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Comfort First! Vehicle-Sharing Systems in Urban Residential Areas: The Importance for Everyday Mobility and Reduction of Car Use among Pilot Users

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Abstract: The aim of this study is to explore to what extent a vehicle-sharing system (VSS) that includes electric bicycles and cars, connected to a block of apartments in a middle-sized city in Sweden, can cater for individuals' everyday mobility needs and reduce the need to own a car. The study connects to two different research areas: the usage of VSS and mobility transitions through pilot projects. Our results show a reluctance to voluntarily sacrifice comfort regarding everyday energy use. Owning and using a private car is to a high degree interpreted as convenient. The results from this study suggest that a VSS has the potential to satisfy mobility needs for people living in urban areas. However, in order for it to be successful, both in terms of satisfying mobility needs as well as being regarded as an attractive alternative to private car ownership, we argue that reconfiguration of modal choice and accessibility on different sociotechnical levels is a necessity. Interventions such as satisfactory public transport and better infrastructure for cycling and walking are suggested, as well as stricter parking regulations, banning cars in certain areas and making car use and ownership more expensive. In other words, the deployment of both soft and hard measures in combination is necessary.

Keywords: vehicle-sharing, bicycle-sharing, residential vehicle-sharing, pilot users, demonstration projects, travel behaviour, everyday mobility

1. Introduction

The ongoing trend of densification in cities is aimed at creating attractive and sustainable urban environments. In dense areas, the conditions for a wide range of services and activities are good, and vehicles that are more space- and energy-efficient than the car can be used [1]. At the same time, places for work, shopping, sports and leisure activities, are often located outside the inner city in car-friendly areas, and the roads within and around inner cities are heavily used [2,3]. Frequent car use is motivated by its ability to meet individual transport needs, since it often offers more rapid and flexible transport compared to walking, biking and public transport [4]. Households owning one car or more tend to use the cars for most of their journeys [5]. However, cars are parked about 95 percent of the time, which is why there is an overcapacity of vehicles in cities [6]. It is therefore important that densification is followed by significant efforts to reduce private car ownership and to offer mobility alternatives that are attractive and provide good alternatives to car ownership.

Recently, the introduction of mobility services has been framed as a possible radical solution to excessive car use and ownership [7]. Vehicle-sharing systems (VSSs) provide an example of such services, and can include bicycles, cargo bikes (including e-bikes) as well as electric or/and conventional cars. The addition of digital components makes it possible to search for, get access to

and unlock the vehicle with smart phone applications, which facilitates sharing. The implementation of VSSs (often bike-sharing) has increased in cities all over the world during the past decade and is expected to have a large impact on sustainable mobility development in urban areas. VSSs are frequently included in a wider urban planning strategy, often highlighting changed parking norms, to densify and reduce the number of parking spaces. Collaboration between construction companies, property owners, housing associations, municipalities and private actors has been pointed out as crucial to develop well-functioning concepts [8–10]. VSS and BSS (Bike-sharing systems) are often set up in pilot projects which reflects a recent trend of viewing cities as innovative sites for sustainability transitions [11,12]. State- or/and privately funded demonstrations, test-beds, living labs and experiments targeting "smart mobility" are expected not only to enable new radical innovations to grow [13–15], but also to "push" or "nudge" users in to more sustainable behaviour [16]. While the literature on smart mobility governance is still emerging, issues of VSS usage have been investigated in previous research for some years. However, how VSSs can be developed and consolidated in different contexts, and how they are received by the intended users, pose urgent research questions.

During the last decade, research has focused on vehicle sharing systems from a variety of perspectives. Several studies are concerned with practical functionalities in the implementation of VSSs, such as the location of bike stations [17], and charging stations for electric cars [18]. Moreover, researchers have modelled the optimisation of the location and number of bicycle stations [19–21]. Another area of research concerns users' experiences of the systems. Important motivators for participating in VSSs or using such services are curiosity, convenience, flexibility and economic/value motivations [22,23]. Concern for the environment has been shown to be a weak motivator but is an important bonus for the users. In an overview of shared mobility, Machado et.al. [10] found that many users of mobility services are environmentally concerned and familiar with technological devices. The authors highlight that users put high demands on reliable, flexible, available, attractive and comfortable transport solutions that are not too expensive. They conclude that mobility solutions alone cannot solve urban transportation problems but are one way forward. Fishman, Washington, and Haworth, [24] state that in order for BSSs to be an attractive alternative to the car, the systems must enable a reduction of travel time and be convenient for the user. Börjesson Riviera and Henriksson [25] explored a trial with providing access to a cargo bike pool in a housing association in Sweden. The results show that a cargo bike pool can facilitate a car-free life, although many of the users expressed a desire to live a car-free life, already before they joined the trial. How a similar offer would work for people who are not already convinced of a car-free remains to be explored. According to Fyhri and Fearnley (2015) [26], e-bike use increases with time, indicating a learning effect among users. However, it has been suggested that private bikes provide greater freedom, comfort and convenience compared to public bikes [27]. In a review of BSSs development in four continents, Shaheen, Guzman and Zhang (2010) [28] conclude that the increased number of BSSs has resulted in reduced car use, increased bike use for everyday mobility and a growing perception of the bicycle as a convenient transport mode. The authors state that more research is needed on the environmental and social benefits of bike sharing. Fishman et al. [29] have shown that an important barrier to use BSSs is when docking stations are too far from home, work and other frequently visited places. Similar findings were made by Bachand-Marleau, and El-Geneidy (2012) [30] in a study of BSS in Canada. They found that people are more likely to use the systems when the docking stations are near to home. The authors suggest that an increased number of docking stations in residential neighbourhoods has the potential to increase usage of BSS. It is our assumption that if VSSs are located in residential areas, and even in the garage of multi-family housing, and easily available to the tenants, it could be a more attractive solution than docking stations far from home. The main objective of residential VSSs is to provide tenants with a fleet of mobility opportunities in combination with walking and public transport, and consequently reduce the need for privately-owned cars. However, VSSs for tenants within residential areas is still a relatively new phenomenon. Under what circumstances residential VSSs can offer accessibility and contribute to modal shift is therefore still unclear. Furthermore, most previous studies have focused either on bike-sharing or car-sharing, while access to a combination of different vehicles, including public transport, has

