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Investigating the Use of an Online Peer-to-Peer Car Sharing Service

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Abstract. Online peer-to-peer car sharing services are increasingly being used for enabling people to share cars between them. However, our body of knowledge about peer-to-peer car sharing is still limited in terms of understanding actual use and which opportunities and challenges present for those who use them. In this paper, we investigate peer-to-peer car sharing between car-owners and car-borrowers as facilitated by the Australian car sharing service Car Next Door. We conducted a study with 6 car-owners and 10 car-borrowers. Our findings, outlined in four themes, suggest that P2P car sharing fuels different goals for both borrowers and owners. While it is complementing traditional means of transportation car sharing is also in itself a mean of mobility, for example, for recreational purposes. Further, the sharing service plays a central role in supporting the users to make it more convenient to share cars, for example, by letting borrowers find and book cars instantly reducing resources needed to borrow a car. We further discuss our findings and relate it to existing literature providing opportunities and challenges for future research and design on car sharing in HCI.

Keywords: Car sharing; Sharing economy; Mobility;

1 Introduction

Car sharing services enable new and promising ways for car-owners to share their cars with drivers who do not own one [21]. At the individual level car sharing offers the car-owners an opportunity to make money on their car and car-borrowers can get a car at a cheaper price than owning one. On a societal level car sharing offer to reduce the number of privately owned cars on the road [21,34,43]. Car sharing, which is a part of the sharing economy, has in the recent decade become increasingly popular [1]. Observers argue that this development is largely a result of the mediation or digitalization of sharing marketplaces [4,20,24,39].

In HCI research, the sharing economy has sparked an interest in recent years [12]. A number of mobility-related studies focus on applications such as sharing rides and car-pooling, modes of transportation where people can ride together (e.g., [11,33,46]). These studies highlight important aspects such as motivational factors towards making

people participate in the sharing economy but also challenges such as the lack of trust in fellow sharers (e.g., [12,36,45]). Within HCI, car sharing has received little attention. Although areas such as social sciences have provided valuable insights into the use of car sharing, such as highlighting differences between owning and sharing cars (e.g., [9,15,32]), we still lack HCI insights into how emerging services are actually used.

Inspired by similar studies on other sharing economy platforms such as ride-sharing and accommodation, in this paper, we extend previous work in HCI on the sharing economy with an empirical understanding of a specific type of car sharing where cars are shared between car-owners and car-borrowers (P2P car sharing). As such, we investigate how and why people share cars, in which situations they share it, how they reflect on their own mobility, and what role the sharing services have. The research presented in this paper is based on a qualitative study with 6 car-owners and 10 car-borrowers that use the Australian peer-to-peer car sharing service Car Next Door [8]. Our findings, presented in four themes, suggest that car sharing services provide opportunities for both borrowers and owners of cars. On one hand, specific characteristics of these systems provide important support to create efficiency for example by reducing time spent when booking cars. As a result, car sharing is seen as a viable option to many other means of transportation and not just for shorter trips. On the other hand, our findings also suggest challenges exist such as the feeling of alienation for borrowers and owners when face-to-face communication is reduced. This led to a decrease in trust and as a consequence, coping strategies were used such as leaving personal objects to make borrowers take better care of the cars. Finally, we discuss our findings and implications that our findings have for future HCI research and design on car sharing and how it scales up in sharing economy in general.

2 Related Work

Although the sharing economy in general has gained an increased interest in the HCI community in the last 5 years [12], there is still a lack of research on car sharing. In the following two sections, we firstly unfold sharing economy in HCI, and secondly give an overview of the literature on car sharing.

2.1 The Sharing Economy

The sharing economy (with common synonyms such as collaborative consumption [4] and peer economy [3]) that focus on access to goods rather than ownership is becoming an increasingly larger part of our daily lives with an estimated global revenue of approximately 18.6 billion dollars in 2017 [38]. Sharing economy can potentially address the problem of finite resources or shared commons also described by [22] and [5]. Although sharing is not a new concept, observers tend to agree that recent development is largely a result of the mediation of the traditional sharing marketplaces to reach a wider population [4,24]. As the sharing economy has evolved it now includes many different markets a definition has become a matter of interpretation and is not only restricted to sharing between people. As pointed out by Huurne et al. [24], the sharing economy

today remains an umbrella term because it does not refer to a specific market but to different ones which include B2B, B2C and, P2P.

2.2 The Sharing Economy in HCI Research

An increasing amount of research in HCI involving sharing economy that focuses on the digitalization of marketplaces used for sharing. Towards this end, HCI studies focus on finding reasons for the participation in sharing like motivational factors such as sustainability concerns [30,37], belief in the commons [11,37], and social relationships between participants [11,33,46]. On the other hand, some HCI studies raise concerns and report on issues such as privacy and the lack of trust between strangers online (e.g., [10,11,30,46]). Towards this end, some studies also report on challenges such as discrimination and exclusion(e.g., [10,25,33]).

