarian motive): saves time, reduces effort and responsibility, thus it can increase the quality of life (all-inclusive price, helps avoid the burden of paid parking, etc.)
3. **Lifestyle/Belonging** (affective motive): Importance of self-expression, fun, and creating a community
4. **Indirect environmental thought** (altruistic motive): Which is just a positive side effect, captured by the desired vehicle characteristics (small, fuel efficient vehicles)[22]

Schaefers, 2013 found that, the usage of an FFCS service is directly related to personal benefits, such as money or time savings. Customers enjoy the most the reduced effort coupled with the lack of responsibility, and appreciate the cost savings they can get on their monthly travel expenses. They are more concerned with **personal utility and convenience**, than social or environmental benefits. (Lane, 2005 in Nurul Habib et al., 2012)

Contrasting the real-world users of traditional and free-floating carsharing, we find that the **average FFCS customer** is around 30 years old, male and technophile (they are the first-movers); however experience shows, with time more and more women and older people use the service as well. (nytimes.com, 2013) On the other hand, the **average traditional carsharing customer** has the following demographical characteristics: 30-40 years old with a low/medium monthly income and a higher than average environmental consciousness. (Dorn and Gabert, 2010 p. 63) Multiple studies suggest that a traditional carsharing is often used as a

[21] Based on hierarchical value maps (HVM) created after a means-end chain analysis. (More about the methodology in Schaefers, 2013)
[22] However, for the same price, customers most probably wouldn't reject a luxury car either.

substitution of the second or third family car[23] (e.g. used for weekly shopping tours), or used in the weekend (for family trips, holidays, etc.) by households without a private car. (Koss, 2002 p. 257) (Keller, 2000 p. 95)

One major topic of the carsharing literature is to estimate the **effect of carsharing on vehicle ownership**; namely, by how much could carsharing contribute to decrease the number of cars on the roads[24] (by affecting the car owners putting down their own vehicle or to postpone a car purchase). Getting a precise estimate on how the individuals change their long-tem mobility behavior exclusively thanks to carsharing is extremely hard and can be misleading; nevertheless e.g. Firnkorn and Müller, 2011 found that around 13.5% of the car2go users in Ulm, Germany might reduce their vehicle ownership by selling their car or postponing a purchase.

In conclusion, the objective of this chapter was nothing else, but to define the underlying usage motives of FFCS; estimating how does carsharing affect consumer behavior; and to ballpark the mobility behavior patterns of the (potential) customers that need to be addressed by the car sharing service providers.

[23] Seems like a rational choice, since they would still have one car for emergencies, compulsory rides, etc.
[24] The goal is to find out the environmental effects/ sustainability character of carsharing; by how much could it contribute to help solving the environmental crisis

4. Drawing a Balance

Based on the previous chapters, an account can be made about the characteristics of carsharing. Thus, in this chapter, the advantages and disadvantages of carsharing will be contrasted; moreover the traditional carsharing will be compared with the free-floating system at the end. The chapter aims for completeness using enumeration.

4.1. Advantages

Each of the following points describes a special aspect of free-floating carsharing that can be considered as an advantage.

Advantages from the **consumers' perspective:**

1. The FFCS **reduces the required effort and responsibility** of the people compared to vehicle ownership (feeling able to go careless). Owning a private car comes with duties (insurance, tax payments, regular maintenance and compulsory inspection, etc.), which require significant amount of time and effort from the owner (not considering the money aspect).

2. It is probably the most **flexible, fast and comfortable** urban mobility solution (increases individual mobility e.g. compared with public transportation). It provides an even higher degree of freedom compared to private cars, because the free-floating characteristic allows for one-way trips and careless parking in the city. (Duncan, 2011 p. 364)

3. FFCS is a useful **travel demand management tool** (Duncan, 2011 p. 365). It increases efficiency, in a way that it gives an incentive for a conscious choice about travel. Since each and every ride will be booked and paid

separately, the user feels motivated to consider more directly, how much each trip costs ('pay-as-you-drive', incentive to avoid rush hours and traffic jams).

4. Another advantage of FFCS is that it **makes a car available** for those, who otherwise couldn't afford to owe one (or need one just occasionally). Unemployed people, students, etc can use a car relatively inexpensively, when in need of fast transportation, or carrying heavy packages, etc.

5. Theoretically FFCS could make it possible **not to tie the people to one car brand**, but allowing them to try out various models (cabriolets, sport cars, etc.). This could be a first personal experience (test drive), which could eventually end up in a purchase.[25] However, the uniform fleet of car2go could decrease the maintenance costs of the service provider (uniform spare parts, etc.), and presents a uniform brand image. (Koss, 2002 p. 217)

Advantages for the sake of the **'public good'**:

6. Since the FFCS vehicles are equipped with GPS technology, remote controlled security system, built-in communication, wireless data transmission tools, and remote controlled diagnostic (in-vehicle) sensors[26] (Shaheen et al., 2012 p. 80), they can contribute to the **increased control/monitoring of the traffic system** (increased safety). The advanced technology of the FFCS vehicles could help investigate accidents or crimes; or simply decrease the lag between the time of an accident and the call for an ambulance.

[25] This case is an advantage from the car producers' point of view as well.
[26] Maybe even applying built-in cameras in the future?

7. FFCS can **trigger technological innovation** (e.g. in the fields mentioned in previous point 6). Through providing the first personal experience (test drive), it can also help to shift the general mobility behavior towards electric vehicles, and provide crucial learning experience for the electric car developers.[27].

8. (Traditional) carsharing can help to **reduce the costs of real-estate development** through reduced parking requirements.[28] Real-estate developers can reduce their construction costs, if they include carsharing into their projects, which could reduce real-estate prices, and also promotes 'car-free living'. CS can achieve a reduction in obligatory parking spaces (normally one parking space for each apartment, or depends on the built square meter: floor area ratio), thus it can not only decrease the construction costs substantially; but it can also be used as a marketing scheme, to sell the apartments as: 'flats with carsharing'.[29] (Enoch and Taylor, 2006 p. 440)

9. An advantage often assigned for carsharing is its **synergy effects with public transportation** (cross-utilization). Although, it is rather hard to prove its real extent (and the effects of traditional carsharing cannot be directly equated for free-floating car sharing), it is a highly plausible scenario that consumers use FFCS one-way of their trip, while they travel with public transportation on the way back home. This effect is not necessarily an ecological advantage, meaning carsharing users not always drive less or ride more public transportation.[30] It simply means that carsharing and public transportation are inevitably connected in a mobility network.

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[27] In Stuttgart, Germany car2go offers exclusively electric-driven smarts
[28] FFCS could contribute to this point, if the local authorities would also permit the reduction of the obligatory parking spaces in the operating areas with high vehicle availability. (It is a less likely scenario today.)
[29] E.g. the 'Autofreie-Mustersiedlung' project in Floridsdorf (21st district, Vienna, Austria) launched by the Green Party in 1999. 250 apartments were built with only 25 parking spaces exclusively for carsharing vehicles, so they could save 9% of the total construction budget (1.6 Mio EUR). (Enoch and Taylor, 2006 p. 440)
[30] It is also highly plausible that some people replace the public transportation with the much more flexible and more comfortable FFCS service, thus they will drive more eventually.

10. Whether carsharing itself is a **more sustainable mobility solution**[31], is not dependably proven yet. Both cases are easily thinkable: in which one person stops using his car, starts riding a bike or public transportation, and uses carsharing only when it is unavoidable; while another person could feel that he finally can afford a car, and he replaces public transportation with FFCS (especially if he lives in a not well-covered area by public transportation). The final effect of carsharing on the aggregate mobility behavior will determine its environmental character. (Some scientists suggest that currently the effect is already positive: Firnkorn and Müller, 2011 p. 1527; Keller, 2000 p. 22; Martin, Shaheen & Likicker, 2010 in Shaheen et al., 2012 p. 72-73.)

[31] Public benefits would be, if proven: reduced vehicle ownership, reduced vehicle kilometers travelled, reduced greenhouse gas emissions, reduced parking demand in urban areas, reduced monthly transportation costs and the promotion of 'healthy' way of mobility. (Shaheen et al. 2012)

4.2. Disadvantages

Each of the following points describes a special aspect of free-floating carsharing that can be considered as a disadvantage.

Disadvantages from the **consumers' perspective:**

1. The **availability** of the FFCS cars can never be 100%, which means it can always happen that at a certain time, at a certain location there is no car available in the vicinity.[32] (Keller, 2000 p. 24) Of course 'vicinity' is a subjective term, that's why literature suggests choosing a distance, e.g. ~**500 meters**, as a threshold for availability. (Koss, 2002 p. 207; Sullivan and Magid, 2005 and Cervero et al., 2007 in Shaheen et al. 2012) According to this, if a free car is located within 500 meters from our standing point, that car is considered to be available. In this case our transaction costs are zero, meaning it is not a burden for us to walk the distance and rent the car. (In the inversed case, transaction costs apply, which can be even transformed into monetary values: check chapter 6.1)

2. Although a technological failure can always happen just as well with private cars, the **reliability** of the carsharing service depends significantly on the functionality of the technological instruments. The various built-in technologies have to operate well under every (weather) conditions; otherwise the consumer satisfaction will be hurt.

3. Renting an FFCS car requires a relatively high **extra time before and after the ride** compared to the private cars. Walking to the car, swiping the membership card, entering the personal PIN code, etc. takes precious minutes, especially when one is under time pressure. Although, in most of the cases the steps of the renting process take not more than 5 minutes, one has to calculate with this unavoidable extra time. (Koss, 2002 p. 201)

[32] This is a great disadvantage, since some rides (commuting, driving children to the kindergarten, etc.) require 100% availability.

4. Although, the public parking spaces throughout the city are pre-paid, and are included in the renting price; the issue of **searching for a free parking place** (especially in the city centre) is still an unsolved problem. According to Shoup, 2006 in Firnkorn and Müller, 2011 these extra cruises can account for more than 10% of all traffic in several cities, which contributes to the over-crowdedness of the city centers significantly. Moreover, it is still undecided, how does FFCS affect this issue: does it generate extra car traffic and decrease the number of free parking spaces, or vice versa. (Firnkorn, 2012)

5. The carsharing user – though he must agree with the terms of the **insurance contract** of the CSO, when signing up – he has no power influencing it.[33] However, in case of an accident or criminal wrongdoing, a problematic and long legal procedure (compared to the case with private cars) must start among three affected parties. (Shaheen et al., 2012)

6. The FFCS customer has to consider of course that the rented **vehicle is not personalized** to his special needs and wishes, which only a private car can provide.

Disadvantages from the **CSO's** or from the **public's perspective** respectively:

7. Since the carsharing user has no incentive to save fuel, or to ride carefully/slowly (on the contrary: with car2go the user pays less, if he gets to his destination faster), there is a **moral hazard** issue that needs to be solved.[34] Hidden problems (e.g. in the engine) are an unavoidable aspect of cars' nature; however, carefulness could prolong their life expectancy. In case of FFCS, the degree of amortization and life expectancy of the vehicles is unknown in the long run yet, but experience suggests that the

[33] Currently, the liability of the customer is 500 EUR.
[34] Citeecar in Berlin is allocating a 'host' to each car, who will be its overseer/keeper, he takes care of its cleanness, fills it up, etc. He gets free riding minutes in exchange of his service. (morgenpost.de, 2013)

lack of property rights is not motivating the users to take good care of the vehicles at all. This issue is not only making losses for the service operator, but can cause safety dangers for the users as well. (Koss, 2002 p. 219)

8. The average rides with the FFCS are rather short distances (5-10 kilometers); although **short rides increase environmental pollution**. The majority of harmful gas emission happens in the first few minutes after the start, while the catalytic converter is not operating on the right temperature. (Koss, 2002) (Firnkorn and Müller, 2011)

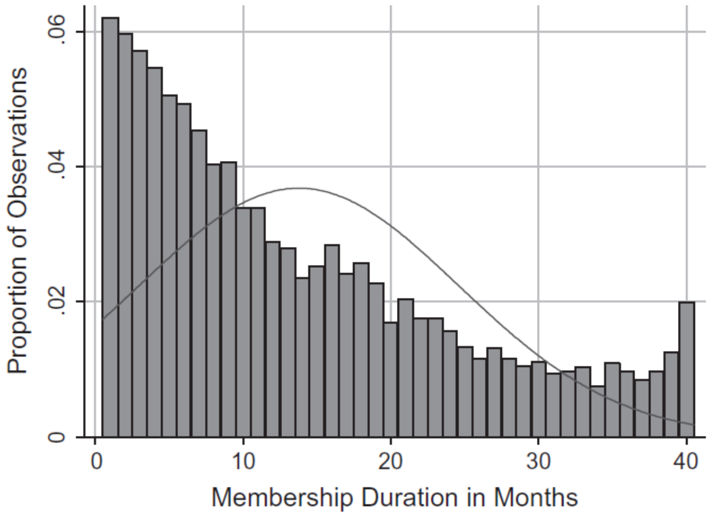
9. An **appropriate fleet size** could be determined in every city, not only from the CSO's perspective (profit maximizing fleet size), but also from the public's perspective as well. If the fleet size turns out to be too big, or the service seems to be too cheap, then it could generate extra car traffic and decrease the number of free parking spaces in the city. It is a sensitive trade-off balance that needs special attention. (Firnkorn, 2012)

4.3. Limitations of Station-based Carsharing

The general effects of traditional carsharing cannot be equated with the effects of free-floating carsharing. Concluding from one to the other can give misleading results, which must be avoided. That is why, it is crucial to collect the characteristics of traditional carsharing and highlight its differences from FFCS.

First of all, stationed-based carsharing is not suitable for spontaneous or one-way rides (obligatory reservation in advance), thus the usage is **less flexible**; only a much smaller customer base can adapt it to his mobility behavior (only for those with a rational user orientation (no SUV drivers) and a low annual VKT). Usually TCS service providers use a much more **complicated tariff system**: a combination of time- and distanced-based pricing (VC) coupled with a small monthly fee (FC), which are organized into different packages (like with mobile phone operators). They are segmenting the customers into more groups, offering the package everyone, which suits his mobility behavior the best. However, this tariff system makes the service way too complicated for the users, who appreciate the simple, quickly calculable pricing of the FFCS; moreover the monthly fixed costs require an unnecessary commitment from them. According to Nurul Habib et al., 2012, the proportion of inactive members at a TCS in Montréal, Canada is around 50-80%, while the average membership duration is about 14 months, as it can be seen on the graph on the next page. The graph shows that many people quit in the next couple of month after signing up (probably to avoid the compulsory monthly fee); although, those who stayed for at least a year, tend to remain members for a longer period. This is of course a very unfavorable symptom for the CSO, since it can only hold less than one third of the initial people, who were interested in carsharing.