typically not been investigated. This study attempts to contribute to filling these knowledge gaps. The aim of the present study is to explore to what extent a VSS with electric bicycles and cars, connected to a block of apartments in a middle-sized city in Sweden, can cater for individuals' everyday mobility needs and reduce the need to own a car. The study contributes with knowledge of how diversified VSSs in residential areas can be designed to reduce the need for fossil-fuelled, privately owned cars.

Of special interest for this paper is that participants in experimental settings are often described as "lead users" or "innovative users", reflecting a vast body of management and innovation literature [31,32]. Innovative users are described as active, and how they modify, redesign and improve new energy-efficient services or technology are highlighted [33]. Nyborg [34] argued that traditional management literature pays little attention to how the meaning and use of artefacts and innovations are context-bound. Building on Nyborg, this study contributes to a wider understanding of "pilot users", where their everyday practices and material surroundings are highlighted. While Nyborg, as well as a significant proportion of related research, is empirically interested in smart grid solutions, we shed light upon VSSs in residential areas. We specifically provide insights into how pilot users influence and adjust their everyday mobility practices when given access to new mobility solutions. This framing highlights travel behaviour and modal shift and calls for an activity-based mobility approach.

The paper is structured as follows. Initially we introduce research perspectives that contextualise and positions the study within the field of mobility research. That is followed by description of data, method and analysis. The subsequent section presents the empirical results, followed by a discussion of how VSSs can be integrated into the everyday mobility arrangements of individuals and contribute to sustainable mobility in dense cities.

2. Travel behaviour and modal shift

Research on travel behaviour and modal shift has been undertaken in several research fields, with approaches such as mobility biographies [35], trajectory-based studies [36], social practice analysis [37] and stated and revealed preferences [38,39]. In the literature, travel behaviour has often been explained by individuals' habits, norms and attitudes [40,41], as well as being affected by factors that lie beyond the individual's immediate control, such as the build environment, availability of transport modes and access to social services and activities [42–44]. Models and theories stemming from social psychology, like the theory of planned behaviour (TPB) and the Trans Theoretical model of change (TNN), have had a strong impact on research on travel behaviour and mainstream transport planning and travel demand management. In this paper, travel behaviour is largely regarded as 'choices' exhibited by a traveller and captured by her revealed or stated preferences and actions, best visualised through quantitative measures such as travel surveys [45]. Modal shift and a general change towards more sustainable transport is, according to these theoretical views, mainly achieved by altering people's perceptions about reality (e.g. attitudes towards different modes of transport) which then will encourage them to make other choices, rather than changing the reality itself (e.g. restrict car use, change the infrastructure). Such interventions can be understood as representing a form of "libertarian paternalism" [46], which is a specific expression of public governance heavily influenced by a libertarian worldview [47]. Governance in accordance with this ideology would typically aim at motivating or 'nudging' people into a desired behaviour by altering their perception of the consequences of a typical behaviour. However, the final decision on travel mode should be left to the individual, and a range of choices should still be available. This kind of governance is also linked closely to the term 'soft' transport policy measures [45,48].

The theories and models aiming at explaining travel behaviour have in common the assumption that decision-making units (i.e. individuals and households) have complete knowledge about the factors surrounding the decision they are about to make [49]. The idea that individuals make rational travel choices is problematic because it is based on an implicit assumption that decision-making is made in a social vacuum [50]. The motives and experiences behind transport mode choices vary

greatly among individuals [51]. In traditional travel surveys, which often describe aggregated travel patterns of a population, with peak times, travel length and the most common means of transport, individual motives for modal choices are seldom visualised. Even so, they are used as an explanatory framework for modal choices.