A number of studies focus on existing applications within the sharing economy. Dillahunt and Malone [10] studied how sharing economy applications (e.g., Lyft, Airbnb, and TaskRabbit) can benefit unemployed or financially constrained people. They found a large potential in the disadvantaged communities, although digital literacy, privacy and security were seen as major concerns [10]. A number of papers investigate more specific applications in sharing economy. Towards this end, several papers exist on ride-sharing and car-pooling (e.g., [7,11,18,33,46]). Towards this end, Svangren et al. [46], provides empirical understandings of ride-sharing through GoMore and Facebook. They find that searching for and booking rides can be a complex task that involves leveraging several preferences and combining transportation options. A number of papers also exist on accommodation (e.g., [25,26,30,36]). As an example, Qiu et al. [36] studied the role of how reviews impact trust in Airbnb and find that people's accommodation choices are highly subjective to information such as user reviews.

2.3 Car Sharing

Many years of HCI research have provided insightful knowledge about different aspects of the car, however surprisingly, car sharing in HCI, has received little attention. In this section, we will include literature from other areas to illustrate important findings on car sharing.

Car sharing overview. Car sharing refers to the concept of sharing cars between groups of people. In the literature, the term "car sharing" is often mistakenly used to describe a number of other sharing concepts [14]. However, in car sharing, it is the car itself is shared and is therefore different from other sharing schemes like ride-sharing or carpooling where it is a ride that is shared [14]. The first historical examples of car sharing describe informal and unorganized groups, typically in small communities such as between friends and family [35]. According to Shaheen et al. [43], one of the first attempts of a more organized form of car sharing was a small scale initiative started in Switzerland in 1948, by individuals that could not afford to purchase a car. Organized car sharing has evolved since then, especially since the introduction of the internet, which has sparked many different digital cars sharing services that today serves more

than 7 million users worldwide [1]. Car sharing can seem similar to other businesses like car renting, however, although similarities exist, there are differences such as car sharing typically grants access to cars independent of the time of the day (e.g., users does not rely on office hours to get the keys) [43].

Car sharing as a concept is broad and covers several types of businesses [40], for example, while peer-to-peer (P2P) businesses facilitates sharing between car-owners and car-borrowers (e.g., the company Car Next Door [8]) other businesses fall into the category of business-to-consumer (B2C) where car-borrowers are borrowing cars directly from companies (e.g., the companies GoGet [19] or Zipcar [48]). Opportunities and challenges exist for each business. The P2P business potentially allows for a much greater spatial distribution of cars which potentially is anywhere car-owners live [42]. However, because people own the cars, they must also be returned to their original location after they have been borrowed, a model usually referred to as the traditional or round-trip car sharing which does not always fit into the travel patterns of the borrowers [27]. The B2C business relies on companies managing cars, however, to do this, the cars are often confined to fixed parking spaces or hubs spread across the city. The B2C business allows for different car sharing models such as free-floating car sharing where cars can be returned to any available spot owned by the car-sharing company [16]. The free-floating model has been adopted by several car sharing companies, however, although it is considered more flexible for borrowers it presents more organization overhead for the facilitating company, such as keeping track of cars [2,31].

Car Sharing. Much of the existing research on car sharing focus on the ways it confronts the use of the private car [28]. Investigating the viability and usage of car sharing Duncan [15] finds that sharing cars requires a conscious decision and is often planned in advance. Further, the decision to car share depends on how the fixed cost of ownership is leveraged against the variable cost of sharing and because of this shared cars are used more consciously, for example, instead of a second car for the household [43]. Studies also reveal that car sharing is only part of an ecosystem of transportation options used by sharers. Small-distance trips that are not mundane are often in favor when choosing car sharing over other options [9,32]. Motivation towards car sharing has also drawn interest. On one hand, instrumental or practical reasons such as saving money weigh heavily on the choice to car share rather than owning a car [15,34]. However, on the other hand, some studies show that people who car share are also focused on more intrinsic reasons such as environmental consciousness and value initiatives such as carbon offsetting [9]. Most of the studies conducted focus on B2C car sharing with fewer studies specifically focusing on P2P car sharing. However, while the B2C car sharing has potentials such as cost reduction and efficiency, P2P has other qualities. Conducting expert interviews with experts on P2P car sharing, Shaheen et al. [42] found that besides monetary and environmental motivation to engage in car sharing, providing others with mobility was seen as important to P2P sharers and face-to-face communication in P2P car sharing was seen as important to create trust amongst participants. Studies also find that P2P car sharing has the potential to support wider car accessibility over traditional car sharing [21,41,42] and further improve interconnectivity between other modes of transportation [41].

Research within the computing literature tends to focus on more technical aspects of car sharing. For example, suggestions to improve access control systems [13] or demand modelling [23] for free floating car sharing. However, although car sharing is represented in the computing literature, there is still a lack of HCI studies on car sharing focusing on real-world applications and use of systems which have already been investigated in a number of other contexts within sharing economy (e.g., ride sharing and accommodation).

3 Empirical Study

Although research in many areas has focused on different aspects of car sharing, there is still a lack of HCI research that studies actual applications and provide insights about actual use. Responding to this gap, we have investigated digital car sharing services through a study of people using the service Car Next Door. In this section, we first describe the context of Car Next Door. Secondly, we describe our study method consisting of a three-step approach (gathering initial experiences, conducting interviews and walk through, and participant observations). Lastly, we describe data integration and analysis.