Graph 4: Membership duration distribution at a CSO in Canada



Source: Nurul Habib et al. (2012, p. 248)

The stationed-based character (the car has to be returned to the departure station to end the rental) makes the service **unsuitable for commuting**, because even during the dwell time (work time), the customer must pay for the service[35]. That is why, experience suggests, the **typical user behavior** is to use this service for pre-planned family trips and shopping routes (primarily in the weekend) (Koss, 2002 p. 134), or sometimes instead of a second car by the housewife. (Keller, 2000 p. 64) According to Nurul Habib et al., 2012, a TCS in Montréal, Canada is used 3.9 times per month by a customer on average. However, even this demand can result in **bottlenecks** in the weekends and on public holidays, because the TCS is less flexible for demand fluctuations. There can only be fix number of cars per stations (usually one car per station), and if it is taken, the whole neighborhood (location cluster) remains without a car to rent.

All in all, the traditional carsharing can rather be considered as a **'modern rent-a-car service'**, which is much more flexible and cheaper[36] than the traditional rental services (for a detailed comparison check table 1 in chapter 2).

[35] FFCS is also not perfectly suitable for commuting to work, because it is not available 100% of the time.

[36] The biggest saving element is that the renting process is automated instead of employing commercial personnel.

Interestingly, since the 1970s (up until recently), traditional carsharing **was made for pure environmental concerns**: according to an old standardization initiative of the ecs (European Carsharing Association), the free-floating carsharing wouldn't even belong to the carsharing services, because it does not meet the following criteria of the ecs about the terminology (Keller, 2000 p. 146):

- Minimum ratio: 10 members per car
- No 'fun' cars allowed (fuel efficiency favored)
- Tariff mustn't be cheaper than the comparative public transportation service
- Tariff system must provide incentive to drive less
- Minimum rental time: 1 hour
- Customers have to be members at a CSO

5. Prerequisites of Successful Operation

This chapter tries to collect all the success factors that are necessary for operating a successful carsharing service, thus in a way these factors can be considered as prerequisites of a profitable business. The chapter aims for completeness using enumeration.

The following ten requirements, when met, increase the chance of profitability (successful business) significantly:

1. First and foremost, using a carsharing service **must provide** (cost) **savings** or some kind of personal utility benefits (e.g. time savings as discussed in chapter 3) for the customers. (Duncan, 2011 p. 363) The best way to report this signal towards the people is a clear and simple pricing system, which helps them to perceive this advantage. The most basic way to estimate for the cost saving potential of carsharing is to compare its price with the corresponding **vehicle ownership costs**. (Of course in countries, where car ownership is relatively more expensive, carsharing has a better chance for success.) This comparison is a key element in estimating the viability of carsharing, that's why it will be deeper analyzed in a primary research in chapter 6.1.

2. The second key element of the viability of carsharing is a **high degree of vehicle availability** (and technical reliability). There must be a car available for rent, whenever and wherever the potential customer needs it, otherwise the CSO not only falls away from some income, but the customer satisfaction will be harmed as well (High transaction costs for the customers, if they have to walk a long distance to get a free car). In order to avoid this situation, the appropriate fleet size must be estimated, which can

provide a required degree of availability.[37] (Realistically, the vehicle availability can never reach 100%, but with an appropriately high number of vehicles, this value can be approximated.) The degree of availability and the appropriate fleet number will be estimated in a primary research example in chapters 6.2 and 6.3 respectively.

3. Another prerequisite carsharing has to overcome still, is the issue of relatively low **service recognition**. The novel business model of carsharing (especially FFCS) is relatively unknown for the wide population; confusion with e.g. carpooling is an everyday occasion. On the other hand, carsharing must reach large-scale, so it can provide significant aggregate benefits for the public, and reach profitability for the CSO. The way to bear down this obstacle is the enhanced use of marketing and communication tools, which require usually great financial investments. (Enoch and Taylor, 2006 p. 436)

4. Carsharing (FFCS especially) can only operate in (high density) **metropolitan/urban areas**, where the high population concentration provides a constant (higher level) of demand, and keeps the vehicles more actively used. Integration of carsharing into a mobility system (e.g. cross-utilization with public transportation) is also a prerequisite, and increases the chance that the service meets the mobility behavior patterns of a larger population.

5. In order to lower the effects of the moral hazard issue discussed in chapter 4.2, carsharing can better function in (‘developed’) cities, where the rate of car thefts and vandalism is low, and the culture ensures a **higher level of respect against public and private goods**.[38][39] The long-term life expectancy of the carsharing vehicles remains unknown, but surely the fines from speeding and parking tickets and the cost of spare parts due to physical damage must be kept low, in order to reach profitability.

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[37] Also, according to Nurul Habib et al., 2012 p. 251, a high number of available cars can result in higher frequency of usage.
[38] No wonder that Switzerland is the root of carsharing. (‘Eidgenossenschaftsgefühl’)
[39] In Germany, a certificate of good conduct (‘Leumundszeugnis’) used to be a prerequisite of membership in some CSO-s as well.

6. The reason, why carsharing became a trend only in the past few years is the recent breakthrough in **technological innovation**. It was necessary to make the renting procedure smooth enough for the customers; and the operation of the cars safe enough for the service provider. Especially the automation of the billing process was a big step towards profitability, which can provide minimal outstanding liabilities for the CSO, and ensures that the money is transferred to the CSO's bank account the day after usage (balanced cash flow).[40] The table below collects all the technologies that are usually built-in a carsharing vehicle.[41]

Table 2: List of carsharing technologies

Technologies	Mechanism	Purpose
Vehicle control and security	Door lock controls	Manage access
	Remotely controlled security system	Prevent theft
	Engine disable	Prevent theft
	In-vehicle sensor network	Detect accidents or parts theft
Data recording and transmission	Global positioning system (GPS) tracking that combines satellite navigation and vehicle tracking (e.g., time, distance traveled, speed)	Record vehicle use to satisfy personal vehicle sharing legislation requirements (e.g., records identifying the date, time, initial and final vehicle locations, and kilometers/miles driven); vehicle tracking to prevent theft; and operational data collection and analysis
	On-board diagnostic parameters (e.g., fuel used, emissions, engine load)	Vehicle operational data collection and analysis (e.g., environmental impact assessment)
	Wireless data transmission	Real-time data recording
	In-vehicle communication	Emergency response and reservation changes

Note: In-vehicle data recording and transmission devices are commonly referred to as telematics (combined computer and wireless communication systems).

Source: Shaheen et al. (2012 p. 80)

7. This prerequisite is a general condition in almost every B2C business with an enhanced consumer orientation. Hence, the service configuration has to **always adapt to the customer behavior**; follow its changes and account for the feed-back. Carsharing is still week enough to fail, if the connection to the customers is lost. (Fliegner, 2002 p. 202)

[40] Before automated billing, the customers paid on a monthly basis.
[41] According to Shaheen et al., 2012 p. 78, the costs of equipping a car with such technology is around 400-800 EUR/car.

8. Moreover, the service configuration have to take into consideration the **local factors** and customs (tradition towards taxi or public transportation), which can modify the service parameters from the pricing system, till the size of the operation area.[42] All in all, as Enoch and Taylor, 2006 put it: *"Carsharing is likely to only be economically viable in rather specific locations where the right cultural, geo-demographic, economic, political and transport elements are in place."* (Enoch and Taylor, 2006 p. 435)

9. Another exclusive prerequisite is the **acceptance by the local authorities**, which determines the conditions of providing public parking spaces. These conditions are usually negotiable; and its qualities are depending significantly on the applied policies of the city towards transportation (long-term mobility strategies, transportation policies, etc.). From the CSO's point of view, it makes a huge difference financially, if it has to pay more thousands of Euros after each car per year, or perhaps it can get the parking places free of charge.[43]

10. Last, but not least, the long-term success of carsharing can be enhanced by handling the following future challenges. Mainly due to legal reasons, the **interoperability between countries** is not always possible yet. Using all the different branches of the same CSO with one membership-card (one registration) would increase the service value of carsharing significantly; providing a much higher potential benefit for the customers. The other side of the same coin (namely to bear down the obstacles of limitless travelling), is the potential in offering **short-term membership-cards for tourists** (perhaps coupled with a special offer), who shouldn't be included in the normal customer base, but they would still count as a large customer segment, worth exploiting.

[42] Currently, car2go in London, UK can only operate in the outer districts of London, and not in the inner ones, or in city centre.
[43] In many cities the parking fees of car2go are revised annually, based on the time they spent in paid parking in the previous year. This can be proven by the collected GPS data of the cars.

As a final remark, it has to be mentioned that in general **governmental subsidy** should not be considered as a prerequisite of success. The carsharing industry is still in its premature consolidation phase, when as a natural process, many players will be forced to exit the market. In this situation, governmental subsidy counts even as a form of discrimination, which provides undeserved benefit for one competitor against the other. (Of course, the competition is severe: there are rather high entry barriers, as well as a first-mover advantage effect; moreover, the type of competition varies from city-to-city, depending on the strategy of the local competitors: a price competition, differentiation (segmentation), or a quality/quantity competition is also imaginable.)

6. Viability of car2go in Vienna

This chapter comprises the primary research part of the thesis. Based on the key-element success factors discussed in chapter 5, the example of the car2go free-floating carsharing service of Vienna, Austria will be further analyzed. In the three following sub-chapters, the cost saving potential, the degree of vehicle availability and the appropriate fleet size of car2go in Vienna will be estimated respectively.

6.1. Cost Saving Potential

Crucial is to estimate the **break-even point** of money saving between car2go usage[44] and private vehicle ownership. This comparison can underlie the argument for car2go's viability the most; it can help the customers to decide about joining car2go, while matching the results of the analysis with their own mobility behavior.

In order to get undistorted results, a **car ownership scenario** was configured, which uses approximately the same Daimler smart fortwo™ car, as car2go uses in Vienna. [45][46]

The **average costs** of this vehicle were estimated **over five years** of usage[47], and were allocated into **three different sub-scenarios**: namely a cheaper scenario (lower purchase cost, somewhat lower operating costs), a more expensive scenario (higher purchase cost, somewhat higher operating costs), and a scenario without resell of the initial car after five years (since the resell price reduces the total costs significantly). The three scenarios together determine a more realistic

[44] Costs are based on the valid car2go tariff in July 2013.
[45] Of course the SUV owners would achieve money savings simply by downgrading the vehicle they use for a more economical Smart.
[46] Although car2go uses special/modified smart car2go edition vehicles, the costs of the same car were approximated by configuring a smart fortwo coupé™ with a 52 kW gasoline engine, leather seats, air-conditioning system, GPS navigation system, basic steel wheels, electric windows, etc.
[47] Assuming Viennese-based operating and maintenance costs

upper and lower bound of a threshold range (zone), what can be better used for further real-world estimations (determination of only one break-even point may be misleading).

The applied costs of the 'expensive' sub-scenario can be seen on the graph below, while the two other cost tables can be found in appendix 2. The underlying idea in the construction of the cost tables is to approximate all the expenses, what are included in the car2go rental price as well. (That's why the purchase of winter tires and annual highway stickers are included in the total costs as well.) The table shows that the fuel consumption and the maintenance costs are considered as variable costs (depended on the travelled distance), while all the other cost elements are handled as fix costs.

Table 3: Vehicle ownership cost table[48]

smart 'expensive' scenario						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total cost
Fix Costs						
Purchase price	13 000,00 €					13 000,00 €
Resell price					-4 500,00 €	-4 500,00 €
Registration fee	185,25 €					185,25 €
Vehicle Inspection Sticker	40,00 €			40,00 €		80,00 €
Insurance (with vehicle tax)	850,00 €	850,00 €	850,00 €	850,00 €	850,00 €	4 250,00 €
Highway vignette	80,60 €	80,60 €	80,60 €	80,60 €	80,60 €	403,00 €
Winter Tires	300,00 €					300,00 €
Cleaning	40,00 €	40,00 €	40,00 €	40,00 €	40,00 €	200,00 €
Parking Permission (for residents)	138,20 €	120,00 €	120,00 €	120,00 €	120,00 €	618,20 €
					Total Fix Costs:	**14 536,45 €**
Variable Costs						
Maintenance	300,00 €/10 000 km					
Fuel Consumption	0,0658 €/km					

48 Cost estimation resources: Purchase price: www.smart.at; Resell price: www.autoscout24.at www.eurotaxglass.at; Registration fee (KFZ-Zulassung): www.help.gv.at; Vehicle Inspection Sticker (KFZ-Pickerlkosten): www.wien.arbeiterkammer.at; Insurance calculator: www.durckblicker.at; Highway sticker: www.asfinag.at; Winter tires: www.idealo.at; Parking permission (Parkpickerl): www.wien.gv.at;

Moreover, the following **exogenous variables** were used in the analysis:

- The average speed of cars in the city of Vienna is approximately 25 km/h, as it was already mentioned in chapter 2.2. (Trunk, 2010 p. 13) However, as a benchmarking line a somewhat faster (35 km/h) scenario will be discussed as well, since the cost saving potential depends greatly on the achieved average speed (plausible maybe outside the rush hours).
- The fuel consumption value of a smart in the city is approximately 4.5 – 4.7 liter/100 km, depending on the style of usage. (smart.at, n.d.)
- The average gasoline price used in the analysis is 1.4 EUR/Liter. (spritbarometer.at, n.d.)

The **cost of car2go usage** was calculated as follows: Based on the pricing system of car2go described in chapter 2.2, the average rental price per minute is 0.2787 EUR[49] (16.72 EUR per hour), which using the average speed of 25 km/h, gives us a kilometer price of **0.6689 EUR/km**, while using a speed of 35 km/h, the price is **0.4478 EUR/km.**

Finally, the result of the cost comparison can be seen on the graph on the next page. The chart comprises the three car ownership cost scenarios (green, red, yellow lines), the two car2go cost scenarios (dark and light blue), moreover as a benchmarking, the Viennese taxi costs[50] (purple line), based on the valid taxi tariff table in appendix 1.