This study contributes to the mobility literature that understands travel behaviour as being intertwined with social structures and everyday activities which are influenced by space-time restrictions and resources (for an overview of this literature, see Kwan and Schwanen [52]**).** In this paper, we view travel behaviour theoretically as an integrated part of social life, in accordance with the new mobility paradigm and the time-geographical perspective [53,54]. Mobility as a concept and a phenomenon is understood here as more than travelling between places. It is also an expression and reflection of feelings, experiences, norms and values [55,56]. Thus, transport mode choices might reflect individual attitudes, but also reflect different preconditions for mobility and participation in social life [42]. Analytically, we explore mobility and transport mode choices by applying a time-geographical framework [54].

3. Time- geography as a theoretical and analytical approach

The time-geographical approach used here views travel as derived from people's need to carry out activities. Such activities take time and are performed at certain places [54,57]. In contrast to studying behaviour as a result of individuals' rational decisions or attitudes, the time geographical approach is based on the standpoint that: a) mode choice is activity-based and reflects the scheduling of activities in time and space throughout the day; b) sequences of activities and related journeys constitute the relevant analysis unit, not single trips; c) household types, life stages and other social conditions influence activity and travel patterns and; d) spatial and temporal conditions restrict mobility, transport mode choices, and participation in activities. Time-geography offers conceptual tools to grasp experiences, emotions, associations and strategies in everyday life and illustrates how restrictions and barriers, which should not be understood as physical only, but even socially constructed ones like policy, have an impact on individual space-time movements [57]. Three types of restrictions surround the individual and limit the freedom to implement activities [54]: *capacity restrictions* concern the individual's biological characteristics and access to tools and the ability to use them. Some of these restrictions are of such character that they limit the use of time, such as the need to sleep and eat on a regular basis. *Coupling restrictions* concern the fact that production, consumption and socialising necessitate that individuals, tools, material artefacts and the physical environment are interconnected into coordinated entities. Such interconnections can be found within a family, at an office, between individuals and tools at a factory, and there are also short-term interconnections, for instance between a doctor and a patient. *Authority restrictions* refer to how domains and places are available only for certain persons and activities at certain times. The domains are surrounded by laws, rules, norms and expectations concerning who gets access to places and services, at what times and at what eventual costs. A family, a company a workplace, or a local public transport system are all examples of domains that organise activities and protect assets and resources, and limit access.

The concept of restrictions is used as an analytical tool in the study to illustrate how the organisation of everyday life activities among individuals and households influences mobility and travel behaviour. It highlights how transport is about moving between different components of interconnected entities which, in themselves, impose different requirements concerning being present in time and space [54]. The transport modes that enable fewer compromises with scheduled timetables therefore seem superior to the implementation of the various activities during the day.

4. Materials and Methods

4.1. Context

The study draws on a research project, "GoMate", funded by the Swedish Energy Agency, for which a VSS (including e-bikes, cargo e-bikes and a variety of cars) was set up in a newly built urban

residential area in Jönköping, a middle-sized city in Sweden (Figure 1). In Sweden, CSSs are relatively well established and used in urban neighbourhoods. In the three larger cities of Stockholm, Gothenburg and Malmö, BSSs have been available for many years. Currently, several middle-sized cities are planning to implement BSSs to reduce car use and promote sustainable travel behaviour. Jönköping is such a middle-sized city, with nearly 100 000 inhabitants. There are two lakes in the city and it is located on the southern coast of Sweden's second largest lake, Vättern. It is surrounded by hilly slopes, which make it difficult to get around by foot and by bike in some parts of the city, especially for the elderly. A highway runs through the city, splitting it into two halves. There are many large industries and shops in Jönköping, and Jönköping University is centrally located. The public transport system offers trunk routes with frequent services as well as city buses. Recent travel surveys conducted by the municipality show that car use is increasing in Jönköping which has generated problems with traffic congestion.

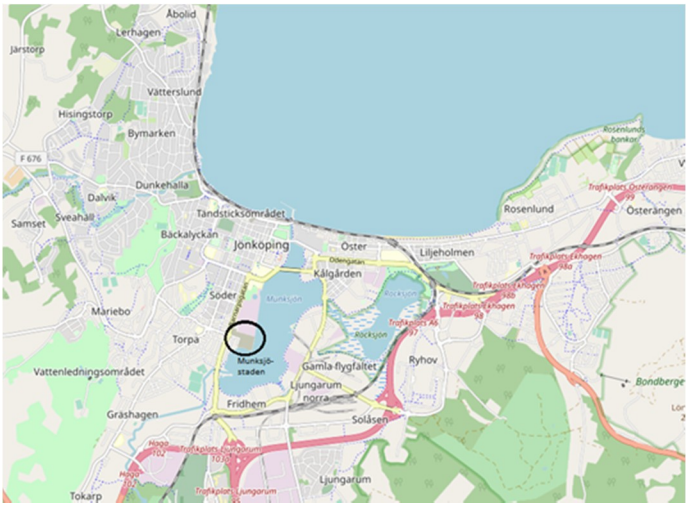

Figure 1. Map over Jönköping. Studied neighbourhood (Munksjöstaden) circled. © OpenStreetMaps contributors.

4.2. Research Design

This study is based on a qualitative research approach with data collected through interviews with individuals living in a newly built neighbourhood (Munksjöstaden) in Jönköping. A qualitative approach has the possibility of generating in-depth understanding and context dependent knowledge of the phenomenon being studied [58]. By studying a particular case, valuable knowledge can be generated that has the potential of being valid beyond the particular case [59].