3.1 Study Context

Extending previous work on the sharing economy, in this paper, we present a study of how people from Brisbane, Australia use the P2P sharing service Car Next Door (CND) [8], and how they experience sharing cars. CND was chosen based on their status as one of the few P2P car sharing services in Australia and at the same time have a significant number of users and rentals.

CND is represented in many of the larger cities in Australia, although still a young company with a five-year-old history. The service started in Sydney in 2013, with 20 cars and 60 borrowers. In 2014, they expanded and included Melbourne and in 2017 Brisbane. By 2018 they count over 60.000 members, 1550 cars, and 2000 trips weekly across Australia. CND offers their service through an application for desktop and on smartphone on the mobile platforms IOS and Android. CND facilitates sharing between car-owners and car-borrowers. Cars are spread across town often near the owner's addresses. CND uses a traditional car sharing model where cars need to be returned to the place where they were picked up.

In addition to rational incentives such as offering low borrowing fees and a guaranteed income for owners, CND also promotes themselves on more intrinsic values. For example, they provide a social aspect as they are facilitators of car sharing between people (P2P), and they provide a sustainable aspect as they are investing in carbon emission offsetting through reforestation projects throughout Australia. CND has made a number of choices regarding their platform and includes technological features for both car-owners and car-borrowers. For example, they make sharing more convenient by providing instant bookings that requiring less time to get a car. Every car contains a

lockbox for key handover, a GPS for tracking, a toll tag for automatic toll handling, and a fuel card.

When borrowing out cars, the service does not require interaction from an owner such as accepting bookings as these are automatically accepted. Further key handover is handled via the lockbox which is usually attached to the door of the car. As an extra security measure, the owner can follow the car's location through the app, however, only if the car is returned late. For borrowers, the CND platform offers transparency regarding user ratings and vehicle type, that is, the borrowed car and its ratings will be exactly the same as the one described when they book the car. In addition to regular car borrowing, CND also offers instant borrowing of cars which makes it possible to get a car with short notice. At the pick-up time, the car can be located through the CND mobile application where the GPS module provides an exact location of the car. When the borrower picks up a car, the car keys can be acquired by entering a provided pin code from the mobile application into the lockbox without face-to-face communication. Before and after the trip, borrowers are asked to take pictures of the car using the CND mobile app to document damages made before and after borrowing the car.

3.2 Study Method

In this section, we describe our study approach consisting of three methods. Firstly, we gathered initial experiences. Secondly, we conducted interviews and walk-throughs with car-owners and finally, we observed and conducted interviews with car-borrowers.

Gathering Initial Experiences. Initially, we conducted an exploratory investigation with the purpose of creating interview guides for owners and borrowers for later interviews. The first author booked and borrowed three cars through the CND mobile app. Different makes and types of cars located in different places in Brisbane were selected. For the first booking we borrowed a small size Holden Barina located in the center of the city, the second was a mid-size Toyota Camry located in the suburbs, whereas in the last booking we borrowed a large size Mitsubishi Outlander also located in the suburbs. We borrowed the cars for different periods of time. We borrowed the first car for two hours to go grocery shopping, the second car for a day to go to the nearby mountains, and the last car for a five-day period to go on a road trip. The experiences were documented in researcher notes and images. Most of the documentation was created at the time of the booking, pick-up, and drop-off point as most interaction occurs at this time. The first author shared his knowledge and notes with the remaining authors which lead to the creation of two interview guides used for semi-structured interviews [29] with owners and borrowers. Interview guides were based on Yins [47] four question forms (*how, what, where, why*).

Owner Interviews and Recalling Bookings. We explored car sharing from an owner's perspective by conducting semi-structured interviews with 6 owners. Through cooperation with CND we had access to their user email list that contained all users in and in the near vicinity of Brisbane, Australia. We deployed a questionnaire to all owners in

the area asking if they were willing to participate in interviews. For sampling purposes, the questionnaire included questions about age, gender, address, number of cars in the household, number of cars on CND, and the number of times their car(s) had been borrowed out in the last three months. The questionnaire resulted in 7 candidates that were sampled based on an even distribution between questionnaire questions. Candidates was emailed asking to participate of which 6 participants replied and were recruited. The six owners were between 26 and 69 years of age (M=44.3) and equally distributed between male and females. Three owners lived alone, and three lived in families consisting of three, four, and six members. Four lived in houses and two in apartments. Owners had borrowed out their car between three and thirty times in the last three months and had been members of CND between four and fourteen months. Three had an additional car and three only had one car. To get a more in-depth understanding of the booking process from the owners' perspective, before the interviews, we instructed them to write down a short description of their specific actions and thoughts when receiving a booking such as checking out borrower information, rescheduling bookings, and checking payments. The owners were then instructed to bring these descriptions with them to the interviews. If no bookings were received before the interviews, we asked them to recall the last booking that they received. Interviews lasted between 45 minutes and 1 hour and were recorded on audio. In addition, researcher notes were also taken. This resulted in a total of 4,5 hours of audio and 8 pages of researcher notes.

