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Demand and capacity asymmetry in carsharing

A comparative case study of preventative measures

Master's Thesis in the Master's Programme Supply Chain Management

JOHAN BJÖREFELDT
JACOB GRUNDÉN

Department of Technology Management and Economics
Division of Service Management and Logistics
CHALMERS UNIVERSITY OF TECHNOLOGY
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JOHAN BJÖREFELDT
JACOB GRUNDÉN

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Supervisor: Ivan Sanchez-Diaz, Technology Management and Economics
Company sponsor: Johan Haldén, EY Advisory Services

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Department of Technology Management and Economics
Division of Service Management and Logistics
Chalmers University of Technology
SE-412 96 Gothenburg, Sweden
Telephone: + 46 (0)31-772 1000

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Abstract

In today's urban mobility landscape, carsharing is growing in importance. It enables a more efficient use of vehicles, leading to lower cost of car travel for users and less environmental impact. This efficiency is, however, reliant on the carsharing organization consistently achieving a match between demand and capacity. To explore measures to achieve this match, a literature review and subsequent empirical data collection through nine interviews were conducted. Further, this data was analyzed using the method of grounded analysis to delineate the characteristics of these measures and their applicability. This thesis identifies ten distinct strategies to counter demand and capacity asymmetry in carsharing services. Out of these, the strategies of network design, vehicle relocation, and class bookings are of particular importance. The thesis also shows that these strategies are more or less effective depending on the characteristics of the carsharing provider, its context, and its organizational focus. These results provide a basis for decision making to practitioners in how to match demand and capacity of their service. In turn, this will aid in increasing the efficiency of carsharing, hopefully leading to a higher quality service at a lower price. Although based on a limited subset of cases from the carsharing industry, the findings of this thesis have been generalized so as to have significance for a larger variety of carsharing providers.

Keywords: carsharing, resource utilization, demand and capacity asymmetry.

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1
Introduction

This chapter introduces the concept of carsharing and the background of the demand and capacity asymmetry issue of the industry. The three carsharing forms station-based, free-floating and peer-to-peer are expanded upon. Further, technologies relevant to carsharing are described, including autonomous vehicles and their potential effect on providers. Ridesharing and ridesourcing, as business models closely related to that of carsharing, are explored. Lastly, the aim and research questions of this thesis are outlined along with limitations and delimitations as to its results.

1.1 Background

Carsharing is a mobility solution in which multiple individuals share access to and usage of a limited pool of vehicles (Namazu & Dowlatabadi, 2018). It may be thought of as a form of car rental, albeit most commonly more short term than the traditional form (Shaheen, Sperling, & Wagner, 1998). Modern carsharing has experienced rapid growth since its introduction in the late 1980s, aided and enabled by modern digital solutions (Deloitte, 2017; World Resources Institute, 2015). Today, millions of members share tens of thousands of vehicles worldwide and with large corporations entering the industry, in addition to various startups, the scale and variety of carsharing programs are growing exponentially (Le Vine, Zolfaghari, & Polak, 2014; Shaheen & Cohen, 2016). Because of the limited history of carsharing, particularly of some of its more recently introduced forms, relatively little is known about the business of this transport mode (World Resources Institute, 2015). However, there is reason to believe this concept will increase in popularity, as young people today are less interested in owning a car themselves, compared to previous generations (Kotler, 2013). Carsharing has the potential to catalyze auto driving in countries with low car ownership by lowering the barriers to access, or to decrease future auto driving by providing an effective alternative to car ownership (World Resources Institute, 2015). It has shown considerable positive effects including reduced traffic congestion and environmental benefits (Deloitte, 2017). The concept of carsharing is therefore of great interest to researchers, policy-makers, consumers, and industry alike.

The nature of people's way of living means there is uneven demand for shared cars at different times and at different geographical locations, with weekdays having lower demand than weekends and central locations having higher demand than residential

neighborhoods. This creates difficulties for carsharing providers in how to balance the supply of shared cars to meet demand at peak times, while not having too many cars at off-peak (non-rush hour) times. This fundamental industry problem can be summarized as an asymmetry in the demand for travel and the carsharing provider's capacity for fulfilling that demand. Identifying effective strategies to match demand and capacity, thereby increasing resource utilization of vehicles and delivering high levels of service, is imperative. The high cost of cars means that achieving high resource utilization is important in order to offset tied-up capital. Cars must be moved one by one rather by a driver than in bulk as in many other vehicle sharing systems, which reduces the flexibility of carsharing (Chiara Boldrini, 2017). Further, availability of vehicles is of high importance to customers, meaning that these strategies matching demand and capacity are also of high importance in ensuring customer satisfaction. This point is critical to carsharing organizations.

The asymmetry issue in carsharing can be approached either from the demand or the capacity side, i.e. by managing the characteristics of demand for the service to fit its capacity or by adjusting capacity according to demand. Demand can, by use of e.g. different pricing strategies, be better matched to available capacity in terms of geographic location and points in time. The management of demand is explored further in Section 2.3. In the context of a carsharing provider, capacity entails the number of users which can be served, or the number of trip requests which can be fulfilled, at a given time and location. This capacity is in turn decided by a number of factors including the number of stations, parking spots per station, and number of vehicles. How capacity can be managed generally, and in the specific context of carsharing, is discussed in Section 2.2. Although carsharing is clearly a service, some of its characteristics can be likened to that of a product. Therefore parallels are drawn between literature covering both services and products. Carsharing providers often use several different strategies to counter the issue of demand and capacity asymmetry in their service. These include both strategies for managing demand and managing capacity.

1.2 Carsharing

The principle of carsharing is for individuals to gain the benefits of private automobile use without necessity for taking on the costs and responsibilities of vehicle ownership (Shaheen, Chan, Bansal, & Cohen, 2015; Ciari, Bock, & Balmer, 2014). A household or business can, via carsharing providers and their platforms, access a fleet of shared vehicles on an as-needed basis (Shaheen et al., 2015). Through this, carsharing allocates the fixed costs associated with owning a vehicle over many users and reduces inefficiencies of personal vehicle ownership, since cars remain idle an average of between 92% (He, Mak, & Rong, 2019) and 95% (Ballús-Armet, Shaheen, Clonts, & Weinzimmer, 2014) of the time. Most carsharing organizations have consequently established a high ratio of number of users to number of vehicles when compared to that of private car ownership. The exact ratio in use appears to vary drastically, according to Katzev (2003) between 10 to 15 members to each vehicle is typical while Deloitte (2017) cites ratios between 45 and 125 users per vehicle

depending on the carsharing variant. The cost structure for carsharing providers is composed of fixed costs in the form of lease payments, insurance, parking fees, telematics upgrades, and branding, as well as variable costs in the form of fuel, fleet management, damages, and call center costs (Dandl & Bogenberger, 2018).

Carsharing organizations differ from other mobility solutions like ridesharing or carpooling in that they are not primarily designed to facilitate transporting a group of individuals to a common destination, but rather as an alternative to private car ownership (Katzev, 2003). They also differ from traditional car rental in that users can access a vehicle for brief usage and be charged in time increments of hours or even minutes with some providers also charging for the distance driven, while car rental agencies typically rent out their cars on a day-to-day basis (Katzev, 2003; Shaheen et al., 2015). Carsharing providers differ in their approach to e.g. administration, pricing, and requirements for their solution, but a number of features are more or less pervasive throughout the industry. The user is typically obliged to go through a pre-qualification process for verification of identity and driving record (Shaheen et al., 2015). Some providers also require sign-up or membership fees (Shaheen et al., 2015). In addition, there are large differences, e.g. in user experience and use cases, between the three major types of carsharing services; station-based, free-floating, and peer-to-peer. Further, each type of carsharing poses a unique set of challenges for the provider. As illustrated in Figure 1.1, these carsharing variants also differ in distance travelled and flexibility of the service. Peer-to-peer being typically used for longer distance travel than the alternatives and free-floating carsharing being the most flexible of the three (Deloitte, 2017). Carsharing is generally most effective as a transport mode filling the gap between transit and private vehicles, i.e. between longer distance travel where air transport, rail, or bus may be better suited and short distances where one might walk or use a bicycle (Shaheen et al., 1998).

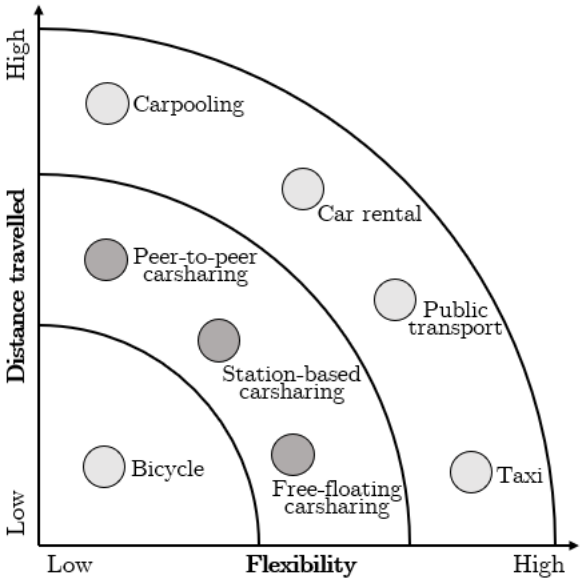

Figure 1.1: Classification of carsharing solutions among existing mobility concepts (Deloitte, 2017).

1.2.1 Station-based carsharing

Station-based, or stationary, carsharing has a comparatively long history spanning more than twenty years (Deloitte, 2017). This carsharing variant relies on parking stations at fixed locations and oftentimes provides only round-trip travel with the start and end points of the journey being the same. The more flexible alternative of one-way carsharing is also widely in use, wherein users are also allowed to pick up a vehicle at one station and return it at another (Correia, Jorge, & Antunes, 2014). Fixed infrastructure is often located at the stations, such as customer service kiosks and charging equipment for electric vehicles (Le Vine et al., 2014). Therefore, the deployment of stations is typically a major cost entry for station-based systems (Boldrini, Bruno, & Conti, 2016). At the same time, providers are steadily increasing the number of stations with the number of registered users, as expanding the business is considered vital in maintaining competitiveness (Hu, Chen, Lin, Xie, & Chen, 2018). The attributes of carsharing stations, including their location and the number of available parking spots per station, have been studied extensively (Hu et al., 2018). These and other attributes are highly relevant when providers make decisions related to the installation of new stations or the allocation of vehicles to specific stations. For example, stations which have been established for long periods of time and stations with a high number of available vehicles are both attractive to users (Hu et al., 2018). However, neighboring stations and vehicles compete for customers, and many areas therefore have an oversupply of vehicles (Hu et al., 2018; De Lorimier & El-Geneidy, 2013). To optimize the efficiency, the catchment area of the stations (i.e. the area within which a station attracts customers) and the car density should be calculated to fit the demand in the local area (Hu et al., 2018). A more extensive review of methods used to plan infrastructure and fleet management can be found in Section 2.2.1.

Station-based carsharing providers normally provide greater fleet variety than other carsharing forms in terms of vehicle brands and models, which is weighed against lower levels of flexibility due to the need for vehicles to be returned to a station (Le Vine et al., 2014; Deloitte, 2017). In the context of urban mobility, station-based carsharing is typically associated with use cases which require only short amounts of idle time for the vehicle during the user's rent period (Ciari et al., 2014). This is because idle time, e.g. when the vehicle is parked outside of a store during a shopping trip, is part of the rental and therefore needs to be paid for by the user (Ciari et al., 2014).

1.2.2 Free-floating carsharing

Free-floating, or flexible, carsharing allows users to collect and return a vehicle anywhere in a specified area, oftentimes a city-wide service area (Deloitte, 2017; Becker, Ciari, & Axhausen, 2017; Willing, Klemmer, Brandt, & Neumann, 2017; Herrmann, Schulte, & Voß, 2014). This typically involves on-street parking, requiring a contractual arrangement between the carsharing providers and the entity (local government or agency) managing parking permits (Le Vine et al., 2014). Also, given that most free-floating operating areas are located in city centers where parking space is ex-

pensive and hard to come by, most providers offer mainly small to medium-sized cars which ensures relatively easy parking for users (Deloitte, 2017). Free-floating carsharing, in contrast to station-based, is also more attractive for activities such as commuting in urban and suburban environments as there is no need to pay while the car is parked during working hours (Ciari et al., 2014). The exception to this would be for station-based carsharing allowing one-way trips where there are stations located conveniently close to both the home and work place of the user. This flexibility of free-floating carsharing is counterbalanced by a greater lack of predictability in supply, as there is no guarantee of finding an available vehicle when required (Ciari et al., 2014). In the case of the commuter using free-floating carsharing to get to work, the vehicle parked outside the work place may be unavailable at the end of the day.

The characteristics of free-floating carsharing raise complexity and place higher requirements on available technology than the station-based alternative. Users must be able to effectively locate (and sometimes unlock) available vehicles via their smartphones, and drivers are subsequently charged on a per-minute or per-mile basis as administered by their smartphones (Willing et al., 2017). As users are allowed to leave their vehicles where they choose, cars are also not necessarily always located where they are needed most. Vehicles are sometimes displaced to areas of lower personal transportation demand while being in demand elsewhere (Weikl & Bogenberger, 2013). Clearly, this unbalanced allocation of vehicles decreases their level of service (Papanikolaou, 2011; Correia et al., 2014). A user frequently experiencing that there are no available cars close to their demand points, will likely not accept the system as a viable substitute to another more reliable transportation mode (Herrmann et al., 2014). This means, in turn, that providers often are forced to conduct costly relocations of vehicles to rebalance supply and satisfy customers (Willing et al., 2017). This is indeed the case for both free-floating and one-way station-based carsharing, and effectively executing these relocations may oftentimes be a crucial factor as availability and reliability of the service are key influences on user behavior (Herrmann et al., 2014). Even so, it seems carsharing providers at least until recently did not utilize relocation techniques to any large extent. As indicated by Weikl and Bogenberger (2013), distribution of vehicles was at that point typically either self-organized (only dependent on the users' demand) or in a few cases manually controlled by system operators. A broader review of theory relating to vehicle relocation strategies can be found in Section 2.2.2.

1.2.3 Peer-to-peer carsharing

The key distinction of peer-to-peer carsharing, as opposed to the other two variants, is that ownership of the vehicle fleet is decentralized where private individuals own the vehicles rather than a central provider (Deloitte, 2017; Le Vine et al., 2014). Peer-to-peer models are not highly capital intensive like station-based and free-floating carsharing (Cohen & Kietzmann, 2014). Carsharing providers provide a platform connecting vehicle-owners to prospective users while handling transactions, offering insurance, and in some cases providing telematics devices for the vehicle to

ensure easy access (Deloitte, 2017; Le Vine et al., 2014). Members of the platform then make their private car temporarily available for use by others and receive payments when it is rented out to a user (Ballús-Armet et al., 2014). Peer-to-peer carsharing networks are also, as station-based and free-floating systems, focused on urban areas and cities but are generally restricted to round-trip travel, with pickup and stopping locations being the same (Shaheen et al., 2015). Even more so than free-floating carsharing, peer-to-peer networks are also dependent on the proliferation of smartphone technology (Ballús-Armet et al., 2014). State-of-the-art platforms are typically required to ensure ease of use and success of a peer-to-peer carsharing provider and their service (Deloitte, 2017).

1.2.4 Carsharing technologies

The vehicles used in carsharing need to have some specialized equipment installed before they are put into commission. In contrast to regular vehicles on the road, shared cars need to coordinate and enable communication between the user, the vehicle, and the operating system or platform (Invers, 2019). Complex technology is involved in virtually every step of the user experience, which means that the success of a carsharing provider to a large extent is built upon the foundation of a reliable technology platform (Invers, 2019). The cars are fitted with an immobilizer that only allows the car to be started by the user that made the booking (Vägverket, 2003). There are also RFID readers fitted that allow the cars to be locked and unlocked using a card, either a specific card provided by the carsharing provider or some other smart card, e.g. a transit pass (Sunfleet, 2019; Convadis AG, 2019). Alternatively, vehicles can be accessed using the user's smartphone. For other vehicles, particularly older models which do not make use of either a smartphone or smart card for access, there is typically a holder where the car keys and fuel card are stored when not in use. If the keys and card are not put back in the holder at the end of the journey, an alarm will go off to prevent the users from mistakenly taking the keys with them (Convadis AG, 2019). The trip information is recorded by the hardware in the car, with parameters such as when the user entered the vehicle at the start of the trip, the total distance of the trip, and when the keys were put back in the key holder at the end of the trip (Invers, 2019). This data is then used to calculate the total cost of the trip and the cost is billed to the user's credit card (Invers, 2019). Carsharing providers also have differing prerequisites when it comes to the efficient procurement and installation of these IT solutions. Vertically integrated providers (i.e. vehicle manufacturers also operating a carsharing service) enable efficient design and fitting of carsharing technologies like telematics equipment into its vehicles (Le Vine et al., 2014). This is in contrast to the alternative of procuring these technologies as after-market add-ons (Le Vine et al., 2014).

In terms of the models, brands, and types of cars in use for carsharing service providers throughout the world, the selection is quite broad. Whenever a user of a carsharing service makes a reservation they may choose from vehicles that vary in attributes such as rental price or passenger capacity (Zoepf & Keith, 2016), which is partially dependent on the type of the vehicle. The powertrain types vary be-

tween diesel, gasoline, hybrid, and electric vehicles (Vasconcelos, Martinez, Correia, Guimaraes, & Farias, 2017). This has an effect on the cost structure of a particular vehicle, with electric cars typically being considerably more expensive than the alternatives, followed by hybrids (Vasconcelos et al., 2017). This includes costs associated with establishing vehicle stations, in the case of station-based carsharing, where an electric vehicle fleet typically requires additional investment due to the need for recharging infrastructure (Boldrini et al., 2016). The powertrain type also seems to have a noticeable effect on user experience and preferences, as users appear to prefer hybrid models over the alternatives, all else being equal (Zoepf & Keith, 2016). Of course, the types of vehicles that are put into commission for a certain carsharing company depends in large part on the variant of carsharing it operates, i.e. station-based, free-floating, or peer-to-peer. For example, due to the nature of the service, free-floating carsharing fleets typically consist of small and compact vehicles while the fleets of station-based and peer-to-peer providers are more varied to suit a variety of purposes (Deloitte, 2017).

1.2.5 Introduction of autonomous vehicles

Autonomous vehicles (AVs) can be defined as *"[...] conveyances to move passengers or freight without human intervention"* (Greenblatt & Shaheen, 2015, pp. 74). This technology is not expected to become readily available for public or private use for some time, though there is significant uncertainty regarding how long it will take. Stocker and Shaheen (2017) find it conceivable for AVs to become a widely accepted technology by the year 2030, Bert, Collie, Gerrits, and Xu (2016) claim they will likely *"[...] affect large-scale mobility patterns [...]"* from 2027, and according to Wadud, MacKenzie, and Leiby (2016) experts predicted that vehicles will be capable of self-driving within 10-20 years. As illustrated by Figure 1.2, Deloitte (2016) forecasts that sales of autonomous vehicles will overtake those of manually driven vehicles by 2035. Moreover, shared vehicles are projected to represent a larger part of sales even sooner, by the year 2030 (Deloitte, 2016). However, the eventual advent of autonomous driving will likely have considerable impact on the carsharing industry (Deloitte, 2017). The combination of carsharing with AVs, i.e. replacing current vehicle fleets of manually driven vehicles with autonomous ones, has the potential to transform urban mobility even further (Glotz-Richter, 2016). Bert et al. (2016) argue that this will be a powerful enabler for carsharing services, in large part due to lower operating costs for vehicles, improved maneuverability, and the ability to be exactly where users need them. Carsharing has traditionally mainly been present in urban areas, but AVs may serve to increase the potential user base significantly by spreading the offering to densely populated suburbs and smaller cities as well (Deloitte, 2017; Bert et al., 2016). New users may also be attracted as autonomous carsharing provides more convenience for the user than the traditional variety (Bert et al., 2016). For instance, the usage of traditional carsharing is to a large degree determined by the walking distance for users to access the vehicle, and with the use of vehicles which can pick up the customers directly, the walking distance will be close to zero (Krueger, Rashidi, & Rose, 2016). Autonomous cars would also solve the relocation problem since they can drive themselves where they are needed rather

than requiring an operator or user to conduct relocation (Firnkorn & Müller, 2015). This would contribute to lower operating costs for providers. Reduction in insurance premiums would contribute further, as a result of lower likelihood of accidents with the introduction of autonomous vehicles (Krueger et al., 2016).

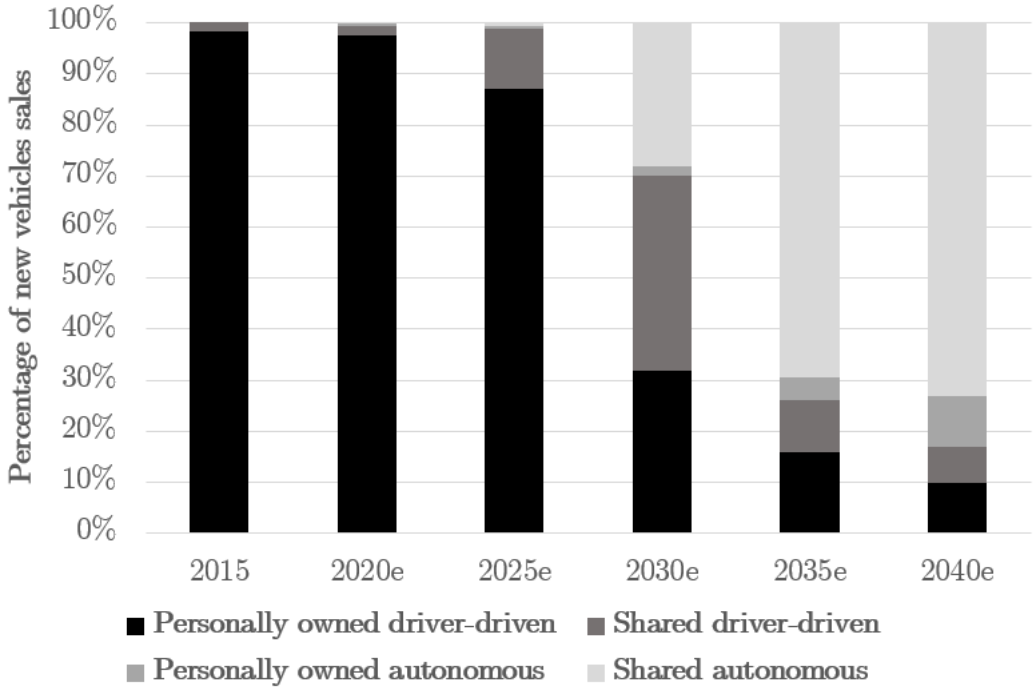

Figure 1.2: Forecast of new vehicle sales distribution in urban areas of the United States (Deloitte, 2016).

Cities and public institutions are beginning to consider how to deal with shared AV fleets, including how to regulate or operate them (Stocker & Shaheen, 2017). This is likely because of the considerable benefits they are expected to bring to local city environments. For example, AVs used in carsharing could reduce the number of cars on the road during rush hour by up to 23%, according to the International Transport Forum (2015), when applying sequential pick-up and drop-off of single passengers. Fagnant and Kockelman (2014) further indicate that the impact could be as large as each AV replacing eleven conventional vehicles in the overall fleet while actually incurring around 11% more travel time. Shaheen and Cohen (2018) speculate that vehicle automation could either increase the average vehicle occupancy by growth of shared fleets or, on the other hand, lower it through growth of zero occupant vehicle trips. As AVs are able to relocate without a driver or passenger, this gives rise to the concept of trips with zero occupants of the vehicle. Greenblatt and Saxena (2015) as well as Fagnant and Kockelman (2014) agree that shared AVs will have significant positive impact on emissions. This appears to apply to vehicles shared through carsharing, ridesourcing, and traditional car rental. Interestingly though, as AVs become available, the concepts of ridesourcing and carsharing will converge (Bert et al., 2016). Presently, the distinction between them is the presence of a driver operating the vehicle in the case of ridesourcing. If autonomous cars are used in both settings, that difference will no longer exist.

1.3 Ridesharing and ridesourcing

Ridesharing services allow users to share a ride in a vehicle with a driver going a similar route as the passengers (Münzel, Boon, Frenken, & Vaskelainen, 2018). Individual travelers thereby share travel costs such as fuel, toll, and parking fees with others who have similar itineraries and schedules (Furuhata et al., 2013). This inludes vanpooling, where groups of seven to fifteen people travel together in a van, and carpooling, where groups of up to seven passengers travel together in a car (Shaheen & Cohen, 2018). It is a system which combines the flexibility and speed of private car travel with the benefits of reduced costs but at the expense of convenience (Furuhata et al., 2013). One example of this type of service is the European ridesharing platform BlaBlaCar (Münzel et al., 2018).