In the GoMate project (mentioned above) a vehicle-sharing system has been made available for rent in one block of apartments in the neighbourhood (Figure 2 and 3.). The sharing system includes one plug-in hybrid car, two conventional diesel cars, one electric car, 12 e-bikes and three cargo e-bikes. The cars were provided by Sunfleet, a major car-sharing company in Sweden, and the bicycles were provided and maintained by a bicycle-sharing company (Cykelpoolen). Since there were two different providers of the vehicles, two different booking systems were used—one for bicycles and one for cars. The vehicles were booked via smart phone applications. At the time of the study, the bicycle-sharing system was free of charge for the users. The membership fee for the car-sharing service was paid by the housing association and was thus free of charge for the users. They paid for the cars per use according to a price list. The following abbreviations for different vehicle-sharing systems are used: BSS (bicycle-sharing system), CSS (car-sharing system) and VSS (vehicle-sharing system). Separate terms are used in order to reflect how the respondents used the vehicle-sharing system differently.

Figure 2. Bicycle-sharing system in Munksjöstaden. Photo: Therese Silvander.

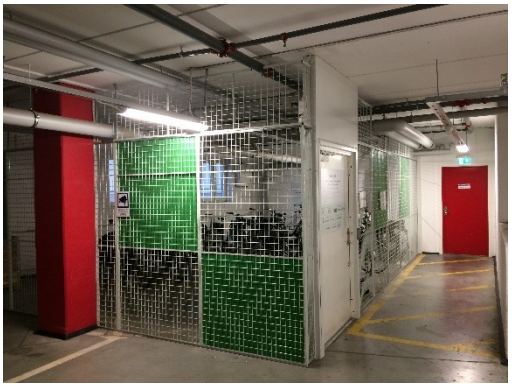

Figure 3. Electric bicycles and bicycle storage. Photo: Therese Silvander.

4.3. Recruitment and Procedure

At the time of the study, 275 individuals had access to the vehicle pool, i.e. all residents over the age of 16 in the block of apartments. The participants were recruited via an information meeting about the VSS, held in the start-up phase. Approximately 40 persons came to the meeting, thus showing interest in the VSS and in participating in the forthcoming study. When the recruitment for the interview study started, everyone that participated in the information meeting was contacted by e-mail and phone and invited to take part. In total, 11 persons (of which two were women) agreed to take part in the study. The others did not want to participate or could not be reached. Before the interviews took place, the informants were asked to use the vehicles (both the cars and the bicycles) as much as possible for at least one week, and to record details of all trips they undertook that week in a travel diary. The documentation included walking, use of public transport and use of their own bicycle(s) and car(s). The columns in the diaries recorded the start and end times of the trip, where the trip began and ended, the purpose of the trip, the mode of transport, and whether the informant had travelled alone or with a companion. The purpose of the travel diaries was to visualise the actual number of trips undertaken and to minimise subjective estimates of how they usually travelled. The travel diaries served as discussion material during the interviews.

The interviews were semi-structured and conducted using an interview guide. The interview guide was developed around four themes: (1) living conditions and transport; (2) previous experience of using electrical vehicles; (3) the travel diary and test week and; (4) experiences of using the VSS, and future usage. The purpose of the interview guide was to ensure that vital information about the participants' use of the VSS was gathered. However, freedom for the participants to freely express other issues, as well as for the interviewer to follow up on interesting matters, was also ensured in the interviews.

4.4. Analysis

The analysis took a content analysis approach [58], involving the three authors at all stages. The analysis procedure consisted of three phases. In the first phase, the verbatim-transcribed interviews were read by the authors in order to get an overview of the material. That was followed by coding and thematization, also done by the authors individually, bearing in mind the aim and research questions of the study. Specifically, travel patterns and experiences of using the VSS in everyday life were of interest. In the second phase, the codes, themes and interpretations that were found or made were critically discussed among the three authors. Broad dialogs were also held e.g. about the users, the characteristics of the VSS and the social and material context. This stage ended with a jointly analytical framework being developed. In the third stage the material was re-read with the analytical framework in mind. This stage generated some new interpretations, which after additional discussions resulted in the final version of the results presented in the paper.

The analysis revealed variations in the extent of time-space restrictions and differences in travel behaviour, preferred mode of transport and use of the VSS. These differences are illustrated by a presentation of five different cases (Marco, Eddie, Thomas, Molly and Kristoffer) with the aim of providing a broad and holistic view of experiences of using the pool, situated into different living conditions. Marco was selected because he had small children and worked irregular hours, which was why he used a private car a lot. Eddie was chosen as he had few regular activities besides work and few responsibilities that affected his space-time use. Thomas and Molly are a married couple with a small child. They were selected because the two of them had different opinions and practices regarding mobility and modes of travel. Kristoffer' case is of particular interest because his lifestyle and attitude towards travel behaviour differed significantly from the other informants. He was very enthusiastic to cycling but a frequent user of the CSS.