Borrower Interviews and Observation. We explored borrower's perspectives by conducting semi-structured interviews with 10 borrowers. With an email list supplied by CND, we recruited borrowers through a questionnaire deployed to all borrowers in and in the near vicinity of Brisbane, Australia. The questionnaire was targeted borrowers who had borrowed a car at least once. For sampling purposes, we included questions about the number of cars borrowed in the last three months, if they owned another vehicle, and how many times a month they drove a car. The questionnaire yielded 21 answers from borrowers of which we selected 10 participants based on a distribution from questionnaire questions. The recruited borrowers (five female) were between 22 and 59 years of age (M=40), and all lived in urban areas (e.g., city centers and suburbs). They had borrowed a car between one and six times within the last three months and had been a member of the CND service between five and eighteen months. Seven borrowers lived alone, three lived with their partner or families. Six borrowers were living in houses and four in apartments.

We asked the borrowers to give a short description of their last booking. We instructed them to give a short description of actions and thoughts such as looking up car and owner information, important booking criteria and reasons for borrowing. We further asked borrowers to bring their mobile phone for the interviews so that they could show us examples of how they booked a car. Owner interviews lasted between 45 minutes and 1,5 hours and were recorded on audio and in addition researcher notes were taken. This resulted in 10.5 hours of audio recorded and 20 pages of researcher notes.

3.3 Data Integration and Analysis

A total of 15 hours of audio and 28 pages of researcher notes was transcribed, anonymized and coded separately for thematic analysis [6] by two of the authors. Firstly, we familiarized ourselves with the data by reading the transcriptions several times and specifically looking for use of the sharing services. We then identified suggestions for codes (e.g., "*convenience*"). Secondly, we generated codes to interview quotes (e.g., the code "*mundane car sharing*" for the quote "*Often I just borrow the same car down at the corner, I know all its quirks and I know the price. Besides I'm just getting the groceries and there's a limit towards how much time I'm willing to put into it*"). Thirdly, we generated and reviewed themes using affinity diagramming, where quotes were put on a bulletin board and reorganized into themes over several iterations. As a final result of this, a set of four themes emerged.

4 Findings

We found that the car sharing service investigated in this paper (CND) was a significant contributor towards car sharing for both owners and borrowers of cars in a number of ways. In the following sections, we outline our findings in four themes describing opportunities and challenges associated using P2P car sharing. The four themes are; *Fueling Individual Motivation, Supporting Daily Mobility, Facilitating Car Sharing Purposes,* and *Socializing P2P Car Sharing Services.*

All data presented have been anonymized. We distinguish between owners (**O**) and borrowers (**B**) and refer to each participant by an index like **O1** as owner one and **B5** as borrower five. Occasionally we refer to the number of participants behind a finding, for example, (8/10) is eight out of ten borrowers and (4/6) is four out of six owners.

4.1 Fueling Individual Motivation

To some participants, rational motivation such as earning money of their assets was a motivation for car sharing, and to others. To others, ideological motivation such as reducing their carbon footprint was in focus. In the following sections, we describe the individual goals achieved through the platform for both borrowers and owners.

Utilizing Unused Assets and Environmental Awareness. For most owners (5/6) the primary motivation for car sharing was bound in rational motivation such as utilizing unused cars, while one owner's primary motivation was more intrinsic as he felt like he was helping others. All six of them had at least one car that they used rarely and many of them found that sharing this car through CND would justify their ownership. Although owners were annoyed with own an unused asset, the car was generally perceived as necessary because of flexible mobility needs where alternative (public) transportation means didn't always suffice. As such, several of the owners (5/6) were initially attracted to having an extra income from using CND. Some of them (3/6) had considered alternative solutions like selling their car, however the perceived extra value of owning a car along with the possibility of losing money kept them from doing selling

it, for example, one owner mentioned that after having purchased a new car, altered personal living arrangements made the car less needed and used, as he argued this way:

> *"I moved here recently from Sydney. And so, because I live and work in the city my car is basically in my carport just carrying rust. And because it is quite new, I was looking at different options because I didn't want to lose money by selling it"* **(O3)**

Most owners (5/6) also articulated a strong environmental awareness and car sharing made them reflect upon their own behavior and driving needs, for example one owner that had started cycling instead of taking the car every day: *"I mean now that I don't use my car I have started to cycle again, which has made me less depressed about the world and the problems that cars impose on the environment"* **(O4)**. Seven of the ten borrowers also mentioned environmental concerns was something that motivated them to car share. Further, almost all borrowers (9/10) mentioned, like some of the owners, that they felt more comfortable giving money to a company that they perceive as being facilitators of relationships amongst people, which they perceived CND to be, and not just in it for the business:

> *"It's partly price, and partly ethos. I would much rather borrow from a company that I trust is not just taking my money, and that is very good at one thing and is based on a relationship with people versus a bigger company that is a business of sharing or renting cars"* **(B4)**

Convenience and Helping Others. Mentioned by both owners and borrowers were the convenience that CND handled issues that otherwise would add complexity to car sharing (e.g., finding cars, insurance, communication, and payment). Convenience was a major motivational factor for the borrowers in relation to car sharing. All ten borrowers articulated that they could not completely live their lives without the use of cars, because alternative transportation forms such as buses or bikes could only satisfy some of their needs. Many of them (7/10) lived in the inner city with limited needs for daily car transportation. Here they had access to many public transportation options and bike lanes, and as a result, these seven borrowers did not own a car. The three remaining borrowers were living outside the inner city, however, still near their workplaces and did therefore not need a car on a daily basis. However, sometimes a car was needed for going out of the city or driving a long distances where other transportation types were insufficient. All ten borrowers found car renting using CND convenient as an easy alternative to get a car when they needed one especially because of cars being distributed across town, for example:

> *"... opposed to rental companies where you have to go to a place to pick up the car and do a lot of paperwork ... with this service, in less than 5 minutes, I can in most cases, find a car, book it, and pick it up"* **(B3)**

Community building was also found important for both owners and borrowers when using car sharing, and many of them felt that they, in fact, helped others from their community when either renting or renting out a car. In fact, one of the primary reasons for using a peer-to-peer car sharing service like CND was that sharing was between people rather than companies owning the cars. Owners stressed a personal feeling as-

sociated with the sentiment of helping those in need, i.e. people without a car. For example, **O2**, who were the one with the most borrowing of his car, explained that he started to car share to help others: *"I think that a lot of people is in a financial position where they can't afford a car and we are in a position where we can supply one, that just makes me feel good"* **(O2)**. Complementing this perspective, five borrowers mentioned that contributing to a community and the feeling of helping other people were reasons why they sometimes maintained borrowing a car:

> "*In my own imagination, I felt good about the fact that I'm contributing, that's why I keep doing it, I think. I know that he or she might be an oversee student and probably have the need for her car at the weekend, but it helped me feel good about myself. I felt in that case that I was helping this person because they were going to get some of my dollars*" **(B6)**

4.2 Supporting Daily Mobility

Both borrowers and owners expressed the need to use many different modes of mobility to support their daily trips and that it required some degree of flexibility in order to be able to car share. The following sections we describe the reasons for choosing car sharing and some of the requirements for being a car sharer.

Transportation Types. We found that borrowers had a number of transportation types that they mentioned as being available to them and that they had to consider actively when going on a trip. Often public transportation, biking, or walking would fulfill their commuting needs for going to work or on smaller trips. However, these transportation forms were also perceived as impractical when carrying physical items like groceries. In such situations, the borrowers would consider renting or borrowing a car. As an alternative, some participants (5/10) mentioned that they had used taxi and ridesharing services. Although these services were perceived as convenient - the car would come to them and not vice versa – the borrowers also stressed that this depended on the specific trip, for example, it wasn't very well suitable for transporting larger or more personal pieces of goods:

> *"It's a choice depending on the trip. Sometimes I take a taxi or an Uber if I'm in a hurry and just have to go and see my friends in town. I don't think it's very suitable if you want to go shopping or want to just move some stuff. It's really only suitable for one-way stuff. For example, I don't want to be stuck outside the store, waiting for a cab. Then it's much more convenient to get a car"* **(B10)**

Public transportation and taxi services were not seen as a viable alternative for trips like freighting larger goods, driving long distances, or going doing something extraordinary. For such purpose borrowers would, therefore, prefer to rent or borrow a car. In contrast to car sharing, car renting was seen as an expensive alternative even though some participants would use it from time to time. Most borrowers agreed that car sharing in some case were more practical over rentals because of price and distribution of cars instead of having to go to an office. Alternatively, if borrowers needed to borrow a car and it

was beyond walking distance some borrowers (4/10) articulated that they would combine different transportation types which also meant planning and comparing them separately on each individual service:

> *"Sometimes, if you really want a specific car and you need to travel a bit to get it you need to find other means of transportation to get it. One time I had to take a train and then a bus to get a car, it was quite tedious because I had to compare departure times manually on each service. That would have been easier if CND would provide me an overview of the different transportation options instead"* **(B1)**

Flexible Car Ownership. Occasionally owners would need to use their own car which they all believed required a degree of flexibility. Some (3/6) would book their own car and block out times on the service well in advance, while others wouldn't block out times unless it was absolutely necessary as they wanted to get as many bookings as possible. Most owners (5/6) had previously experienced unavailability of their own car in a situation where they actually needed to use the car. In those situations, they were forced to arrange other transportation forms. Interestingly, in relation to this, car sharing actually triggered self-reflection towards own transportation needs. Several of them (4/6) commuted to work using public transportation, a bike, or walking. Many owners said that before they began to share their car, they had often taken the car to work because it was seen as easier or as a subconscious choice than having to deal with alternative transportation. Joining CND however made them reflect on their actual needs:

> *"Car sharing requires a degree of flexibility, that's just embedded into it. There have been a few times where we have let the car be rented and haven't thought about it, it's not until a few days before that we think oops, we've got this on and we need two cars, but then I just use a taxi, or we can just work around it. It's good because it makes you think about your options"* **(O3)**

Also sharing in the household was seen as requiring flexibility which was not always shared. Some owners (3/6) expressed that they were more interested in sharing their car than the rest of their household and were motivated by different things. Owners living with a spouse and children expressed that the other family members often didn't share their enthusiasm about car sharing The reason was that even though the rest of the household thought that sharing was a good idea, they were less interested in being flexible partly because of the requirement to find another mean of transportation if their car was unavailable: *"We have four cars and we could easily make do with only two, but my wife and I are very different in terms of sharing and flexibility. She wants a car she can access and drive all the time, whereas I am much more inclined to work it out, but CND doesn't help you with it"* **(O2)**.

4.3 Facilitating Car Sharing Purposes

We found that borrowers used car sharing for many different purposes which can be categorized as ad-hoc and planned car sharing. In the following sections describe the specific purposes that car sharing is used for and how it is facilitated by CND.