Ridesourcing, also known as ridematching or app-based rides (Rayle, Shaheen, Chan, Dai, & Cervero, 2014), is a business model where companies like Uber and Lyft, often referred to as transportation network companies, match the request from a customer with an affiliated private driver nearby (Zha, Yin, & Du, 2017). Customers can hail nearby cars using GPS technology and their smartphones which means that traditional dispatching can be bypassed, and it also creates a direct and trackable connection between the driver and the customer (Anderson, 2014). When first introduced, ridesourcing services were commonly referred to as ridesharing, though experts argued that this was a misnomer as drivers and passengers did not share the same destination (Clewlow & Mishra, 2017). Ridesourcing drivers, rather than their counterparts in ridesharing, normally do not share a destination with passengers but are instead motivated by income (Rayle et al., 2014). In contrast to traditional taxi services which are heavily regulated, ridesourcing drivers and vehicles are unlicensed and subject to much less stringent regulations (Anderson, 2014). Ridesourcing companies provide the opportunity for the drivers to decide their own work schedules, with some drivers working full time and others just sporadically (Zha et al., 2017). This means that the supply of drivers and vehicles in ridesourcing is more flexible than traditional taxi services (Anderson, 2014).

Carsharing, ridesharing, and ridesourcing are all part of a wider set of developments known as *"shared mobility"* (Münzel et al., 2018). While they are related, the dynamics of carsharing are significantly different from the two other concepts (Münzel et al., 2018). For example, their value propositions differ starkly (Cohen & Kietzmann, 2014). Also, other than the peer-to-peer type, carsharing makes use of vehicles owned by the service provider while ridesharing and ridesourcing use private vehicles (Cohen & Kietzmann, 2014).

1.4 Aim and research questions

The aim of this thesis is to provide carsharing providers with a basis for decision-making in the choice of method for countering the demand and capacity asymmetry issue for their service. More specifically, this thesis aims to identify and evaluate

the different strategies used by today's carsharing providers to meet peak demand of service while optimizing the utilization of resources. In addition, the thesis aims to identify and evaluate potential future solutions not currently in use by providers.

To achieve the aim of this thesis, the initial investigation will identify the strategies currently in use, and that could potentially be put into use, by today's carsharing providers to counter demand and capacity asymmetry. These strategies will further be explored to determine noteworthy differences and the context in which they are in use (e.g. the geographical market, type and size of vehicle fleet, digital solutions in use, etc.). Hence, the first research question below can be formulated.

RQ1: What are the characteristics of the potential strategies which could be used by carsharing providers to counter demand and capacity asymmetry?

In order to provide the basis for decision-making necessary for providers to make informed decisions in regard to these strategies, their applicability for different types of providers will also be explored. In line with this, the second research question below is formulated.

RQ2: How do the characteristics, contexts, and priorities of carsharing providers influence their choice of strategies to counter demand and capacity asymmetry?

1.5 Limitations and delimitations

This thesis is delimited to assess station-based and free-floating carsharing systems. Peer-to-peer systems, ridesharing, and ridesourcing are deemed vastly different in terms of their dynamics, their value proposition to users, and their supply chain characteristics (see e.g. Cohen & Kietzmann, 2014). This means the issue of demand and capacity asymmetry as well as resource utilization do not apply and cannot be assessed in the same manner for all mentioned business models. Therefore, data collection, analysis, and conclusions will relate to carsharing in the forms of station-based and free-floating varieties exclusively. In addition, focus is on the perspective of carsharing providers and effects on other actors such as customers and municipalities are not investigated further than their direct impact on providers.

This thesis is limited in the sense that its broad scope prohibits deeper exploration of specific topics which may otherwise have been conducted. The potential strategies to counter demand and capacity asymmetry explored herein could each potentially be the subject of a thesis on their own. As time, resources, and access to interviewees were all limited, however, all concepts were not explored as deeply as they might have been. This thesis gives a broad perspective of these issues in their entirety, rather than a detailed look at each component. It is also limited in terms of the carsharing companies included as cases. Four case companies are included, which are unlikely to represent all states of the industry when it comes to insights, variations, or applications on the topic of this thesis. However, the chosen case companies are thought to be largely representative, as detailed further in Section 3.2.2.

2

Literature review

The following chapter includes the theoretical context upon which this thesis is based. The first part of the chapter explores variability in demand and its effects. The area of capacity management and related carsharing techniques for managing capacity are then explored. Lastly, demand management is examined as it relates to the purposes of this thesis. This includes pricing schemes applied in carsharing and the particular characteristics of demand for transport services.

2.1 Demand variability

The variability of service demand can largely be attributed to habit and culture, with most people eating their meals at roughly the same time of day, doing recreational activities during the weekends, taking their vacation in the summer, etc. (Klassen & Rohleder, 2001). These variations are rather predictable and can often be mitigated by the selling organization while other fluctuations are more random in nature, making it impossible for the organization to foresee them (Chopra & Meindl, 2013; Lovelock, 1984). Other examples of similar predictable variability are seasonal variations such as demand for winter clothing as well as nonseasonal variations such as promotions (Chopra & Meindl, 2013). These types of changes in demand create numerous problems throughout the supply chain if not properly mitigated (Chopra & Meindl, 2013). Demand variability issues, ranging from high levels of stockouts or loss of sales during peak demand periods to high levels of excess inventory or low resource utilization during periods of low demand, increase the costs and decrease the responsiveness of the supply chain (Chopra & Meindl, 2013). Thus, when demand for a service fluctuates widely but can be predicted to some extent, it may often be economically viable and worthwhile to develop strategies designed to smooth out these fluctuations (Lovelock, 1984). However, the success of such efforts depends on gaining correct understanding of why customers from specific market segments choose to use the service at specific times (Lovelock, 1984). For example, commuters on public transport have clear peak periods of demand, namely morning and afternoon rush hours, as this is determined by people's working hours. Clearly, commuters of this example are unlikely to be persuaded to shift their demand of transport services to off-peak periods and so other types of efforts must be employed.

2.2 Capacity management

Capacity management is the control of the amount of resources an organization has at its disposal and uses to perform work (Yu-Lee, 2002). For any given organization, these resources may include space in which work is performed, labor resources performing tasks associated with completing this work, and equipment automating or otherwise enabling the tasks being performed (Yu-Lee, 2002). Capacity is among the most important aspects of managing an organization as it represents a significant portion of a firm's costs, a large amount of a firm's assets, and has major impacts on the overall ability of the firm to operate and perform adequately (Yu-Lee, 2002). The profitability of the organization is therefore, in large part, determined by how well it can manage its available capacity. Indeed, the majority of operational costs in car rental are typically related to vehicles being idle, i.e. not being utilized by a customer (Oliveira, Carravilla, & Oliveira, 2017). Thus, the ideal operational goal of car rental companies is to utilize all available capacity at all times, having 100% of vehicles occupied 100% of the time (Oliveira et al., 2017). Capacity management is also closely connected to customer service, since having enough capacity to serve the customers effectively will lead to higher customer satisfaction and a better brand image (Yu-Lee, 2002).

The distinctions between goods and service industries have major implications on the way capacity management should be conducted for the particular industry or business (Sasser, 1976). Lovelock (1992) defines the capacity of a service organization as the highest quantity of output possible in a given time period with a pre-defined level of resources such as staffing, facilities, and equipment. For a car-sharing organization, this corresponds to the number of trips available to be made, or alternatively the number of customers possible to serve, in a given time period with pre-defined resources such as number of vehicles, types of vehicles, number of stations, and so forth. Perhaps the most significant difference of capacity for services and products is that whereas the consumption of goods can be delayed, services are generally produced and consumed at the same time (Sasser, 1976). Looking at service industries specifically, it is apparent that successful companies manage capacity of their operations while unsuccessful ones do not (Sasser, 1976). Given a certain level of demand for a company's services, there are a number of ways in which the company may respond to adjust capacity accordingly. If the given level of demand can be met by the current capacity, the market is the constraint and a few strategic decisions need to be made (Yu-Lee, 2002). Two options could be to either reduce the capacity if the overcapacity is predicted to be an issue long-term or to try to get extra demand by, for example, outsourcing the capacity or moving it to where there is demand (Yu-Lee, 2002). If the organization cannot meet the demand, it can either try to optimize the output given the limited capacity or it can seek to gain additional capacity (Yu-Lee, 2002). Internal capacity may be increased through initiatives like maximizing efficiency, e.g. offsetting activities which are non-essential for delivering the service to periods of off-peak demand, or increased customer participation (Yu-Lee, 2002; Sasser, 1976). Seeking external capacity, on the other hand, may involve investing in additional resources or outsourcing to take advantage of another party's

spare capacity (Yu-Lee, 2002; Sasser, 1976). When using outsourcing to gain the extra capacity, the higher transactional cost and potentially higher cost of goods or services sold need to be carefully considered so as to not impact the bottom line negatively (Yu-Lee, 2002).

Adenso-Díaz, Gonzalez-Torre, and García (2002) suggest that the ideal situation for a service industry is to have the possibility of reducing capacity in periods of low demand and increasing it in high season. While there are few examples in literature of this practice being in use for carsharing providers, neighboring industries appear to employ this strategy extensively. For example, for car rental businesses, acquisition and removal of cars to and from the vehicle fleet is significantly flexible (Oliveira et al., 2017). The method for resizing a vehicle fleet can also include leasing or subcontracting vehicles on a temporary basis, further adding to its flexibility.

2.2.1 Network design

The planning and design of vehicle sharing systems on a strategic level involves decisions related to aspects like the number of stations, station locations, station capacity, and fleet size (Ali Askari, Bashiri, & Tavakkoli-Moghaddam, 2016). Finding the optimal design and location of carsharing stations may be categorized as objectives relating to *infrastructure* while determining vehicles to include in the service may be referred to as *fleet management* (Ferrero, Perboli, Rosano, & Vesco, 2018). The location and accessibility of stations is a critical success factor for providers, but determining this positioning and sizing is challenging (Rickenberg, Gebhardt, & Breitner, 2013). Large geographical coverage attracts more service adoption and higher revenue, but also brings operational challenges such as fleet repositioning to ensure availability (He et al., 2019). Studies show that carsharing companies tend to open stations in all available locations rather than forming a planned station network (Ciari, Weis, & Balac, 2016). Reasons for this include not having the financial means to obtain the best locations, or that the local authorities simply will not grant access to them (Ciari et al., 2016). Further, the number of vehicles in circulation for a carsharing provider has large implications on cost, where smaller fleets necessitate more redistribution to maintain a set service level (Barrios & Godier, 2014). Fleet sizing can be approached on a strategic or tactical level, depending on the flexibility of a provider's fleet deployment or redeployment (He et al., 2019). Previous academic literature approaches the balancing of vehicle sharing systems in many different ways (see e.g. Ali Askari et al., 2016; Gavalas, Konstantopoulos, & Pantziou, 2016; Fanti, Mangini, Pedroncelli, & Ukovich, 2014).

Some academics propose broad methodologies to achieve balance of the vehicle distribution. Correia and Antunes (2012) introduce an optimization approach for locating stations in one-way carsharing under certain conditions. Application of their approach in the case of Lisbon, Portugal showed that positive financial impact could be achieved by selecting the appropriate number, location, and size of stations. Boyaci, Zografos, and Geroliminis (2015) propose a generic model for supporting the same decisions, taking into account vehicle relocation and charging requirements for

electric vehicles. The effectiveness of the model is demonstrated for the case of Nice, France and is concluded to be applicable to a variety of settings. Others develop more focused techniques which determine locations of stations or fleet sizing. Kumar and Bierlaire (2012) apply their own optimization model in the city of Nice, which identifies the most appropriate locations for establishing carsharing stations in order to maximize overall system performance. Their main measure of performance is the average number of rides per day. Interestingly, they identify a complex tradeoff between locating stations in central areas of high demand which already have a high density of stations (thereby risking cannibalization) versus the untapped outskirts of the city. Fedorčáková, Šebo, and Petrikova (2012) develop a model to determine the required vehicle fleet size to satisfy demand. This is applied in the case of Košice, Slovakia where they find an opportunity to reduce the number of needed vehicles by over 50%. The early model proposed by Barth and Todd (1999) determines the most effective fleet size to satisfy user wait time, and is determined to be broadly applicable in vehicle sharing services. These are only a few examples of models developed to support decision-makers in optimizing the strategic planning of carsharing services. A large portion of academic literature on carsharing during the past fifteen years has been related to this optimization of infrastructure and fleet management (Ferrero et al., 2018).

2.2.2 Vehicle relocation

One-way carsharing, of both the station-based and free-floating variety, poses considerable challenges to providers concerning the balancing and rebalancing of capacity in different locations. Flexibility in return times and return locations for users creates a dynamically disproportionate distribution of vehicles which becomes a problem for providers (Kek, Cheu, Meng, & Fung, 2009). As a result, periodic relocation of vehicles is required to ensure that a sufficient number of vehicles is spread geographically so that user demand can be met (Kek et al., 2009). The target of relocation strategies, generally, is to reduce costs and to provide users with high flexibility and low waiting times (Cepolina & Farina, 2012). Without relocation, there will either be a concentration or a shortage of vehicles at popular destination and origin stations, ultimately leading to a reduction in customers (Di Febraro, Sacco, & Saeednia, 2012). These relocations can be performed by operators employed by the carsharing company or by incentivizing users to return vehicles to high demand areas or stations (Brendel, Brennecke, Zapadka, & Kolbe, 2017; Cepolina & Farina, 2012). These two vehicle relocation strategies may be referred to as *operator-based* and *user-based* relocation, respectively.

The questions to be answered by a carsharing provider when employing vehicle relocation to balance capacity are twofold. First, what algorithm should be used to determine which stations to move vehicles to or from and when should a relocation be done? Second, whether the relocation strategy is operator- or user-based, what methods should be used to perform relocations and how should these be administered? A number of different algorithms for determining when and how vehicle relocations should take place have been proposed in academic literature. This in-

cludes static relocation where thresholds are calculated for specific stations which determine when an additional vehicle is needed and when a vehicle can be reallocated from the station in question to another (Barth & Todd, 1999). It also includes historical predictive relocation which determines expected demand at a given point in time with a specific station as origin (Barth & Todd, 1999). This enables scheduling of relocations in advance.

For operator-based relocation, Kek, Cheu, and Chor (2006) present two potential solutions, shortest time and inventory balancing relocation. Shortest time relocation means transferring vehicles to or from neighboring stations in the shortest possible total travel time (Kek et al., 2006). Relocation by inventory balancing means moving a vehicle from a station with oversupply to one with shortage (Kek et al., 2006). Thus, the former has a focus on service levels by simply attempting to restore service level as quickly as possible while the latter focuses on cost-efficiency by solving a shortage and an oversupply issue simultaneously (Kek et al., 2006). To conduct user-based relocation, Di Febraro et al. (2012) explore a method where customers have an option to agree to drop off their vehicle in a place different from their desired destination and proposed by a system manager. Their findings showed that this technique significantly reduced the number of vehicles needed to run the carsharing system efficiently, but that the amount of the discount offered to incentivize customers was of great importance. All user-based relocation strategies are aimed at incentivizing users to exhibit desirable behavior or patterns of demand. This concept of demand management, and particularly that of incentivization through pricing, is explored below in Section 2.3. Clearly, the operator- and user-based relocation strategies present different challenges to the carsharing provider. Operator-based methods impose a burden on the provider to employ extra staff and incur added cost while user-based methods entails a loss of privacy for the user and a partial loss in fare revenue for the provider (Di Febraro et al., 2012). It should also be noted that the selection of relocation methods and algorithms for scheduling relocations presented above is in no way exhaustive.

2.3 Demand management

Demand management is the process which balances customer requirements (demand) with the capabilities of the supply chain (supply) (Croxton, Lambert, García-Dastugue, & Rogers, 2002). Its main capability is in influencing the level, timing, and composition of demand in order to achieve the company's objectives (Kotler, 1999). A well thought-out implementation and execution of this process can have significant benefits for a company's financial performance through, for example, improved asset utilization (Croxton et al., 2002). Demand management is frequently thought of as being limited to forecasting, but this view generally produces mediocre results (Crum & Palmatier, 2003). Traditionally, rather than forecasting the actual demand of a market or channel, companies also focus excessively on the quantities which should be produced (Chase, 2016). Instead, companies must realize that the role of the demand management process encompasses the synchronization of demand and supply, increase of flexibility, and reduction of variability (Croxton et

al., 2002). Taking a broader view of demand management can help companies in better understanding their customers and markets, subsequently producing better forecasts, but also in better positioning the company to achieve meaningful competitive advantages (Crum & Palmatier, 2003).

As can be seen in Figure 2.1, the broad-view model of demand management consists of four major elements. *Planning demand* is an essential business tool for most organizations (Vlckova & Patak, 2011) and should include more than a forecast alone. A competent demand plan rather becomes a commitment to execute the marketing and sales activities necessary to achieve specified sales volumes (Crum & Palmatier, 2003). It describes how the organization ensures that the right quantities are produced at the right time and at an acceptable cost (Vlckova & Patak, 2011). Demand planning, in this way, aims to sense the demand requirements of the market and translate them into an actionable demand response which can later be supported by a response from the supply side (Chase, 2016). *Communicating demand*, in this context, entails communicating the generated demand plan to other functions, such as supply and finance, as well as other supply chain partners. Thus, effective interfacing between sales, marketing, and other internal company functions becomes crucial. By effective communication of the demand plan throughout the organization, it can be used to drive supply and financial planning (Crum & Palmatier, 2003). *Influencing demand* is done by marketing and sales efforts such as pricing, promotions, and product positioning. It includes not only the stimulation or growth of demand, but also impacting it in other ways to achieve the company's objectives (Crum & Palmatier, 2003). This could involve purposefully redirecting demand to specific parts of the assortment or postponing customers' buying decisions. Finally, *prioritizing demand* simply amounts to managing customer orders for optimum performance (Crum & Palmatier, 2003).

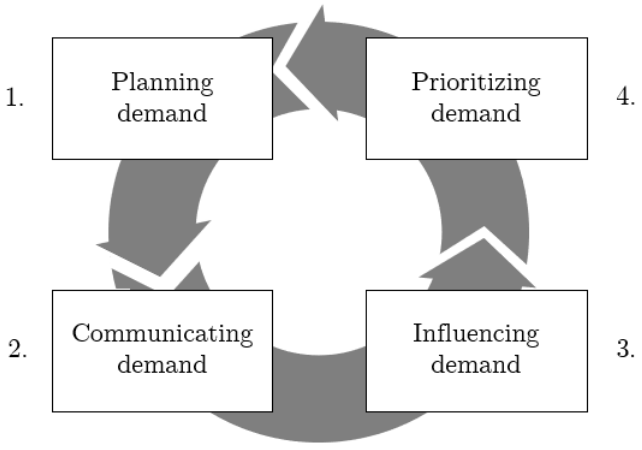

Figure 2.1: Broad-view model of the demand management process (Crum & Palmatier, 2003).

Each of the four elements in the broad-view model are influenced by the other three and follow one another in successive iterations, as illustrated in Figure 2.1. When

integrated with other supporting processes and more information this gives a clear picture of the demand (Crum & Palmatier, 2003). The marketing and sales departments should be the ones responsible for leading the process since the demand forecast is based on the efforts by these departments to stimulate demand (Crum & Palmatier, 2003). One factor that separates successful companies from less successful ones when it comes to demand management is whether the sales and marketing departments are actively participating in the process, or if they simply delegate these tasks to other parts of the organization (Crum & Palmatier, 2003).

Demand management requires resources, but it can provide great value to the companies that master it. By looking at what consequences poor demand management could bring, it is possible to determine the worth of the demand management process (Crum & Palmatier, 2003). Poor demand management could have negative consequences both if the customers order more than the forecast predicts and if they order less. If the demand is higher than the forecast it could lead to loss of sales revenue since the demand cannot be met (Crum & Palmatier, 2003). A higher demand than forecasted also means that the supply organization must change their priorities which can lead to higher costs and lower margins due to inefficiencies of the expediting (Crum & Palmatier, 2003). When the demand is lower than the supply, on the other hand, there will be an excess of inventory and an increase in inventory carrying costs (Crum & Palmatier, 2003). There is also the risk of the inventory becoming obsolete (Crum & Palmatier, 2003). If there is limited capacity available and the demand is lower than the forecast, there could be a waste of capacity if the product mix is wrong meaning that there could bee too much of products that are not selling and too little of the products that are in demand (Crum & Palmatier, 2003). Given the substantial risk of these negative outcomes, and today's economic and competitive business landscape, implementing an effective demand management process is likely a key step for any revenue-generating organization (Crum & Palmatier, 2003).

Influencing demand is done to make customers buy the company's products or services in a way that is synchronized with the capabilities of the supply chain and thereby in line with the company's goals (Croxton et al., 2002; Crum & Palmatier, 2003). This does not only include increasing the demand, but also encouraging customers to purchase alternative products instead or to postpone their purchase (Kotler, 1999; Crum & Palmatier, 2003). This process, of sensing demand signals and shaping future demand, must focus on identifying key market opportunities and subsequently leveraging sales and marketing programs to capture those opportunities effectively (Chase, 2016). For example, this can be done by increasing the price of products which are in short supply to encourage the customers to postpone their purchases, or by increasing the price on unprofitable products to push customers towards more profitable items in the assortment (Crum & Palmatier, 2003). When the demand is higher than the supply and there is no possibility to provide the additional demand in time without disturbing the production schedule, there is a need for managing and prioritizing the demand (Crum & Palmatier, 2003). This can be done in several different ways including fulfilling the demand late, delaying the de-

livery to other customers so that one customer gets its demand fulfilled, offering an alternative product, or simply declining the additional demand (Crum & Palmatier, 2003). When the customer is sold an alternative product to what they intended to purchase it is crucial to keep track of what the customer wanted to buy in the first place, since forecasting is done using historical data and it should be based on the actual rather than the substituted demand (Crum & Palmatier, 2003).

For service firms in particular, fluctuations in demand appear to be a troublesome issue (Zeithaml, Parasuraman, & Berry, 1985). While many of the strategies for demand management are applicable for both physical products and services, the characteristics of services pose some unique challenges. The *perishability* of services, i.e. the fact that they cannot be saved in inventories as buffers in anticipation of future demand in the same manner as physical goods, means that service businesses often find it difficult to synchronize supply and demand (Sasser, 1976; Zeithaml et al., 1985). Times of low demand means a waste of productive capacity since services cannot be produced during those times and stored in inventory like physical products can (Lovelock, 1984). Likewise, when demand is so high that it exceeds the capacity of the organization, rather than drawing from already established finished goods inventories as a goods manufacturer would, the business will likely experience loss of sales (Lovelock, 1984). However, while supply of services such as personal transport can rarely be inventoried, demand oftentimes can be (Lovelock, 1984). This could be done by e.g. asking customers to wait in line on a first-come first-served basis (i.e. queuing) (Lovelock, 1984). An important part of employing queuing and having users accept the waiting time is *"finding ways to make this time pass quickly and pleasantly"* (Lovelock, 1984, pp. 18). It could also be done by offering opportunities to make reservations in advance (Lovelock, 1984). A service organization with fixed capacity can experience these four conditions (Lovelock, 1984):

- Demand is higher than available capacity
- Demand is higher than optimal capacity
- Demand and supply are balanced and optimal
- Demand is lower than the optimum

As previously described, when the demand is higher than available capacity, the customers' needs cannot be satisfied, they may be discouraged, and their business may be lost forever (Lovelock, 1984). In the case where demand exceeds the optimal capacity level, there is a risk that the customers experience a deterioration in the quality of the service and therefore become dissatisfied (Lovelock, 1984). Having the demand match the optimal capacity level is of course the most desirable situation. The optimal capacity level does however differ between different types of services (Lovelock, 1984). For example, the customer experience in a sports arena might benefit from a full house since it creates a more exciting atmosphere, meaning optimum and maximum capacities are the same, while airline travelers might prefer a lower load factor since it gives each passenger more space and more attention from the crew (Lovelock, 1984). Demand that is lower than the optimum may in some cases also cause the customers to doubt the viability of the service (Lovelock, 1984).