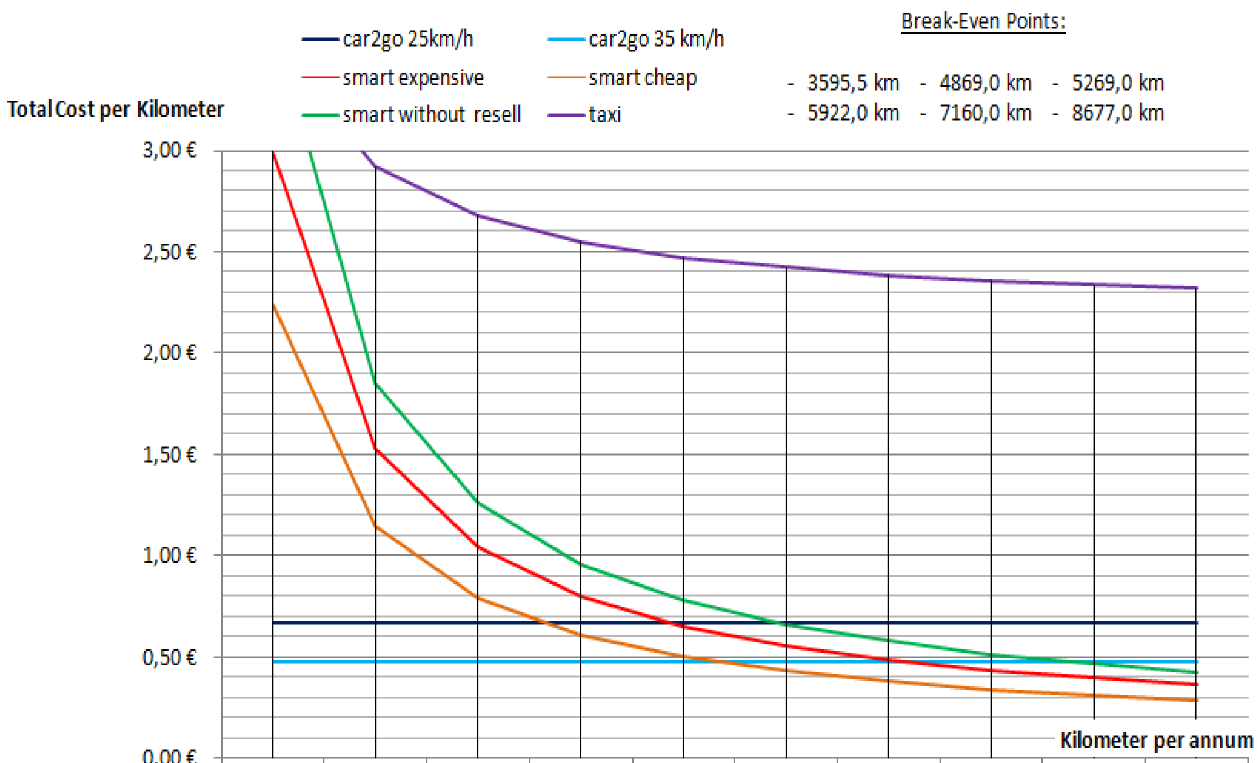
The graph shows the total costs per kilometer for the upper mentioned scenarios for the annual travelled distances between 1,000 and 10,000 kilometers (The less significant, however very interesting 0-1000 km/year part of the graph can be found in appendix 3). From this, we can conclude that car2go has a certain cost advantage for less than 3595.5 km per year, while for more than 8677.0 km driven

[49] Using the minute prices of the 1st hour, since from the 45th minute onwards, the user pays the maximum hourly price: 12.9 EUR (not considering the discount of the daily maximum rental price, which applies from the 266th minute onwards only).

[50] Since the taxi kilometer price depends on the travelled distance, for the purple line it was assumed that the customer rides a taxi one time per day (a distance which adds up to the labeled yearly sum).

annually, owning a smart is the more favorable choice. The break-even points between the two values are depending greatly on one's mobility behavior (driving style, etc.); as a rule of thumb, the **4869.0 km/year break-even point** will be used in the following.

Graph 5: Break-even points



	1000	2000	3000	4000	5000	6000	7000	8000	9000	10000
car2go 25km/h	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €	0,6689 €
car2go 35 km/h	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €	0,4778 €
smart expensive	2,9791 €	1,5254 €	1,0409 €	0,7986 €	0,6533 €	0,5563 €	0,4871 €	0,4352 €	0,3948 €	0,3625 €
smart cheap	2,2313 €	1,1491 €	0,7884 €	0,6081 €	0,4999 €	0,4277 €	0,3762 €	0,3375 €	0,3075 €	0,2834 €
smart without resell	3,6313 €	1,8491 €	1,2551 €	0,9581 €	0,7799 €	0,6610 €	0,5762 €	0,5125 €	0,4630 €	0,4234 €
taxi	3,5187 €	2,9175 €	2,6786 €	2,5490 €	2,4727 €	2,4216 €	2,3837 €	2,3564 €	2,3343 €	2,3174 €

However, the **limitations** of the graph have to be mentioned as well. The comparison doesn't account for the annual inflation (ever so little it is in Austria: 2.3% in 2012); moreover one should consider that car2go's usability is rather limited for 'inside the city' rides, while private cars doesn't have this constraint.[51] Of course, this reduces the real value of the comparison significantly.

[51] The average driving distance with car2go is 5-10 km, the rental can be ended only within the operation area; while private cars can be used freely, the average driving distance depends solely on the driver's decision.

In the next step, the analysis is extended with the **issue of the short-term parking costs**, which occur independently from the travelled distance, although they usually represent a rather significant amount in the total costs. In order to estimate for the order of magnitude of the monthly parking costs, the following scenarios were assumed, collected together in the table below.

Table 4: Monthly total costs including parking and transaction costs

			Monthly Total Cost						
			smart ownership				car2go		
			No dwell	Dwell			No dwell	Dwell	Transaction
Km per annum	Tour length	# of tours a week		2h	1h	10min		10min	Cost
15600		10	€ 335,61	€ 355,61	€ 345,61	€ 335,61	€ 869,57	€ 888,57	€ 882,13
12480		8	€ 316,95	€ 332,95	€ 324,95	€ 316,95	€ 695,66	€ 710,86	€ 705,71
9360	30 km	6	€ 298,28	€ 310,28	€ 304,28	€ 298,28	€ 521,74	€ 533,14	€ 529,28
6240		4	€ 279,61	€ 287,61	€ 283,61	€ 279,61	€ 347,83	€ 355,43	€ 352,85
3120		2	€ 260,94	€ 264,94	€ 262,94	€ 260,94	€ 173,91	€ 177,71	€ 176,43
7800		10	€ 288,94	€ 308,94	€ 298,94	€ 288,94	€ 434,79	€ 453,79	€ 447,35
6240		8	€ 279,61	€ 295,61	€ 287,61	€ 279,61	€ 347,83	€ 363,03	€ 357,88
4680	15 km	6	€ 270,28	€ 282,28	€ 276,28	€ 270,28	€ 260,87	€ 272,27	€ 268,41
3120		4	€ 260,94	€ 268,94	€ 264,94	€ 260,94	€ 173,91	€ 181,51	€ 178,94
1560		2	€ 251,61	€ 255,61	€ 253,61	€ 251,61	€ 86,96	€ 90,76	€ 89,47
2600		10	€ 257,83	€ 277,83	€ 267,83	€ 257,83	€ 144,93	€ 163,93	€ 157,49
2080		8	€ 254,72	€ 270,72	€ 262,72	€ 254,72	€ 115,94	€ 131,14	€ 125,99
1560	5 km	6	€ 251,61	€ 263,61	€ 257,61	€ 251,61	€ 86,96	€ 98,36	€ 94,49
1040		4	€ 248,50	€ 256,50	€ 252,50	€ 248,50	€ 57,97	€ 65,57	€ 63,00
520		2	€ 245,39	€ 249,39	€ 247,39	€ 245,39	€ 28,99	€ 32,79	€ 31,50

In **case of the car2go** the public parking spaces are pre-paid in the rental price; the customer doesn't have to bother buying an hourly parking ticket (he typically terminates the rental at the destination location). On the other hand, in case of a short (e.g. 10 minutes) stopover, the customer doesn't always end the rental (risking of losing the car to another person), but instead he keeps it and pays a reduced minute price (0.19 EUR/minute) for the duration of the stopover. This value has been added to the monthly costs in the table above ('10 min. dwell car2go' column).

In **case of private cars**, the parking issue is inversed. While a 10 minute long stopover doesn't account for any extra costs[52] (no dwell column and 10 min. dwell column values are the same); the hourly fee of a public parking space costs 2 EUR in Vienna, which increases the monthly total car expenses significantly, as the number of weekly tours are increasing.[53]

The last extension of the cost analysis deals with the **issue of 'transaction costs'**. As it was already mentioned in chapter 4.2, if a free car2go vehicle is located within 500 meters from our standing point, then the car is considered to be available. In this case, our transaction costs are zero, meaning it's not a burden for us to walk the distance and rent the car. However, if the free car is located further than 500 meters, transaction costs apply, which can be even transformed into monetary values (Duncan, 2011 p. 368).

As it will be explained later in chapter 6.2, on average 22% of the time, there is a free car2go only further than 500 meters in Vienna (the average distance to these 'far' cars is 688 meters). Using the 'conversion rate' introduced by Duncan, 2011: the cost of walking 688 meters to a free car is 5.71 EUR, which value was also considered in table 4 above (transaction cost – car2go column)[54].

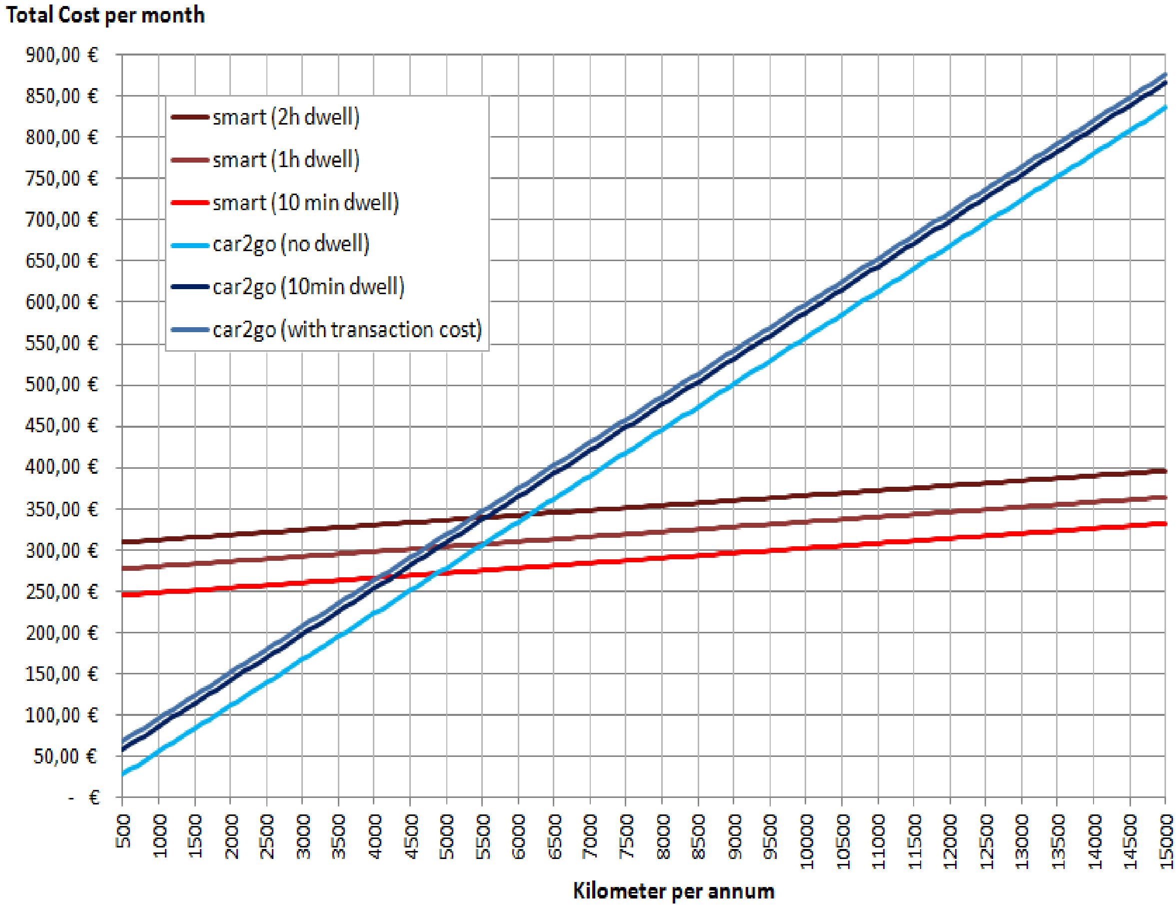
The values of table 4 are converted in a graphically much more straightforward graph below. Here – next to the basic car2go and car ownership scenarios with no short-term parking costs and no transaction costs – it will be assumed that there are eight rides per week, four of which are spent in paid parking (one and two hours respectively).

The graph shows that the original 4869.0 km/year break-even point (intersection of light blue and light red lines) increases in favor of car2go, if we account for short-term parking costs with the private car (more than 6000 km/year in case of the 'two

[52] Maximum 15 minutes parking is free of charge in Vienna.
[53] It was assumed, that 50% of the weekly routes are spent in paid-parking zones (one and two hours long respectively).
[54] In 22% of the weekly routes this extra cost applies.

hour dwell' scenario); however, if we consider the extra transaction costs as well, which apply 22% of the time in case of getting a car2go, the **new break-even point** is around **5500 km/year** (intersection of the gray-blue and dark red lines).

Graph 6: Monthly total costs break-even points



6.2. Degree of Vehicle Availability

The issue of availability is the second key prerequisite for a viable carsharing service (detailed in chapter 5), what is going to be analyzed now in detail. The degree of vehicle availability tries to estimate: **What is the average probability that a free car2go is located within 500 meters?**

This measure is not only important from the customers' point of view (service with high degree of usability), but also for the service provider, because he can indirectly conclude for his **opportunity costs**. Namely, how many rides didn't happen (thus producing no income), because a car was not available?