Ad-Hoc Car Sharing. Borrowers typically rented cars for mundane purposes to support typical day-to-day transportation needs, e.g., grocery shopping. We saw a clear preference for getting a cheaper, and also older car, for these purposes. Such trips could often only be planned ad-hoc and were last-minute bookings. None of these borrowers exclusively used car sharing for mundane purpose, however, choosing car sharing over alternative transportation options was mostly associated with convenience and what is right for the moment: *"Now and again I find the kids want to go and do something and it's a little bit of a stretch on the bike and the city is not well set up for cycling, and there are some roads that I won't take the kids to … it's just sometimes easier to borrow a car"* (**B6)**. Ad-hoc planning and easy access to cars were important in such situations, and in case no nearby cars were available, they would often consider other transportation options or means:

> "*I got called into the hospital one day at 2:30 am, no public transport. I checked Uber, but there were no Ubers around, so it would be like 30 minutes. We had patients and I had to get there very quickly. I checked Car Next Door and the car that I normally take was available for the couple of hours that I needed it and I booked it and within seven minutes I had a car and was on my way to work. I work with humans, they will always come first, and just having that nearby made a huge difference in my ability to provide care. I came back and dropped the car off and I just walked home. It was brilliant"* **(B5)**

Interestingly, we found that borrowing cars for mundane purposes and smaller trips would often result in borrowers attempting to rent a previously rented car. Several borrowers (5/10) reported that they had borrowed the same car near to them several times to save them the time of finding a new one: "*Often I just borrow the same car down at the corner, I know all its quirks and I know the price. Besides I'm just getting the groceries and there's a limit towards how much time I'm willing to put into it*" **(B10)**. We found that reasons such as it was close by, were important for choosing car sharing over other transportation options. However, also important was familiarity with the car such as its location and its condition, in particular when going for a quick or short ride. To support these trips, we found that instant bookings were appreciated and perceived as necessary by the borrowers.

Planned Car Sharing. While mundane mobility needs were prevailing, borrowers would occasionally rent cars for extraordinary or special experiences, like renting an exclusive car, going on holidays, or on weekend trips outside the city. Our interviews revealed that many of these trips were for longer periods of time which indicate more use of car sharing than borrowers using it primarily for day-to-day trips. Opposed day-to-day trips, these were often planned well ahead and borrowers would often use the car sharing service to browse cars because they liked the experience. Several borrowers (5/10) mentioned that they used car sharing as a way to achieve extraordinary driving experiences by borrowing a more exclusive car than their own or a car that could impress others. Interestingly, we found that especially transparency in the service, where borrowers could see exactly which car they would get, the associated expenses, and the location was perceived as important for choosing car sharing:

"Yeah, because on CND you always can see which car model you will get, whereas all the usual car companies will just say this or similar, so you never really know what you will get most of the time" **(B6)**.

Compared to day-to-day car sharing, borrowers were willing to put more resources into getting a car for a longer trip and would accept higher prices or going further to pick it up: *"I mean realistically if someone had one of those for hire (a Smart convertible) I would probably go an hour to pick it up. And even if, I don't know, $250 a day of something"* **(B6)**. Several borrowers (6/10) mentioned that they had or thought about borrowing a nicer car just for fun and for showing off for friends or family. We found no preference for car age, as this mode was mostly associated with getting experiences, which could be from an older car as well as a new one. For example, **B1** mentioned that she had arranged to borrow an older convertible with her sons and going for a trip along the coast. Experiencing cars could also be associated with easing into car ownership. We found that two of the borrowers (**B2**, **B10**) knew that they had to buy a car in the future and therefore was trying out car models to see which one they liked the most.

4.4 Socializing P2P Car Sharing Services

Both borrowers and owners expressed that they were engaged in car sharing and were considering it actively in their daily lives. For example, to borrowers, the ability to access a car instantly was important and for owners the ability to not have too much interaction to borrow out their cars were important. However, the choice from CND to reduce this overhead from users also resulted in challenges

Efficiency vs. Interacting with people. One reason for many borrowers and owners using CND was the reduced overhead of not having to think about bookings, who borrows the car, who borrowed it out, the handling of practical things as payment were mentioned as a contributor towards using a service. All participants agreed that these things were best handled through the service and many participants mentioned that the complexity of handling these issues was too much for them if they were to handle it themselves, and thus, outsourcing this complexity to the service made car sharing a viable option for them in their otherwise busy lives: *"I think the service is really important, because without that I would worry too much, for example, about who borrows my car and if he will damage it its simply too complex, with the CND I know there's insurance so there's no risk in it for me, so in a way you could say that I've outsourced that part*" **(O3).** We found that many owners believed that too much management would simply exclude some borrowers because they would worry them too much and start looking up borrowers on the internet. For example, one owner mentioned that getting to know the person who borrows their car would simply start too many thoughts and be too complex for him and he, therefore, relied on CND to take care of it:

"My mind is so analytical and if I had to manage every booking myself then I'm going to think about what will happen if this person crashes my car and this and that. I don't have time for that. So, in a way, I'm outsourcing the job to Car Next Door" **(O3)**.