2.3.1 Dynamic pricing

Dynamic pricing is a demand management strategy where the price of the product or service is changed in a dynamic fashion based on factors like supply, demand, and time of day (Elmaghraby & Keskinocak, 2003). It is a popular tactic used to manipulate demand, both to stimulate it when sales are low and to deter it when demand cannot be met (LID Editorial, 2015). This approach to pricing has mainly been used in cases where the seller has little control of the available supply in the short term, such as sales of airline tickets (Gallego & van Ryzin, 1994; Elmaghraby & Keskinocak, 2003). Historically, static pricing has been used, wherein prices of products and services have remained constant over long periods of time (Elmaghraby & Keskinocak, 2003). Lack of demand information and high transaction costs for changing the prices were the main reasons for this approach (Elmaghraby & Keskinocak, 2003). One could think of static and dynamic prices, respectively, as being a price which is independent of the current state of the system and a price which is not (Waserhole, 2013). The advancement of information technology has played a large role in enabling more companies to adopt dynamic pricing (Elmaghraby & Keskinocak, 2003). To be able to set the right price, the seller has to be knowledgeable of its own operating costs and the supply, but also of how customers value the product and what the demand will be in the future (Elmaghraby & Keskinocak, 2003). While dynamic pricing can have a positive impact on a company's revenue and its ability to match supply and demand it can also potentially harm customer relationships, as explaining and justifying price fluctuations to the customer may be difficult (LID Editorial, 2015). There are examples of strident backlash from consumers when it has been used in pricing mobility solutions, particularly ridesharing (Yaraghi & Ravi, 2017). Transparency and open disclosure of pricing mechanisms in use is often the recommended course of action, to avoid some of this controversy (Yaraghi & Ravi, 2017). Dynamic pricing has also been argued to be a way to avoid cross-subsidization, that is letting customers during one time period pay for the deficit of another (Stubbs, Tyson, & Dalvi, 1984). This can, for example, include customers during low demand paying more than their service costs to cover the losses inflicted on the provider during peak demand (Stubbs et al., 1984).

Customers' purchasing behavior also influences the way that companies set the prices and a distinction can be made between *myopic* and *strategic* purchasing behavior (Elmaghraby & Keskinocak, 2003). Myopic behavior means that customers buy the product as long as the price is below their reservation price (i.e. the highest price the buyer is willing to pay), not taking potential future price cuts into consideration (Elmaghraby & Keskinocak, 2003). The seller can therefore set the future price without any risk of detrimental effects on current purchases (Elmaghraby & Keskinocak, 2003). Strategic customers, on the other hand, also consider the future price when making buying decisions (Elmaghraby & Keskinocak, 2003). This makes strategic customer behavior difficult to manage, since the seller has to take the effects of both current and future prices into consideration when trying to understand customers' buying decisions (Elmaghraby & Keskinocak, 2003). Although, lack of time and information combined with a tendency to make spontaneous purchasing decisions disallows customers from behaving strategically (Deksnyte & Lydeka, 2012).

Views on the suitability of applying dynamic pricing policies vary in academia and industry. In their study of the hotel industry, Rohani and Nazari (2012) compare dynamic and static pricing to investigate the response of consumers, their emotions, and their behaviors toward each pricing scheme. While it is prudent to note that their results from the hospitality sector likely cannot be directly applied to the carsharing setting, parallels may certainly be drawn. They distinguish between what they refer to as high involvement and low involvement consumers, the former of which *"[spends] more time, effort, and money to search for better deals"* (Rohani & Nazari, 2012, pp. 147). These consumer behaviors appear to correspond loosely to strategic and myopic behaviors respectively, as described above. Their results indicate that consumers generally are apt to favor dynamic pricing and that highly involved consumers respond to it more positively (Rohani & Nazari, 2012). Others attempt to dissuade practitioners from applying dynamic pricing. Peng, Yan, and Bai (2017) recommend carsharing enterprises not to use it in the initial operational stages of the business. Demand based dynamic price adjustments, they argue, should instead be introduced at later, more mature stages when customer groups are stabilized and their habits are established.

Dynamic pricing strategies have been used and also studied extensively in vehicle sharing systems broadly (Bianchessi, Formentin, & Savaresi, 2013; Waserhole, 2013) and carsharing systems specifically (Jorge, Molnar, & Correia, 2015). Pricing has been proposed specifically, and as an alternative to the more extensively studied vehicle relocation techniques, for the purpose of mitigating the effects of vehicle stock imbalances (Jorge et al., 2015). Two separate uses of pricing for re-balancing vehicle distribution were identified by Jorge et al. (2015); policies providing price incentives for users to choose a specific drop-off location for their vehicle, and changes to the total trip price to control the demand while taking the stock balancing into consideration. For the first method total demand stays unaltered (Jorge et al., 2015), users are not disincentivized from using the service but simply incentivized through lower fair charges to end their trip in a specific location. A simple illustration of this can be found in Figure 2.2. In this example, while the user's final destination may be closer to station C they may still choose to end their journey at station B due to the more attractive price, thus contributing to the balancing of vehicle distribution. The pricing information associated with this strategy can be communicated to users before or during a trip through the use of e.g. scalar fields, heat maps, or contour maps via the user's mobile device (Papanikolaou, 2011). This technique serves to control the vehicle distribution of the service while decreasing, or eliminating, the need for costly and time consuming operator-based relocations (Bianchessi et al., 2013). Effectively, the user becomes both service recipient and service provider by aiding the carsharing organization in the balancing of vehicle stock levels (Papanikolaou, 2011). This is referred to, within this thesis, as user-based vehicle relocation. For the second method, demand is increased or decreased in a deliberate manner depending on its contribution to vehicle stock balancing (Jorge et al., 2015). For example, prices may be increased during times of day with peak demand or the price of initiating a trip from a particular area may be decreased if an excessive number of vehicles are currently parked there. Dynamic pricing incentives have been shown to be effective

in redistributing vehicles, in bicyclesharing (Pfrommer, Warrington, Schildbach, & Morari, 2014; Haider, Nikolaev, Kang, & Kwon, 2014) as well as carsharing schemes (Bianchessi et al., 2013; Jorge et al., 2015).

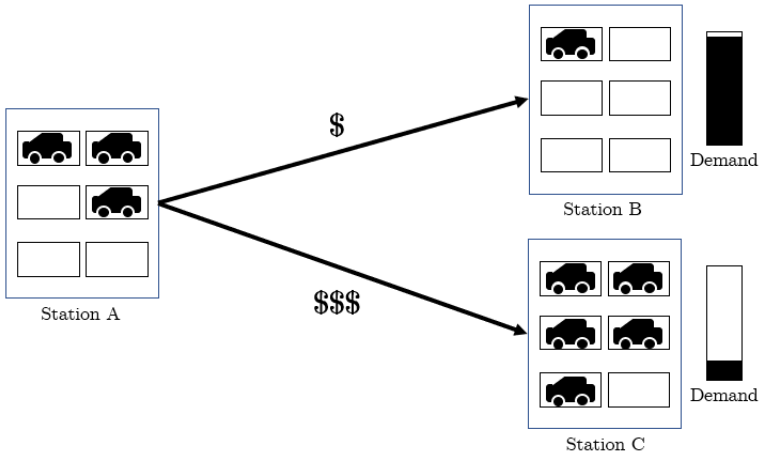

Figure 2.2: Dynamic pricing scheme for station-based carsharing, with fare pricing determined by supply and demand at arrival stations.

2.3.2 Transport demand

Demand for personal transport services in particular can be said to be comprised of two components; commuting and infrequent travel (Wang & Xie, 2016). This demand is influenced by a number of factors including the purpose of the trip, the price of the service, prices of competing or substitute services, and methods by which users are charged (Button, 1982). Demand for transport services to be used for commuting is predictable to a high degree (Wang & Xie, 2016), with demand for transport in urban areas being markedly higher early mornings and late afternoons (Button, 1982). By contrast, infrequent travel demand is highly randomized (Wang & Xie, 2016). This is mainly due to the underlying characteristics of variability of travel activities, i.e. the purpose for which the personal transport is in demand (Wang & Xie, 2016). Price sensitivity also varies depending on trip purpose, with e.g. business trips appearing to be comparatively insensitive to changes in pricing (Button, 1982). This means that analyzing transport demand should not be attempted without taking into consideration what type of trip is being undertaken (Button, 1982). The influence of pricing on usage is difficult to generalize, but it seems as though price changes within certain limits have relatively small effects on quantity of travel demanded (Button, 1982). In practice, the expenditure of a trip from a user's perspective involves both cost in terms of money and time (Stubbs et al., 1984). This further limits the impact of fare changes, especially if the fare constitutes only a small proportion of the combined cost (Stubbs et al., 1984). Interestingly, in the specific context of urban car travel, users prove almost totally insensitive to decreased prices for alternatives such as public transport (Button, 1982). Thus, it would stand to reason that attempts by city authorities to reduce car travel by subsidizing fares for public substitutes will be largely unsuccessful. This has indeed proven to be the case (Button, 1982). In addition, the manner in

which users are charged for transport has a considerable effect. For example, since they are charged periodically rather than on a per-trip basis, most private car owners perceive a much lower price for travel than what is actually the case (Button, 1982). On the other hand users of public transport are typically made more aware of the costs as they are required to purchase a ticket, which presents a distinct marginal cost for each trip (Button, 1982). Of course, as many public transport providers offer season tickets or other types of bulk-buying of transport, this distinction does not necessarily hold true in all cases.

Managing personal transport demand, particularly in urban environments, is a topic of much discussion in academia and local government. In its broadest sense, transport demand management is *"[...] any action or set of actions intended to influence the intensity, timing, and spatial distribution of transportation demand for the purpose of reducing the impact of traffic or enhancing mobility options"* (Meyer, 1997, pp. 13). In practice, it involves any number of policies implemented in order to reduce the demand for car use and generally promote sustainable transportation (Gärling & Schuitema, 2007). Policies attempt to accomplish this through two types of initiatives; promoting more efficient modes of travel to utilize available infrastructure more effectively and spreading the travel demand across a longer time period (Smart Growth America, 2013). Meyer (1999) also proposes a third type of initiative involving achieving the purpose of the trip without the use of transportation, for instance by substituting the use of telecommunications for working out of the office. These policies include pricing initiatives (Lindsey & Verhoef, 2000; Gärling & Schuitema, 2007) as was already mentioned above, vehicle access restrictions (Gärling & Schuitema, 2007), and regulation of parking supply (Barcik & Bylinko, 2018).

While most transport demand management measures have modest individual impact (Black & Schreffler, 2010), a comprehensive strategy can have synergistic effects (Barcik & Bylinko, 2018). This involves making use of both negative incentives such as parking or congestion fees and positive incentives such as improved travel options (Barcik & Bylinko, 2018). Gärling and Schuitema (2007) also argue this combination of measures (what they call coercive and noncoercive measures) improves effectiveness, and to that end particular emphasis is placed on the improvement of travel alternatives. The promotion of carsharing initiatives is an example of such expanded transportation options (Smart Growth America, 2013). One basic barrier to the use of carsharing as an effective tool in transport demand management, however, is that this transport solution still appears to be relatively unknown to travelers (Barcik & Bylinko, 2018).

3
Methodology

The following chapter describes the methodology used to conduct this thesis and presents the theoretical reasoning behind the selection of this methodology. This includes the research design, collection of primary and secondary data, analytical methods, as well as the quality, trustworthiness, and authenticity of the research.

3.1 Research design

This thesis is constructed as a comparative multiple case study involving the case companies Cambio, Stadtmobil, an anonymized subsidiary to an automotive company herein named AutoCo, and GreenMobility. Its goal is to explain the cases selected and also to shed light on a population or a larger set of cases (Gerring, 2017), namely the carsharing industry as a whole. The comparison of several cases provides a good opportunity for establishing the appropriate circumstances in which to apply a theory, and it may also in itself suggest concepts relevant to an emerging theory (Bryman & Bell, 2015). As this thesis attempts to inform carsharing providers on strategies to match demand and supply of their service, the comparison of their application in different environments therefore is of great interest. The distinguishing characteristics of the cases presented herein are also meant to serve as catalysts for theoretical reflections about contrasting findings (Bryman & Bell, 2015). Moreover, this research is based on interviews of a qualitative nature with representatives of the case organizations. Qualitative research methodology has the advantage that it can facilitate new insights from participants which were not expected beforehand (Kuada, 2012). It allows for the participants to give new perspectives on issues, and therefore qualitative research methods are recommended when trying to gain new insights on a phenomenon rather than confirming existing theories (Kuada, 2012). Qualitative data also has the ability to give a holistic view of the issues explored (Miles, 1979). In the categorization used by Gerring (2017) this is referred to as a "small-C" case study, meaning the number of cases is limited and qualitative cross-case, longitudinal, and within-case analysis are all included to some extent. Cross-case analysis refers to variations across studied cases which provide evidence used in reaching conclusions (Gerring, 2017). This is the primary form of analysis conducted within this thesis. Longitudinal analysis focuses on variation for the chosen cases over time (Gerring, 2017). As this thesis is generally concerned with the present conditions of the carsharing industry, this is involved to a lesser extent. Finally, within-case analysis explores variations inside or within a particular case (Gerring, 2017). In this context this is mainly variations between geographies

for particular case companies, which are evaluated at some length.

In inductive research, theory is generated following the observations and findings while in deductive research a hypothesis is generated, based on existing theory, and its validity is then tested through the research (Bryman & Bell, 2015). What is called positivist and constructionist research design methodologies can be distinguished in a similar way. In positivist methods the researcher begins with one or several hypotheses to be confirmed or disconfirmed, while in constructionist methods the focus rather lies on clarifying the context within which different theories are correct (Easterby-Smith, Thorpe, & Jackson, 2015). As research in carsharing is somewhat limited at present, and reasonable hypotheses thus are difficult to generate prior to observations, this thesis follows the method of inductive, or constructionist, research design rather than deductive, or positivist. In addition, the inductive approach is more suitable when attempting to generate theory rather than confirming existing theory (Bryman & Bell, 2015). Ultimately, utilizing inductive research techniques for the purposes of this thesis allowed drawing broader or generalizable inferences out of the observations made (Bryman & Bell, 2015).

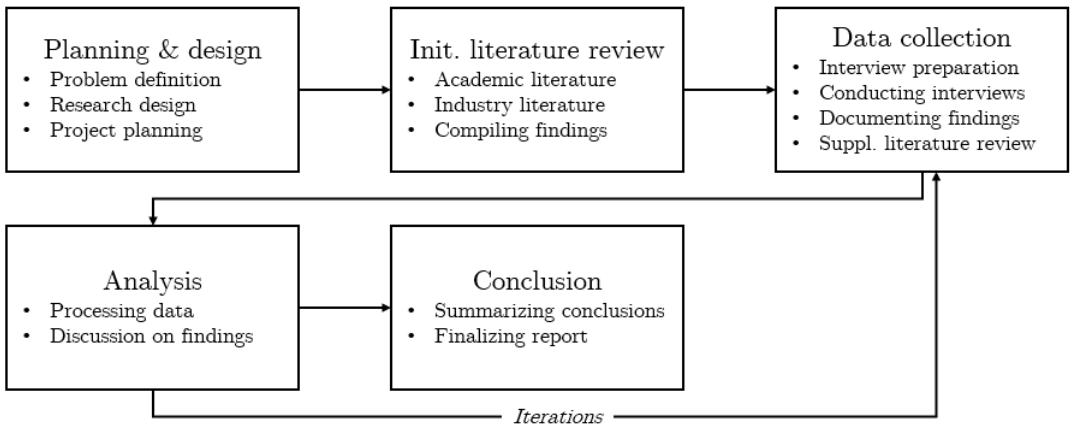

Figure 3.1: Illustration of the research process.

As illustrated in Figure 3.1, after an initial planning phase, the research of this thesis was carried out through a literature review, subsequent data collection through interviews, and analysis of collected data. In addition, this process was iterative in that further literature review and data collection were performed when information needed for accurate analysis was felt to be missing. The methods and techniques used for these components of the process are expanded upon below.

3.2 Data collection

The data collection methods used throughout this thesis are described within this section, including literature review and interviews. The literature review, being one of the most important parts of carrying out a qualitative research project, provides

the basis on which the research questions are justified and the research design is constructed (Bryman & Bell, 2015). In the context of this thesis, interviews were also useful as they enabled the collection of information about specific topics but also the environment in which they operate, which would otherwise be difficult to observe or gain an understanding of (Easterby-Smith et al., 2015).

3.2.1 Literature review

To get a better understanding of the subject and to be able to formulate accurate questions for the interviews, a literature review was conducted. As research theory suggests, this was a continuous process throughout the course of the project including rewriting and refocusing (Easterby-Smith et al., 2015). The literature was centered around carsharing as a concept, but also topics which would aid in understanding and defining the demand and capacity asymmetry problem in carsharing and answering the research questions. In accordance with the general purpose of such literature reviews, this included what was already known about the subject matter, relevant concepts, and research strategies employed within the area (Bryman & Bell, 2015). The literature used consisted of both industry data in the form of trend reports and articles as well as academic research in the form of textbooks and published journals.

3.2.2 Sampling

The sampling plan used for the purposes of this case study consisted of a number of distinct sampling strategies. In qualitative research such a plan is helpful in identifying and contacting research participants (Easterby-Smith et al., 2015). Carsharing providers included in the case study were carefully selected to enable comparisons to be made and to provide a representative depiction of the carsharing industry, as was consistent with the scope of this thesis. Also, representatives from other companies, namely suppliers to the carsharing industry, were chosen in the same manner and interviewed to provide additional data. This could be described as case selection by intrinsic importance, meaning companies were chosen based on their theoretical or practical significance (Gerring, 2017). Alternatively it could be thought of as purposive sampling, which is a fundamental principle in sampling for qualitative research, wherein selection of cases is done in a strategic way so as to include cases relevant to the research questions (Bryman & Bell, 2015).

Similarly, interviewees within these companies were selected based on their roles to ensure they possessed sufficient and accurate information regarding the topics relevant to the case study. The initial selection of interview participants may be considered to have been a combination of ad-hoc and typical-case sampling techniques. Ad-hoc sampling, otherwise known as convenience sampling (Bryman & Bell, 2015), signifies cases being selected based on availability and ease of access while typical-case sampling employs selection aiming at identifying the most typical instances (Easterby-Smith et al., 2015). This was generally the methods used in selecting first points of contact within each case company, before a connection

had been properly established and ad-hoc sampling was deemed necessary to begin data collection. In selecting participants beyond initial points of contact, i.e. in expanding the sample of interviewees within a case company, snowball sampling was also used. Snowball sampling involves selecting participants based on the recommendation by other participants (Easterby-Smith et al., 2015). Again, this was useful in ensuring access to a larger set of interviewees but also enabled making use of the expertise of participants to identify personnel with insight relevant to the research. This practice of employing snowball sampling preceded by other sampling techniques is quite commonly used in qualitative research (Bryman & Bell, 2015). However, snowball sampling through recommendations of previously interviewed respondents plainly has its risks in that the chain of selection may simply become friends of initial respondents (Kuada, 2012). This makes the sample of interviewees purposefully selected rather than reflective of the views of the entire organization (Kuada, 2012). This potential aspect of the case and interviewee sampling plan has been considered during the process of conducting this thesis and been accounted for during the analysis phase in an attempt to minimize its significance.

Table 3.1: Carsharing companies included in the case study.

Company	Variant	Primary market	Vertical integration
Cambio	Station-based	Germany	No
Stadtmobil	Station-based & Free-floating	Germany	No
AutoCo	Station-based	Sweden	Yes
GreenMobility	Free-floating	Denmark	No

Table 3.1 outlines the companies included in the case study, the carsharing variant they operate, the geography within which they are currently active, and whether the company is vertically integrated with a vehicle manufacturer. As can be seen in this table, the selected case companies represent both free-floating and station-based carsharing providers. The geographical coverage of these carsharing providers is also quite varied, though focused on European markets. Likewise, these case companies represent both vertically integrated carsharing providers (i.e. providers owned and operated by a vehicle manufacturer) and standalone providers. As qualitative sampling aims to identify reasonable instances of the larger phenomenon under research (Luker, 2010), a variety of carsharing providers have been included representing large parts of the wider industry. Theoretical saturation, i.e. the point at which a concept is saturated with data (Bryman & Bell, 2015), was important to achieve in order to reach a sufficient sample size of case companies. Theoretical saturation is achieved at the point at which no new or relevant data appears to be emerging, the concept at hand is well developed regarding its properties, and relationships among concepts are well established and validated (Corbin & Strauss, 2015). While it is impossible to know for certain when theoretical saturation has been achieved (Bryman & Bell, 2015), the sample was deemed large enough to do so. Stated in more common parlance, samples should generally not be so small as to make it difficult to achieve theoretical saturation (Onwuegbuzie & Collins, 2007). At the same time, the sample should not be so large that undertaking deep case-oriented analysis becomes difficult (Sandelowski, 1995). While it cannot be shown formally

that these conditions hold true for this case sample, the number of companies and their spread by type, geography, etc., was deemed appropriate and sufficient for the purposes of this thesis.

Within the included companies, interviewees were selected based on their roles and areas of expertise. Individuals within three specific roles were primarily in focus as potential interviewees for the case study; chief executives, marketing and sales representatives, and operations professionals. These individuals were thought to be able to provide adequate knowledge of the company and its context, the demand side, and the supply or operative side of the business. The sample size in terms of total number of interviews was deemed appropriate as it appeared to achieve reasonable theoretical saturation. In particular, the number of interviews was sufficient to establish what was considered a good understanding of the entire sample of case companies and it was not apparent that new relevant data would emerge by conducting additional interviews. Table 3.2 outlines the interviews included in the case study; the roles of the interviewees in their respective companies and the duration of each interview. This includes both the case companies of Table 3.1 and additional companies whose representatives provided additional data, mainly on the background of the industry. These interviewees represent a mix of roles, though are typically part of senior leadership within their companies. This puts them in a good position to provide a broad perspective on the topics of this thesis, including nuanced observations on the technical aspects of their business and service.

Table 3.2: Interviews conducted for the case study.

Company	Interviewee role	Date	Duration	Abbreviation
Cambio	Communications Officer	19-03-08	30 min	C_1
Stadtmobil	Board member	19-03-20	60 min	SM_1
	CEO	19-04-08	60 min	SM_2
AutoCo	COO	19-03-12	40 min	AC_1
	Product marketer	19-04-01	60 min	AC_2
GreenMobility	CEO	19-04-04	30 min	GM_1
EY	Sr. Manager, Mobility Innovation	19-03-07	30 min	EY_1
Invers	CEO	19-03-19	60 min	I_1
TechCo	Manager, Customer Unit Europe	19-03-27	60 min	TC_1

3.2.3 Interviews

Based on the literature review, a number of key areas to be brought up during interview sessions were identified. Individuals with expertise in these areas were identified and contacted in order to schedule interviews. As many of the contacts were based outside of Sweden, all interviews were held via either telephone or online conferencing tools. While most interviews were also held in English, interview AC_1 was held in Swedish and was translated to English after-the-fact. Interviews were recorded by audio as well as written notes. This was essential to ascertain accurate transcripts and an unbiased record of the conversations (Easterby-Smith et al.,

2015). After the interviews were held, summaries were sent to and confirmed by all interviewees to enable them to redact or recant any statements which upon further reflection were not consistent with their view. This aided in further ensuring the credibility of data gathered through interviews as well as any qualitative interpretations made during the course of the conversations. It also enabled interviewees to confirm that no aspects of their views or statements were lost in translation between Swedish and English. Summaries of all interviews can be found in Appendix B.

The interviews were held in a semi-structured format, meaning some level of understanding was gained prior to the interviews through the previous literature review. Questions and topics were pre-defined and sent in advance to all interviewees in order for them to have the opportunity to prepare their answers. However, this question form was not strictly adhered to at all times and digressions were made as seen fit. This semi-structured approach is an appropriate way to perform a qualitative interview when, as in the case of this thesis, the research already has a fairly clear focus and there are certain topics to be covered in the interview (Bryman & Bell, 2015; Easterby-Smith et al., 2015). It allowed the introduction of additional relevant questions in order to explore specific dimensions in specific interview situations or contexts (Kuada, 2012). A semi-structured interview is also preferred if the fieldwork is done by more than one person (Bryman & Bell, 2015). The question forms used for case company representatives and personnel of carsharing industry suppliers, as developed in advance of the initial interview session, can be found in Appendix Sections A.1 and A.2, respectively.