In order to estimate for this, the following primary analysis was concluded. **Ten random, pre-defined locations** were chosen throughout Vienna (for a graphical illustration of the ten points relative to the operation area of car2go, check the graph in appendix 4); for these points the distance to the closest available car was checked for **ten days, seven times per day**.[55][56][57]

To get the **minimum distance in meters**: first, the GPS coordinates[58] had to be converted into meter values. Taking into account the shape of the earth, this gives the following approximate conversion rates at the coordinates of Vienna: latitudinal value: 1=111320 m; longitudinal value: 1=106650 m. (ncgia.ucsb.edu, n.d.) After that, the Euclidian distance[59] was measured between the pre-defined points and the locations of each free vehicle in the database. Finally, by setting the desired observation times (at every uneven hour sharp between 09:00 and 21:00 daily), the closest free car with the minimum walking distance could be determined.

[55] A real-time public database of the free car2go cars (plate numbers, GPS coordinates included) is available at: http://cardivvy.com/view.php?location=wien (last access: 06.07.2013)
[56] The data was automatically collected (logged) in an Excel table, with the help of a Java Script, which ran repeatedly in every ten minutes.
[57] Dates of the data collection: 02.06.2013-11.06.2013 (every day between 09:00-21:00)
[58] Decimal degrees system used by e.g. Google Maps
[59] Parks and other walking shortcuts allow a movement nearly in a straight line in such 'short' (couple of hundred meters) distances.

For each location, a **summary table** was made; two examples can be seen on the tables below (the rest of the tables can be found in appendix 5). The values of the tables represent meter distances; the columns are the observed dates; the rows are the observation times of the day. The green values represent the cases, when a free car was located within 500 meters; while the yellow color signals the cases of 'far' cars (a free car was available only further than 500 meters). The highlighted percentage in the upper right corner describes the location's degree of vehicle availability: it is the ratio of the amount of green values to the whole number of cases (in case of location 1 below: 47 over 70).

Table 5: Location 1 - Summary table (values in meters)

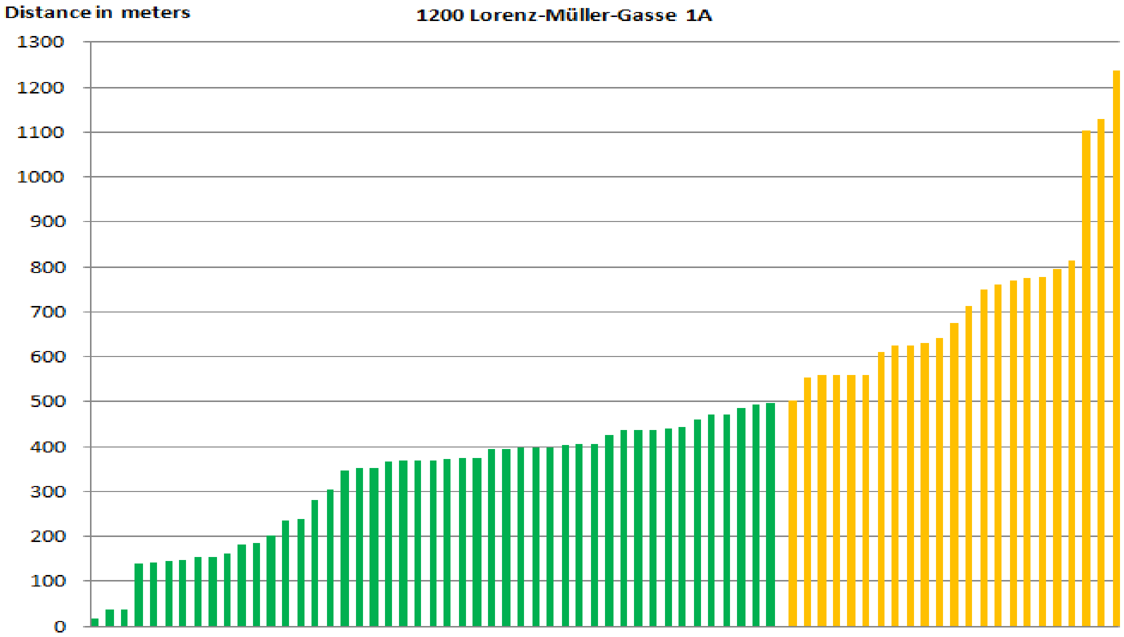
1	1200 Lorenz-Müller-Gasse 1A					48.244189,16.368769					67,14%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	153,1	1130,4	282,0	*437,8*	402,8	642,4	471,2	*36,3*	*558,6*	750,8	486,5	296,5	454,5
11:00	153,1	769,7	441,2	437,8	405,7	1238,7	795,6	36,3	558,6	501,5	533,8	323,9	471,3
13:00	425,6	610,9	353,2	437,8	405,7	623,6	370,3	142,3	711,8	495,3	457,6	154,6	431,7
15:00	183,5	374,9	353,2	777,6	486,3	366,6	630,5	202,3	623,4	236,2	423,4	190,9	370,7
17:00	396,5	553,6	460,7	371,4	676,8	443,8	374,6	238,1	368,7	394,9	427,9	112,6	395,7
19:00	396,5	303,4	369,2	774,9	761,6	495,8	1103,5	558,6	184,8	394,9	534,3	260,2	446,1
21:00	814,6	*399,1*	16,4	148,3	347,4	*471,2*	138,9	558,6	144,7	162,1	320,1	232,7	254,7
Mean	360,4	591,7	325,1	483,7	498,0	611,7	554,9	253,2	450,1	419,4	454,8		
Dev.	217,2	264,8	137,6	207,9	146,6	271,4	295,5	205,6	204,3	178,6		245,3	
Median	396,5	553,6	353,2	437,8	405,7	495,8	471,2	202,3	558,6	394,9			415,7

Table 6: Location 2 - Summary table (values in meters)

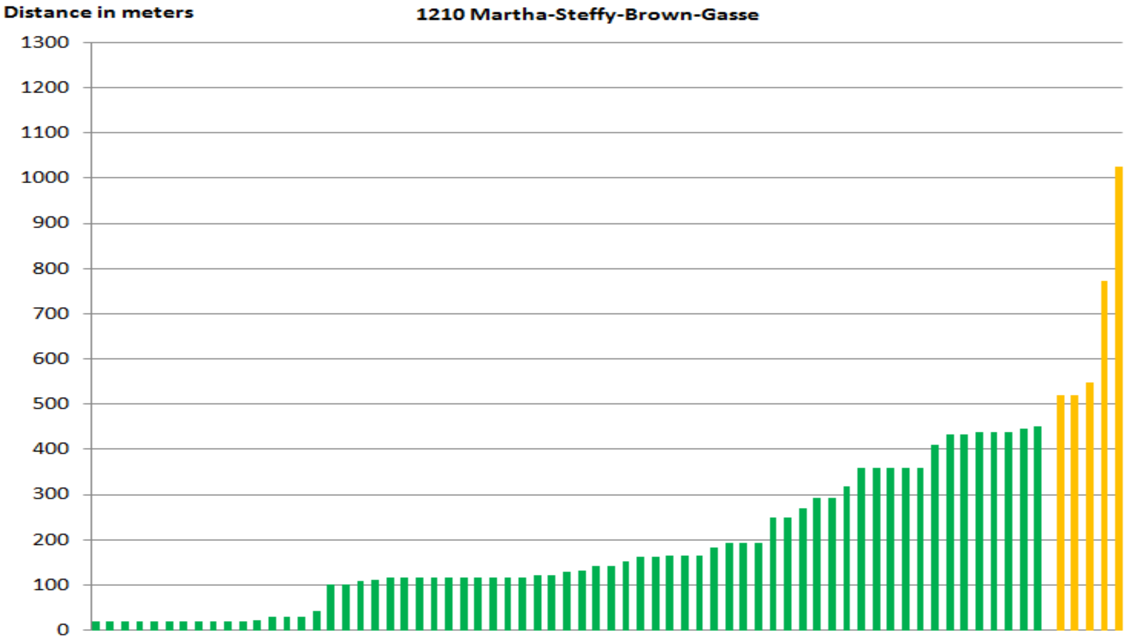
2	1210 Martha-Steffy-Brown-Gasse					48.26938,16.405854					92,86%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	358,6	102,0	433,4	115,8	548,6	111,7	269,1	18,3	116,9	410,5	248,5	170,6	193,0
11:00	358,6	116,9	433,4	115,8	142,6	120,6	444,8	18,3	116,9	130,6	199,9	144,2	125,6
13:00	358,6	116,9	109,9	115,8	142,6	29,0	318,7	18,3	165,9	163,0	153,9	104,0	129,7
15:00	358,6	116,9	183,4	115,8	153,3	29,0	18,3	18,3	165,9	163,0	132,2	96,7	135,1
17:00	358,6	129,6	41,7	115,8	164,7	29,0	18,3	18,3	193,0	438,7	150,8	138,4	122,7
19:00	450,1	520,8	22,8	248,8	1025,5	293,7	18,3	18,3	193,0	438,7	323,0	293,5	271,2
21:00	102,0	520,8	122,3	248,8	772,2	293,7	18,3	18,3	193,0	438,7	272,8	229,6	220,9
Mean	335,0	232,0	192,4	153,8	421,3	129,5	158,0	18,3	163,5	311,9	211,6		
Dev.	100,2	182,8	160,1	60,1	337,5	110,0	168,4	0,0	31,6	139,0		192,4	
Median	358,6	116,9	122,3	115,8	164,7	111,7	18,3	18,3	165,9	410,5			142,6

If the observation values are transformed in **histograms** (in ascending order), it gives us the following straightforward graphs, as it can be seen below for location 1 and 2 (the rest of the graphs can be found in appendix 6). The size of the observed columns differ greatly on graph 7 (less staggered as e.g. location 2 on graph 8), which implies a rather high fluctuation of the vehicles at this location.

Graph 7: Histogram of location 1



Graph 8: Histogram of location 2



The average results of the ten pre-defined locations are collected in the table below. From this, we can conclude for an **average degree of vehicle availability of 78%**, which represents an average distance of 347.9 meters to the closest free car2go car. However – as it was mentioned in chapter 6.1 – 22% of the time there is only a 'far' car available in an average distance of 688 meters.

Table 7: Summary table of degree of vehicle availability

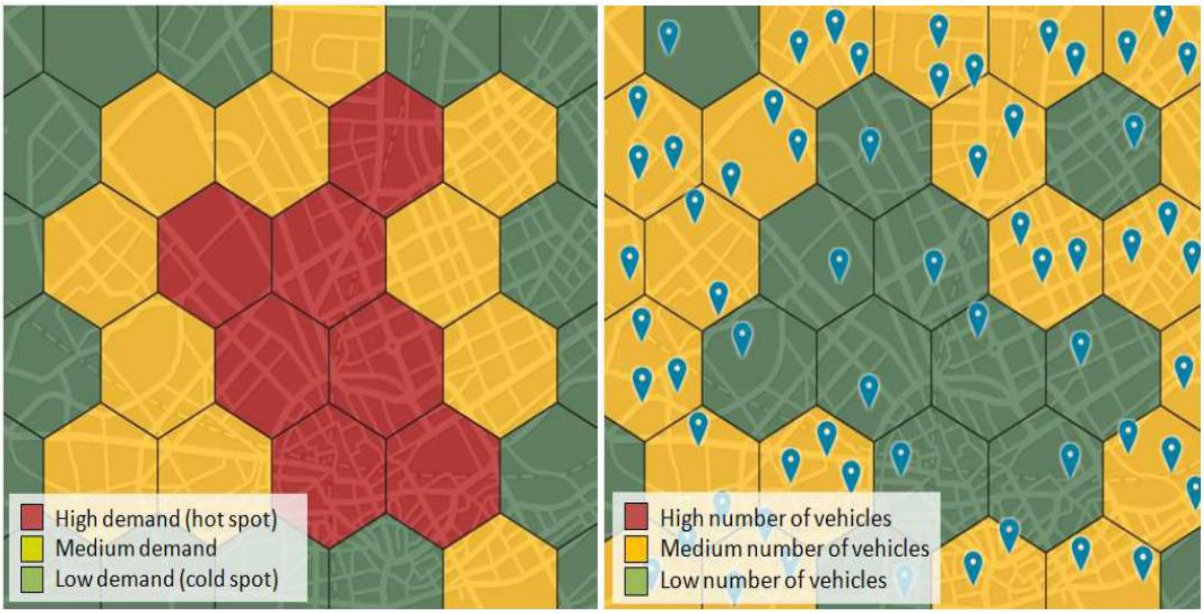
Average Availability	78,00%
Deviation Availability	14,20%
Minimum Availability	50,00%
Maximum Availability	97,14%
Mean Distance	347,9
Deviation Distance	226,4
Median Distance	302,1
Minimum Distance	8,4
Maximum Distance	1336,0
Mean Distance to far cars	688,0
Mean Distance to close cars	252,7

It must be mentioned that there are some **limitations** of this analysis (reducing its real world value), which are mainly caused by the short data collection window. It raises the issue of **seasonality**, which could distort the results in an unknown direction (the weather conditions during the data collection were especially rainy). Moreover, the small number of pre-defined points cannot provide a full representative result for the whole city of Vienna; the determined average degree of vehicle availability can only serve as a general rule of thumb, which can be applied to help the people in making their decision about using car2go.

About the differences between the various locations, the following conjecture can be made in general. The **demand of a location 'cluster' depends** on its (Weikl and Bogenberger, 2012 p. 359):

- Relative attractivity: the number/size of attractors in the zone (companies, cultural institutions, universities, popular transportation stations, etc.)
- Population density
- Demographic parameters
- Purchasing power
- Parking options: a car can appear only, where it can be parked
- Relative location: e.g. closeness to the border of the operation area.