5. Results

The interviews reveal that the interest in the BSS was greater than for the CSS. Of the 11 respondents that participated in the study, four had used the cars in the pool, two had used the electric cargo bikes and all had used the electric bikes. The reason why so few had used the cars was that they already had their own car or borrowed cars from others, or they did not have a driving licence or had no use of a car. Many were also curious about how electric bikes worked while the car was no novelty. The main reason why the electric cargo bikes had not been used was that the bikes had not yet been delivered to the VSS at the time of most of the interviews. Personal factors as well as social structures and environment influence the choice of transport mode. These factors can both explain preferences for the VSS as well as preferences for not using it. The portraits below highlight their use of and their attitudes toward the VSS which they had access to through the GoMate pilot project.

5.1. Marco

Marco is married and has two children under the age of eight. He works irregular hours within the healthcare sector. He and his wife have two cars and have therefore not used the entire VSS, only the bikes. Marco usually commutes to work by private car because on most days he is responsible for dropping off the children at their schools and picking them up. The schools are located in different places, about 5 km apart. If he took the bus, he would have to change bus in the city centre and drop the children off earlier at school, and he already starts work very early, at 6.45. Before the introduction of the bike pool Marco had thought about buying his own e-bike. Since the introduction of the bike pool he has used that instead and did not have to invest money in a private e-bike. He has also calculated that it is not profitable to buy an e-bike at present while the children are small:

> I thought I could wait a while for the girls to grow a bit and at least the big girl could bike to school and back. But she's only seven now and even though the school is only 2 km away, the traffic is terrible.

The quote from Marco exemplifies how the relation among space, time and responsibilities limits his choice of transport modes and even though he was positive towards biking, it was insufficient for

him to carry out the activities of work and care. Although living in the city offers proximity to relations and activities, the traffic environment that promotes mobility among car users, restricts children's safety and independent mobility. Marco could only use the bike on days when he works the evening shift from 1.30–9 p.m. Since the road to work is very hilly, e-bikes were good alternatives to the car; however, due to restrictions in the vehicle pool, they could not be used after 11 p.m. which was a coupling restriction for Marco because he could not use a bike for night shifts at work. Another coupling restriction is that Marco has a job at the hospital where he is tied in space and time, and he cannot work from home or benefit from flexible employment times. This means that when he has to run private errands during the daytime, such as taking the children to a doctor's appointment, he needs to take the car to work in order to travel quickly between work, school and the intended activity.

5.2. Eddie

Eddie is in his 20s and lives with his partner. He works office hours, and the work is located 2.5 km from home. For a long time, both Eddie and his partner have been walking and biking to work. Eddie also uses public transport. His own bike was stolen a while ago and he thought about buying a new one. However, when the BSS project came up, he decided to try that instead. He experienced the BSS and its digital functions as very user-friendly. When he needed to transport things, he used a women's bike as it is equipped with a basket.

Eddie and his partner bought a car not long before the interview took place. She needs it to go to the riding centre. Before they bought the car, she used the CSS several days a week. However, renting a car is not sufficient for her needs. For one thing, it became very costly to rent a car and secondly, her car is needed for storing all the equestrian equipment which she previously carried up and down from the garage to the apartment. Her car use exemplifies how the car is used for different kinds of errands, and that the cars in the CSS are not always suitable for all purposes.

Besides work, Eddie has very few space-time restrictions. About twice a week he hangs out with friends at someone's home or watches a football game at a stadium. All his friends live within walking distance from him. A few times a week he goes to a pub with his friends. At weekends, they go to a shopping centre or take a trip somewhere in the car, which they seldom did before they had their own car. To summarise, Eddie is an example of those informants who have few space-time restrictions, and live close to work and other places for leisure and social activities. Eddie said that e-bikes are very convenient because he is lazy, and since the introduction of the BSS he has used it continuously. The BSS was thus a capacity resource for him, but it did not improve or impair accessibility in his current life situation. Similar reasoning is given by other informants whose accessibility and mobility needs were satisfied by walking or using a private bike. For example, Sia, preferred her own bike since it was more convenient to park it outside the apartment building than to take it down to the garage. She must travel 4 km to work and 1 km to the gym, and she preferred to use a regular bike than to pay for using an e-bike and miss out on daily physical effort. Furthermore, she did not want to be restricted by the hours the pool bikes are available for use.

5.3. Thomas and Molly

Thomas and Molly are in their thirties and have a two-year old son. They are both employed. They have one car in the household. Thomas mostly drives to work, at the other side of the highway 5.4 km from home. Molly usually walks to work, which is 1.2 km away. She thinks that biking and walking are much more convenient than driving, and she says that she is a bad driver and is afraid to drive. She also loves to bike. "With the bike you can park in the city, right outside H&M", she says. Thomas, on the other hand thought that the car is more convenient than walking and biking and explained that he become accustomed to driving a long time ago. He explained that he does not have the time nor the opportunity to freshen up at work if he gets sweaty from biking or wet if it is raining. He was not ready to sacrifice the comfort and convenience that the car gives. "I can do other things for the environment", he said. This line of reasoning was put forward by several respondents, who stated that they value comfort more than the environment. However, when Thomas and Molly

thought more closely about aspects they value when it comes to everyday life, like proximity, they discussed whether they actually need a car:

> Thomas: In fact, we are very privileged, having so many things close by. Honestly, we don't have to go very far to shop.
>
> Molly: To be honest, we could live a life without our own car and rent a car when we needed it.
>
> Thomas: Yes.
>
> Molly: And use the car less, but it would mean a readjustment.
>
> Thomas: Yes, and the pricing.
>
> Molly: Well, yes, if we sold the car. I mean how often do we really need a car?