3.3 Analysis

The advantages of qualitative data are clear, but it has one large drawback in that there are few well formulated methods and rules for analyzing it (Miles, 1979; Bryman & Bell, 2015). It can be difficult to avoid self-delusion and the presentation of unreliable conclusions (Miles, 1979). Another difficulty with qualitative data is that condensing the complex and contextual information into a convincing format can be challenging (Easterby-Smith et al., 2015). It requires, among other things, a clear description of how the analysis was done (Easterby-Smith et al., 2015). The analysis of qualitative data is often an iterative process, with the collection of data and the analysis of it taking place alternately (Bryman & Bell, 2015). This was also the case during this research project as analysis of the gathered data was an ongoing process. As is typically the case in the collection of qualitative data, a large volume of information was accumulated (Bryman & Bell, 2015). The analysis of the data gathered followed the *grounded analysis* approach as described by Easterby-Smith et al. (2015). It is a seven step process which aims to develop theory by comparing the data fragments with each other (Easterby-Smith et al., 2015). The first step is *familiarization*, which simply means to go through the available data and was done through review of notes and audio recordings of the interviews. The second step is to *reflect* on the data and how it relates to existing knowledge. The data is then *coded*, which means that chunks of data are summarized with a word or a short phrase to link the unstructured and overwhelming data to more systematic categories. This

labeling can for example be in terms of what general category the data fit into or what topic the data is an instance in (Bryman & Bell, 2015). After the coding is done, the codes are analyzed to try to find patterns among them in a process which is called *conceptualization*. When the most important codes and categories have been identified, the data is coded again with more focused codes in a process called *focused re-coding*. This second coding cycle has the purpose of framing the data in a way that that enables a deeper analysis of the most important areas. After this, the analytical framework should be quite clear and the way the categories and concepts relate to each other and how these can be integrated into a theory can be conceptualized. The codes included can be found in Tables 4.1, 4.2, and 4.3. From this a first draft can be produced and verified by outside parties. This process is called *linking*. The seventh and final step of grounded analysis is *re-evaluation*. Here the input from others is taken into account and areas where more work was needed are looked upon again. Both parties from academia and industry participated in linking and re-evaluating the data.

The application of grounded analysis as described above was enabled through the use of NVivo 12 Pro, a computer software package specialized in qualitative data analysis. This software was designed specifically to process rich text-based information where deep levels of analysis on large volumes of data are required (McNiff, 2016). It was particularly useful in the coding, conceptualization, re-coding, and linking components of the analysis. It allowed the data gathered through interviews during the course of the case study to be succinctly gathered and viewed in their entirety, which in turn enabled more detailed analysis.

3.4 Trustworthiness and authenticity

Qualitative research can be evaluated based on trustworthiness and authenticity (Bryman & Bell, 2015). The trustworthiness in turn can be judged based on four dimensions: *Credibility*, *transferability*, *dependability*, and *confirmability* (Bryman & Bell, 2015). Credibility refers to the extent to which appropriate research practice has been adhered to during the study and that those who were studied have validated that the findings were understood correctly by the researchers (Bryman & Bell, 2015). Summaries of the interviews were sent to the interviewees, making sure that there were no misunderstandings that could lead to false conclusions. A near-final draft of the thesis was also sent to interviewees to further ensure the nonexistence of such misunderstandings. Having the respondents validate the transcripts in this manner is a good way to increase the credibility of the research (Kuada, 2012). In addition, the methodology described above was thoroughly reviewed and grounded in established research theory. To achieve high transferability, the context of the research must be well documented so that future researchers can compare their results to see whether the findings can be applied in other contexts as well (Kuada, 2012). This was done by in detail describing the context in which each of the studied companies operate. Documenting all the phases of the research, proving that it was conducted according to prescribed methodology, is also required in order to have high dependability (Kuada, 2012). Ensuring this, the methodology of this research

has been described in detail previously within this chapter. Finally, to have high confirmability it must be ensured that no personal values have influenced the research in any direction and that all findings are objective (Bryman & Bell, 2015). In accordance with this, all crucial data was interpreted and viewed by multiple individuals reducing the risk of contamination from personal preferences or preconceptions. Interviews were, as mentioned, also recorded to ensure the objectivity of transcripts.

The authenticity of the research is dependent on to which degree the study is deemed fair, improves understanding of the investigated phenomenon, and provides opportunities to readers to improve their insights and act upon them (Kuada, 2012). This means, in part, that all relevant individuals and perspectives have been included and considered (Bryman & Bell, 2015). This was ensured by selecting interviewees from different organizations, both carsharing providers and hardware suppliers. Further, the aim of this thesis was explicitly designed to enable carsharing providers, the prospective target readership of the thesis, to make more informed decisions as regards the subject matter.

Throughout the course of work on this thesis, its progress and content was overseen by external individuals representing both academia and industry. The direction and advice stemming from this aided not only in the continuous development of the content of the thesis, but also in ensuring its quality.

4

Results

This chapter describes the empirical findings collected during the course of the case study. All information contained herein has been sourced from interviews conducted with case company representatives and other carsharing industry experts, unless other sources are stated. These interviews are outlined in Section 3.2.2. First, descriptions of all companies included in the study are presented, both case companies and industry suppliers. These descriptions allow for a comprehensive understanding of the contexts in which the carsharing providers are operating and various strategies are applied. Empirical findings regarding carsharing industry priorities, carsharing users, and strategies to counter the demand and capacity asymmetry issue, are then presented. Tables 4.1, 4.2, and 4.3 display in which interviews certain topics were discussed, and the total number of instances in which they were brought up.

4.1 Company descriptions

All companies included in the study, whose representatives were interviewed, are described below. These descriptions are meant to give the reader a sense of the general characteristics of each carsharing provider, the geography within which they operate, and the service which they offer. Other companies not included as cases, but interviewed for background, are also described. These companies are different types of suppliers to carsharing providers whose employees have extensive knowledge of the industry and actors within it. The interviewed personnel from each company are also described below.

4.1.1 Cambio

The first case company is Cambio CarSharing which is a carsharing provider operating since 2000 when it was formed through a merger of several German and Belgian providers. Their vehicle fleet includes more than 2,800 vehicles positioned at around 600 stations in cities throughout Germany and Belgium. This makes it one of the three largest carsharing companies in Germany. Their service offering is station-based and round-trip, with allowed rental times between one hour and thirty days and different types of vehicles for different reasons for traveling. These include smaller cars, station wagons, and larger vehicles. Through offering a flexible service in terms of e.g. rental time and vehicle choices they aim to offer people an opportunity to organize their personal mobility without having to own a car. To that end, Cambio has sub-firms in the different cities in which they operate. These sub-firms

work independently to a large extent, which allows for local control of their vehicle fleet and stations within a city. The interviewee from Cambio is its Communications Officer who has worked with the company for around five years, focusing on corporate communication as well as the company's social media activities.

4.1.2 Stadtmobil

Stadtmobil is the second case company, a German carsharing provider consisting of seven regional companies with a common brand, marketing, website, reservation system, and common development of software and technology. It is one of the largest carsharing organizations in Germany, with a total of 1,800 cars, around 800 stations, and 38,000 members. Their offerings include both station-based and free-floating solutions. A board member of the Stadtmobil Rhein-Neckar organization was interviewed for the case study. She joined the company in 2011 and her responsibilities in the organization include customer service, communication, and human resources. Stadtmobil's member firm in the Rhein-Neckar region operate approximately 540 cars. This includes station-based vehicles in 25 cities within the region, as well as the free-floating solution called JoeCar which operates in two major cities, namely Mannheim and Heidelberg. Stadtmobil Rhein-Neckar also has a clear expansion strategy which involves the goal of deploying their service in one additional city every year. Service availability is of highest importance to the company and its customers. The second interviewee from Stadtmobil is the CEO of the Stadtmobil Rhein-Ruhr organization, who has a background mainly in information technology. The Rhein-Ruhr region of Stadtmobil was established in 2009, which means it is a lot younger than its counterpart in Rhein-Neckar. It is operating around 110 station-based vehicles as well as around 20 vehicles through their free-floating offering, called Stadtflitzer. As the company is relatively young, they have a more conservative expansion strategy, opting to expand within their current cities before attempting to enter other markets. The balance between costs and availability is in focus for the organization, as both fair prices and high availability are key components of achieving customer satisfaction.

4.1.3 AutoCo

The third case company, herein given the name AutoCo, was founded in 2018 to conceptualize and bring new mobility business models to market as an alternative to car ownership. The company also owns an existing, large carsharing service in Sweden. This service has been operational for around twenty years with a fleet of approximately 1,600 vehicles in forty cities. For this service the company believes it has found a suitable compromise in terms of vehicle availability versus utilization. AutoCo, in addition to operating this existing service, is in the midst of launching a new carsharing brand, with a more premium focus, in Sweden and the United States. The company will aim to provide the same levels of vehicle availability with higher utilization with this service. As this service is not yet launched, the focus will at least initially be primarily on customer satisfaction. Both services are station-based and round-trip concepts.

The first interviewee from AutoCo is the COO. His role and responsibilities currently include three major tasks. Firstly, he manages the conceptualization and implementation of the operative model for the new carsharing service being launched. This includes operative planning for vehicles, customers, station placement, and a number of internal processes such as insurance claims. Secondly, he ensures the success of the company's go-to-market strategies. This encompasses which countries and cities to enter and how specifically to do it. Lastly, the COO is responsible for data science operations within the company. This includes all things relating to decision support and business intelligence, above all when it comes to advanced operational analysis such as station placement, utilization levels, and demand prediction. The second interviewee from AutoCo is its product marketer, who has been with the company for around six months. Her role involves focusing on customer value in its different forms, working with the marketing team, research and insights, sales, and pricing. She has a background in marketing strategy, including a lot of digital marketing and customer relationship management in the automotive industry.

4.1.4 GreenMobility

The final case company is GreenMobility, which is a free-floating carsharing service based in Denmark and operating in Copenhagen as well as Oslo, Norway. The service launched in Copenhagen in 2016 and in Oslo in December 2018 (GreenMobility, 2019). The company manages around 650 vehicles, which are all fully electric Renault Zoes. By the end of 2018 GreenMobility had a total of around 40,000 users (GreenMobility, 2019). The focus for GreenMobility is continued growth in current markets, as well as expanding to other cities across Europe. Therefore the choice of which markets to enter next is under careful consideration, based on demand from different cities for green transportation solutions and carsharing services specifically. In addition, service availability is an important focus as this is the biggest concern of customers. The interviewee from GreenMobility is its CEO, founder, and main shareholder.

4.1.5 EY

EY, formerly Ernst & Young, is one of the largest professional services firms in the world and provides assurance, tax, and advisory services to other businesses. The firm has approximately 270,000 employees operating in around 150 countries. Their advisory services in particular encompass various strands of risk management, performance improvement, and capital management. Advisory service engagements with the carsharing industry include strategic market positioning, market entry or implementation, operational issues, and partnerships. The interviewee from EY is a Senior Manager of Mobility Innovation, with extensive experience from the automotive and carsharing industries both working within the industry itself and advising clients in the industry while working with EY. He has approximately twelve years of experience within different roles and companies in the automotive industry. Particularly, he has been involved in the development of new mobility services and

business models including carsharing and concepts of autonomous driving. He joined EY in early 2017 and has since been engaged in various projects including ones specific to the carsharing industry.

4.1.6 Invers

Invers is a German technology company for shared mobility services. They build software and smart hardware for providers of carsharing, scootersharing, kick scootersharing, and peer-to-peer corporate carsharing. Their technologies aim to make it easier for providers to establish their service and run it at scale. This includes the operating system of shared mobility services, fleet management systems, data collection, and data access which becomes the foundation of various other solutions that enable business insights such as e.g. demand prediction. The company has customers worldwide and their technology currently powers approximately 100,000 shared vehicles, but most of their projects are concentrated in Europe and North America. The interviewee from Invers is its CEO and has been with the company for seven years. His background is in business, technology, as well as entrepreneurship and he was an early adopter as a user of carsharing services.

4.1.7 TechCo

The final company included in the study, herein referred to as TechCo, is a Belgian carsharing technology company founded in 2015. It was a joint venture between an exclusive importer of Volkswagen vehicles in Belgium and one of the leading automotive suppliers. The company, which currently has approximately 100 employees, is a carsharing telematics technology provider. It manufactures hardware which enables carsharing solutions as well as software which supports the backend of vehicle fleet and vehicle data management. The company does not provide a turnkey carsharing solution as some of its competitors, but rather remain flexible in terms of the other technologies they integrate with their own system. Their customers include short-term and long-term rental providers, carsharing providers of both the station-based and free-floating variety, taxi companies, Uber drivers, corporate carsharing providers, and logistics fleets. The interviewee from TechCo is a Manager of Customer Unit Europe. His responsibilities include managing customer contact in Europe but also partly in the Middle East and Asia, business development in these regions, sales, billings, and strategy. He also has a long background in the automotive industry. His former experience is with different car manufacturers, working in navigation telematics aftermarket, connected services, contract services, and financial services.

4.2 Industry priorities

Interviewees were asked about the priorities, from their point of view, of the carsharing industry in general and their own companies in particular. By priorities is meant the major issues currently affecting providers, what is most discussed, or what is most pressing. From this data collection, four major themes were brought up

that are on top of the agenda for companies within the industry; expansion, market positioning, partnerships, and operations. The breakdown of how frequently, and in which interviews, these topics were discussed, can be found in Table 4.1 below.

Table 4.1: Interviews discussing industry priorities.

Subject	Interviews	References
Industry priorities	TC_1	1
Expansion	EY_1, I_1, SM_1, TC_1, GM_1, SM_2	9
Market positioning	EY_1, AC_1	2
Partnerships	EY_1, I_1	3
Operations and cost	EY_1, C_1, AC_1, I_1, SM_1, AC_2, GM_1, SM_2	17

Carsharing providers generally are heavily concerned with expansion, i.e. how to grow their business fast in terms of geographic coverage, user count, and overall usage. The Stadtmobil region of Rhein-Neckar, for example, aims to expand to one new city every year which involves the need to establish a customer base of a minimum of ten to fifteen people in that city in order to be viable. This is a significant risk to the organization as they are normally not profitable in new cities for a number of years. However, as the board member of Stadtmobil Rhein-Neckar states in interview SM_1: *"[...] this is the risk we take, because we think carsharing is something important to solve the climate problems and the traffic problems [...]"* Thus, the decisions of where to expand to, and how to introduce their service in a new area of operations, is of high importance. As a younger organization, Stadtmobil Rhein-Ruhr is less focused on expanding their geographical coverage. They rather expand within their current markets in order to not add overwhelming costs to the business. As Stadtmobil Rhein-Neckar, GreenMobility are heavily focused on the decision of which markets to enter. Its CEO states that their main focus for the time being is expansion, and that they are looking into international growth beyond their current markets in Denmark and Norway. Customer access to the service, or active membership count, is also of great importance to the competitiveness of carsharing providers. The TechCo Manager of Customer Unit Europe explains that *"When you have the app installed [...] in fact, [using the service] is very easy. So what our partners are looking for is to increase the number of users in their mobile application."* He describes the barrier of getting users onto the carsharing provider's platform as the main priority for most providers he speaks with.

Market positioning and branding was also brought up by interviewees as a focus for carsharing providers. Establishing a premium brand in order to generate additional margins may be necessary for some providers because of the significant costs associated with the service. Vertically integrated providers may be in a situation where they need new strategies in regard to this, since automakers have a very different process of generating the perception of a premium offering, as the Sr. Manager of Mobility Innovation at EY speaks about. He says that *"[...] [the automakers'] whole pricing, and also margin and positioning in the market, is a long build-up of the brand. While for the carsharing, or the more service-oriented business, those brands play a much minor role than they're doing in the car business."* He goes on

to make a comparison to the airline industry, where consumers do not particularly care about whether the aircraft they are flying with is an Airbus, Boeing, or something else, when evaluating the quality of the airline service. Interestingly, this view does not seem to be consistent for all interviewees. In interview SM_1, the interviewee states that a part of their customer base has a clear preference for Volkswagen vehicles, even when they are associated with a higher price. Providers are not yet sure of how to generate brand loyalty or the perception of premium quality.

The management of partnerships in carsharing services is also a major topic of discussion. Providers are not only dealing with their vehicle suppliers and end customers, but also a lot of intermediaries and partners. Particularly, city relationships are challenging to carsharing providers in that they involve a number of actors with different interests and political agendas. Providers are also reliant on city authorities in order to operate their service. Vertically integrated providers may have a larger challenge here as well, as stated by the EY interviewee. Managing these relationships is a very different activity than what is involved in their traditional business, i.e. vehicle manufacturing.

Lastly, the operations and costs of carsharing services in general, and resource utilization levels in particular, are of major interest for providers. As the CEO of Invers describes the importance of considering resource utilization: *"It's a pretty key component to drive profitability [...] If you have something that is working with resource utilization or demand prediction, this is in our mind a pretty key asset to the [provider]."* The acquisition of vehicles and their maintenance are the most significant costs for carsharing providers, and they need to be offset by resource utilization levels that are as high as possible. Similarly, increasing resource utilization levels can be thought of as a way to reach certain availability targets and satisfy customer demand. The balance between service availability and cost is difficult to find, and always involves some form of compromise, as described by the CEO of Stadtmobil Rhein-Ruhr. In addition, the limited parking space made available to carsharing providers in inner cities also means that increasing resource utilization is one of very few ways to generate more business. Additional vehicles or stations cannot be introduced, and thus the provider must make better use of existing resources. The board member of Stadtmobil Rhein-Neckar describes the limitation of parking space as the main obstacle in trying to match demand and supply for their service. Increasing resource utilization numbers in general is one of the most important aspects to achieving a competitive advantage in carsharing and solutions which accomplish it are key assets to providers. GreenMobility has been working on the issue of matching supply and capacity since their inception. Its CEO states in interview GM_1 that *"More or less since we started, we knew that the logistics would be an issue for us. We have developed different systems which can monitor demand during the day, and which [are] more or less effective today."* Their main issue in matching supply and capacity are the random fluctuations in demand which are hard to predict, such as those caused by weather, the traffic situation, or events.

4.3 Users

The behavior, flexibility, and sentiment (attitudes on specific aspects of the carsharing service) of carsharing users were also discussed during the interviews. The way in which interviewees obtained their insights into these aspects of their user base varied, but included qualitative interviews and market research, user-based historical data on demand or travel patterns, and experience with common requests or complaints. Table 4.2 below outlines the subjects of the interviews.

Table 4.2: Interviews discussing carsharing users.

Subject	Interviews	References
Users	AC_2	1
Behavior	AC_1, SM_1, AC_2	3
Flexibility	C_1, SM_1	2
Sentiment	C_1, AC_1, I_1, SM_1, AC_2, GM_1, SM_2	20

Prospective users of carsharing services are often quite specific types of people. The product marketer at AutoCo speaks in interview AC_2 about the company's commercial design target which describes *"[...] progressive individuals that are socially aware, who live in metro-urban areas and have a certain level of household income."* Subsets of this market then includes more functional segments like existing car owners, in-market car buyers, and existing car-renting or carsharing users. In interview AC_1, the COO further describes the behavior of existing users as the greatest obstacle in increasing the utilization of their vehicle fleet. Users in the business-to-consumer (B2C) segment have very consistent behavior patterns over a season and over a week. As the COO describes it: *"[...] this puts quite a strong limitation on how far you can go with only one type of customer."* Users as well as prospective users are also limited somewhat by where they live, as access to public transport and other transportation options like bicycles are important enablers for carsharing services. Customers rely on public transport to complement carsharing when it replaces car ownership, as public transport is more fitting for certain kinds of use cases. It is clear that users only prefer carsharing for certain specific use cases. The product marketer of AutoCo mentions shopping trips as one of these, where the user needs to transport something heavy.

For short-term vehicle rental solutions like carsharing, the flexibility of customers is fairly limited. As the interviewee from TechCo describes it: *"[...] if the user needs a mobility solution, he needs it now."* This is especially true for free-floating services, but it is also the case for station-based and even pre-booked station-based carsharing systems. The users require high availability in order to rely on the service, and cannot always adjust their own schedule to accommodate the capacity of the provider. This is not only true for time requirements, but also for the type of vehicle the user may require, the station or location at which it needs to be available, and at which price it needs to be available. At times, some users will be able to adjust their plans accordingly, but this should not be expected. The CEO of Stadtmobil Rhein-Ruhr

speaks about a user with a doctor's appointment as an example of an urgent use case which cannot be postponed.

Interviewees appear to agree that availability is the most important aspect of the service to users. The product marketer at AutoCo states that *"[...] the lack of availability is the biggest pain point for [customers], we know that we need to be able to deliver on that in order to keep our customers happy and to reduce churn."* If a user is not able to access a vehicle when they want to this has significant negative impact on customer satisfaction and, by extension, on customer loyalty. Price is the second most important aspect to users. Particularly, users seem to be sensitive to sudden changes in pricing. Stadtmobil, Cambio, and AutoCo all aim to have very transparent and predictable pricing to avoid such sudden changes. Some differentiation in pricing does however seem to be desirable for certain customers. To some extent, fleet variety in terms of the types of vehicles included is also an important factor to users. This is at least true for customers of Stadtmobil Rhein-Ruhr, which accordingly offers a broad selection of vehicle types and brands.

4.4 Strategies

The preventative measures carsharing providers take to combat asymmetry in demand and capacity vary greatly between cases. As the Sr. Manager of Mobility Innovation at EY also says regarding how to combat this asymmetry: *"[...] in general there is not one simple answer to that."* Interviewees have provided insights and views on these various measures based on experience from their own service or knowledge about the industry in general. Which interviews discussed which measures, and in how many instances it was brought up, is outlined in Table 4.3.

Table 4.3: Interviews discussing strategies for carsharing providers to prevent asymmetry in demand and capacity.

Subject	Interviews	References
Strategies	EY_1, AC_1, I_1, GM_1	5
Alternate use		0
External channels	I_2, TC_1, SM_2	4
Internal channels	EY_1, AC_1, I_1, AC_2, GM_1, SM_2	7
Booking suggestions	C_1, AC_1, I_1, SM_1, TC_1, AC_2, SM_2	14
Class bookings	I_1, SM_1, TC_1, AC_2, SM_2	10
Communicating demand	C_1, AC_1, SM_1, TC_1, AC_2, GM_1, SM_2	10
Dynamic pricing	EY_1, C_1, AC_1, I_1, SM_1, TC_1, AC_2, GM_1, SM_2	20
Fleet resizing	C_1, AC_1, SM_1, TC_1, GM_1, SM_2	15
Network design	EY_1, C_1, AC_1, SM_1, AC_2, SM_2	17
Area of operation	EY_1, SM_1, AC_2	6
Fleet balancing	EY_1, C_1, AC_1, SM_1, TC_1	8
Queuing	C_1, I_1, SM_1, TC_1, GM_1, SM_2	6
Refusing trips	C_1, TC_1	2
Vehicle relocation	EY_1, C_1, AC_1, I_1, SM_1, TC_1, AC_2, GM_1, SM_2	30

Interviewees are conscious that the utilization of vehicles needs to be high enough to offset the operational costs of said vehicles. Increasing the utilization can however have detrimental effects on customer satisfaction since the availability of cars will most often be lower. The behavior of users greatly affects resource utilization, but it can be difficult to influence customers to behave according to the goals of the carsharing providers rather than their own. The ten distinct strategies to counter demand and capacity asymmetry discussed below were identified partially through literature review and interviews.

4.4.1 Alternate use

As previously mentioned, the consistent behavior of users in the B2C sector affects the possibility for carsharing providers to achieve high resource utilization. Getting access to users with complementing demand patterns was brought up during several of the interviews as a promising way to increase utilization. This can be illustrated with an example given by the COO at AutoCo: *"I usually give the example of newspaper deliveries. They are the only ones who want access to a car between two and six [in the morning]."* It is clear that different types of professional users have the need for a carsharing service during different times of the day. Corporate carsharing vehicles are mostly used during weekdays and not on holidays or weekends while the opposite is true for vehicles in the B2C sector. This makes it attractive for providers to try to get more corporate users for their cars. In fact, the COO says in interview AC_1 that *"The biggest limitation for [our current service] has traditionally been to increase sales to businesses and get businesses to use the same cars as B2C customers."* Broadening the customer base to include groups with different demand patterns is believed to be important to increase resource utilization as well as profitability, and it is actively pursued.

This can be done either by offering the cars through internal channels or by making the cars available through another platform externally. A prerequisite for these kinds of external collaborations is that the providers trust each other and do not consider each other to be competitors. An example of using external channels that was brought up during the interview with the Manager of Customer Unit Europe at TechCo was that peer-to-peer providers are trying to add corporate carsharing cars onto their platforms. These vehicles would then be made available for reservation on the peer-to-peer platform after working hours. This is to increase the capacity for the peer-to-peer provider during peak hours and at the same time increase utilization of the corporate carsharing cars. In addition to increased availability, this also brings more benefits to the users since corporate carsharing cars tend to be newer than the average peer-to-peer vehicle. While marketing vehicles through external channels was brought up as a possibility in both interviews I_1 and TC_1, of the case companies in the case study only Stadtmobil Rhein-Ruhr appears to be using this to any considerable extent. Its CEO sees the potential for moving cars between Stadtmobil regions in Germany if for example different regions of Germany have summer holidays during different times. This enables having a larger fleet during summer holidays in each respective region, thereby satisfying demand more effectively.