Graph 9: Illustration of location clusters



Source: Weikl and Bogenberger (2012 p. 359)

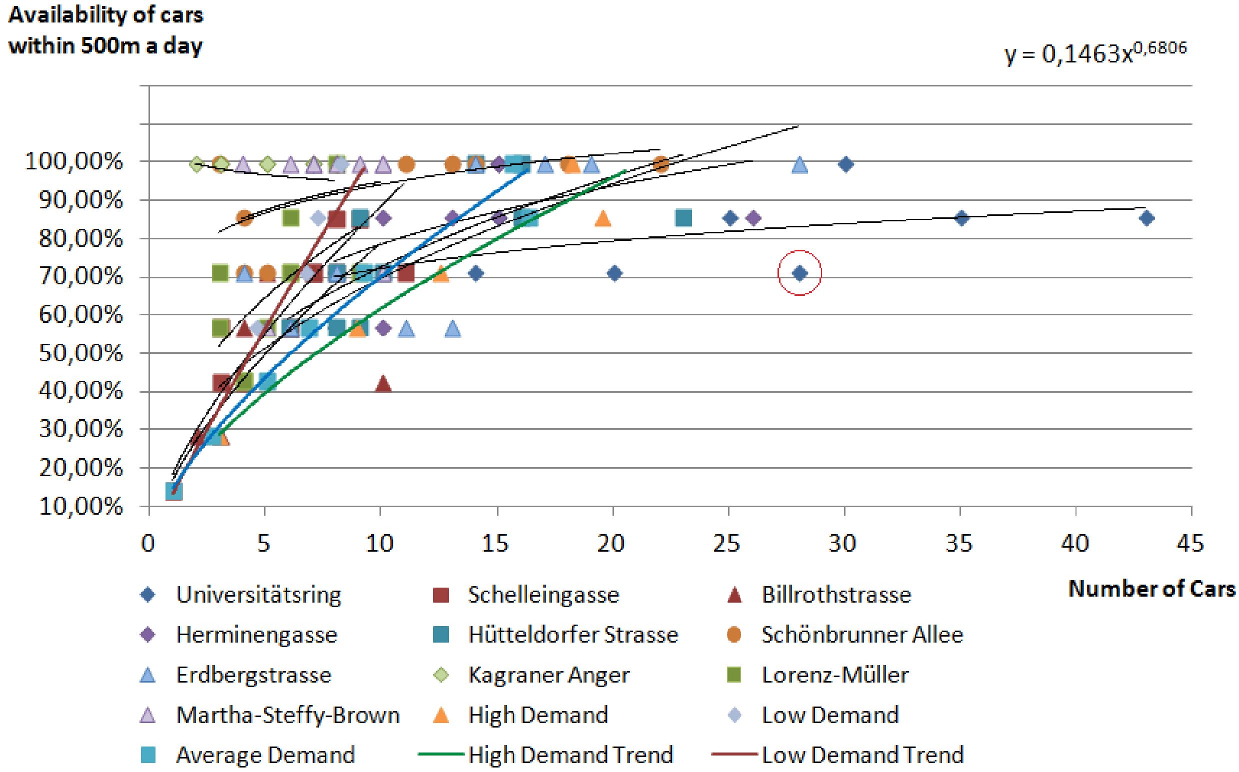
These are the most important factors that influence the natural placement of the vehicles, and determine the **long-term mobility pattern of each cluster** (hot-zones, cold-zones: for a general illustration, check graph 9). Although, a precise demand model based on these influence factors would be extremely complicated to make (ex ante forecasting tool); with continuous monitoring of the data, the service provider would be able to identify repeating demand patterns (ex post), and perform adjustments (fine-tuning) in the service (Weikl and Bogenberger, 2012 p. 359). This could also help to justify the **reallocation strategy** of the CSO[60], which is a very costly action in carsharing; it should be performed only, if the additional earnings compensate for the extra costs (and opportunity costs) of the reallocation (this is the general criteria).[61]

[60] Reallocation is the controlled displacement of the cars to a more demanded location. More about the FFCS reallocation can be found in Weikl and Bogenberger, 2012.
[61] E.g. a vehicle should be reallocated, if it hasn't been used for X hours (pickup and delivery problem); or buffer depots can be used with additional vehicles at hot spots (e.g. at sport events).

6.3. Estimating the Appropriate Fleet Size

Based on the results of the analysis in chapter 6.2, the current fleet of car2go (600 cars) is providing a 78% vehicle availability on average. Theoretically, with an appropriately chosen number of vehicles, this value can be increased till a required (pre-defined) level. Using the available data about car2go, in this subchapter, the appropriate fleet size will be estimated.

Graph 10: Appropriate fleet size estimation



The colorful points in the graph above represent the relationship between the availability percentages on any given day at one pre-defined location, and the number of different vehicles within 500 meters on that day (identified using plate number information). E.g. the red circled point on the graph means that at the observation location 'Universitätsring', on one day during the data collection, there were 28 different cars available within 500 meters, which resulted in 71.43% vehicle availability that day. Putting all the locations and all the observation days to one graph, we can identify the **concave trend lines** we were looking for.

The **black lines** on the graph above represent the trend lines of each individual location (tracing out a nice concave relationship of the axes); the **red line** is the trend line of the 'low demand'[62] locations cluster (theoretically, at these locations a 100% availability can be reached already with approximately ten cars per day); while the **green line** is the trend line of the 'high demand'[63] locations cluster (here, theoretically, more than 20 cars per day are needed for a 100% availability).

The **blue line** is the trend line of all locations combined (in the upper-right corner of the graph above can be found the function of this trend line), which can be used to estimate for the appropriate fleet size. As it can be seen on the table below, if we set the **'required' availability to 95%**, the trend line function gives us an **appropriate fleet size of ~731 cars**. This is the amount of cars, car2go should use in Vienna, so the customers could reach a free car within 500 meters 95% of the time.[64]

Table 8: Appropriate fleet size table

Availability Now	78
Required Availability	95
Fleet Number Now	600
Y value now	11,3777
Required Y value	13,8574
Appropriate Fleet Size	**730,7692**

Of course, the **limitations** of the initial analysis are still valid, meaning that the estimation about the 731 cars is nothing more than just a rule of thumb, when extending it to the whole city; the calculation could only measure punctually the situation of the ten pre-defined locations supported by primary data.

[62] The 'low demand' location cluster consists of: Lorenz-Müller-Gasse, Schelleingasse, Schönbrunner Allee, Martha-Steffy-Brown-Gasse, Billrothstrasse, Kagraner Anger

[63] The 'high demand' location cluster consists of: Universitätsring, Hütteldorfer Strasse, Erdbergstrasse, Herminengasse

[64] This conclusion is of course based on a great simplification; its goal is nothing else, but to show the underlying logic behind the analysis.

Finally, an overview table (below) of the ten pre-defined locations should be presented. As it can be seen, the **average number of different cars** (within 500 meters) per location cluster was around ten, which resulted in the previously introduced 78% of vehicle availability. As it was mentioned earlier, there are rather big differences between the locations, which make it advisable to separate the locations into two clusters. Such differentiation would also help the CSO in his ex post adjustment (e.g. reallocation), as mentioned earlier in the chapter 6.2.

Table 9: Average number of cars per location

	Location	Average number of cars within 500 m a day	Availability
'Low demand' cluster	Billrothstrasse	5,1	50
	Lorenz-Müller-Gasse	5,4	67,14
	Kagraner Anger	5,4	97,14
	Schelleingasse	6,3	62,86
	Martha-Steffy-Brown-Gasse	7,6	92,86
	Schönbrunner Allee	10,2	92,86
'High demand' cluster	Hütteldorfer Strasse	11,9	77,14
	Erdbergstrasse	12,3	74,29
	Herminengasse	14,1	85,71
	Universitätsring	22,6	80
	Average	10,09	78
	Deviation	5,20	14,20
	Minimum	5,1	50
	Maximum	22,6	97,14

7. Conclusions

Based on the findings of chapter 6, the following **summarizing conclusions** can be made:

- In Vienna, using car2go would be a more rational choice than vehicle ownership (because it has a cost advantage) under an average annual VKT of around 5,500 kilometers.[65]
- The average degree of vehicle availability is currently around 78% (average distance to a free car is 348 m); although, this level could be increased to ~95%, using an appropriate fleet size of ~731 cars.
- Daily, there are ten different cars on average in a location cluster (within a 500 m radius from the measurement point); however, at ‘high demand’ locations more than 20 different cars would be needed; while at ‘low demand’ locations 10 different cars would be sufficient to reach a close to 100% availability level.
- As a future consideration: a tool that could measure/estimate more precisely the opportunity cost of car2go (the amount of non-realized income, due to the unavailability of a ‘close’ vehicle), would be extremely useful for the service provider.

In general, we found that probably the most important advantage of the free-floating carsharing systems lies in their high degree of flexibility.[66] However, because they can be used like a ‘modern taxi service’, the FFCS is a **direct competitor** of the taxi services. In the long run, this conflict could raise some (yet unknown) insoluble challenges, which could endanger the large-scale spread (or even the survival) of the FFCS services.[67]

[65] Of course, the individual mobility behavior and the limitations mentioned in chapter 6.1 have to be taken into consideration as well.
[66] People choose FFCS because of its ability to save money, time, reduces responsibility and effort. (More to it in chapters 3 and 4)
[67] First signs of objections/protests of taxi drivers against FFCS in Québec, Canada (cjad.com, 2013)

As Obradovits, 2011 points out in his economic model, *“a very high quality sharing company with high capital utilization can be detrimental to social welfare”;* because, if a downstream sharing company triumphs over a traditional retailer (in our scenario, if the taxi industry would be forced to exit the market entirely), it would result in a significant destruction of economic value, both from the companies’, and from the consumers’ point of view. (Not mentioning the negative effect on unemployed taxi drivers; and the ‘correction’ steps the governments would take to avoid such situation.)

However, we have to mention that the weight of taxi in the transportation modal split is only a marginal 0.2% (Finkorn and Müller, 2011 p. 1523) (~4,300 taxis in Vienna), which questions essentially the ‘strategic’ importance of the industry. Moreover, the taxi industry could always exploit the rest of the market, which FFCS cannot reach: transport of people, who are unable or not allowed to drive.

Nevertheless, it is assumed that the biggest step in securing the future of the FFCS industry would be, if its environmental friendly character will be finally proven undoubtedly.

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9. Appendix

Appendix 1

Graph 11: The Viennese Taxi Tariff Table

The regulated Taxi Tariff of Vienna (since 01/12/2012)			
Daytime (workdays from 6-23)			
Basic Tariff	3,80 €	inkl. 859,2 m	
Distance Tariff till 4 km	0,20 €	for each started 140,7 m	= 1,42 €/km
Distance Tariff from 4 km	0,20 €	for each started 184,6 m	= 1,08 €/km
Distance Tariff from 9 km	0,20 €	for each started 190,6 m	= 1,05 €/km
Time Tariff	0,20 €	for each started 25,9 sec	= 27,8 €/Hour
At Night (workdays from 23-6) Sundays and Holidays (0-24)			
Basic Tariff	4,30 €	inkl. 1000 m	
Distance Tariff till 4 km	0,20 €	for each started 123,2 m	= 1,62 €/km
Distance Tariff from 4 km	0,20 €	for each started 156,8 m	= 1,28 €/km
Distance Tariff from 9 km	0,20 €	for each started 169,5 m	= 1,18 €/km
Time Tariff	0,20 €	for each started 25,9 sec	= 27,8 €/Hour
Additional fees			
Reservation per Telephone	2,80 €		
Reservation per Taxi Telephone	1,40 €		
Transport of more than 4 people	2,00 €		

Source: taxi60160.at (2013)

Appendix 2

Table 10: Vehicle ownership costs 'cheap' scenario

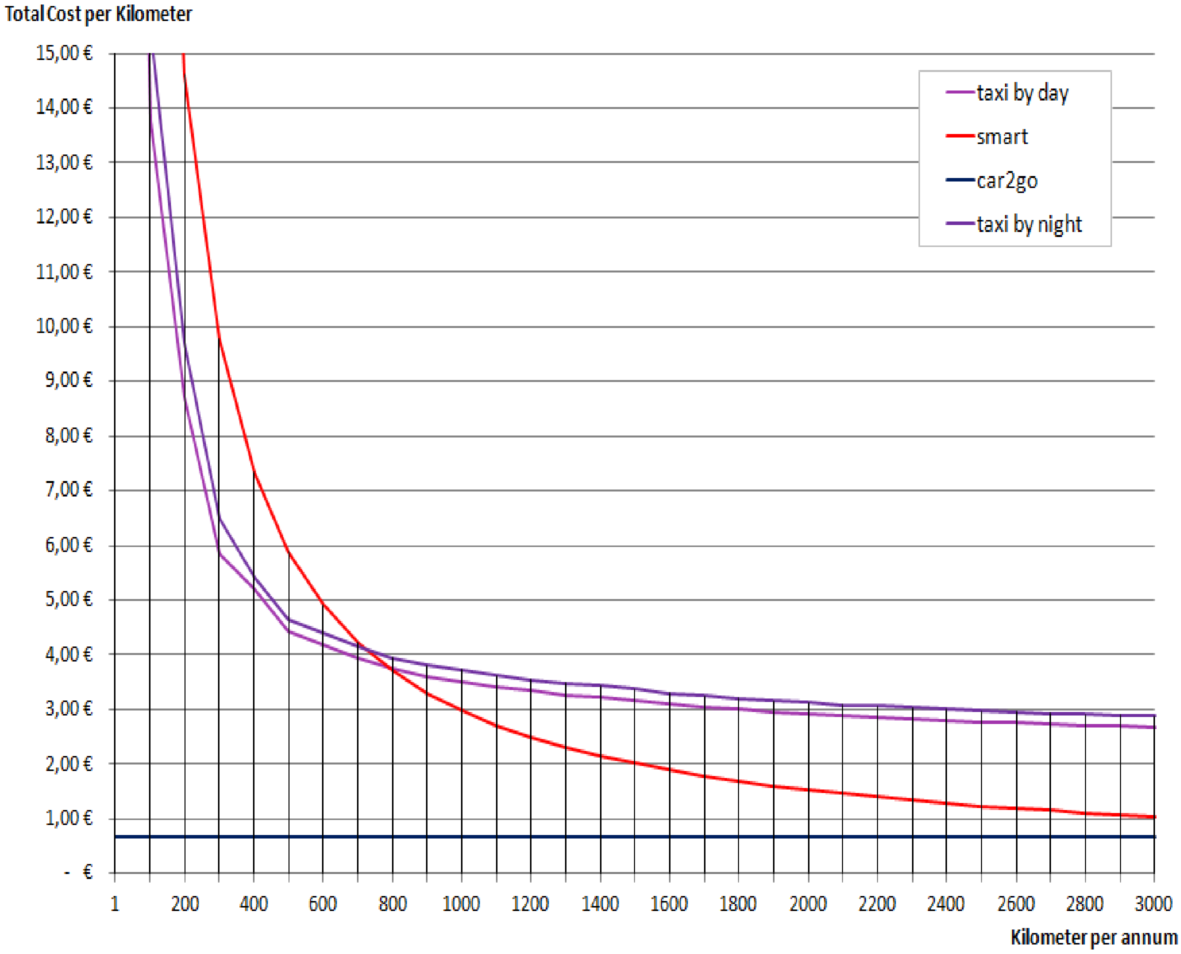
smart 'cheap' scenario						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total cost
Fix Costs						
Purchase price	12 000,00 €					12 000,00 €
Resell price					-6 500,00 €	-6 500,00 €
Registration fee	185,25 €					185,25 €
Vehicle Inspection Sticker	40,00 €			40,00 €		80,00 €
Insurance (with vehicle tax)	707,00 €	707,00 €	707,00 €	707,00 €	707,00 €	3 535,00 €
Highway vignette	80,60 €	80,60 €	80,60 €	80,60 €	80,60 €	403,00 €
Winter Tires	300,00 €					300,00 €
Cleaning	40,00 €	40,00 €	40,00 €	40,00 €	40,00 €	200,00 €
Parking Permission (for residents)	138,20 €	120,00 €	120,00 €	120,00 €	120,00 €	618,20 €
					Total Fix Costs:	**10 821,45 €**
Variable Costs						
Maintenance	200,00 €/10 000 km					
Fuel Consumption	0,0630 €/km					