Most borrowers (7/10) shared the same opinion as owners. Part of them wanting to keep communication to a minimum with the owner was to avoid the feeling of guilt and owner's reactions, for example if they called about car damage: *"The service is critical, I wouldn't have started with borrowing if I didn't know that CND has my back if something happened. I always call them if there is a problem. Imagine calling the owner and telling him that his car is broken. I would avoid that conversation because it's probably not going to be very pleasant"* **(B4).** Interestingly, and quite opposite, not all borrowers thought this way. To them (3/10) not having any communication between owners and borrowers was expressed as alienating and that the only connection between them was the car and as expressed as somewhat odd because usually them wanting to put a face on the one they were borrowing from and not only a profile picture from the app:

> *"In a way, I would like more interaction with the people that I'm borrowing from. I have some information about the person, I can find that the app and that is fine, but it is a little bit alienating. For example, there is this one woman that I'm borrowing from quite a lot, but I have no connection with the person except via the car, I find that a little odd because I would like to thank her personally"* **(B6)**

Cars as personal items. To several borrowers (8/10) a borrowed car was a personal item, important to the people owning them, and therefore they took extra good care of it compared to rentals:

> *"It's interesting you know, I never take particularly good care of rentals, but I always take extra good care of the cars that I borrow. The fact that it belongs to people makes me want to take extra good care of it I suppose"* **(B7)**

Interestingly some owners (3/6) tried to facilitate this as they believed that they needed not only to provide a car but also provide a good experience to borrowers especially due to the lack of face-to-face communication. Towards the owners had started to personalize the experience by leaving small items of personal value in the car to make borrowers feel a little more at home and to make them feel less like a stranger in someone else's car. This was seen as a less resource demanding action however still adding to the borrowing experience. For example, **O1** who often left candy and her CD collection in the car and **O5,** who often left a personal note and mints from her to the borrower in the car. Further, personalizing the car was seen as a mechanism to prevent damage:

> "*I always leave a little note and some mints in the car and just say, you know, that I hope that they enjoy our car and have a great trip or whatever. Although CND offers me some security by offering me insurance for damage, I don't want the hassle of sorting that out after it's happened. They are borrowing something that is a value to our family and if you can humanize that experience for them you might catch it before by them taking a little bit better care of your car*" **(O5)**.

Borrowing a car containing a few personal items were a positive experience and that a car feels more personal if it contains the owner's items which could lead to affection towards the vehicle. For example, borrower mentioned that his son was so familiar with a particular car both because they had borrowed it several times and because it contained some personal items familiar to him that he had given it a name: *"We've borrowed the same car a couple of times, and you know what, my son gave it the name*

Bob, because previously we had this car named Bob, and the new one reminded him of it because we had some of the same items in the car. So, in a way, you could say it became a part of the family which also made us take better care of it" **(B4)**.

5 Discussion

Our study highlights several interesting aspects of P2P car sharing enabled through the digital service Car Next Door. For example, individual motivation and synergies between car sharing and alternative transportation forms can be highlighted as important.

Adding to these finding, in the following sections, we discuss considerations that we hope may inform and inspire further HCI research and design on car sharing.

5.1 Beyond Individual Modes of Transportation

In itself, car sharing provided transportation for many of our participants in their everyday lives. However, there were also a plethora of situations where car sharing was not perceived as being practical, for example, travelling the inner city to go to work. Car sharing has the potential to improve interconnectivity between other modes of transportation [41] however, a clear challenge is to know how and when to combine it sequentially with other transportation in order to do so. With regards to this, we think it is important to consider car sharing as part of a larger transportation ecology used by people. Ecologies are also suggested by studies of other areas of transportation available in a larger ecology where users combine the different options to fit their needs (e.g., [9,32,46]). Therefore, when complementing other mobility types car sharing fits into the daily lives of users and not the other way around. We argue to study car sharing as part of an ecology further, for example by drawing on inspiration from the literature describing fundamental interactions in ecologies (e.g., [44]).

One way of designing transportation ecologies could be letting them make an informed choice from a number of transportation types (e.g., bus, train, and car sharing) and letting them know when it is opportune to choose car sharing over other types. Further, going beyond choosing one specific transportation type is the opportunity for continuous [44] transportation where users can combine different types of mobility to form a larger trip. The opportunity to not only integrate other transportation types, but also other modes of car sharing services. We must remember that car sharing, and especially the type of car sharing we investigate in this paper (round-trip P2P), only provides one of many alternatives for users. For example, although our participants had said that they didn't use any other sharing services, it wasn't an active choice and they were definitely open towards open for other types like one-way ride sharing. We argue that research and design along these lines could be beneficial for the sharing services to support mobility.

5.2 Supporting Ad-hoc and Planned Car Sharing

Our insight provides a dimension towards P2P car sharing, that is, ad-hoc trips which can't be planned in advance and further for purposes like getting groceries or commuting to work. This is different from many studies that suggest that borrowing cars are associated with smaller trips planned in advance (e.g., [9,15,32]), Interestingly, this describes a new and different dimension than what the literature provides. Ironically this can seem counterintuitive, that borrowers can borrow a car from an owner with little planning ahead. We argue that finding can largely be ascribed to the choices made by CND to make their platform more effective by reducing the amount of coordination between parties involved in sharing a car. Features increasing efficiency, such as instant booking, not having to interact with an owner to get the keys, and the large distribution of cars around town, which the CND platform supports, is closely related to the purpose of getting a car ad-hoc. However, although we think that designers should consider these mechanisms if aiming to support ad-hoc P2P car sharing, we see a need for further research to understand its potential.