An example of getting complementing demand patterns through internal channels that was brought up during both interview AC_1 with the COO at AutoCo and interview I_1 with the CEO of Invers, was to simply market the cars to corporate users as well, using the existing platform. The CEO of Stadtmobil Rhein-Ruhr, in interview SM_2, also named this as a very important way of spreading out usage more evenly over a week. This can, however, be problematic since it may tie up cars during large parts of the day, making them unavailable for consumers during that time. The Sr. Manager of Mobility Innovation at EY brought up the example that if the carsharing company also offers traditional car rental it is also possible to, for example, use the fleet for carsharing during the week and traditional two to three day rentals during the weekends. In this way, by combining different business models, providers are attempting to increase resource utilization, meeting different demands for different customer segments. The CEO of GreenMobility indicated the company was considering such an approach. This would involve using a part of the free-floating fleet for station-based carsharing during a limited time.

4.4.2 Booking suggestions

It may not always be possible to provide exactly what the customer wants at the precise time they want it. It is then better to offer the customer alternatives rather than to just leave their demand unfulfilled, as described by the CEO of Invers: *"Usually this is better and more acceptable for the user than not having a car."* It was brought up during several of the interviews that many of the systems used by the carsharing providers allow for alternatives to be shown for the customer if the vehicle or station they would have preferred is not available. It can be an effective way of promoting demand when there is not a specific match with what the user is looking for, as stated by the Stadtmobil board member in interview SM_1. This can be done through a booking calendar that presents all available cars at a certain station, letting the customer choose a car that is available for the duration of his or her trip. Alternatively, by using less transparent booking systems where the users input their preferred station, type of car, and the start and end times of the trip. The system then returns either a confirmation that the customer's demand can be met or other alternatives in terms of stations, vehicles, or start and end times for the trip. These suggestions can be generated by more or less advanced methods, some simply showing the other cars available at the station or at nearby stations, and others trying to understand the demand on a deeper level and giving recommendations that are more targeted to each individual customer based on historical data and such. How effective these suggestions are at nudging users to select alternative vehicles or stations may depend in part on the use case for which they are planning the trip. The COO at AutoCo describes: *"The more important the intent of the trip is, the more willing you are to change your behavior, and the more willing you are to make an effort to get a hold of a car [...] So the longer a trip is, the more important it is, the more you will look to satisfy your mobility requirement."* Users may for example be more willing to walk a bit further to another station if they are going for a longer trip during the weekend than if they are just using the car on a

Wednesday.

The system used by AutoCo for their soon-to-be-launched service is an example of a more advanced system where the stations are sorted into clusters based on how people move in the city rather than just pure geography. If a customer tries to make a booking at a certain station, any of the stations belonging to the same cluster is a suitable alternative for that customer. This may be a very important feature and speaks to a concern expressed by the CEO of Stadtmobil Rhein-Ruhr: *"The second [closest] station isn't always the best, because there might be very good public transport to a station that is a mile or more away."* In addition, the company can attain data on the actual demand or preferences of the user (i.e., the precise trip the user wants to make and in which vehicle they wish to make it) and not only their choice when limited to available vehicles and stations. Stadtmobil and Cambio use simpler methods of suggesting alternatives to users, simply displaying nearby stations and other vehicles when there are none available at the station and time the user originally requested. In interview SM_2, the CEO of Stadtmobil Rhein-Ruhr explains the drawback of not exposing the vehicle fleet directly to users, namely that user dissatisfaction may be generated if a user asks for a particular trip which cannot be provided. Further, he states: *"The customers aren't necessarily more satisfied with [one system or the other]. It is quite interesting that they accept both ways of approaching it."* While direct demand data is useful, users may not be willing to go through a suggestion process but would rather access the availability of the vehicle fleet directly.

4.4.3 Class bookings

Having the users book a certain car themselves and through that letting the users make the allocation of vehicles themselves can have negative effects on resource utilization. It could lead to customers making short bookings spread over several cars rather than just one, making it impossible to meet the demand for longer bookings. Not letting customers book a specific car, but rather a model or class of vehicle can be a way to mitigate this. As the CEO of Invers put it: *"[It] has the advantage that you [as a provider] can play like Tetris with the bookings."* This is similar to what is done in traditional car rental where the customer books a class of vehicle but the actual car is not assigned until as late as possible. The classification of the vehicles is often done according to the size or type of vehicle, for example station wagon. AutoCo, however, is moving away from the classification based on vehicle size and more towards classifying them based on their suitability for certain use cases. Examples of vehicle classes could then be cars suitable for families, cars for urban driving, or more comfortable cars. Not allowing bookings of specific cars is generally accepted by the customers. This was explained by the product marketer during interview AC_2 as: *"Most people want to go somewhere more than they want to have that specific model."* The benefits to the overall service are considered to outweigh the lack of choice for the customers. The approach to class bookings differs among the interviewed companies, with some letting the customers book a specific model, and others only letting the customers book a class of vehicle. Stadtmobil is

one of the companies that let their customers book a specific model but does the allocation to specific vehicles themselves. As they have a large number of models in their fleet they want to give the customers a choice on what to drive. The CEO at Stadtmobil Rhein-Ruhr explained: *"So if you don't like Volkswagen you can drive a Toyota, and if you don't drive a Toyota you can drive whatever. So you do have a wider choice."*

A diverse fleet gives customers a wider choice on the one hand. On the other hand, having fewer models in the fleet means that it is easier to implement a class booking system. Having fewer models in the fleet also brings benefits in the form of easier installation of the hardware and telematics required for carsharing vehicles since the technology does not have to be adapted to several unique models. Buying larger volumes of a single model or brand also means that the price can be negotiated down to a larger extent. Startup companies initially tend to have single model fleets to a higher degree, and then adding more models to the fleet after some time.

4.4.4 Communicating demand

Communicating levels of demand and supply to users entails sharing details of usage, either historical or expected, with the user base so that they can themselves adjust their plans. This, in turn, may smooth out demand for the provider's service. For example, by communicating to a user that a certain station's vehicles are normally fully booked on Wednesdays, the user may adjust their plans and shift demand to a Thursday in order to be more likely to be guaranteed the use of a certain vehicle at that station. This might be done in many different ways. AutoCo, in their current service, use a booking calendar which lets users book vehicles for specific times. The information of when the vehicle is booked is then openly displayed to other users. However, this solution will not be implemented in their newly developed and soon-to-be-launched service. The booking calendar is not necessarily consistent with a customer-friendly user experience, as it puts the responsibility of vehicle allocation on customers. As the COO of AutoCo describes it: *"Well, that's our problem, not the customer's. How we solve demand."* It also has various undesirable side effects. For example, it can lead to attempts of gaming the system, where users preemptively book a vehicle for several days only to cancel the majority of the booking and use it for a few hours. Other interviewees also have a negative view of this potential solution. Cambio is opposed to introducing it, as their Communications Officer describes in interview C_1. The interviewee from TechCo believes that it is more useful to communicate this information implicitly via pricing. Essentially, when the price rises there is high demand for a particular vehicle or station, and vice versa. This view is also shared by the CEO of GreenMobility who believes that financial incentives is the only way to get a real result akin to that of communicating the demand. He explicitly states this in regard to yield management, a specific type of dynamic pricing, in interview GM_1: *"[...] we believe that yield management will motivate [users] to drive one hour before or one hour later [...] This is probably the only way we can really get a result out of that, by giving or taking money."*

4.4.5 Dynamic pricing

Case companies' attitudes towards dynamic pricing differ quite a lot, but all providers have to some degree considered whether to introduce it as part of their service. It can be used to generate demand in general, but also to even out demand over the course of a week. The carsharing providers are very focused, however, on having a transparent and user-friendly pricing system, without surprises or sudden price hikes. The CEO of GreenMobility stated that they did not want to introduce a more complicated pricing strategy such as yield management until the market had matured. He likened it to when the mobile phone was first introduced and the pricing was very simple, with the customers being charged by the minute. He is wary of the effects that the introduction of dynamic pricing has caused for other providers: *"We can see competitors who are introducing different prices during the day. They have more cost and more complaints and more confused customers than we have."* Further, some carsharing providers (within the sample of this study, Cambio) believe it is important to ensure that customers make conscious mobility choices based on the actual price of a trip. For Cambio, this means charging for the distance traveled and basing the price per kilometer on the price of fuel. Basing pricing on availability of vehicles is thought by them to not only obscure the real price of travel, but also make the service less reliable since it will be less affordable during certain periods. Therefore, some users will not be able to rely on the service due to cost at those times. There is also resistance to the idea of promoting user demand for travel, as this has a potentially environmentally detrimental effect. Both Cambio and AutoCo express this concern. The CEO of Stadtmobil Rhein-Ruhr also expressed a concern over how implementing dynamic pricing could be perceived as a decision taken purely to increase the revenue, straying from their vision of a more sustainable society in terms of the mobility solutions offered. Interviewees further expect that customers could respond negatively to sudden or drastic fluctuations in pricing. As the board member of Stadtmobil Rhein-Neckar describes it in interview SM_1: *"I think they would accept [dynamic prices] in a certain range [...] 150% more expensive is not possible, but I think a range of 10% up or down would be okay."* The TechCo Manager of Customer Unit Europe also believes that the use of dynamic pricing differs by business model. Free-floating carsharing systems, he argues, use dynamic pricing in the same way as ridesourcing services like Uber. Station-based services on the other hand may use less frequent variations in price, offering particular pricing options for specific longer-term events or holidays. He states: *"The free-floating [vehicle] is [rented] for fifteen minutes, ten minutes, something like that. So dynamic pricing is done very intensively for the free-floating mode. In the station-based mode it is more for events or holidays."*

Some providers have instead used what might be called a type of static differentiated pricing. The Cambio Communications Officer describes their system as different tariff levels for different patterns of mobility. Different pricing levels are employed for customers who use the service a lot and those who only drive rarely. The COO of AutoCo also describes that the company is considering similar differentiated pricing levels. Though there are different implementations of these pricing schemes, there is a lot of interest among carsharing providers for dynamic pricing in general. As the

CEO of Invers puts it *"There is a lot of experimentation going on. I think no one has really found the 'Holy Grail'."* He, however, considers dynamic pricing a more interesting alternative in combating demand and capacity asymmetry than some of the alternatives. The CEO of Stadtmobil Rhein-Ruhr also agrees that from a business point of view dynamic pricing is *"really attractive"*, but that their customers in particular would likely not appreciate it.

4.4.6 Fleet resizing

Changing the size of the vehicle fleet to fit with demand patterns is a strategy employed by three case companies; Cambio, Stadtmobil, and AutoCo, though implemented differently from case to case. In all cases, it allows the carsharing provider to decrease the size of the fleet in times of low demand, and conversely to increase its size in peak demand periods. Cambio describes their resizing efforts as seasonal adjustments, where the total number of vehicles comes down during winter where there is less demand and up again for the summer season. In the summer, some customers rent cars for longer periods of time to travel for their vacations, but the company still needs to maintain their availability locally and thus requires more vehicles. Depending on the city, some cars are leased and some bought or sold when resizing. AutoCo also use similar adjustments of fleet size by season. Their leasing agreements normally begin in the spring and last for eighteen months, meaning there is a natural variation in the size of the fleet, with less vehicles being available for the winter months. The company also uses shorter term adjustments, adding a smaller amount of cars for specific weekends or holidays where high demand is expected. The COO at AutoCo describes this way of working as pragmatic and well functioning. The company's process for incorporating vehicles in its system is also a lot faster than for many competitors. Stadtmobil Rhein-Neckar has limited adjustments in fleet size during the winter months where they know demand is lower. New vehicles are also bought exclusively in the spring months in anticipation for summer, and so (similarly to what is described in AutoCo) there is a natural fleet resizing cycle of buying vehicles in spring and selling in fall or winter. The Stadtmobil Rhein-Neckar organization, however, is somewhat unsure as to whether this measure is cost-effective. The company's board member describes their view in interview SM_1:

> It doesn't make such a difference if we keep [the vehicles over winter], because we're not talking about hundreds of cars, we talk about twenty cars, and for us, from the cost of the persons who has to build everything, take everything out of the cars, and then drive them to the car parks where we can sell them, we are not really sure if it makes a difference.

The CEO of Stadtmobil Rhein-Ruhr on the other hand does recognize seasonal fleet resizing as effective to some extent. Not necessarily as dynamic changes from week to week, but rather as longer term changes. Further, their customers rarely take note of their changes in fleet size, as it is done to such a minor extent.

The Manager of Customer Unit Europe at TechCo emphasizes that the handling of equipment such as telematics can be a barrier when introducing and removing

vehicles from the fleet over short periods of time. Technology needs to be installed or removed when resizing which prevents some providers from making use of this measure. One prospective approach to short-term increases in the vehicle fleet is to temporarily incorporate demo cars from car dealerships. Customer reactions to resizing of the fleet can also be noteworthy. Stadtmobil Rhein-Neckar customers notice quickly when vehicles are removed from a nearby station and answering customer requests to reinstate the vehicle to the station can be cumbersome. The Stadtmobil Rhein-Ruhr operation, on the other hand, does not resize the fleet to an extent that customers typically take note of. The interviewee from Cambio also remarks that customers tend to notice when vehicles are removed, however the company aims at still providing a certain reliable level of supply to users.

4.4.7 Network design

The design of the carsharing network involves dimensioning and deciding locations of stations, or the system's area of operation, as well as balancing the vehicle fleet. This is done as a first step when establishing the service but is typically also done continuously in successive iterations in order to improve service availability and resource utilization. While all carsharing providers clearly do this, it is approached in different ways by different companies. Data, analytics, and experience are used to differing degrees. The same is true for approaches based on trial and error, where the provider does small changes to the fleet and station network and adjusts based on the outcome. Some work in a more static way, only rarely changing the composition or placement of vehicles, while others rebalance the fleet more dynamically.

Cambio bases the location of their stations and the size of their fleet at various locations largely on demographics, socio-economics, and the public transport situation. Decisions of network design are taken on a local level, where each city's organization is largely responsible for them. Decisions are based largely on experience, but also on dialogue with customers in the particular city. The company is conscious of the fact that customers need to rely on their service, and that customers sometimes rely on a particular vehicle to serve their everyday mobility needs, thus they will rarely make sudden or drastic changes to the fleet composition or stations. As each city's organization knows the area well, this puts them in a good position to detemine where and what the demand is. Users are also asked where stations should be located to better serve their needs. In some cities, Cambio even cooperates with the municipality and lets the public vote on where new stations should be established. Stadtmobil similarly relies heavily on the experience of their employees in particular cities, although there seems to be more of a focus on data in the Rhein-Ruhr organization than that in Rhein-Neckar. In Rhein-Ruhr, decisions on the location of stations and the composition of the fleet are made on a regular basis. The organization considers how often vehicles are used, how far they are driven, what number of customers uses them, etc. Based on similar data, stations and vehicle fleet composition are altered from time to time. However, the issue of not knowing the actual demand of users becomes a problem when trying to predict demand in areas in which the service is not yet established. An interesting observation made

by the board member of Stadtmobil Rhein-Neckar, in interview SM_1, concerned the impact of the operational area's size on the need for vehicle relocation. Larger areas of operations require a higher number of vehicles to service them or, alternatively, more interventions to increase resource utilization. Additionally, customers generally respond negatively to a provider reducing the size of their operational area. Because of this, the organization is careful to start out with smaller operational areas in new markets, increasing them successively when warranted. The Sr. Manager of Mobility Innovation at EY echoes this in interview EY_1, stating that narrowing the area of operation minimizes the necessity for vehicle relocation.

AutoCo, in their current service, has worked in a relatively static way with deciding on the layout of their station network and their vehicle fleet. When a new station has been established, the service initially has a certain number of vehicles stationed there. Depending on the usage of these vehicles, one or several may be removed or added. With their soon-to-be-launched service, the company works more dynamically with their network design, basically on three different levels. Firstly, on a strategic level, the company attempts to identify the areas in which they will achieve the highest vehicle usage. This involves identifying which cities or neighborhoods the service should be established in, how the right customer segments are targeted, and how to approach competitors. The next level is dimensioning the existing network. Where is there a need to increase or decrease the amount of vehicles? This is done more dynamically than strategic decisions of which markets to enter or exit. Lastly, the company works on a weekly basis by considering demand patterns in their network. Decisions are to a large extent driven by data on potential customers, but the company also attempts to confirm new network designs in the real setting. Access to direct demand data also helps in this regard, as this knowledge allows AutoCo to evolve their service to better serve the needs of their customers. The interviewee at EY also places particular emphasis on data collection as a precondition for providers to be able to design their networks effectively.

4.4.8 Queuing

Queuing users, or attempting to offset their usage in time, is a potential way of capturing demand which cannot be fulfilled at the moment. It relies on customers waiting for access to a vehicle which currently is unavailable, possibly by being offered a fare reduction or other types of incentives. All station-based case companies of the case study offer booking in advance, and GreenMobility also offers it to a limited extent, but none of them appear to use queuing strategies beyond that. The idea of more directly attempting to incentivize customers to offset usage is broadly rejected. User habits are difficult to change. As the Manager of Customer Unit Europe at TechCo states regarding queuing: *"I don't really see the interest to do that, because if the user needs a mobility solution he needs it now. He is not able to wait."* The same sentiment is echoed in interviews I_1 and SM_2; the user generally needs access to a vehicle for a specific purpose, and is rarely willing to change their plans. GreenMobility makes a limited part of their fleet available for advanced bookings up to six hours in advance. Their CEO describes it as a *"fine*

balance" to decide how large a part of the fleet should be dedicated to entirely free-floating operations and how many the users can book in advance. The company has discussed the possibility of offering the alternative for customers to be notified when a vehicle is made available. Rather than being incentivized to wait until there is available capacity, the user simply receives the information when their demand can be met. The CEO of GreenMobility speculates that this is one of the things which could aid people in fully adopting carsharing, as opposed to personal car ownership.

4.4.9 Refusing trips

Clearly, certain trips made by users have an adverse effect on the vehicle distribution of a carsharing provider. In essence, such a trip would involve a user taking a vehicle from an area with high demand to an area with low or non-existing demand. One approach to dealing with the issue of such trips would be to simply not allow the user to make them, keeping vehicles in areas of higher demand where they can be better utilized and serve customers more effectively. There seems to be a strong opposition towards refusing trips overall. The communications officer at Cambio described it as: *"[...] we can't say to our customers 'Thank you for using Cambio, but not in this case,' that is just not our policy."* If a provider has defined an area of operations and the trip starts and ends within that area, the customer must be allowed to take that trip. Even if that trip will result in a distribution of vehicles that is not optimal when looking at the demand, the providers cannot prevent users from using the service, as long as they are not violating the terms of service. Refusing trips has a detrimental effect on customer satisfaction and loyalty potentially leading to a loss of customers, which is the worst case scenario for most providers.

4.4.10 Vehicle relocation

Relocation of vehicles is used to some extent by all case companies. There is a mix of user- and operator-based relocation and different organizations rely on relocation activities to varying degrees. How much relocating is needed is affected in part by the size of the operational area, with larger areas requiring more relocation. In order for relocation of vehicles to be viable, the relocation must result in enough utilization to offset its cost. The attitude towards relocation is mixed, with some interviewees doubting its cost-efficiency and some viewing relocation as vital. The CEO of Invers argues that it is relevant as a solution of last resort, e.g. for moving electric cars to a charging station when the charge is low. Generally, he argues, moving vehicles to simply try and match capacity to demand is too costly for providers. In contrast, the CEO of Stadtmobil Rhein-Ruhr mentions vehicle relocation as potentially the most important measure to combat demand and capacity asymmetry.

Three case companies; Stadtmobil, AutoCo, and GreenMobility, are using operator-based relocation. Stadtmobil moves their station-based fleet on a longer term basis and to a large extent simply based on customer requests, emphasizing that customers should be able to rely on a certain amount of vehicles for long periods of time. The free-floating fleet, however, is relocated more actively. Initially, when the

service was established, cars were moved frequently based on whether or not they had been used in the last few days. As the organization has become more conscious of the costs, relocations now take place more seldom. GreenMobility is conscious of the balance that must be achieved between the revenue generated and the costs related to moving vehicles. However, relocation has generally been very positive for the company, and has always been a part of its operations. The CEO of GreenMobility also emphasizes that operators are somewhat necessary for reasons other than simply relocating vehicles. Certain tasks are difficult to incentivize customers to perform, such as cleaning the vehicles and other basic maintenance tasks. While GreenMobility uses both user- and operator-based relocation, the impact of its own operators in particular is significant. Its CEO states that *"[...] if we are not focusing on having [operators] on the street, we can have a reduction in [sales] by between five and ten percent, in comparison to similar periods [where operators are utilized]."*

Both AutoCo and GreenMobility are also utilizing user-based relocation. AutoCo has experimented with offering special deals to users for transporting vehicles between stations. While user-based relocation may be cheaper than operator-based, as indicated by the interviewee at TechCo, changing the behavior of users or nudging them to drop off cars in areas with high demand is associated with significant costs also. Justifying vehicle relocation, either by users or operators, is therefore only possibly during certain times, according to the COO of AutoCo. He states: *"[...] for extended weekends, for holidays, and things like that it is certainly reasonable to make tailored offers. Because this can be done on a rather large scale, pretty cost-effectively, to increase resource utilization for a specific location."* GreenMobility clearly displays the areas in which users will be rewarded for dropping off their vehicles. Customers are rewarded through free trips and credits when they park cars in zones with high demand, or when they charge a vehicle. Through the use of heatmaps, users can see for which areas these deals are in place, and potentially choose to re-route their trip to end in such an area. This has been a very positive solution for the company and users also seem to respond positively to it. To the company's surprise, some users have even begun relocating vehicles on a regular basis to earn free trips which can be transferred to other users. As the CEO describes:

> Some older gentlemen who have stopped working many years ago, they are simply starting their morning looking into our app to see where there are cars with low capacity and picking them up to drive them to one of our charging hotspots.

Similar to user-based relocation, the idea of crowdsourcing vehicle relocations was brought up during the interview process. The CEO of Invers describes this as a potentially more useful than attempting to incentivize users during their trip, as such changes in behavior are difficult to realize. He states the following regarding crowdsourcing of relocations:

> I would imagine it's definitely cheaper, but I still think the incentive you need to give somebody who actually doesn't want to do the trip is substantial. And if that person would have done the trip [without incentives], you also lost money.

5
Analysis

The following chapter presents the analysis of findings from the case study. The empirical findings are contrasted to literature and analyzed according to the procedure of grounded analysis, as laid out in Section 3.3. The analysis aims to accurately reveal and elucidate the characteristics and patterns of the concepts explored within this thesis, to answer the research questions and fulfill its purpose. Firstly, the strategies to combat demand and capacity asymmetry in carsharing services are analyzed, in relation to the first research question. Secondly, in relation to the second research question, the characteristics of the case companies are analyzed similarly.

5.1 Strategies

There are ten distinct strategies for carsharing providers to combat demand and capacity asymmetry that have been identified during the course of this study. Clearly, their usability and effectiveness differ and depend in part on the context in which they are used. These ten strategies are outlined in Table 5.1, their respective characteristics are described below and briefly summarized in Table 5.2. Four of these strategies are primarily used to manipulate the demand side, one is a combination of demand and capacity side interventions, while the remaining five manipulate the capacity side. As Table 5.1 also shows, case companies differ somewhat drastically in which strategies they employ. As the strategies aim to increase resource utilization and availability, they are all related to the priority of operations and cost.

Table 5.1: Strategies in use by case companies; Cambio (C), Stadtmobil (SM), AutoCo (AC), and GreenMobility (GM).

Strategy	**Affecting**		**Used by**			
	Dem.	*Cap.*	*C*	*SM*	*AC*	*GM*
Alternate use	✓	✓	✓		✓	
Booking suggestions	✓		✓	✓	✓	✓
Class bookings		✓	✓	✓	✓	
Communicating demand	✓			✓	✓	
Dynamic pricing	✓					
Fleet resizing		✓	✓	✓	✓	
Network design		✓	✓	✓	✓	✓
Queuing	✓					
Refusing trips		✓				
Vehicle relocation		✓		✓	✓	✓

Table 5.2: Brief summary of strategy characteristics.