Table 11: Vehicle ownership costs 'no resell' scenario

smart 'no resell' scenario						
	Year 1	Year 2	Year 3	Year 4	Year 5	Total cost
Fix Costs						
Purchase price	12 500,00 €					12 500,00 €
Resell price						0,00 €
Registration fee	185,25 €					185,25 €
Vehicle Inspection Sticker	40,00 €			40,00 €		80,00 €
Insurance (with vehicle tax)	707,00 €	707,00 €	707,00 €	707,00 €	707,00 €	3 535,00 €
Highway vignette	80,60 €	80,60 €	80,60 €	80,60 €	80,60 €	403,00 €
Winter Tires	300,00 €					300,00 €
Cleaning	40,00 €	40,00 €	40,00 €	40,00 €	40,00 €	200,00 €
Parking Permission (for residents)	138,20 €	120,00 €	120,00 €	120,00 €	120,00 €	618,20 €
					Total Fix Costs:	**17 821,45 €**
Variable Costs						
Maintenance	200,00 €/10 000 km					
Fuel Consumption	0,0630 €/km					

Appendix 3

Graph 12: Break-Even Points (1-3000 km/year)



Appendix 4

Graph 13: Ten pre-defined locations and the operation area of car2go

The squares represent a one km^2 area

Source: Self-made based on car2go.com (n.d.)

Appendix 5

Table 12: Locations 3-10 - Summary tables (values in meters)

3	1010 Universitätsring 1					48.212988,16.361399					80,00%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	525,6	206,7	53,0	179,4	210,3	408,3	39,8	270,1	85,4	79,7	205,8	151,5	193,0
11:00	512,4	217,2	53,0	250,7	227,4	79,7	77,6	321,8	123,1	104,9	196,8	134,9	170,1
13:00	296,1	151,2	53,0	105,1	148,6	179,1	276,1	211,4	221,2	140,2	178,2	71,1	165,2
15:00	533,1	151,2	293,6	469,2	187,0	298,6	664,3	767,3	319,1	261,5	394,5	195,3	308,9
17:00	467,7	362,1	239,2	678,0	712,7	717,4	288,6	295,4	537,4	493,3	479,2	172,0	480,5
19:00	262,7	617,0	1336,0	256,0	255,1	308,1	263,4	235,9	110,5	248,7	389,3	338,1	259,3
21:00	198,0	210,9	176,2	776,6	206,8	513,8	263,4	137,2	1098,4	425,0	400,6	299,1	237,2
Mean	399,4	273,8	314,9	387,8	278,3	357,9	267,6	319,9	356,4	250,5	320,6		
Dev.	131,5	154,6	426,6	239,5	180,0	196,9	187,4	191,1	336,2	147,4		241,5	
Median	467,7	210,9	176,2	256,0	210,3	308,1	263,4	270,1	221,2	248,7			255,5

4	1040 Schelleingasse 33					48.185996,16.370602					62,86%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	663,9	422,4	805,5	635,0	433,9	61,4	386,6	515,8	197,1	942,1	506,4	253,2	474,9
11:00	430,8	701,3	672,9	635,0	736,3	683,1	989,8	650,2	398,3	639,1	653,7	154,5	661,6
13:00	766,2	626,2	452,4	397,1	260,3	331,3	465,6	749,8	398,3	399,3	484,7	163,5	425,9
15:00	542,0	133,9	303,9	173,1	116,5	183,5	293,4	919,9	208,6	435,5	331,0	234,7	251,0
17:00	446,6	122,5	285,7	173,1	116,5	127,0	255,7	670,1	415,4	465,8	307,8	176,7	270,7
19:00	79,9	86,9	267,7	681,3	111,2	230,8	514,0	232,9	515,6	450,7	317,1	199,3	250,3
21:00	512,3	423,6	383,8	309,8	113,6	340,0	167,6	826,7	515,6	578,7	417,1	196,4	403,7
Mean	491,7	359,5	453,1	429,2	269,8	279,6	439,0	652,2	378,4	558,7	431,1		
Dev.	201,2	232,2	193,5	205,2	220,8	189,6	251,0	209,2	120,4	175,1		231,7	
Median	512,3	422,4	383,8	397,1	116,5	230,8	386,6	670,1	398,3	465,8			423,0

5	1020 Herminengasse 5					48.218384,16.374105					85,71%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	400,2	290,1	298,4	443,7	84,5	480,5	580,2	87,7	380,5	393,5	343,9	151,4	387,0
11:00	184,2	361,7	297,1	444,4	512,1	368,3	470,6	87,7	380,5	482,8	358,9	129,3	374,4
13:00	401,7	238,1	414,4	365,1	443,3	188,3	137,0	841,9	81,0	95,6	320,6	216,9	301,6
15:00	461,1	260,4	460,5	132,6	211,8	297,0	544,3	389,7	32,5	273,8	306,4	151,2	285,4
17:00	431,9	822,6	547,7	87,1	435,2	359,1	30,1	346,3	62,2	317,5	344,0	230,5	352,7
19:00	386,5	465,7	248,7	84,0	1097,7	578,6	692,6	295,6	428,3	181,8	446,0	277,4	407,4
21:00	215,3	95,5	199,2	543,1	410,5	408,8	77,3	67,1	207,9	8,4	223,3	167,6	203,5
Mean	354,4	362,0	352,3	300,0	456,4	382,9	361,7	302,3	224,7	250,5	334,7		
Dev.	100,8	215,4	115,8	179,2	296,5	116,2	251,8	253,1	157,8	154,3		205,0	
Median	400,2	290,1	298,4	365,1	435,2	368,3	470,6	295,6	207,9	273,8			360,4

6	1190 Billrothstraße 60					48.240938,16.348833					50,00%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	273,2	68,8	688,3	799,1	566,3	497,5	171,7	295,8	43,1	440,2	384,4	243,9	368,0
11:00	692,5	407,8	233,0	183,1	599,5	564,1	363,7	295,8	781,2	440,2	456,1	188,4	424,0
13:00	798,5	755,7	454,2	798,1	463,0	520,1	365,2	585,1	499,3	278,7	551,8	171,7	509,7
15:00	914,1	370,4	451,6	660,2	462,9	73,8	688,4	613,4	185,3	689,0	510,9	241,1	538,2
17:00	666,6	357,9	437,4	597,5	617,4	776,8	618,9	477,3	435,2	516,0	550,1	120,7	556,7
19:00	142,4	812,3	418,6	547,3	573,6	538,2	737,4	797,2	610,0	290,7	546,8	204,9	560,4
21:00	573,1	705,3	222,9	559,3	790,0	246,6	620,1	359,2	76,6	28,9	418,2	253,9	459,2
Mean	580,1	496,9	415,1	592,1	581,8	459,6	509,3	489,1	375,8	383,4	488,3		
Dev.	257,8	249,7	145,5	192,9	102,5	212,8	194,3	173,8	260,4	193,7		217,8	
Median	666,6	407,8	437,4	597,5	573,6	520,1	618,9	477,3	435,2	440,2			507,6

7	1150 Hütteldorfer Straße 48					48.198666,16.325055					77,14%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	210,4	231,5	411,4	429,4	271,7	314,7	235,7	360,3	396,0	263,8	312,5	77,2	293,2
11:00	210,4	503,0	431,7	612,1	252,7	143,9	177,6	125,6	495,3	701,1	365,3	198,1	342,2
13:00	210,4	307,7	512,1	789,0	252,7	143,9	317,4	125,6	396,5	391,9	344,7	186,4	312,5
15:00	390,8	364,5	931,2	912,1	643,1	243,4	317,4	563,1	396,5	323,7	508,6	234,7	393,7
17:00	779,1	272,6	544,5	313,1	483,0	217,2	328,2	214,8	240,5	208,4	360,1	177,3	292,9
19:00	115,3	272,6	194,4	359,9	735,4	48,3	747,1	406,5	347,2	265,7	349,2	222,0	309,9
21:00	115,3	835,8	274,3	431,7	529,5	48,3	155,2	222,0	247,9	667,8	352,8	243,4	261,1
Mean	290,2	398,2	471,4	549,6	452,6	165,7	325,5	288,3	360,0	403,2	370,5		
Dev.	216,9	196,8	220,1	211,4	183,5	92,1	183,9	150,0	83,9	185,7		206,7	
Median	210,4	307,7	431,7	431,7	483,0	143,9	317,4	222,0	396,0	323,7			317,4

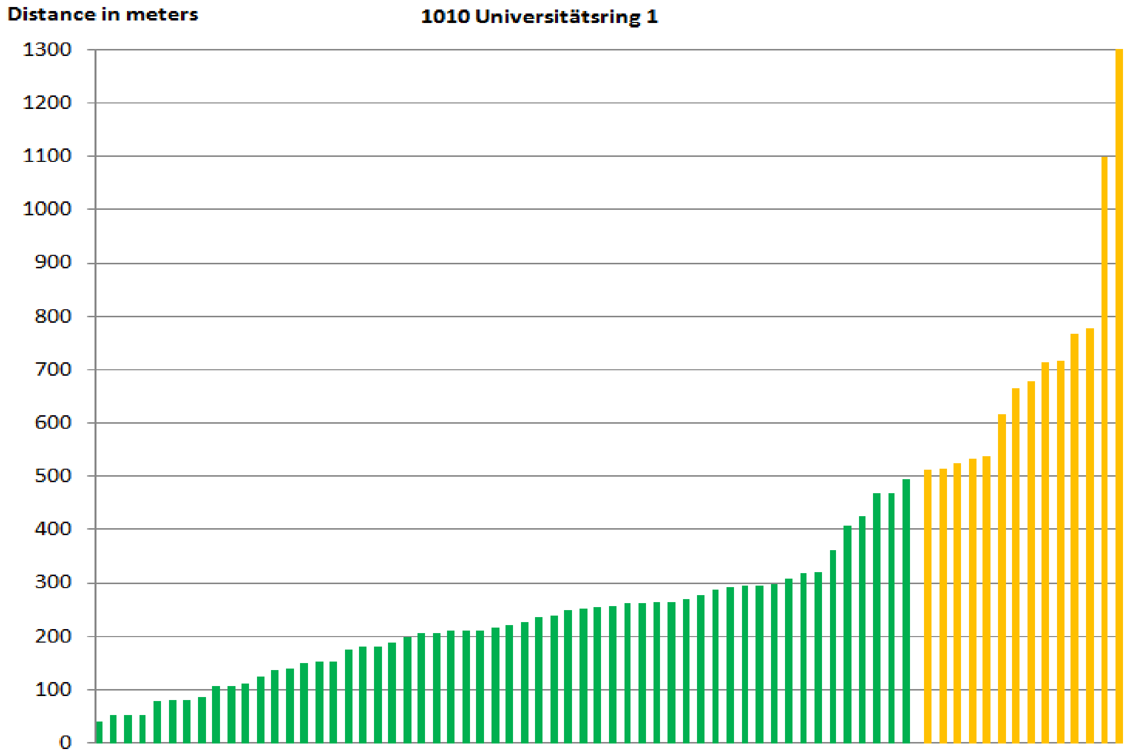
8	1120 Schönbrunner Allee 40					48.171144,16.311412					92,86%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	51,9	186,5	360,8	514,5	365,4	403,5	218,7	271,2	333,1	381,4	308,7	123,9	347,0
11:00	51,9	437,2	253,7	306,0	633,2	358,2	218,7	271,2	333,1	381,4	324,5	143,6	319,6
13:00	51,9	320,9	253,7	365,4	633,2	358,2	218,7	312,7	333,1	400,6	324,9	139,5	327,0
15:00	51,9	258,1	509,8	272,0	232,2	312,2	218,7	206,2	310,7	63,9	243,6	123,4	245,2
17:00	51,9	83,8	815,0	272,0	232,2	193,0	177,4	334,2	56,2	244,0	246,0	209,7	212,6
19:00	51,9	83,8	260,8	272,0	82,4	350,8	177,4	334,2	204,3	83,1	190,1	105,9	190,8
21:00	186,5	83,8	260,8	272,0	281,4	350,8	312,7	334,2	324,3	83,1	249,0	93,7	276,7
Mean	71,2	207,7	387,8	324,9	351,4	332,4	220,3	294,9	270,7	233,9	269,5		
Dev.	47,1	127,9	195,1	83,8	194,5	62,0	41,8	44,6	97,5	144,3		146,5	
Median	51,9	186,5	260,8	272,0	281,4	350,8	218,7	312,7	324,3	244,0			271,6