Until recently, they had an electric bike which mostly Molly used. Unfortunately, the bike was stolen. The electric bike was the best way to travel short distances with their son because they had a child's seat attached to it. However, at the time of the interview, child seats could not be attached to the bikes in the BSS, and the cargo bikes had not yet arrived. Thomas and Molly explained that their son is at that age when he does not sit still in the stroller and therefore, they preferred to take the car than walk with the stroller when they were going somewhere.

Several space-time restrictions affected their transport mode choices and experiences of the BSS. The fact that every day both must either leave the son at kindergarten or pick him up was a coupling restriction which tied them in space and time. In order to bike, both had to have a bike with a child seat. Since the BSS bikes do not have child seats, Molly walked, and Thomas drove to work. Other coupling restrictions concerned the material aspects of the BSS and its functions. The battery and the locks needed to be charged separately, thus the function of the BSS was based on users taking responsibility for charging the bikes and the locks correctly; otherwise the bikes would be uncharged for the next user. Molly had to leave the bike at work one day when the battery for the lock was discharged and she could not unlock it. The material aspects of the BSS (such as locks, gears, batteries, charging technology, seat adjustment and smart phone applications needed to use the bikes) were also brought up by other informants, either as constraints when something was not working or as resources that made the use convenient and easy. For example, when the charge level in the smart phones was below 10 percent, the bikes could not be unlocked. On the other hand, it was very convenient when it worked well, since keys were not needed. The technological functions affected the extent to which the informants could rely on the BSS for everyday mobility.

Another capacity restriction was that Molly felt insecure driving a car which she was not used to. Furthermore, since the cars did not have child seats it was a hassle to attach a child seat and secure it in the right way every time they went somewhere. A coupling restriction was the uncertainty of car availability in the VSS if one wanted to make spontaneous trips. Finally, Thomas explained that to give up the convenience of a private car and rely on the VSS would require very low rentals or subsidised prices.

5.4. Kristoffer

Kristoffer's main mode of transport was to bike on a private conventional bike. He biked 3.5 km to work all year round, regardless of the weather, and also biked 9 km to band practice, a regular activity which he attended at least one day a week, sometimes with a luggage trailer to bring his instruments. He believed his time was too valuable to be spent at a gym; he preferred to get free exercise from biking. He also pointed out that being accustomed to conventional biking, an electric bike does not go as fast as he likes and therefore failed to save him time. The fact that Kristoffer is relatively young and in good physical shape is an important capacity resource that enables active mobility. For him, to bike was not an innovative form of mobility. He has always biked and was not affected by the fact that there was a BSS in the residential area. As with a few other informants, the BSS did not improve Kristoffer's mobility and accessibility, and in that sense, he is similar to Eddie

and Sia. However, Kristoffer differed from all other informants in his way of talking about his own travel behaviour in relation to other people's travel behaviour. He was sceptical of electric bikes because they provide a false exercise experience. He wanted to stand out as an engaged cyclist with a lifestyle characterised by environmental awareness, outdoor life and physical activity, and he did not hesitate to comment on other people's travel behaviour, e.g. that of his colleagues. The BSS, on the other hand, was of great use when friends were visiting, as they could bike when they went somewhere together. He is very fond of bicycles and related gadgets, and he owns several bikes, including an old cargo bike. Despite his interest in biking, Kristoffer and his partner were frequent users of the CSS. They mainly used it for longer trips, e.g. hiking, camping and when they were visiting relatives in another town. They tried to minimise car usage and choose public transport when possible. However, the CSS enabled a car-free everyday life. In line with how many argue about car usage, Kristoffer believed that a car gives a sense of freedom and it makes life easier, but he said he did not need to have that feeling every week. Kristoffer reasoned about how easy it is to become addicted to car use:

> If you start compromising with yourself by not biking because it rains, you will eventually end up in a car. What will the next step be? I mean, we would like to take it [biking as the norm] further if we have children. I think that if we had owned a car, we would not have lived the life we do. Then we would have taken the car to work just like everyone else.

The quote from Kristoffer implies that that there is risk that he, like others, might fall into routine car use without reflecting upon it. At the same time, he emphasised the freedom of not having a car, in not having to take care of it, change the tires, or check the oil and so on. However, since he sometimes needed a car, he liked having the opportunity to use the CSS or to borrow a friend's car. Thus, the VSS has the potential to allow Kristoffer and his future family to maintain a life without car ownership.