Strategy	Costs	Prerequisites	Applicability
Alternate use	Finding new customer groups, marketing, platform expansion	Awareness of demand patterns, sales across user groups (internal), vehicle cross-usage compatibility (external)	Useful to increase resource utilization
Booking suggestions	IT-related	Compatible booking system, ability to record actual demand	Important to prevent short-term service loss, more suitable with high station density
Class bookings	IT-related, risk of user dissatisfaction in some cases	Compatible booking system, more suitable for streamlined fleets	Pools capacity of the fleet, important for services with bookings in advance
Communicating demand	Risk of user dissatisfaction	Customers with non-urgent use cases	Generally lacks potential as users are unwilling to change behavior
Dynamic pricing	IT-related, risk of user dissatisfaction	Compatible IT system, mature user base, customers with non-urgent use cases	Attractive way to promote or smooth out demand, can be confusing for users
Fleet resizing	Installation and removal of technology, administration, potential loss of revenue	Flexibility in fleet deployment, ability to anticipate demand, more suitable for larger fleets	Commonly used, useful in adapting capacity to anticipated demand
Network design	Administration, risk of user dissatisfaction in some cases		Necessary initiative, applications differ, potentially more effective with data-based decision making
Queuing	Incentivization, risk of user dissatisfaction	Customers with non-urgent use cases	Not used in practice, generally lacks potential
Refusing trips	Risk of user dissatisfaction	Booking system which records end location at start of trip	Not used in practice, generally lacks potential
Vehicle relocation	Salary (operator-based), incentivization (user-based), fuel	Compatible platform (user-based)	Commonly used, important to prevent short-term service loss

5.1.1 Alternate use

Whether by internal or external channels, alternate use for the vehicle fleet is an important measure which can serve to increase resource utilization by moving capacity to areas with demand when it is lacking for the regular user base or ensuring that demand is generated to match available capacity. Additional customers can be served, and additional revenue generated, by the use of this strategy. Finding alternative use cases for vehicles does not seem to be a common subject throughout academic literature on carsharing, but the concept is widely known on the broader level of capacity management. In particular, Yu-Lee (2002) argues that outsourcing or moving the capacity to where there is demand is a potential alternative when the given level of demand can be met by the organization and the market therefore is the constraint of production. The findings of the study indicate that this

is indeed the case; carsharing providers are intermittently limited by the customer demand at certain points in time. For example, during working hours on weekdays where consumers generally do not use shared vehicles. The strategy of alternate use, then, attempts to reallocate capacity to customers, platforms, or third parties which are generating demand during that specific time. Importantly though, finding and capturing these alternative sources of demand is associated with various costs. For example, costs of expanding an existing platform, costs of identifying new potential user groups, or costs of marketing and sales targeted at these new user groups. Whether the strategy will ultimately be profitable or worthwhile for a particular carsharing provider will depend on its context, characteristics, and priorities.

Making use of this strategy pre-supposes that the carsharing provider is well aware of demand patterns of different customer segments. The provider must work actively to identify the user groups exhibiting demand patterns which complement those of other users. Doing this likely requires some amount of reliance on data collection and analytics. Also, if the proper user groups are identified, capacity must then be made available to these users by internal or external channels, as mentioned. Making use of internal channels generally requires providers to expand their targeted customer groups or use cases, for example from consumers to professionals or from short-term to long-term trips. This step of increasing sales to new target groups can be challenging for providers, as evidenced by the COO of AutoCo. External channels, on the other hand, may not require the establishment of new customer groups for the provider's own booking platform. However, it requires the vehicle fleet to be compatible with cross-usage between the provider's and a third party's platform. It puts requirements on the underlying IT infrastructure of the two parties, in order for them to be able to exchange information while the vehicle is used outside its native network. In this regard, a certain level of trust also needs to be established between the two parties.

Alternate use of vehicles seems to be in line with the priorities of operations and costs as well as expansion. When it is used effectively, resource utilization is heightened and fixed costs are spread out over more usage. It also serves to increase the provider's user base (through internal channels) or simply increase revenue (through external channels). On the other hand, for companies focusing more heavily on user availability or its market positioning this strategy may be less suitable. Of course, making use of a vehicle elsewhere or to serve new customer segments causes a risk of service loss for the current user base. This is likely especially true for doing it through external channels, as the carsharing provider may have less control over its vehicle while it is being utilized through another platform. Depending on the details of this setup, a provider's fleet may effectively be downsized for certain periods of time, lowering availability for their current customer base.

In some ways, the strategy of alternate use is similar to that of vehicle fleet resizing, as explored in Sections 4.4.6 and 5.1.6. Both strategies are based on the idea of temporarily removing vehicles from what they are normally being used for. The difference between them, as they are categorized within the context of this thesis,

is that with alternate use the provider retains ownership or control of the vehicle during the entire process, while for fleet resizing it does not.

5.1.2 Booking suggestions

Providing booking suggestions is a way of meeting the customers' most important need in regard to the service; the need for mobility. All of the interviewees considered the availability of cars to be one of the most important issues for customers. It was also clear that most customers want to use the service to get somewhere at a specific time rather than to drive a specific car. This means that offering a mobility solution at the right time is more important than it being the specific vehicle or station the user initially requested. Thus, booking suggestions can be used to limit user dissatisfaction in cases where the customer's exact request cannot be met. At the same time it can influence the demand for customers to use the service in a way that is better matched with the company's capabilities, by getting customers to use cars which would otherwise be unutilized and thereby increasing resource utilization.

It is important to provide the user with relevant suggestions to increase the effectiveness of this strategy. When suggesting cars at other stations it may not only be the geographical distance that makes a station a suitable substitute or not for the user. All of the interviewed companies who utilize booking suggestions do take the distance into consideration when suggesting alternatives but some acknowledge that it is not the sole factor for determining an alternative's suitability. Intimate knowledge of the particular city and the users, as well as of individual use cases, also appears to be important in determining alternatives. This is indicated by the statements on these topics by both the COO at AutoCo and CEO at Stadtmobil Rhein-Ruhr. Since the distance to the alternative station is one of the determinants for the suitability of said station, however, the density of stations has an effect on the eligibility of using booking suggestions. This strategy may therefore be more successful for providers who have built up a big station network, and less successful for providers who are just starting up.

Booking suggestions can be seen as a way to meet the customers' demand in the second-best way. As it does not meet the customer's demand entirely, the customer satisfaction may not be as high as if the customer would get exactly what they wanted. It would therefore be important to make efforts to try to meet the customers' demands better in the future. Thus, as Crum and Palmatier (2003) described, the actual demand must be recorded when the customer is offered a substitute. This is to not make the forecasts based on substituted demand and therefore inaccurate. Having forecasts based on the substituted demand would result in some stations or cars having a seemingly higher demand than what is actually the case. This could in turn cause the provider to make decisions on where to station new cars that will lead to a distribution of vehicles that does not match with demand. Having a system capable of recording the actual demand can therefore be considered a prerequisite for applying booking suggestions in an optimal manner. Although not all of the interviewed station-based providers have systems capable of doing this,

they all use booking suggestions. If the actual demand is not recorded, booking suggestions are merely a way of masking the fact that a customer's demand could not be met.

5.1.3 Class bookings

Class bookings can give flexibility to the provider in terms of vehicle allocations, allowing for operator-based allocations of vehicles to maximize resource utilization (see Figure 5.1 and Figure 5.2). This strategy pools the capacity of the entire fleet or a part of the fleet, effectively postponing differentiation in the sense that all available vehicles can be used to meet the demand up until the start of the booking. The example in Figure 5.1 shows how the bookings could look during a day if the customers are allowed to freely book a specific vehicle themselves. As can be seen in the figure, the vehicles spend large parts of their time being unutilized. When the bookings are allocated in this way, there is no way of accommodating longer bookings without adding extra capacity. If class bookings are implemented, the allocations would look more like Figure 5.2. This allows longer bookings to be made for the second vehicle and on a larger scale this efficient allocation will mean fewer vehicles are required to accommodate the same bookings.

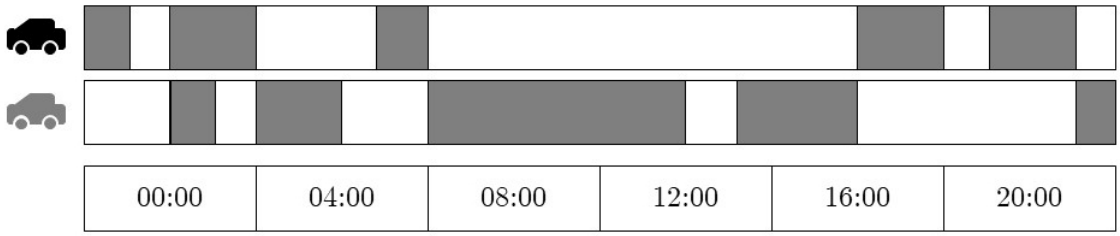

Figure 5.1: Illustration of user-based allocation.

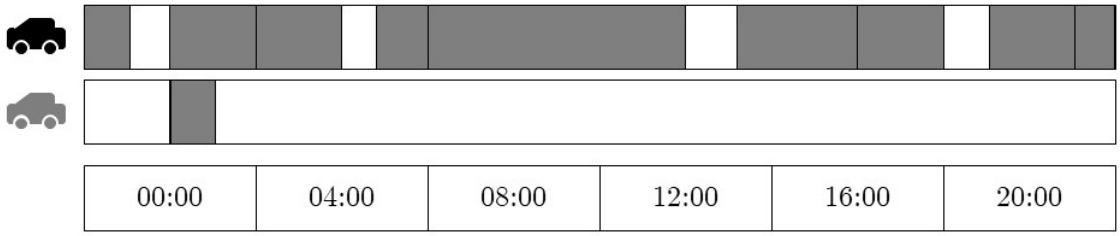

Figure 5.2: Illustration of operator-based allocation.

A provider's current booking system may prevent the implementation of class bookings without drastically redesigning the user interface. For example, the use of class bookings is not compatible with a booking calendar, as in such a booking system users choose which specific car to drive based on its availability presented graphically. The composition of the fleet could also determine the suitability of a class booking system. In a vertically integrated provider such as AutoCo, the customers can be

sure which brand they will get no matter what class they choose. For providers such as Stadtmobil which have a more diverse fleet with several different brands, customers would not be certain that they could drive their favorite brand if a class booking system was implemented. This could prove problematic as some customers prefer a specific brand of car. Stadtmobil for example has customers who have a strong preference for Volkswagen, so for them it would not be appropriate to implement a class booking system without the possibility for the user to specify a brand. This could explain why Stadtmobil lets their customers book a model rather than a class, while the specific car is not assigned until near the start of the trip. This, however, limits the effectiveness of using class bookings since the more vehicles that are in a class, the more flexibility it gives to the provider to do the allocations in a way that minimizes idle time and also allows for longer bookings. The drawback of a larger class is that the customers do not know what car they are going to get.

5.1.4 Communicating demand

The power of this strategy to influence the behavior of users appears to be low. There are limited examples of this measure being employed in academic literature as well as in practice. Communicating demand and capacity to customers is used by case companies only in the sense that Stadtmobil and the current service of AutoCo make use of a booking calendar displaying booked and available vehicles which, however, clearly brings with it several negative effects. These include externalizing the issue of matching demand and capacity by requesting that the user takes part in this activity. As brought up previously, customers simply want access to a vehicle when they have demand for it. Asking users to re-route their trips or adjust their plans (as is the overall purpose of communicating demand and capacity to users) is generally neither popular nor successful. There may be certain cases where it would be more useful, however. This would involve customers with use cases which, in contrast to the typical customer's use case, are neither urgent nor particularly time-sensitive. A provider would need to be able to accurately identify users with that kind of use case and target them effectively with information which changes their behavior to fit with available capacity. There appear to be few examples of carsharing providers achieving this to any significant extent in practice, however, as none came up during the course of the case study.

This same information is communicated indirectly through dynamic pricing, attempting to offset usage during periods of peak demand and promote it when demand is low. Dynamic pricing may be a more effective and user-friendly way of promoting the desired effect of this strategy.

5.1.5 Dynamic pricing

Dynamic pricing schemes have significant utility when employed in carsharing services in increasing, offsetting, or altering demand, but it gives rise to potentially adverse effects when it comes to customer satisfaction. When applied effectively, dynamic pricing can smooth out usage over the course of any given time period,

increasing availability at times of peak demand and increasing resource utilization levels at off-peak periods. On the other hand, dynamic pricing can be used purely as a revenue maximization tool, attempting to set the highest price a customer is willing to pay at any given moment. That particular use of dynamic pricing is not relevant as a tool in matching demand to capacity.

Dynamic pricing is perhaps the most clear-cut way of manipulating demand to better fit with the capabilities of a carsharing provider's operation. It can be likened to the third step of the broad-view model of demand management by Crum and Palmatier (2003), namely influencing demand. Thus, it is also heavily influenced by the model's other components such as forecasting. While none of the case companies are currently employing dynamic pricing, findings indicate that the carsharing industry at large is making use of it to a large extent. This appears to be primarily dynamic pricing based on location, time of day, and current level of demand, rather than based on supply and demand at an arrival location as portrayed in Figure 2.2. Dynamic pricing can also be a way to combat cross-subsidization and make rates more fair to users, as described by Stubbs et al. (1984).

Dynamic, as opposed to static, pricing generally worsens transparency and user-friendliness in regard to pricing. Many users value straightforward pricing, and replacing predictable and stable prices with unpredictably fluctuating ones generates high levels of dissatisfaction with these users. This is the main concern of case companies as to the effects of dynamic pricing. Even the CEO of GreenMobility, who is considering introducing and is generally positively inclined towards dynamic pricing, stresses that it can cause dissatisfaction. These experiences seem to be in line with the observation by Yaraghi and Ravi (2017), that transparency and the open disclosure of pricing mechanisms goes a long way towards counteracting customer backlash to the introduction of dynamic pricing. The findings also indicate that dynamic pricing is less successful if used initially when starting up a carsharing operation and users are less familiar with the system. Rather, the provider is better served by introducing dynamic pricing once the market has matured. This is argued by Peng et al. (2017) and further confirmed by the CEO of GreenMobility.

Promoting increased demand, even at times where availability of vehicles is high and utilization therefore low, increases overall driving and would add to negative externalities of vehicle use. Many carsharing providers (Cambio, Stadtmobil, and AutoCo within the case study) are therefore somewhat opposed to the idea of trying to stimulate increased demand through dynamic pricing since a prominent part of their mission is to promote sustainable transportation. GreenMobility, on the other hand, are using a fully electric vehicle fleet, meaning that added externalities are less prevalent, and therefore may not have the same issue with increasing demand. Dynamic pricing in the interest of smoothing out demand rather than promoting additional demand, however, does not pose the same problem for providers. Of course, issues of customer response to the pricing scheme may still be problematic.

Generally, users are unwilling to offset their usage, even in order to enjoy a decreased trip fare. This is indicative of myopic, rather than strategic, purchasing behavior, as described by Elmaghraby and Keskinocak (2003). Deksnyte and Lydeka (2012) also state that lack of time and information in making a purchasing decision makes strategic purchasing more difficult to maintain. The observation by the Manager of Customer Unit Europe at TechCo *"[...] if the user needs a mobility solution, he needs it now,"* along with other similar statements throughout the interview process certainly point to a lack of time in the purchasing decision of many carsharing users. The tendencies towards myopic purchasing behavior speak for the use of dynamic pricing in carsharing services. However, by the definition of Rohani and Nazari (2012), carsharing users appear to be more in line with low involvement consumer behavior. Low involvement consumers, they claim, respond more negatively to dynamic pricing. It should be noted, though, that their study was not focused on its use in carsharing, but rather the hospitality industry. While these seem to be the general purchasing behaviors of carsharing users, different use cases are associated with different user behaviors. Users are more willing to make an effort to satisfy their mobility needs when the purpose of the trip is important, as described by the COO of AutoCo. It can therefore be assumed that users are likely to be less price sensitive in such a scenario. Dynamic pricing, then, is likely more suitable in altering demand patterns for carsharing providers targeting use cases less important or urgent to their customers. Conversely, if the provider's motive is simply to extract as much revenue as possible (making customers pay a higher price per trip), more important use cases where users have higher willingness to pay are more fitting. Button (1982) observes that business trips tend to be relatively price insensitive, for example, which would indicate that they are a fitting use case for dynamic pricing aiming to maximize revenue but not altering demand.

The use of dynamic pricing puts heightened requirements on IT systems to administer price changes or, alternatively, heightened requirements on personnel to administer them manually. For some providers, e.g. Stadtmobil Rhein-Neckar, this is a significant barrier to using the technique. Further, station-based services appear to be somewhat less suited for dynamic pricing initiatives than their free-floating counterparts. This is due in part to the fact that station-based trips are typically longer on average than free-floating. Dynamic pricing of a long trip would become complicated as it would involve several different rates during the course of the trip. It may also explain why GreenMobility, the entirely free-floating service, is the case company most positively inclined towards dynamic pricing.

There may be static differentiated pricing schemes which could serve to provide some of the benefits of dynamic pricing with fewer of its issues. Dynamically changing the price based on real-time demand makes it impossible for customers to calculate the price of a trip in advance, likely leading to lower customer satisfaction. Changing the price on a fixed schedule could make it more predictable and, depending on the intervals used, less confusing for the customers. The findings suggest that demand for carsharing vehicles is highest during weekends and lower during weekdays. Charging a higher price for usage during weekends would serve to shift some of the

demand to weekdays where there is spare capacity. Changing the price a couple of times a week rather than several times a day would lower the risk of confusion among customers. This may be a suitable alternative to providers whose customers would be less accepting of frequent price changes, or whose IT systems are ill equipped to facilitate them.

5.1.6 Fleet resizing

Fleet resizing is generally a useful strategy for carsharing providers as it adapts capacity to anticipated demand. This appears to be the case for both station-based and free-floating services. The usefulness of this strategy is to be expected from literature, as Adenso-Díaz et al. (2002) state that having the possibility to do this is very valuable for a service organization. Of course, resizing the fleet effectively is dependent on the organization being able to accurately anticipate the demand to begin with. If the organization has this capability, temporarily decreasing the size of the vehicle fleet allows the provider to avoid costs associated with owning and operating the vehicle during that time. Of course, these decreased operational costs must be weighed against any costs associated with removing the vehicle from the fleet and later returning it (whether that is by sale, by switching leasing agreement, or otherwise), removing and reinstalling equipment such as telematics, and any potential loss of revenue as a consequence of the vehicle no longer being operational. A temporary increase of the fleet size, conversely, is associated with the same costs but a potential increase of revenue while the additional vehicles are part of the carsharing fleet. Consistent with the observations by Yu-Lee (2002), the impact of these increased costs on profitability must be carefully considered.

Increasing or decreasing the size of the fleet to fit predicted demand levels is a common practice among carsharing providers, though it is used mainly as a response to long term shifts in demand. Cambio, Stadtmobil, and AutoCo all make use of this technique by adjusting fleet size to some extent according to the time of year. Such seasonal adjustments appear to be very effective for these providers. The possible exception to this is Stadtmobil Rhein-Neckar, whose board member describes in interview SM_1 that as this solution affects such few vehicles it is unclear whether it is cost-effective. This indicates that seasonal fleet resizing needs to be conducted to a large enough extent for it to be profitable and that it thus is more applicable for larger providers. It is possible that this is due to advantages of economies of scale in making larger temporary adjustments to the fleet size, though this is speculative.

More dynamic adjustments, on a tactical level, to fleet size seem to be more rare. The Manager of Customer Unit Europe at TechCo indicates this in interview TC_1, stating that customers he is in contact with are purely using adjustments to fleet size in a seasonal setting. Some carsharing providers, including AutoCo, do however make use of shorter term adjustments. These are temporary increases of the fleet of a small number of vehicles over a short period of time. AutoCo has a very effective process in place for these more dynamic adjustments to the fleet. *"We know we are much faster than our competitors,"* as the COO puts it in interview AC_1. It is pos-

sible that this is in part due to the fact that AutoCo, as opposed to the other case companies, is a vertically integrated provider. Thus, they are able to work closely with the vehicle manufacturer from which the company leases their cars, to work out an efficient technical solution. Le Vine et al. (2014) also observe that vertically integrated providers have an advantage in this regard. The example of using demo cars for these short-term adjustments may also be more applicable for a vertically integrated provider since the necessary partnerships are already established through their parent company. Further, as He et al. (2019) observe, a provider's ability to make fleet sizing decisions on a tactical level depends in part on their organization's *"[...] flexibility of fleet deployment or redeployment [...]"* (He et al., 2019, pp. 463). The success of shorter term size changes is thus dependent on a provider's ability to remove and reintroduce vehicles to their fleet quickly, smoothly, and at low cost.

5.1.7 Network design

Network design is the one strategy which all carsharing providers must employ in order to establish their service. Decisions related to both infrastructure and fleet management are necessary at an initial stage when setting up the operations. The operational area and fleet composition of a provider have considerable effects on its success, as evidenced by e.g. Rickenberg et al. (2013) and Barrios and Godier (2014), and confirmed by several interviewees. The findings of the study indicate that, at least in the context of one-way carsharing, the size of the operational area is a key component to successfully serving users. Additionally, it seems clear that carsharing providers are best advised to initially launch their service in a conservatively sized area, and expand it as the service gains traction, rather than risk launching with a too large area of operation. This is consistent with the observations by He et al. (2019). However, providers all operate under considerable constraints when designing their network, particularly the infrastructure component, as other parties like the municipality has a say in where stations are established, how stations can be dimensioned, where vehicles can be parked, etc.

The difference between providers is how frequently decision regarding network design are made, the way in which they are made, and what they are based on. It is unclear why certain carsharing organizations prefer to redesign their networks purely on a long term basis, and others do it more dynamically. It may depend in part on the organization's mission and the behavior of their target customer groups. One example of this is how Cambio, due to their emphasis on offering a reliable alternative to car ownerhsip, only approaches network rebalancing on a long term basis. It also may depend on the data the company has available to them. Stadtmobil's representatives emphasize their lack of available data in making network design decisions as problematic. While they regularly take close looks on the balancing of vehicles and stations, this is made more difficult by the fact that the company does not collect data on what their customers' actual demand is. AutoCo, who make more use of data, appear much more willing to trial their network design choices dynamically, and subsequently adjust based on their results. In line with this thinking, the Sr. Manager of Mobility Innovation at EY thinks of the trial and error approach

to network design as a key way of combating demand and capacity asymmetry. He also places particular emphasis on data collection as a precondition for the provider to be able to do this.

There is likewise a contrast between Cambio and Stadtmobil, on the one hand, and AutoCo, on the other, when it comes to the basis of their decision making related to network design. Local decision makers, in the case of Cambio and Stadtmobil, are able to gain intimate knowledge of their specific market, its conditions, and its customer base. This is likely why they are able to be successful in adapting to the demands of their users, even without extensive use of data and analytics. AutoCo, though, may have less of an opportunity to use knowledge of local markets in this way, as they are more spread out geographically, forcing them to rely more on data. This may however be beneficial, as the theoretical results of e.g. Correia and Antunes (2012), Boyaci et al. (2015), and Fedorčáková et al. (2012), outlined in Section 2.2.1, seem to suggest that this data based approach has the potential to enable significant cost savings through optimization.

5.1.8 Queuing

No case company employs the strategy of queuing, or offsetting customer usage in time. In general, the findings of the study indicate that this would not be an effective solution in the carsharing industry. This is primarily because users are typically unwilling to postpone usage, since their daily plans or time schedules may largely depend on their ability to get access to a vehicle at the precise time they need it. This is a more or less consistent point throughout the interviews conducted for the case study. Interviewees from Invers, TechCo, and Stadtmobil Rhein-Ruhr agree that queuing would not be effective.

Lovelock (1984), who brings up the solution of formalized queuing, speaks of it in a broader service industry context. However, in the specific setting of carsharing it appears to be more challenging to apply. Carsharing providers do not necessarily have many apparent options to make users more accepting of the waiting time. Where goods or users cannot be kept in a queue, he suggests reservation systems as another way of inventorying the demand for a service. All case companies apply this method to some extent. It serves to pre-sell the service, guaranteeing availability to users at a specific point in time and (hopefully) aiding carsharing providers in matching demand to capacity. Advanced reservations, however, are also associated with potential issues, such as users without reservations experiencing low availability or users gaming the system by pre-booking vehicles they do not end up using.

GreenMobility's potential solution, of alerting users who request to be notified when a car is made available in their area, is an interesting variation of the queuing mechanism. It uses no form of incentivization, but it is possible that it would increase the likelihood that the user holds off for a period of time before seeking other means of transportation or otherwise losing interest in the service. This would rely, of course, on the user in question not having an urgent need for mobility.