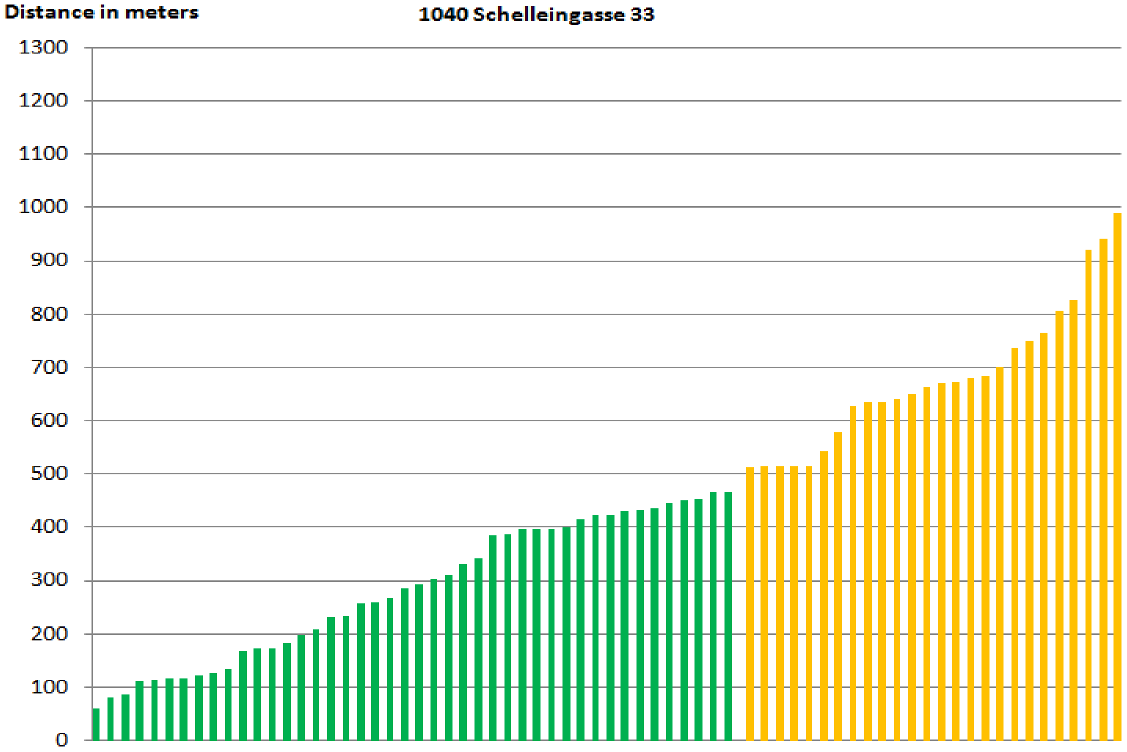
9	1030 Erdbergstraße 127						48.194615,16.40882				74,29%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	739,6	244,8	289,8	120,5	292,0	113,9	364,7	112,8	237,1	188,1	270,3	176,1	241,0
11:00	773,3	244,8	289,8	154,3	292,0	113,9	500,4	366,8	237,1	173,8	314,6	185,9	267,3
13:00	393,6	190,5	502,1	154,3	251,1	113,9	500,4	190,9	114,9	238,5	265,0	140,6	214,7
15:00	197,8	190,5	456,6	281,0	181,2	115,0	373,2	780,0	114,9	214,5	290,5	192,9	206,2
17:00	773,3	770,4	514,0	456,0	260,0	115,0	486,0	1031,3	117,9	693,8	521,8	285,8	500,0
19:00	730,4	586,2	142,1	130,5	184,7	115,0	486,0	1005,4	110,4	530,2	402,1	297,5	335,3
21:00	730,4	953,9	392,3	364,7	251,7	115,0	380,8	377,4	110,4	549,9	422,6	249,5	379,1
Mean	619,8	454,4	369,5	237,3	244,7	114,5	441,6	552,1	149,0	369,8	355,3		
Dev.	212,2	291,3	125,9	122,4	42,2	0,6	59,9	353,6	55,8	198,5		242,2	
Median	730,4	244,8	392,3	154,3	251,7	115,0	486,0	377,4	114,9	238,5			270,5

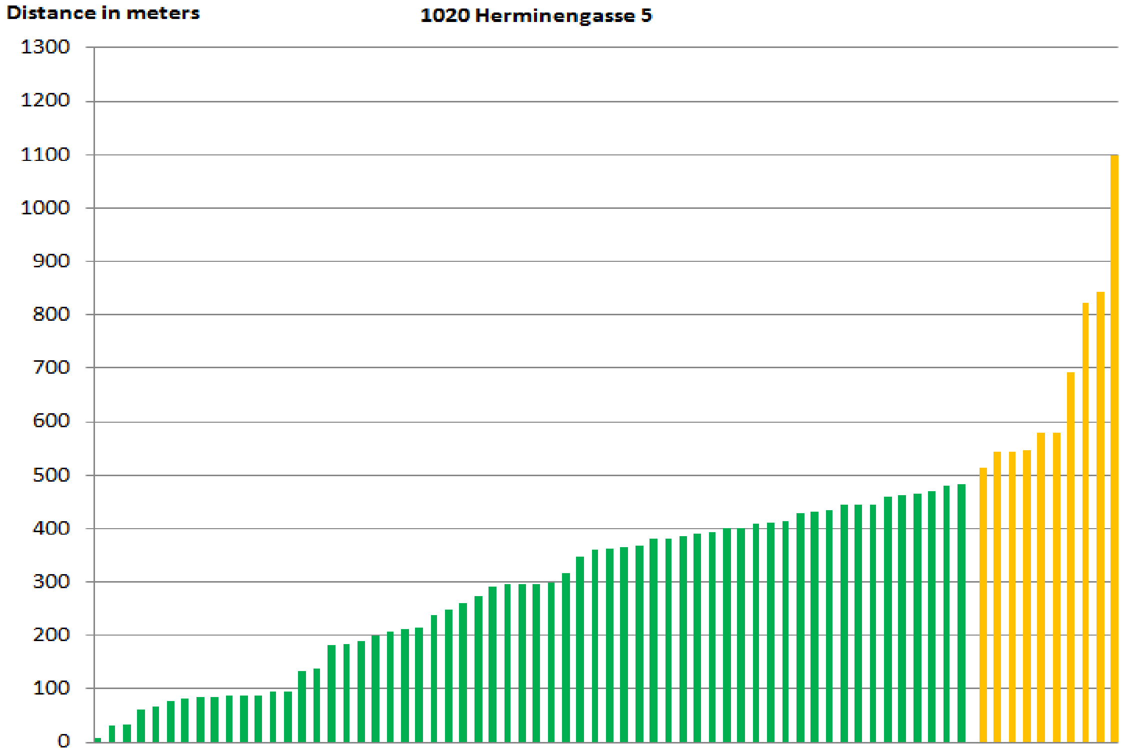
10	1220 Kagraner Anger 91						48.23948,16.449062				97,14%		
	2.6	3.6	4.6	5.6	6.6	7.6	8.6	9.6	10.6	11.6	Mean	Dev.	Median
9:00	404,6	404,6	294,0	129,7	129,7	129,7	373,6	136,7	136,7	622,5	276,2	163,1	215,3
11:00	404,6	404,6	294,0	129,7	129,7	394,4	291,3	136,7	136,7	296,1	261,8	113,0	292,7
13:00	404,6	302,1	20,0	129,7	129,7	394,4	291,3	136,7	136,7	622,5	256,8	171,7	214,0
15:00	404,6	302,1	263,3	129,7	129,7	290,4	291,3	136,7	136,7	277,6	236,2	91,4	270,5
17:00	404,6	302,1	263,3	129,7	64,6	290,4	291,3	136,7	136,7	277,6	229,7	100,6	270,5
19:00	404,6	302,1	263,3	129,7	64,6	290,4	188,2	136,7	274,3	277,6	233,1	96,1	268,8
21:00	404,6	302,1	129,7	129,7	64,6	290,4	188,2	136,7	274,3	115,1	203,5	102,7	162,5
Mean	404,6	331,4	218,2	129,7	101,8	297,1	273,6	136,7	176,0	355,6	242,5		
Dev.	0,0	46,3	96,1	0,0	32,2	82,1	60,8	0,0	62,2	178,1		125,7	
Median	404,6	302,1	263,3	129,7	129,7	290,4	291,3	136,7	136,7	277,6			268,8