5.5. Summary of Results

The results showed that the more space-time restrictions the respondents experienced, for example concerning children and their activities, as in the cases of Marco, Thomas and Molly, the more they believed it was difficult to bike and walk instead of driving. Eddie and Kristoffer were much more in charge of their own time use and could be more flexible in choosing the transport mode. However, other aspects apart from time use affect transport mode choices and the use of the VSS. Many respondents thought that transport should be convenient and seamless without interruptions. Some respondents considered biking convenient, while a majority preferred the car for similar reasons. In most cases, environmental arguments such as CO2 savings, did not affect how attractive they found the VSS. The electric bikes were perceived by many as convenient in general, but not in all circumstances. Some participants said that their own bike was more convenient as it could be parked right outside the house instead of the parking space in the garage allotted for the VSS.

Furthermore, the respondents used the car not only to transport themselves back and forth to work, but also to drive children and spouses, for recycling, and for recreational errands. These activities demand equipment such as child seats and tow bars. Such needs could be met by extra equipment in some of the cars in the VSS. However, to add equipment to some of the cars does not necessarily change the perception of what errands to use VSS cars for.

Identity and ideals are personal factors that influenced the choice of transport mode and often overlap. Identity factors concern maintaining an image of oneself that a person wishes to present to others, along with the values they stand for. A few informants were convinced that people must decrease their car use and use modes of transport more sustainably for environmental reasons, and they therefore used the BSS, their own bike or public transport rather than driving. To conclude, different types and degrees of space-time restrictions, a desire for convenience, identities and ideals influence the participants' transport mode choices and determine whether the VSS is a viable option

for them. The implications of the results for the possibility to transition to sustainable mobility in cities are discussed in the following section.

6. Discussion

6.1. Pilot Users and Their Mobility Practices

Through qualitative interviews, this study has explored to what extent a vehicle-sharing system (VSS) in a residential area can cater for an individual's everyday mobility needs and reduce the need to own a car. Based on the results, we conclude that the VSS has the potential to reduce car use. It was especially attractive to respondents who did not own a car or a bike. This conclusion can be read in line with Börjesson, Rivera and Henriksson [19]. In GoMate, the VSS was not a motivator for moving to the studied area. The users of the GoMate VSS cannot be described as pilot users in the sense that they are active in modifying and improving the service [33]. They are not necessarily committed to the idea of vehicle-sharing or electric vehicles per se. Rather, through the VSS being placed in their residential area, they have been encouraged to use the system and have been "pushed" into the role of pilot users. These results emphasize the need to forcefully inform pilot users in residential areas of the new service, but also to carefully listen to the perceived needs and desires of the residents in terms of mobility. Our study shows that VSS pilots will not start using the service because of the novelty of it, nor will they modify or redesign it to their needs. Rather, if it does not meet their needs, they will not use the service at all. At the time of the study, the VSS was new and the users were offered the opportunity to use the service for free. Whether they will continue to use it in the future, when they will have to not only share it with more residents but also pay for using it, is uncertain.

The interviews reveal how the residents have arranged their everyday mobility according to their access to and preferences for certain transport modes, where many prefer their private car. Many respondents travel within the city for distances shorter than 10 km, and in many cases under 5 km. Objectively, these trips can be made by using the VSS. However, the respondents' experiences and individual situations are important to take into account to understand if and to what extent VSS is a viable option for personal mobility. By using a time-geographical approach and specifically the concept of restrictions, we identified several space-time restrictions that lie outside the individual's immediate control, such as child care, commitments towards others and working hours, which affect both willingness and the actual opportunity to use the VSS and/or reduce the use of private cars. Respondents with children and who work full-time, experience higher levels of space-time fixity than respondents who do not have children. It has been shown that driving children to/from school is considered as one of the most temporally fixed activities [60], which is also shown in the cases of Marco, Thomas and Molly in this study. Schwanen, Kwan and Ren [60] conclude that due to activities that are fixed in time and space, people perceive opportunities to change travel behaviour as limited. Therefore, interventions aimed at changing people's travel behaviour might not succeed if they are based on ideas in lines with "libertarian paternalism" [46], where people are believed to make the "right" choices if they get access to information but still have a variety of travel opportunities to choose from. The present study can partly confirm this reasoning.

The results further show that many of those who used the VSS already bike or walk as their main mode of transport but used the service during the free period since they were curious how the VSS worked. They are supposedly not the main target groups for initiatives aimed at making mobility more sustainable. However, demands for mobility have been shown to change due to key events during the life course [35,61]. Change of residence, education, changes in working conditions and workplace, as well as changes in family structure are key events in individuals' lives that might change mobility characteristics, for example car ownership, trip frequency, changed mode of transport, and commute distances [17,62–66]. In the light of this knowledge, it is important that sustainable transport alternatives are available and known to the individual. An already well-functioning VSS can be an incentive to choose sustainable modes of travel in a new life situation to avoid the need to acquire a private car or can be an incentive to sell the car.

Furthermore, the participants in the GoMate pilot project typically have the necessary financial resources to own a car and are therefore not economically motivated to sell their own car and use the VSS instead. Thus, the results suggest that just introducing a VSS will not get people out of their own cars and make them use other more sustainable mobility choices.