It is important to note that while queuing does not generally seem like an effective strategy, this is dependent on the particular use case of a customer's trip. If a use case is urgent or important, a user is more willing to go to greater lengths to satisfy their mobility need without having to wait, as observed by the COO of AutoCo. There are, however, conceivable use cases where a customer would be more willing to wait in order to get access to a vehicle. For a specific carsharing provider whose customer base mainly uses its vehicles for non-urgent trips, queuing may therefore be a useful large-scale solution in matching demand and capacity, though this is speculative.

5.1.9 Refusing trips

As with queuing, no case company employs the strategy of refusing trips based on their impact on vehicle distribution. Crum and Palmatier (2003) suggest it as a possible way of managing demand when it is higher than supply. Even more so than with queuing, this strategy is rejected by the interviewees. In essence, if a user's trip starts and ends at stations or within zones that are approved by the provider, the trip must be allowed. Any other policy would be unfeasible, as the Manager of Customer Unit Europe at TechCo explains in interview TC_1. In fact, most one-way carsharing services appear to have no way of knowing where a vehicle will be dropped off before the trip is concluded, as users generally are not required to enter their final destination to pick up the car. Adding this as a requirement, essentially locking the user to a particular destination before the trip commences, would likely have negative effects on user satisfaction. A less intrusive way of limiting the customer's choice in drop-off locations would be to use geo-fencing to dynamically alter the area of operations depending on demand. Although this method would not lock the customers to a particular destination, it would likely have a detrimental effect on the user experience. Negative impacts on user experience would likely deter new customers, making refusing trips unsuitable when expansion is prioritized.

It seems apparent, based on the findings of the case study, that the strategy of refusing particular trips would not be an effective one. It should be noted, however, that areas or stations which have low demand (and trips to which might thus be refused if applying this strategy) may instead be removed from the provider's area of operation. These areas or stations become subject of a provider's network design function, and will be decommissioned if they are determined to not be sufficiently productive or beneficial. Thus, unproductive areas or stations are dealt with on a long term basis through network design, which may act as a substitute for refusing trips outright in the short term.

5.1.10 Vehicle relocation

Vehicle relocations is a way of moving the supply to a geographic area with more demand. This can be contrasted to booking suggestions which reversely aims to move demand to an area with supply. Although three of the four interviewed case

companies use some form of vehicle relocation strategy, it cannot be said that it is a solution to all problems regarding resource utilization. Moving cars around the city is expensive and it must therefore be analyzed whether the relocations are financially viable or not in each company. Some relocations will clearly have a higher likelihood of resulting in increased revenue than others. Both planning and prioritizing demand, as described by Crum and Palmatier (2003) in the broad-view demand management model, is important in this regard.

Incentivizing customers to perform the relocations seems to be a cost-effective alternative, providing free miles or minutes to users rather than providing a salary to operators. However, user-based relocations would probably increase the duration of the trip, making it unattractive to users who are time-sensitive. As described by Stubbs et al. (1984), the cost of a trip from the user's perspective includes both money and time. Time can therefore be regarded as an important aspect of the trip and valuable for the user, something that was expressed during several of the interviews. This means that efforts to change customer behavior in regard to time may be expensive for the provider. The CEO of Invers saw greater potential in crowdsourcing relocations than in incentivizing users. Crowdsourcing can be a way to get people to do the relocations in their spare time when they are not as pressed for time, making it more likely that the strategy of user-based relocations would work. The phenomenon of retired people doing relocations at GreenMobility resembles crowdsourcing as the people doing the relocations are not doing it as part of a regular trip. Rather, they set out specifically to relocate a vehicle. This indicates that the concerns expressed by some of the interviewees regarding user-based relocations can to some extent be avoided by using crowdsourced relocations.

Operator-based relocations can be seen as a form of customer service that provides value to the customers as it reduces the distance they need to travel in order to secure a car. This value has to be weighed against the added cost of the operator-based relocations. The COO of AutoCo explained that it would be easier to make a profit from relocations in their new premium service compared to their existing service. The CEO of Stadtmobil Rhein-Ruhr also stated that they regard taking care of the vehicles as a service they should provide to the customers and not have customers work for them. Further, operators are generally required in order to perform services like maintenance and washing of the vehicles, which customers are unwilling to do. This speaks in favor of operator-based and against user-based relocations, although the Stadtmobil CEO did view user-based relocations as something interesting in free-floating carsharing.

Depending on the focus of the provider, choosing one of either operator-based or user-based relocations may be more suitable. For those who focus on keeping prices low, user-based relocations appear to be the better option as they tend to cost less than operator-based ones. However, due to the services required as mentioned above, some operators will still be needed even if user-based relocations are employed, limiting the potential cost reduction. It should be noted though, as the COO of AutoCo explained, that not every relocation has to be profitable for it to

make sense in the long run. Fulfilling a customer's demand might have benefits that exceed the marginal cost of the relocation when looking at the customer lifetime value.

Seeing that electric vehicles tend to be more expensive than their internal combustion engine (ICE) counterparts, and also require additional investments in charging infrastructure etc., as described by Vasconcelos et al. (2017), it would likely follow that they need to have a higher level of utilization to be profitable. Relocations could therefore be even more attractive for a provider that has electric vehicles in its fleet. GreenMobility is an example of a provider with an all electric fleet that relies heavily on relocations for their operations. Stadtmobil Rhein-Ruhr, on the other hand, mostly has less expensive ICE vehicles in their fleet and does not use relocations to the same extent. They do however move their electric cars to the charging stations when the battery charge gets low. As charging the vehicles takes quite some time compared to refueling an ICE vehicle and the charging is done after a trip rather than refueling which is often being done by the user during the trip, there is a limit on resource utilization. This is because the vehicle cannot be rented out while charging, which in turn means that there either has to be more vehicles added into the system or that more relocations have to be done to ensure availability when using an electric fleet. While it might be possible to do the majority of the charging during periods of low demand, e.g. during night-time, this will likely not always be the case.

6
Conclusions

The purpose of this thesis has been to explore the issue of demand and capacity asymmetry in carsharing, as well as its potential solutions for providers. As carsharing providers today are hard pressed to deliver a low cost service with high availability, they are in need of a basis for decision making in selecting effective solutions. This thesis has identified ten potential strategies, of varying applicability, to dealing with the demand and capacity asymmetry issue. This work thus contributes to existing literature on carsharing, and vehicle sharing systems more generally, as well as the understanding of academics and professionals regarding these concepts.

Matching demand to capacity requires the manipulation of either demand or capacity side dynamics, and the ten strategies identified herein represent a mix of both. Though it may not be an exhaustive list of strategies which can be used for this purpose, the case study indicates that it covers the strategies which are commonly used in practice throughout the carsharing industry. Indeed, all potential strategies which were brought up during either literature review or interviews have been included herein. The findings further indicate that three of the identified strategies, namely those of communicating demand, queuing, and refusing trips, are of very limited value when applied in carsharing. This is mainly due to the difficulty in changing user behavior non-coercively. Network design and vehicle relocation were concluded to be of high importance to carsharing services in matching demand to capacity. The same is true for class bookings in the case of services which allow reservations of vehicles in advance. Network design, in particular, has large impact on a provider's resource utilization and the need for complementing strategies. The remaining four strategies of alternate use, booking suggestions, dynamic pricing, and fleet resizing, are useful in certain circumstances and for certain types of carsharing providers.

Carsharing providers differ immensely in their business models, geographic coverage, platforms, vehicle types, customer groups, and any number of other factors. All of these, and more, have been shown to have an influence on providers in terms of which strategies are compatible or desirable for their services and how they should be applied in each case. The variety of carsharing providers and that of the strategies explored herein make generalizations challenging. However, what is clear from the findings of this thesis is that station-based services have a larger selection of strategies to counter demand and capacity asymmetry than free-floating ones. This is because they incorporate reservations in advance to a larger extent. Providers with larger fleet sizes also have an advantage in some respects since they can gain

economies of scale when implementing these strategies. Further, providers should be mindful that in carsharing services optimal capacity is below that of available capacity. Since users rank availability as more important than price, the customer experience may deteriorate if utilization is too high and users cannot access vehicles on short notice. Measures to increase resource utilization will therefore likely only be beneficial up to a certain level.

Looking forward, carsharing providers will be forced to adopt effective preventative measures in dealing with asymmetry in demand and capacity. New market entrants and heightened expectations from consumers will put pressure on providers to achieve high levels of utilization while providing satisfactory availability. In doing so, many of the strategies discussed herein must be assessed. As the automotive industry changes, and with the advent of new mobility technologies such as autonomous driving, the applicability of these strategies will likely change and they must then be reassessed. In particular, such technologies will enable higher efficiency in vehicle relocation, further increasing this strategy's importance. This thesis has also repeatedly emphasized the value of data and analytics in making decisions in regard to several of these strategies. As data collection becomes more affordable and analytics more accessible, their significance as a tool to improve the operations of carsharing providers, as well as their potential as a differentiator to competitors, will only grow.

Vehicle sharing systems in general, and carsharing systems in particular, would likely benefit from further research in several areas. First, the ambiguities outlined herein, for example in regard to variations in network design strategies, should be further investigated. This thesis has speculated as to the explanation for these ambiguities, but they undoubtedly warrant further investigation. Second, quantitative analysis of the impact on profitability by each respective measure explored herein would serve to provide further clarification to practitioners as to their usefulness. Current literature attempts to model this impact through theoretical means, but grounding this theory in a comprehensive, real-life data set would be beneficial. Finally, the interrelatedness of the ten strategies explored in this thesis should be researched further. Whether some or all of these strategies have significant impact on the effectiveness of others is of great importance to practitioners and a subject rarely explored in current literature.

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A

Questionnaires

Two separate questionnaires were used in performing the interviews of the case study. One for representatives of case companies and one for those of carsharing industry suppliers. These questionnaires are presented below.

A.1 Case company questionnaire

General

1. Please tell us briefly about the company
   (a) Type of carsharing
   (b) Fleet size, models, etc.
   (c) Geography
   (d) Model for pricing
2. What factors are important for your company to focus on? (Lowest cost, high availability, etc.)
3. What is important to your customers? (Availability, fleet variety, pricing, etc.)
4. Who are your competitors/substitutes? (Other carsharing services, public transport, etc.)
5. What are your key selling points vs. the competition?
6. What is your role at the company?

Issues in carsharing and resource utilization

1. Would you consider resource utilization/matching of supply and demand as an issue that your organization is concerned with?
   (a) Why/why not?
2. What resource utilization level (or %) do you have as a target for your vehicles?
3. What are your main obstacles in matching demand and supply for your service?
   (a) Demand varying by geography, by day, by time of day, etc.
4. What is the impact of variations in demand?

Solutions in use

1. Do you use relocation of vehicles (operator-/user-based)?
2. Do you use dynamic pricing?
   (a) Are there differences in how you apply it in B2C/B2B?
3. Do you attempt to offset usage in time (queuing)?
4. Do you offer lower price for less specific requirements in booking?
   (a) How far in advance do customers make reservations?
5. Do you use temporary reduction/increase of the vehicle fleet?
6. Do you ever refuse trips based on their impact on vehicle distribution?
7. Do you communicate levels of demand?
   (a) For each of the above items:
      i. How does this work?
      ii. What is the cost vs. benefit?
      iii. Why has it been effective/ineffective?

iv. For how long has this been used?
v. What are the reactions from customers?
vi. How do you collect data about customer sentiment?
vii. What is this strategy motivated by?

8. Have you considered adopting any other strategies?

Miscellaneous

1. How do you decide where and when to open a new station (if station-based)?
2. How do you go about when deciding on the vehicle mix of a station/location?
3. How often is the vehicle mix revised at each station/location?
4. How far ahead do you plan the capacity?
5. In the case that a user wants to book a certain type of car but is forced to book a substitute, do you consider what the customer actually wanted to book and base forecasts on that?
6. How will the introduction of automated/autonomous vehicles affect the carsharing industry?

A.2 Industry supplier questionnaire

General

1. Please tell us briefly about the company and the products/services you offer
2. Who are your competitors/substitutes?
3. What are your key selling points vs. the competition?
4. Who are your customers in carsharing and what are their characteristics?
   (a) Station-based/free-floating/peer-to-peer, approximate number of vehicles, geography, etc.
5. What is your role at the company and your background in carsharing?

Solutions

1. How do your solutions affect your customers' resource utilization?
2. How do your solutions affect your customers' ability to influence or match supply and demand?
3. Do your solutions enable or support any of the following:?
   (a) Dynamic pricing
   (b) Vehicle relocation
   (c) Temporary reduction/increase in vehicle fleet
   (d) Collecting data on/communicating levels of demand

Industry topics

1. What are the main priorities of your customers (issues they need to solve, etc.)?
2. Are your customers particularly concerned with resource utilization/matching supply and demand? Is this a major topic in the industry?
   (a) What are the industry targets and current resource utilization levels?
   (b) How does the industry generally attempt to combat this?
3. What are your views/your customers' view/the views of the industry about the following strategies:
   (a) Vehicle relocation
   (b) Dynamic pricing
   (c) User queuing
   (d) Incentivizing less specific requirements in booking
   (e) Temporary reduction/increase in vehicle fleet
   (f) Refusing trips based on vehicle distribution
   (g) Communicating levels of demand to customers
4. How will the introduction of automated/autonomous vehicles affect the carsharing industry?

B

Interview summaries

All interviews conducted during the course of the case study are summarized below. Rather than transcripts, below summaries include only the information given by interviewees which was deemed relevant for the purposes of this thesis. All summaries have been reviewed and approved by the interviewee in question.

B.1 2019-03-07, Sr. Manager of Mobility Innovation at EY

He has worked in the automotive industry for about 12 years in different positions, most recently dealing with new business models connected to new mobility services. He joined EY in 2017 and is working with different kinds of new mobility concepts, with carsharing being one of them. The projects range from strategic positioning in the market to more implementation oriented projects to operational issues and partnerships.

The main themes discussed in the carsharing industry today are scaling, operations, and branding and market positioning. The scaling issue relates to how to expand fast while in a city environment with many different stakeholders and partners who have different interests and political agendas.

The automakers' pricing and margins, as well as market positions have been built up over a long time as part of the brand. In carsharing and other services on the other hand, the brand is less important. Price, availability, customer service, the experience etc. play a much larger role. Brand loyalty differs vastly between the automotive industry and the service industry. Premium brands and offerings in the service industry are not as clear as in the automotive industry. Another issue is how to slice the value chain of carsharing, what activities to perform yourself, where to form partnerships and with whom these partnerships should be formed.

The problem with resource utilization can be boiled down to a simple equation: Is the utilization high enough to cover the operational costs? The utilization and operational costs are in turn made up of different factors. The key to success here is to understand the different variables and then prioritize and optimize the different

variables. One approach which is used in the carsharing industry that is very different from the automotive industry is that variables are changed and then evaluated based on the response from the market. The changes are then either made permanent or reversed and something else is tried instead. In station-based carsharing for example, analysis of data on traffic flow and where people are living can be the basis for opening a new station. With all the data that is available, it is quite easy to measure the success of this new station. It can be a matter of the culture of the organization and whether or not they are willing to make these changes and then try again.

Defining the area of operation can be a delicate issue since having a large area of operations can generate more demand but it increases the issue of vehicle relocation. The issue of vehicle relocation can be mitigated by putting more vehicles into the system, but that will on the other hand lead to lower utilization. It is important to have a model that includes all the variables since changing one variable usually has detrimental effects on other variables. One additional approach could be predictive smart relocation, using data from the cities and if there are special events to decide where to move vehicles in advance and maybe utilize pop-up locations.

If a provider has sites in several cities not far from each other, cars can be moved from one city to another in case there is temporarily higher demand in one of the cities. Another solution could be to use the fleet for something else in periods of low demand, something that is rarely done in larger dedicated carsharing providers. Some rental car companies have started to look at the possibility to combine traditional car rental and carsharing as a mean to increase resource utilization.

Autonomous vehicles will not have a real impact until level 4. As soon as the vehicles are able to move without a driver in a specified area, autonomous vehicles can become a game changer in the carsharing industry. AVs would make the relocation much more efficient since the cars could relocate themselves without a driver, perhaps during the night to increase safety as well as resource utilization.

When the cars are able to move by themselves without any restrictions, it would become more like ridehailing than carsharing. The focus would then be on the service of transportation rather than the vehicle itself. Operating a carsharing service is a good way to gain experience in order to be successful in operating autonomous ridehailing services.

B.2 2019-03-08, Communications Officer at Cambio

Cambio Carsharing is a carsharing provider based in Bremen, with operations in 23 German and 44 Belgian cities. They operate a station-based carsharing service with a fleet of gasoline and electric vehicles of different sizes and models. Cambio has its roots in the ecological movement in the 1980's and they want to offer their customers

an alternative to owning a car. Their stations are located in different areas based on demographics and other factors such as traffic, public transportation etc. Depending on the area and the type of car, the utilization is between 6 and 10 hours per day.

In order for the carsharing service to be successful, there needs to be good public transportation in place, as well as good bike paths, since people living in areas without these amenities are less likely to be willing to give up car ownership. Cambio can provide carsharing cars, but in order to fulfil the users' mobility needs, they are very reliant on public transportation as well.

Cambio is organized with independent sub-companies based in the cities in which they operate. This means that they have good contact networks in the local area and know the cities very well in terms of where the demand is etc. They also frequently ask the customers, for example where the customers want the next station to be located. A new collaborative initiative was tried in Aachen a few years ago where the customers could vote on in which area a new station would open. This has since been implemented on a national level.

Since Cambio wants to offer their users an alternative to owning their own car, the distribution of stations and vehicles needs to be ensured over quite a long timeframe. They can't move the cars around on a weekly basis since people are relying on the cars. If the demand changes rapidly, let's say five families move into an area and they need station wagons instead of Ford Fiestas, Cambio can react quickly and meet the customers requirements.

Cambio offers different tariffs for different user groups, ranging from only using the cars sporadically to those who use them frequently. The pricing consists of a charge per hour and a charge per km where the price of fuel is included. If the fuel prices go up, the charge per km will also be adjusted. Cambio wants to offer a reliable service and enable their customers to make conscious decisions regarding their personal mobility and not encourage their customers to drive more. The way that Cambio's customers use the service means that flexibility in terms of when the booking should start is not possible and therefore they don't incentivize the users to be less specific when booking.

The fleet is adjusted based on the season, with more vehicles needed before the holidays and different types of vehicles in the summer and so on. Many customers use the cars to go on holiday during the summer, so extra cars may be needed. When the cars are not needed, they are either sold or returned to the leasor. The aim is to meet the customers' demand and have reliable supply. Reducing the fleet at a small station will clearly be noticed by the customers. In the summer time there are a lot of customers who use the cars to go on holiday, so there needs to be extra cars added to the cities. Cambio does not deny any bookings. If a customer makes a very long reservation at a small station, they might move one car to that station to ensure availability for the other customers using that station. Cambio talks to their customers frequently and get their input, something that they see as

very important.

B.3 2019-03-12, COO at AutoCo

AutoCo focuses on creating an alternative for car ownership and owns a large carsharing provider in Sweden. The carsharing provider has been around for about 20 years and offers station-based carsharing with a fleet of around 1600 vehicles in 40 cities. AutoCo is also in the midst of launching a new carsharing brand with a more premium focus. The existing carsharing provider has found a compromise between availability and utilization which works for them and on which the operational model is based. The new premium brand on the other hand will try to achieve higher availability with the same or higher utilization as the existing carsharing provider. Customer satisfaction is key in this new premium brand, and encompasses both higher availability and a focus on the entire customer journey.

Resource utilization is one of the most important issues according to the interviewee. This conclusion can be reached by either focusing on achieving high availability since then you also have to understand demand and meet it in a successful way, or it can be reached through a financial analysis where the key cost drivers are cars and parking which needs to be offset by as high utilization as possible. The existing carsharing provider has worked with demand in a quite static way, with stations being located in a certain location and with a set number of cars for a long time. The premium brand works with demand in three different time horizons. Strategic demand decisions are where and when to go to market etc. Design decisions regards which stations to grow and which stations to reduce based on seasonality, market development and so on. Decisions are also made on a weekly basis based on where there is a real risk of service loss right now and how this can be mitigated with the current resources, for example using vehicle relocation in a dynamic way.

Very consistent behavior in the B2C sector is an obstacle for achieving higher utilization. People want cars during weekends and holidays. This creates limitations in how high the utilization can be when only having one type of customer. One strategy has been to increase the sales to businesses and use the same cars as for consumers. Finding the right customers is key. Only attracting one customer segment is not enough, but matching needs to be done between different customer segments with different usage behavior to maximize the utilization.

In the existing carsharing provider, different ways of vehicle relocations have been tried, both doing it themselves, have the customers do it, or offering some sort of deal. The more important and the longer your trip is, the more effort you are willing to put in to obtain a car. It can therefore be very expensive to nudge people to move a car on a Wednesday afternoon for example. On public holidays, during summer vacation etc. it is reasonable to create tailored offers for a certain location to increase the utilization. The optimum of course is to locate the stations in areas which will give a high level of utilization. These should be areas where people are living, working, with good access to public transport etc. This natural balance be-

tween supply and demand will however be skewed by different factors, for example stations outside the city or B2B deals which blocks a car for reservations for certain hours.

For the transaction of moving vehicles to be worth the cost, the car has to be rented out for a certain number of hours, something that rarely is the case in the middle of the week, but more likely to happen during the weekends. It can however be worthwhile to do it anyways, just to please the customers and looking at the customer lifetime value. These relocations are based on a number of known cases. It will be easier to cover the costs of doing it in the premium brand than in the existing brand.

The new premium brand will have no surge pricing, but rather an easy to understand pricing strategy with no surprises There will however be some differentiated pricing to attract certain customers. Maybe "daytime customers" will have some sort of permanent offer, or maybe offers for certain events or certain customers.

The existing carsharing provider has a well functioning way of varying the size of the vehicle fleet. Eighteen-month leases which usually start in the spring and end in the fall to have a larger fleet during the summer and a smaller fleet during the winter, which corresponds well with the demand patterns. This can also be done if new cars enter the fleet on a Wednesday, the old cars will be kept until the following Monday to increase the capacity for certain holidays for example. AutoCo can react faster than the competition and bring in temporary cars from other channels.

The existing carsharing provider used a booking calendar, with the users basically only using the station closest to them, or possibly a few stations in close proximity. If the customers see that the cars are fully booked when they need a car, they simply don't use the service. The premium brand will not use a booking calendar since they see it as their problem and not the customers' to meet the demand. Booking calendars can also bring unwanted behavior from the customers, for example booking a year in advance or booking a whole weekend but only using the car for a few hours. They will more likely work with targeted messages for their most loyal customers to plan their travels before the rest of the customers.

The premium brand differs from other carsharing providers in that they look at what the customer wants instead of showing them their offering. When they have understood the demand at a certain location, certain time or a certain car, they have methods to understand what other alternatives are available if the customers exact demands cannot be met. These alternatives could for example be another station 200 m away or bumping the customer to a higher vehicle class. The alternative stations are a cluster of stations which can be used as substitutes for a certain station based on how people move and not on geography.

Regardless if the cars are autonomous or driven by the customers themselves, understanding intent and people's mobility needs is important. Through the operation of carsharing services today, competence is built which will be needed to support a

future with autonomous driving. Many actors in the carsharing and ridesourcing sectors are making massive losses just to own the customer contact when autonomous vehicles eventually arrive.

Large fleet providers will gain benefits in more areas than just transporting the customer from AVs. The cars could for example drive themselves for service during the night, or move to another area where the demand will be the next day. The potential for such applications is higher than just for moving around customers.

Uber for example are very urban, and subject to congestion. AVs will probably be used in city centers and on highways sooner than outside the city. Having a solution that is attractive both in urban areas and outside them will be important in the future. Carsharing has the advantage over ridesourcing in that only 1 in 3 km driven by ridesourcing cars are actual passenger km, while this number for carsharing is close to 1-to-1.

B.4 2019-03-19, CEO at Invers

Invers is a mobility technology company which builds software and intelligent hardware for providers of shared mobility. These technologies make it easier for their customers to establish their service and operate it at scale. A majority of their customers are located in Europe and North America, currently operating approximately 100,000 vehicles by use of Invers technology. Different products have different target customer segments, but generally the product portfolio is targeted to all carsharing providers of all operating models and sizes. The CEO of Invers has a business background, was involved with carsharing early on as a user, and joined Invers seven years ago.

Resource utilization is a key component for carsharing providers to drive profitability. Invers' focus, however, is to provide the underlying technology (access to high-quality data, etc.) so that carsharing providers can leverage other tools to for example improve resource utilization or predict demand. Some of these third-party tools can also be integrated with Invers systems. This can be a key differentiator for carsharing providers, while the underlying technology does not necessarily add value as a differentiator to competitors. In addition, there is often a need to adapt tools of this kind to the specific geography where it is applied. The reasons why and how shared mobility works in Stockholm can be very different from how and why it works in Berlin.