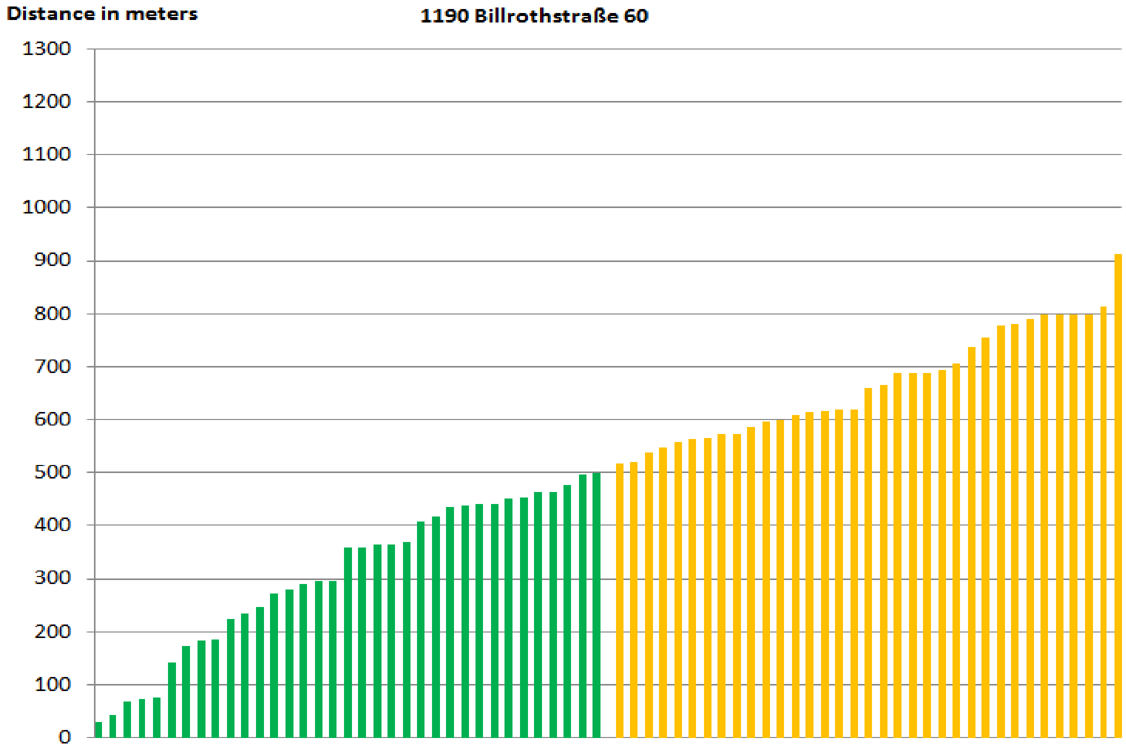
Appendix 6

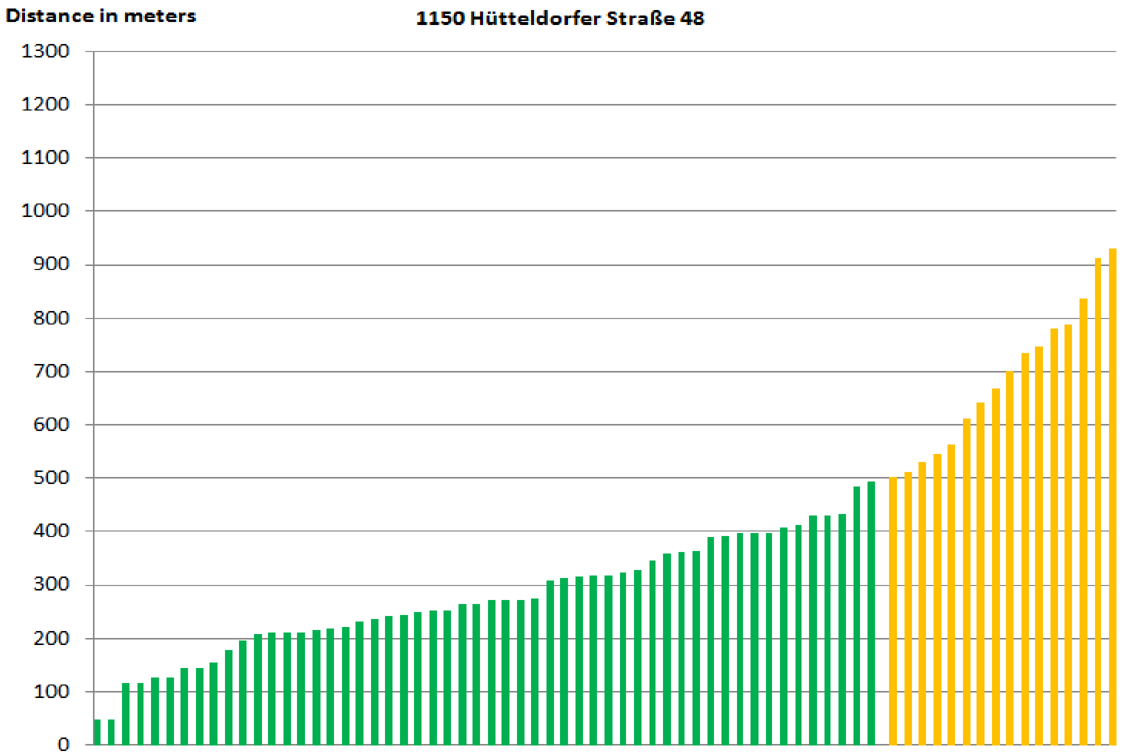
Graph 14: Histograms of locations 3-10

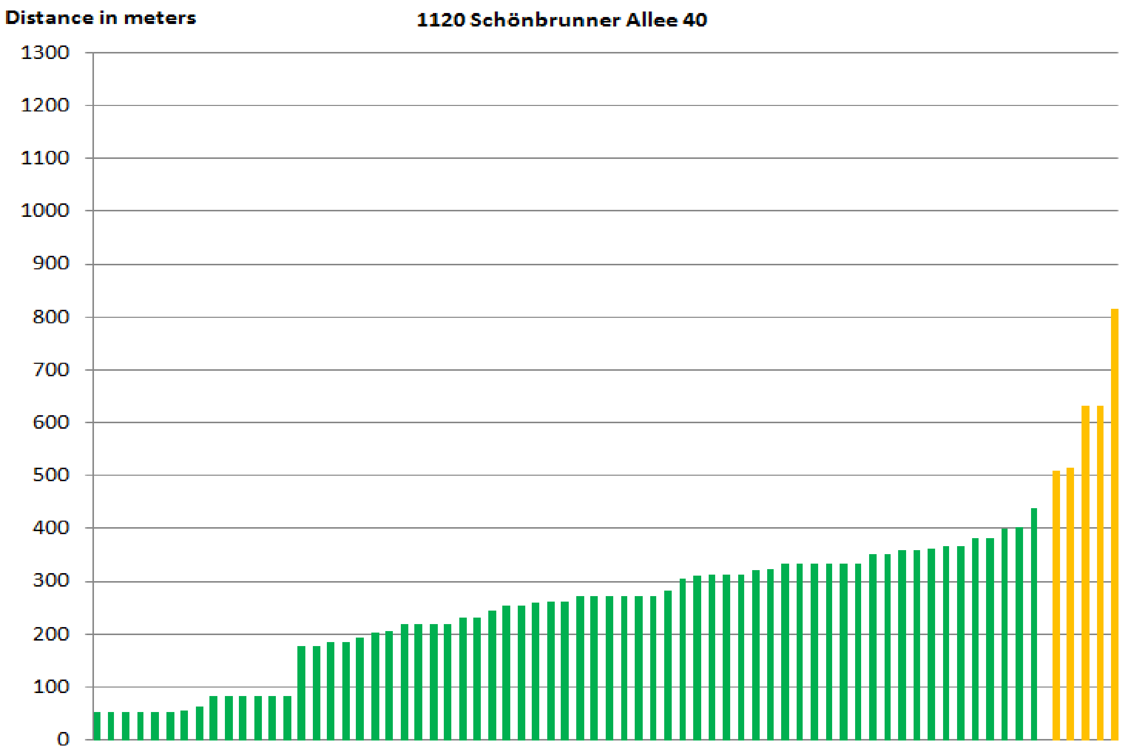


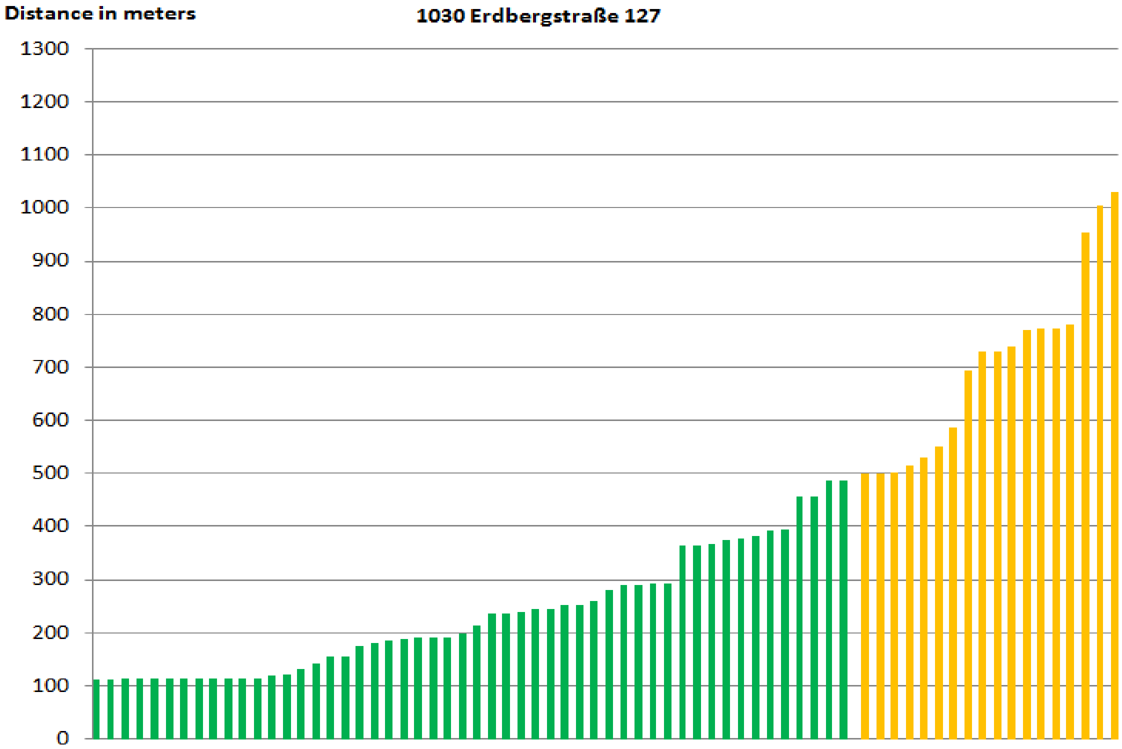


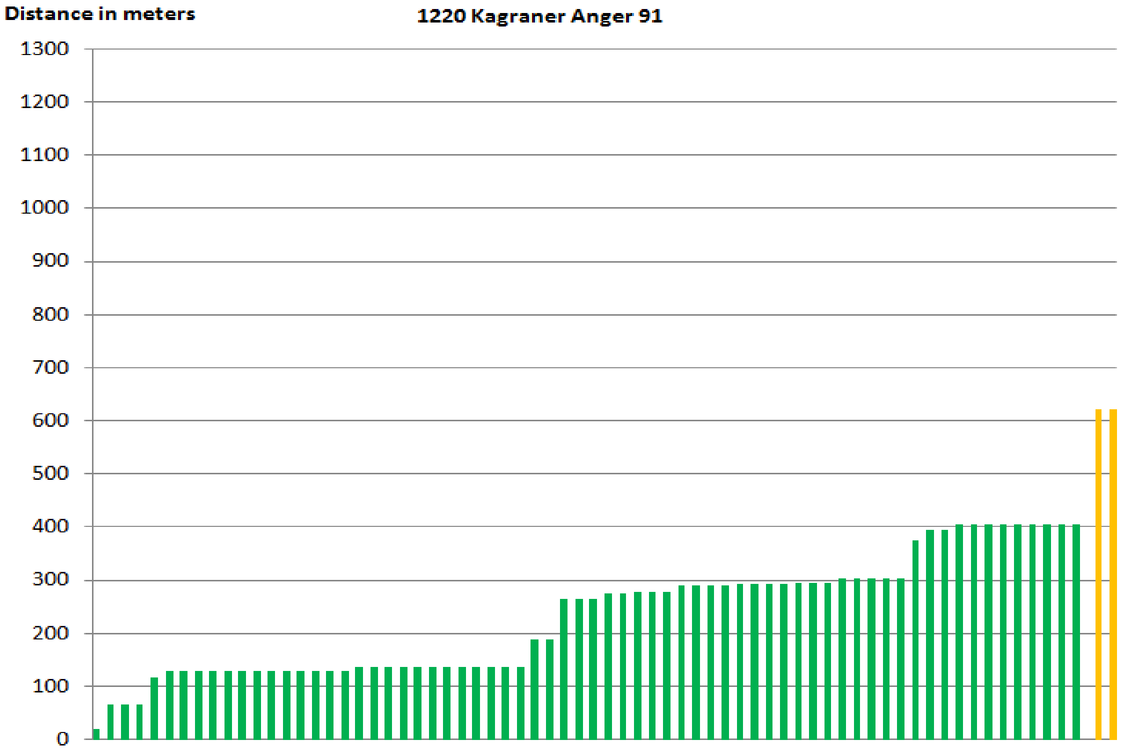

Distance in meters
1020 Herminengasse 5
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0


Distance in meters
1190 Billrothstraße 60
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0


Distance in meters
1150 Hütteldorfer Straße 48
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0


Distance in meters
1120 Schönbrunner Allee 40
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0


Distance in meters
1030 Erdbergstraße 127
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0


Distance in meters
1220 Kagraner Anger 91
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0

9.1. Deutsche Zusammenfassung

Diese Masterarbeit hat ein doppeltes Ziel. Einerseits versucht sie, ein „ganzes Bild“ über free-floating Carsharing – über diesen verhältnismäßig neuen Mobilitätsservice, mittels der Zusammenfassung seiner speziellen Eigenschaften und der Strukturierung seiner Einflussfaktoren – zu geben. Auf der anderen Seite, die Arbeit wäre eine Leitlinie für die potenziellen Kunden, indem es wird eingeschätzt: unter welchen Voraussetzungen ist es lohnt sich wirklich diesen Service zu benutzen.

In dem ersten Teil der Arbeit (Kapitel 1 bis 5) werden die verschiedenen Aspekte des free-floating Carsharings eingeführt, und wird der notwendige theoretische Hintergrund in einer gut strukturierten Form präsentiert. Der zweite Teil der These (Kapitel 6) enthält den Primärforschungsteil, was mit dem konkreten Beispiel von car2go Wien beschäftigt. Die Schlüsselfaktoren: das Kosteneinsparungspotential, der Grad der Fahrzeugverfügbarkeit und die geeignete Flottengröße werden analysiert, um Abschätzungen über die Brauchbarkeit und Wirtschaftlichkeits-potenzial von car2go aus der Perspektive der Verbraucher zu geben.

Wahrscheinlich ist der wichtigste Vorteil des free-floating Carsharing Systems ihr hoher Grad an Flexibilität, die es ermöglicht, das System als eine automatisierte, effiziente „Taxi Service“ zu verwenden. Die Kunden benutzen es, weil sie damit Zeit- und Kosteneinsparungen erreichen kann; außerdem verringert es – verglichen mit dem Fahrzeugbesitz – ihre erforderliche Verantwortung und Bemühungsgrad. Gemäß der Primäranalyse, liefert car2go in Wien bereits ziemlich bequeme Betriebsbedingungen für die Benutzer; jedoch eine Verringerung der Opportunitätskosten könnte noch eine unbekannte Größe von finanziellen Gewinnen erlangen.

9.2. English Abstract

This thesis has a double objective. On the one hand, it tries to give a ‘whole picture’ about free-floating carsharing, this relatively new mobility service, by summarizing its characteristics and structuring the influence factors of the business. On the other hand, it tries to provide a guideline for the potential customers, by estimating: under what conditions does it worth using such service.

In the first part of the thesis (chapters 1 to 5), the various aspects of free-floating carsharing are introduced; the necessary theoretical background is organized in a well-structured form. The second part of the thesis (chapter 6) comprises the primary research part, which deals with the real-world example of car2go, Vienna. The key factors of cost saving potential, degree of vehicle availability and the appropriate fleet size are analyzed, in order to provide estimations about the usability/viability of the car2go free-floating carsharing service from the consumers’ perspective.

Probably the most important advantage of the free-floating carsharing systems is their high degree of flexibility, which allows customers to use them as an automated, more efficient ‘taxi service’ system. People use it, because it can provide time and cost savings; moreover it reduces the required responsibility and effort compared to vehicle ownership. Based on the primary analysis, car2go in Vienna provides already rather convenient service conditions for the users; however, by reducing the opportunity costs still an unknown magnitude of financial gains could be exploited.

9.3. Curriculum Vitae

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Education

2011 - 2013	**University of Vienna, AUT** **Faculty of Business, Economics & Statistics** *Master in Business Administration (M.Sc.)* Specialization in Industrial Management and Innovation & Technology Management; Studies in Transportation Logistics, Private Law and Industrial Organisation; GPA: 2.05 (1 being the best)
01 - 06 /2011	**BI Norwegian Business School, Oslo, NOR** *Erasmus Exchange Semester* Studies in Innovation and Entrepreneurship, Scandinavian Management
2009 - 2013	**University of Hagen, GER - Faculty of Economics** *Bachelor in Business Administration and Economics (B.Sc.)* Correspondence Studies; Studies in Marketing, HR-Management, Services Management, Economic Policy
2007 - 2011	**University of Pecs, HUN** **Faculty of Business and Economics** *Bachelor in Management and Business Administration (B.A.)* Studies in Strategic Management, Business Planning and Controlling; Thesis entitled: "Crisis Management in the Automotive Industry - on Industry and Corporate level, regarding the global recession of the late 2000s"; GPA: 4.63 (5 being the best)
2003 - 2007	**Kanizsai Dorottya Gymnasium, Szombathely, HUN** Emphasized studies in European History and English Language, learning the basics of computer programming

Work Experience

10 /2012 - 08 /2013 — **ISIS-COM Internet Services Kft.**
Product Manager (part-time)
At the West-Hungarian regions biggest independent Internet supplier company, I was involved in preparing comparative analyses and reports in the area of product development; controlling of customer satisfaction and marketing actions.

08 - 11 /2010 — **LuK Savaria Kft. (Schaeffler Group)**
Finance & Controlling Intern
Working at a subsidiary of a multinational automotive supplier, my responsibilities were: Assisting my team with one-time tasks; bookkeeping and handling the invoices of suppliers and freighters mainly in SAP environment.

03 - 08 /2010 — **M.L. Invest Kft.**
Tendering Coordinator (part-time)
Working at a small enterprise dealing with Investment Management, I was involved in: strategic consulting including business plan and investment strategy development.

Other Qualifications

01 /2010 — **Project Consultant Training Course, Budapest**
Applied models and methods of Project Management

07 /2009 — **University of Vienna Summer Course**
German language course in a multicultural community

Skills & Expertise

English Language: Fluent, IELTS Test 7.5 (02/12/2010), ECL Exam C1 Level

German Language: Fluent, Goethe & ECL Exam C1 Level

Hungarian Language: Native speaker

Computer Skills: Profound knowledge in Microsoft Office, Internet Applications

Organizational & Time Management Skills: Planning and shaping the studies require a high degree of personal initiative.

Intercultural Skills: Living in a different cultural environment requires understanding, curiosity and openness.

Hobbies: Travelling (with various means of transportation), contemporary Scandinavian Movies, Running, Squash