In line with previous research, this study points to how environmental issues are not a sufficient motivator on an individual level to reduce car use [23]. Rather, our results support the notion that if a VSS can provide the comfort and convenience that privately-owned motor cars can, there might be a chance that it will attract new users. In the studied pilot project, convenience was interpreted as saved travel times, easy access to the vehicles, easily adjustable bicycle saddles and the possibility to attach child seats, and user-friendly locks and apps. When all these details work seamlessly, there is a possibility that a VSS is interpreted as convenient by the users and can constitute a real alternative to private car use. However, through the use of the time-geographical approach and in-depth interviews, we have been able to reveal that due to the high level of space-time fixity that many residents experience, it might not matter if the VSS is convenient or not. In many cases a VSS cannot compete against the comfort that privately-owned cars provide. Previous studies have not been able to highlight the relationship between the design and implementation of VSS and the organization of everyday life mobility. This is the main contribution of our study. Therefore, when designing and implementing residential VSSs, it is necessary to take the organization of everyday life into account, which include analyses of urban planning reforms in the local area and how they increase or ease space-time fixity. Our results call for a critical discussion about urban planning and the societal norms that support the consumption of energy-demanding resources such as the car. In the final section we will question the notion of "convenience" as a guiding principle when planning for sustainable urban mobility.

6.2. Vehicle-Sharing Systems and Their Role in the Transition towards Sustainable Mobility

To adopt entirely the sustainable mobile regime that VVSs offer would mean substantial sacrifices in comfort for many of the respondents. In a study about individual environmental responsibility, Dahl [67] concluded that many are not ready to make these kinds of sacrifices. Here, in line with previous research, it is important to emphasise how important the concepts of comfort and convenience are for users of technologies such as vehicle-sharing services. While the private car has been able to sufficiently accommodate the 'need' for comfort and convenience, it seems that the studied VSS has not been equally successful. It is already known that factors that can be related to comfort, such as proximity and flexibility, do affect the experienced accessibility of different modes of transport [68]. Today, alternative mobility technologies and services are perceived as less attractive and more expensive [14]. As Shove [69] points out, people do not consume energy-demanding resources per se, they consume the services that such resources provide: the three 'c's' (comfort, cleanliness and convenience).

However, inspired by Shove, we believe it is vital to question the norm of comfort rather than reinforce the importance of it. One reason for doing so is that it might not even be possible to offer the same kind of comfort that motorists are used to through new mobility services. If we do not change the norms that have given rise to unsustainable mobility practices, there is a risk that it will not be possible to change mobility behaviour on a structural level. But how do we adjust the high expectancies of comfort? Is it possible to do so when designing a single VSS? Today, comfort is interpreted as a need rather than a pleasant 'add-on' of societal services. To question whether it is a task for society to bring comfort to citizens, rather than to fulfil needs, could be the start of a new paradigm where needs and comfort are decoupled. But what kind of measures would that demand?

Making changes on an individual level for collective purposes, e.g. reducing global carbon emissions, is regarded as a distant objective for many, thus not motivating them enough to voluntarily make radical changes in life style [70]. Therefore, alongside providing citizens with solutions like VSSs, targeting a shift towards more sustainable mobility, on the basis of our results, we argue that other interventions need to be deployed; otherwise, there is a risk that such soft measures will merely remain solutions under the umbrella of libertarian paternalism [46].

Interventions aimed at reducing car use and car ownership need to be embedded in the whole sociotechnical system of automobility with a combined focus on behaviour, technology and urban planning [37,71,72]. Such interventions include not only alternatives to car use and ownership, satisfactory public transport and better infrastructure for cycling and walking, but also stricter parking regulations, banning cars in certain areas, and making car use and ownership pricier. In other words, the deployment of both soft and hard measures in combination. To carry on pushing forward the well-established sustainable mobility paradigm [73], new norms in urban planning and building are required, where mobility aspects are integrated into practices of planning, designing, re-designing and building urban areas for the future.

6.3. Methodological Reflections

An important aspect to reflect upon is to what extent the results from this study are valid outside the studied area, i.e., transferrable [74] to other contexts. In this study, the participants came from different households, with different life situations, living conditions, occupations and ages. It was also the first time they tried using a VSS provided in this study. In that sense they represent a heterogeneric sample. They were however homogenic in a sense that they all were financially strong, e.g. had an income, were able to live in a newly built urban residential area and owned a private car. The data gathered through the interviews also reached saturation, meaning no novel information came forward towards the end of the data collection, which strengthens the credibility of the study [58]. Bearing this in mind, it is the view of the authors that the results from this study would be transferrable to similar contexts, i.e. urban residential areas, socio-economically comparable to Munksjöstaden in Jönköping. In such areas the chances are high that people have similar mobility needs. Some issues relating to using the VSS, e.g. material aspects, would probably extend even further. However, the results do not reflect the full complexity and diversity of using a VSS for everyday mobility, neither was it an ambition to achieve this. Rather, the study illustrates certain aspects that are shared and general for many. Therefore, this study's results contribute with knowledge of how people experience VSSs, the potential of catering for people's everyday mobility as well as barriers on an individual and societal level.

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