Issues that carsharing providers focus on differs a lot based on whether they are focusing on high-growth or are already well established. Established providers mostly focus on operational challenges. For example, how to handle damage to vehicles, where to park vehicles, and relationships with city authorities. Growth companies who are aiming for expansion focus more on data support for business decisions, scaling fast, and building the organization. Newer players on the market are potentially seeing resource utilization as an opportunity to gain a competitive advantage.

But the question is how to implement it. Particularly, there is great difficulty when trying to change the behavior of users. Crowdsourcing may work better as an alternative, though this is yet untested. Resource utilization levels also have to be weighed against service availability, as high resource utilization usually implies low availability.

Relocation of cars does not seem like a good solution to match supply and demand. The provider almost always loses money when performing a relocation. It is done mostly as a last resort. Doing it by incentivizing users may be cheaper, but the incentives required may still need to be substantial. The provider also loses money if the user already planned to take a certain trip and is then incentivized further to do it. Dynamic pricing is used more and more by carsharing providers, and is probably a more interesting alternative than relocation.

Providers increasingly apply temporary reduction and increase of the vehicle fleet. This can be done by finding other uses for the vehicles in times when they aren't being used. For example, corporate carsharing schemes may be able to use their vehicles for B2C carsharing on the weekends. This largely requires telematics equipment to be enabled for cross-usage on different providers' platforms. There are, however, challenges in that providers need to trust each other to be able to cooperate as competitors.

Communicating levels of demand and supply is done in part through the Invers platform. An algorithm is used to suggest alternatives to a certain booking request if a particular car is not available. This is an important function for carsharing services with pre-planned bookings, since having another option to pick up a car is usually better than not having a car at all. Class bookings are similarly an important feature for pre-planned reservations. This disallows users from booking a specific car at a station. Rather, they make a reservation for a vehicle class, or a type of car. This enables the provider's system to allocate specific cars to user reservations just before the reservation starts, improving flexibility and ultimately resource utilization. This has become a standard feature for station-based carsharing platforms.

Carsharing providers are likely in a good position to offer mobility services when autonomous vehicles become available. Invers' technology will be useful in this setting as well, though autonomous vehicles are probably still far out. Some of the vehicle relocation issues can likely be solved by autonomous driving. Perhaps cars will also be able to drive to users, rather than users walking to the car. This may not work however, as it would likely slow down traffic quite a lot. While there was a lot of hype around autonomous driving a few years ago, this has cooled off slightly. People have started to realize that cars are not optimal for all use cases. Particularly, two-wheeler vehicles are more interesting for many use cases, and those services are in some ways easier to operate.

B.5 2019-03-20, Board member at Stadtmobil

Stadtmobil is a carsharing provider which consists of seven independent companies operating in different regions of Germany. Stadtmobil Rhein-Neckar has been operating for over 26 years and provides 540 cars in 25 cities, ranging from large cities like Mannheim and Heidelberg to smaller cities with around 20,000 inhabitants. Stadtmobil Rhein-Neckar mostly offers station-based carsharing, but in Mannheim and Heidelberg they also operate a free-floating carsharing concept called JoeCar.

Stadtmobil is a company which does not focus on expanding rapidly to increase revenue, but rather on taking smaller steps and growing organically. They offer carsharing in small cities in which it is not possible to make a lot of profit, which is possible due to the success of the service in Mannheim, Heidelberg, Ludwigshafen, and Kaiserslautern. Stadtmobil Rhein-Neckar tries to open operations in a new city each year, and they need 12-15 customers in order to enter a new market. The new cities generally do not turn a profit until after 4-5 years, but since Stadtmobil sees carsharing as an important way to lessen climate and traffic problems they are willing to take the risk. In the past, stations in new, smaller cities were often opened with just one car. Since the customers care a lot about availability and having just one car does not provide much capacity, they have started to open new cities with a minimum of two cars instead to ensure availability for the customers. Customers also consider the cost to be important, but they already consider the prices to be low, so low that some customers have asked for the prices to be increased a bit. The customers don't want to walk too far to get to a station, so these customers are lost if there is only one station in a city.

There are no competing carsharing providers in the region of Rhein-Neckar. There is Flinkster, but they serve another type of user, one who mainly travels by train and then takes the carsharing car for the last part of the journey from the main train station, thus the cars are concentrated at the train stations. Stadtmobil, on the other hand, are present where people actually live. Public transport and bikes are important compliments to the service that Stadtmobil offers since the customers mostly rely on those means of transport because relying solely on carsharing would be too expensive. Stadtmobil sees themselves as the most attractive alternative when the customers need to transport something, or when they are going places where there is no public transport available, or at times when the public transport is not operating.

Stadtmobil does not have any data on the actual demand. For example, if a customer wants to book a certain car but ends up booking another car or a car at another station due to lack of availability, Stadtmobil has no way of capturing the customer's original demand, they can only see what they actually ended up booking. Stadtmobil tries to match demand and capacity by looking at where their customers live and how much the cars are used at the single stations. Based on that they decide whether or not to add a car at the station or open a new station in the area. The reason for not using more data is that the current system cannot handle it. The main obstacle when trying to match supply and demand is finding parking space.

The stations with the highest utilization are typically located in areas where there is very limited access to parking space.

The demand for carsharing is lower during the winter months from November to February, except during the Christmas holiday when there is high demand, so the fleet is reduced during these months. The old cars are sold off in November and the new cars are bought in March. This creates a natural fluctuation in the fleet which corresponds better to the demand. Some more short term increases in the fleet also happen sometimes, if, for example, customers start calling and complaining about never getting a car at a certain station. They might buy one more car and put it at that particular station, but no large moves in the fleet since they lack the resources and partners to be able to do that. The seasonal decrease and increase in the fleet might not be worth the effort, however. They tried doing it for three years and concluded that there was a lot of work with preparing the cars to be sold, taking delivery of new cars and so on. Since it only concerns a small number of cars, around 20, it may be more efficient to just keep them over the winter and live with the lower utilization. The customers almost have a sense of that it is their cars at the stations, so when a particular car leaves the fleet, they call and are unhappy with the decision.

Stadtmobil Rhein-Neckar does not really utilize vehicle relocation for their station-based operation. They mainly do it based on customer request. For example if customers ask for a car with an automatic transmission then Stadtmobil might transfer a car from another station. When starting their free-floating carsharing service they first were under the impression that relocations were needed. They looked at how Car2Go did a lot of relocations in the beginning and realized that they lacked the resources to do relocations at that scale. They, therefore, started their free-floating operations in Mannheim a smaller area, which mostly eliminated the need for relocations. It is cheaper for Stadtmobil Rhein-Neckar to have a car be idle for 2-3 days than to send someone out to move the car to a location with higher demand. When they started their free-floating operations in Heidelberg they chose an even smaller area, which further reduced the need for relocations.

Stadtmobil does not use dynamic pricing since their system does not support it. They have however thought about selling trips on eBay if a car is not booked for the weekend for example. This would, however, need to be done manually, making dynamic pricing impossible to implement on a larger scale with the current system. Dynamic pricing would probably be accepted by the customers however, as long as it is within a certain range, around 10% up or down rather than 150%.
When customers make bookings, they can see alternative stations in the booking system if their preferred station has no available capacity. The customers are well aware that the system works like that and are happy with it. Suggesting alternative stations work even better in the larger cities since the distance to the next station is short, around 200-300 m.

The customers mainly book the small cars due to their lower price, or a station wagon or a van if they need the space, for example if they are going shopping at

IKEA. A certain customer group prefers to drive Volkswagen, so Stadtmobil has bought a few of them and they have been very appreciated despite their higher price. When the customers book a car they can see all the stations and all the cars and when they will be back and so on.

The fact that Stadtmobil operates as seven independent companies means that each company knows the area in which they operate very well. Through this, they can make good business decisions despite the lack of demand data. Since Stadtmobil is not connected to any car manufacturer, getting early access to autonomous vehicles and testing them will probably not be possible. AVs have the potential to partially solve the problem with parking since they will be able to park closer together, thus fitting more cars in the available parking spaces. Another opportunity would be for the cars to drive themselves to get washed during the night for example. AVs could also make relocating vehicles possible on a larger scale since they could drive themselves to an area with high demand, for example, to spread the cars across the city after the cars have been concentrated at the train station in the morning commute and then drive them back to the train station for the afternoon commute.

B.6 2019-03-27, Manager of Customer Unit Europe at TechCo

TechCo was founded in 2015. They are working within Intelligent transportation systems (ITS) and are a carsharing telematics technology provider that sells hardware that enables telematics for carsharing providers, and also the backend for virtual keys, vehicle data management, and APIs to be integrated into their partners' mobile applications. They are not providing a turnkey solution because they want to be flexible and be able to cater to the needs of customers with varying business models. They are working with mobility providers like short-term rental, long-term rental, carsharing providers, taxi companies, Uber drivers, corporate carsharing, and logistics fleets. They also have large projects with transport companies. Some mobility providers try to develop their own solutions using Chinese technology but this has not been successful so most of them return to TechCo. One competitor is Invers and the difference between Invers and TechCo is that Invers provides both the hardware but also the software and is able to provide a turnkey solution. Another competitor is Vulog.

The selling point for the solution that TechCo offers is that it works even where there is no GSM connection, in underground parking for example. The virtual key is downloaded in the mobile application when the booking is made and the app connects to the car via Bluetooth, enabling locking and unlocking of the vehicle without any GSM connection. The system also works with NFC, but when using NFC it needs to have a connection at the start and the end of the booking. The installation of the technology in the vehicles is non-intrusive as no soldering is done to the vehicles' wiring. The box containing the technology is plugged into the vehicles OBD-II port and is then placed behind the dashboard. The aim of the solution

offered by TechCo is to enable more cars to be handled per employee. The administration of the vehicles and the exchange of the virtual key can be done directly to the end customer using the app. There is, therefore, no need for a desk, only parking spaces which not only reduces cost but also enables new locations to be served. The customers within short-term rentals are traditionally station-based but are moving more and more towards free-floating carsharing. Most of the customers are free-floating providers. They also have customers in peer-to-peer carsharing.

For corporate fleets, the target is to decrease the size of the fleet to increase the usage per vehicle. Free-floating providers are more likely to increase the size of the fleet since it is important to have a high volume of vehicles in the operating area in order for people to use the service. The customers have a fleet turnover of anything between three months and two years. It depends on the assets that they have and how the contract is negotiated with the lessor.

The distributors of TechCo are the ones that are mostly dealing with the issue of matching demand and supply on behalf of their customers. One distributor has a solution that enables reorganization of the fleet in case of special events etc. Moving vehicles from a station that is performing poorly to one with high utilization is widely done in the industry. For free-floating carsharing, cars need to be moved around the city, especially electric vehicles which need to be moved to charging stations when their batteries run low. Some short-term rental providers have 60-70% utilization, while the number for traditional long-term rental could be as low as 10-15%.

All of the free-floating providers are incentivizing customers to leave the car at a specific location to avoid the need for relocations. It is cheap to incentivize customers by offering them free miles. Incentivizing using miles also means that the customers will return and use the service again. It can be compared with airline miles and loyalty to an airline alliance. Incentivizing using free miles is a way to both lower the cost of operations and also to increase brand loyalty.

Dynamic pricing is mostly utilized by free-floating carsharing providers. Station-based providers use dynamic pricing for holidays or specific long-term events, while free-floating providers use dynamic pricing in the same way as Uber does it, with surge pricing. Using special offers can be a way to attract new customers. Station-based providers usually give discounts, while free-floating providers are more likely to give out free miles. Communicating the level of demand is not used, but it is done indirectly through dynamic pricing. Queuing of customers is probably not something that is possible to implement. If a customer needs a mobility solution, they need it now. If there is no car available when you have booked a vehicle you will probably go to another provider. When you have booked you will be dissatisfied in case there is no vehicle available. It could, however, work for free-floating carsharing however since no reservation is made in advance.

Since there may be some reverse engineering required to make the technology offered by TechCo compatible with a new car model, single model fleets tend to be more

common among the carsharing providers. This is especially true for startups. This makes it easier to manage, and ordering many cars of the same model means that the price can be negotiated. Because of the installation and removal of the telematics required when a vehicle enters or leaves the fleet, temporary increases or reductions in the vehicle fleet is not commonly used. Peer-to-peer carsharing providers often try to get company carsharing vehicles into their system to offer the cars there after working hours and during weekends and holidays when they would otherwise be unused. The customers like this because these cars are usually newer than the ones used in peer-to-peer carsharing, around 2.8 years on average compared to over 8 years.

Some of the customers assign the vehicle to the customer directly upon booking while others wait and assign the vehicles later to maximize utilization. Class-bookings are often used in traditional car rental. Some of the customers show alternative vehicles or stations when the user makes the booking. Refusing a trip because of its impact on vehicle distribution is not possible to do as long as the trip ends within the area of operations. Refusing such a trip would make the customers unhappy and could lead to the loss of a customer. Loyalty is very important in carsharing so refusing trips just to try to increase the profitability will not work in the long term.

The introduction of autonomous vehicles will have positive effects for TechCo since Continental is working on an embedded solution that uses TechCo's' technology. This means that OEMs will use the same backend APIs as is currently used in TechCo's aftermarket solution. Today there are chauffeur driven cars and short rentals in the form of free-floating and station-based carsharing, but the introduction of autonomous vehicles will mean that there will only be one type of providers since the car will do the driving itself. The chauffeur driven services will come together with the short rental services and operate in the same area, increasing the competition. The one who will be successful in this transformation is the one who will have the most cars on the road, so the big players will outmaneuver the small players.

B.7 2019-04-01, Product Marketer at AutoCo

Currently, AutoCo's soon-to-be-launched service is working towards a controlled test with a controlled number of paying customers with the goal of achieving a product/market fit to know that they have built a product that resonates with customers. The test is done to make sure that there are customers who like the service and are willing to pay for it, giving the confidence needed for the service to be scaled. To assess the product/market fit they are doing a Sean Ellis test among other things.

The service has a commercial design target that is based on a psychographic profile and talks about progressive people who are socially aware and live in urban areas and have a certain level of household income. Within that, there are more functional segments as well, for example existing carsharing users, car buyers, and existing car owners, etc. Lack of availability has been shown through research to be the biggest

pain point among people who are sharing or renting cars, followed by price.

AutoCo has done focus groups in which existing users, car renters, and car owners have taken part. Ease of service and flexibility were what they believed they were paying for, followed by a feeling of it being hassle-free, and that it is a service that is tailored to them in some way. Customers generally don't want to walk more than 10-15 minutes from their home to access a car.

The competitors for AutoCo's new service are in part other carsharing services, but also traditional car rental for longer trips. Uber and short taxi trips are not competitors since they have very different use cases. Carsharing is seen as a compliment rather than a substitute for public transport and the target customers live within a certain range of public transportation. AutoCo is not trying to be there for very short trips and not for commuting either, there are other alternatives to that, like public transportation. If you take a broader view of the competition, car manufacturers are competitors, and also car subscription services. Longer Uber and taxi trips may also be considered to be competing with AutoCo. One of the main reasons for the customers to use carsharing is for going to places like Ikea where they need a car to transport their purchases home. Through improved home delivery alternatives this use case is becoming less important, however.

Product marketing focuses on value in all of its different facets and making sure that they provide the right product to the right audience for the right price with the right message. When trying to decide which areas to serve first they looked closely at where their highest valued customers are, even down to the neighborhood. AutoCo's current service has no problem with getting people to book cars during the weekends, but during weekdays the demand is much lower. This was taken seriously when deciding on how the operational model for the new service would be different.

If managing supply and demand is not done well, there is a risk of disappointing the customers since the customers can't access a car when they want to access a car. This is problematic since the lack of availability is currently the biggest pain point for users of the current service. It is crucial to delivering the availability that the customers desire in order to have high customer satisfaction and avoid churn.

Previously the cars were segmented based on their size but it is likely that this will move towards cars being put into different classes based on their characteristics, like cars being well suited for families, suitable for urban driving, or more comfortable vehicles, etc.

AutoCo's new service wants to have a pricing model that is easy to understand, transparent, and fair. Having lots of discounts and offers may be good in the short term, but it makes the customers more sensitive to price and it can damage the brand in the long run.

B.8 2019-04-04, CEO at GreenMobility

GreenMobility is currently focusing on growth. The company is about two years old and are currently operating in Copenhagen and Oslo. They are now starting to look into expansion around Europe. Different midsize and larger cities around the world have a demand for more green transportation solutions. There is also more and more demand for carsharing and interest from the younger generation for carsharing. The most important thing for GreenMobility according to the customers is to have a car in the right place at the right time. In other words, availability is the most important thing.

GreenMobility has been working with trying to match supply and demand since the start because they knew that the logistics would be an issue. They have developed different systems that can monitor the demand during the day. The systems look at what the demand has been in the past, for example, how has the demand looked every Thursday at 1 O'clock for the last two years. They are using a robot who can do the monitoring and who is getting smarter every day. The problem with the robot is that it can only see the demand where there are cars, so if there are no cars in an area there is no way of knowing the demand. The heatmap is there to show where the customers start and end their trips.

The biggest issue for trying to match the supply and demand are the random fluctuations in demand due to holidays, weather, traffic, etc. To help lessen the issues caused by these fluctuations in demand, GreenMobility has people on the streets who are doing relocations of the vehicles. These people are mostly students who work part-time. If the relocations are not done, the number of minutes used by the customers are expected to be reduced by 5-10%. The balance between the cost of having people on the street and revenue gained as a result of the relocations is an important balance. The method of relocations is considered to be very beneficial for the company.

There are different jobs that need to be done that are related to the vehicles. They need to be charged, cleaned, inspected for damages, etc. Some of the jobs cannot be performed by the users, so there is always a need for a street team to perform these tasks.

The customers have been positive about user relocations. Some retired people even start their day by logging in to the system to see where there are cars in need of charging and drive them to a charging station and then transfer the free minutes to their grandchildren. Giving away free minutes to customers in return for different tasks has some issues with people trying to take advantage of the system. In the past, they gave away free minutes if customers had to wait when they were calling customer service. People then started to claim that they had been waiting for 15 minutes even though they had not even called at all, just to get free minutes.

GreenMobility is not using dynamic pricing currently, but they will probably start

with yield management towards the end of the year. They want to have a transparent pricing model until the market has matured. They are seeing how competitors are introducing different prices during the day and getting more customer complaints and more confusion among the customers. Giving information about the rush hour etc. will probably help the customers a little bit, but yield management has the real potential to motivate people to drive one hour before or later. Giving incentives is probably the only way to get results from this.

GreenMobility believes that the customers are only using the cars when they actually need them, so introducing dynamic pricing might not have an impact on the demand. If a customer needs a car they want it now and they don't want to wait a few hours just to save a few euro cents per hour. They do believe that their model will include lower prices during the night in the future, however.

They are not currently altering the size of the vehicle fleet to better match the demand, but it will be done in the future. It will be done by looking at the demand over the year and use the cars in other ways during periods of low demand, for example by using them for station-based carsharing.

They have a reservation system that allows the customers to reserve a car up to six hours before they are going to use the car. This is good for business but is not good for the sharing economy model. There needs to be a balance between the cars that can be booked and the cars that are available for spontaneous pickups. If a customer needs a car but there are no cars available in the area, they can get a notification through the app when there is a car available. The most common feedback coming from the customers is that they love the service but they wish that there were always cars available so that they could sell their own personal car. GreenMobility is always working on developing new solutions which can ensure that people get a car when and where they need it.

B.9 2019-04-08, CEO at Stadtmobil

Stadtmobil Rhein-Ruhr was founded in 2009 and currently operates a fleet of around 130 cars, ca. 20 thereof being employed in a flee-floating system in Essen and the rest as station-based cars.

Low costs are important to Stadtmobil and low prices, a main selling point in comparison with competitors owned by car manufacturers, are offered to customers. In addition, an acceptable level of availability is crucial in binding customers; a compromise of these two factors is further essential. The growth of Stadtmobil's offer may not be too fast, as costs would increase as well. In contrast to Stadtmobil Rhein-Neckar, Stadtmobil Rhein-Ruhr focuses on expanding in cities where its CarSharing is already employed rather than expanding to new cities. As Stadtmobil Rhein-Neckar has been in business a lot longer, it has concluded the expansion in its main cities and is therefore looking into the expansion to new cities.

Customers expect a selection of different car types in decent condition and at fair rates. They want cars available at all times, but are often flexible concerning the chosen car type or station. If customers are too often unsatisfied with the availability, they look for alternative services or consider buying their own car. Car ownership is Stadtmobil Rhein-Ruhr's main competition as well as other CarSharing providers such as Car2Go, Drivenow etc. Public transport is not considered to be a competitor to CarSharing; it often does not make sense to rely on one or the other and a complimentary usage is more reasonable.

Stadtmobil's competitive edge is their fair pricing system. Larger providers of free-floating CarSharing often employ a pricing structure that charges quite a high rate by the minute, which is suitable for short trips within the city, but not for journeys that take several hours and then become expensive quickly. Stadtmobil also has a large selection of vehicles ranging from small cars to vans or even convertibles. Different makes of cars are offered to customers so they can choose to drive the brand they prefer.

Stadtmobil looks at how the cars are used on a regular basis and relies on this data for decisions concerning the opening and closure of stations and the allocation of new cars. The focus is put on the places where customers are based, their driving behavior, favorite car brands etc., which is, however, not always straightforward with the current system. There is no way of knowing what customers originally wanted to book, it is only transparent what they ended up using. Stadtmobil's system displays the cars that are available so that customers are not disappointed when their demands cannot be met. Cambio, a close cooperation partner of Stadtmobil, uses a different system where customers enter what they want to book and then receive a response confirming their booking or showing alternatives in cases where the exact demands cannot be met. Consequently, Cambio has more details on customer needs. Stadtmobil is only able to take an educated guess, while Cambio can extrapolate future demands from past experience and data. There is, however, no clear correlation between customer satisfaction and the type of the booking system. Customers attach importance to being able to book a car nearby with as low an effort as possible and might prefer not having to type in their preferences, chosen station etc.

Cars need to be utilized throughout the whole day. A car which is only used by a business customer during their working hours and is not used the rest of the day is not sustainable. Likewise, there may be cars which are only used by private users during nights and on the weekend; in that case, efforts have to be made to increase the usage during the day by attracting business or public users. The acquisition of different customer types is crucial, as customers of the same type generally show a similar usage pattern, which leads to unbalanced demands.

In some cases, vehicle relocations are necessary. If a vehicle is not not being used to a satisfactory extent at one station, it can be moved to another. Cars are kept for three years, so it does not make sense to base a car at a station where it is

not being used. Relocations within a city are carried out by Stadtmobil; if cars need to be moved from one city to another, customers might be asked for help. In general, however, and in contrast to flee-floating providers, or providers that use their customers for taking care of their cars by cleaning them etc., Stadtmobil wants to offer its customers a comfortable service instead of letting them work for it.

Customers appreciate that they can rely on on the stability and predictability of Stadtmobil's pricing, as it is adjusted by 1.5% each year. They further perceive Stadtmobil as one of a few companies wanting to change the city mobility; shareholders envision a future with car-free cities. They would therefore be disappointed if Stadtmobil decided to use a dynamic pricing system and an overly business and sales driven model. Dynamic pricing may be attractive from a business perspective, but often gives customers the impression of a company being only interested in making profits.

Customers generally have fixed plans for the day and need a car at a certain time, so trying to push them to use a car at another time is unlikely to be successful. In cases where cars break down, a previous user returns to late etc. and customers have to be rebooked, they most often want another car immediately even if it requires them to use another station or a different type of vehicle. For most users, the time span during which they want to book a car is fixed. When customers want to book a car, they are shown the available cars sorted by distance The results can further be filtered by type of vehicle. Customers have a need for mobility, and if this need cannot be met satisfactory, they will probably use another service for their next trip. If they are offered decent alternatives, they will most likely continue using the same service and appreciate it.

If there are several cars of the same type at a station, it is very ineffective to let customers choose a specific vehicle, since they might book short trips over several vehicles that could have been consolidated into just one. This would make it impossible to accommodate longer bookings. It is important that the booking system carries out the allocations, so that the car availabilities can be kept high. This is only performed in cases where there are several identical cars of the same model and not just of the same class.

Increasing or decreasing the fleet is a question of cost vs effectivity. Different regions in Germany might have summer holiday during different times, so it might be beneficial to move the cars around to get maximum usage. Vehicles are also sold after the summer holidays and new cars enter the fleet during spring, reducing the fleet during winter. The fleet size is not changed from week to week, however, and customers do not really notice when the fleet is reduced, as this affects predominantly stations with multiple cars