Another insight from our findings is that car sharing often is associated with booking a car for a short period of time (e.g., [21,42]). However, our findings also suggest evidence for car sharing being used for longer trips, that are mostly related to experiences or recreation. Interestingly, efficiency and planning become less important for borrowers of cars for these types of purposes. Based on our findings, it seems like supporting getting a car for experience or recreation requires an amount of transparency where a borrower can browse cars and get exactly the one wanted. Further, the experience of browsing through a number of options matching many and diverse cars available through a P2P platform is equally a part of the experience which reflects in our participants' willingness to travel a further distance or pay more to get the car. Besides this seemingly unique aspect of the design of P2P car sharing over other service schemes, we argue that this also presents researchers with an opportunity to inquire such uniqueness of P2P services, one that potentially could be a challenge for other services (e.g., B2C) where a more uniform car park could be preferred.

5.3 Coping Strategies and Social Car Sharing Services

What happens to trust when face-to-face communication is removed from a service? We found that borrowers took particularly good care of the cars they borrowed, mainly because of the feeling that it was a personal item to another person. This was facilitated by some owners that placed small personal items in the car to ensure a more personal experience and thus making the borrower take better care of the car. This is interesting from a trust perspective as it seems that traditional coping strategies (e.g., insurance) is not quite enough as owners still recognizing that damages happen and wanting to avoid the whole scenario of having to deal with the insurance. Trust between people is especially important and is one of the pillars in the sharing economy [4]. Trust is especially important in car sharing, where the shared object is of high personal value to many people. Shaheen et al., amongst other mechanisms for ensuring trust in P2P car sharing and finds that face-to-face communication is perceived as increasing trust and helping

borrowers not damage cars [41]. Towards this end, CND does not provide the feature of face-to-face communication and we do think that they were quite happy about this choice as it saved them time. However, this also meant that some owners employed their own coping strategy to ensure that their car would not get damaged. Alternative coping strategies towards ensuring trust that the P2P services does not provide needs further exploration as it could give inspiration for future designs.

Car sharing can be seen as a way of utilizing existing resources which might fuel motivational desires as a contrast to acquiring new resources. This also goes well in line with the idea of utilizing the commons [5,22]. One aspect is peoples' individual goals that in our findings both revealed rational (e.g., earning an additional income) and intrinsic (helping others and socializing) motivation. Rational and intrinsic motivation has been investigated before in P2P car sharing. As such, Shaheen et al. [42] reports on borrowers and owners motivation and finds that earning money and convenience as a key motivational factor and further, although less important, helping others gain access to a vehicle. Although acknowledging this finding, interestingly, we also found that for some participants this relationship was flipped around by showing helping others as a key motivation. We think that this relationship highly reflects and can be attributed the nature of P2P sharing which seemingly is one reason why our participants chose CND as a service along with the fact that P2P car sharing was believed to be creating relations between people and was thus seen as "less evil" than other car sharing types. Our results indicate that while some aspects of optimizing a service are valued as a mean to actually share, other more intrinsic motivational aspects such as maintaining relationships between people. The aspect of social services can be an interesting dimension for designers and researchers to explore for reaching people that thinks that social values are also important. We think that car sharing is ideal to provide a clear and lucid setting [17] for such investigations, although it might scale up in all aspects of the sharing economy.

6 Conclusions

This paper has presented a study on the use of P2P car sharing services. Through a study with 6 owners and 10 borrowers using the service Car Next Door, we identified 4 themes that describe different aspects of car sharing. Our findings reveal that P2P car sharing is convenient for many participants by allowing them to utilize unused assets and helping each other out. The service explored is used for different purposes supporting ad-hoc and planned trips which allow users to complement existing transportation options at hand. Lastly, it was seen as convenient that Car Next Door provides an efficient way to car share by allowing instant bookings and getting the keys without interacting with an owner. However, the lack of face-to-face communication was in some cases perceived as alienating along with reducing trust in the people borrowing although coping strategies were identified.

To inspire HCI future research and design of sharing services we discussed three themes to serve as an inspiration to researchers and designers of car sharing services. Firstly, we have discussed that car sharing is part of an ecology of transportation options

and how this perspective can be used in the design of new services. Secondly, we discuss how ad-hoc and planned car sharing can be supported and considering the uniqueness of the P2P systems. Thirdly, we argue that P2P services are social car sharing services where alternative coping strategies are developed to handle trust when face-to-face communication lacks.

Our study has some limitations. Firstly, we have only recruited participants living in cities that were already using Car Next Door. We acknowledge that other participants could have been interesting in our study, for example, those who had deselected the service or potential users such as disadvantaged populations. Secondly, we have chosen a peer-to-peer service, however, we do acknowledge that other services exist different from the one we studied. Thirdly, car use and opinions vary depending on location, and so, carrying out a similar study in a different location, such as in another country, could yield different results. Finally, our results provide qualitative insights which are not generalizable across a wider population. As such, we acknowledge that other methods are required to provide statistical generalizability.

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