

Car Sharing as a Key Contribution to Multimodal and Sustainable Mobility Behavior – the Situation of Car Sharing in Germany

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ABSTRACT

So far, car sharing is just a small niche product on the mobility market. The proven positive effects of car sharing can only contribute to solving traffic problems if the number of car sharing customers grows. The present paper investigates, on the basis of a household survey, the awareness and the market potential of mobility service car sharing in Germany. The results show that the majority of the respondents do not know what the term car sharing stands for. Even within the sub-group of people who could explain what car sharing is, local car sharing offers are not well known. To measure the attitudes towards the different modes of transport and the acceptance of the general idea to share a car with other people, statement batteries were used. On the basis of factor analyses, linear and logistic regression models, the factors are determined that influence whether a person has a liking for car sharing or not. Furthermore, the correlation between attitudes and behavioral aspects are revealed. In this context, people with multimodal mobility behavior are found to be more open-minded for shared used vehicle systems. Finally, by taking subjective (attitudes) and objective criteria (current mobility behavior) into account, the potential of car sharing is estimated. The paper starts with a short history of the development and the current status quo of car sharing in Germany and a brief summary of the previous research. In the end recommendations for the further development of car sharing are given.

1. INTRODUCTION

An integrated transport system can be seen as an overall concept for politicians as well as for researchers. On the level of the transport system, the concept refers to the integration of different transportation modes to allow an easy move from one mode to the other. On the level of individuals, the concept evokes the perception of multimodal behavior where, in contrast to monomodal car use dependent on the specific situation, a selection between the different modes takes place (1). The aim of the concept is to enhance flexible mobility decisions and to encourage behavioral change towards sustainable modes of transport.

However, past mobility trends have gone in opposite direction. The last decades have been characterized by continuous traffic growth in western countries and increasing dependency on cars. There is a close link between car ownership and car use. In car-owning households, strong car-oriented mobility routines make it difficult to draw attention to alternative mobility offers.

In this context car sharing – defined as a service where members of shared-use vehicle organizations get access to a fleet of vehicles – plays an important role. Several studies (see section 2) have demonstrated the positive effects of this service, for example modal shift towards sustainable modes of transport and reduction of the annual car-mileage, the number of car trips as well as the number of cars per household. But so far, car sharing is just a small niche product on the mobility market. Only a small minority of people uses this service.

The present paper investigates, on the basis of a household survey, the awareness and the market potential of mobility service car sharing in Germany. It concludes with recommendations for the further development of car sharing.

2. BACKGROUND

This section starts with a short history of the development and the current status quo of car sharing in Germany. The second part provides a brief summary of previous research. As current mobility patterns are part of the basic conditions to set up shared-used vehicle systems, the third part describes the characteristics of mobility behavior of the German population.

2.1 Development of Car Sharing in Germany

Since its inception in the late eighties, car sharing has passed through a remarkable development. After a slow start, both the number of shared vehicles and the number of customers are continuing to grow. In 1997, 19.200 authorized drivers were registered. At the beginning of 2006 the number had increased to 83.000. This corresponds to a growth of about 330 % within nine years, or an average annual growth rate of roughly 17 %. In the same period, the number of vehicles grew by 145 % (from 1,100 to 2,700 vehicles). Despite this success story the numbers do not reflect the low significance car sharing has for the every day mobility. Nationwide only 0.17 % of the 49.6 million people who possess a driving license (2) are registered car sharing users.

Due to its specific history, the German car sharing market is highly fragmented. The first organization, *Stattauto Berlin*, was founded in 1988, one year after car sharing had started in Switzerland, the founding country of car sharing. Since then, the number of car sharing institutions has increased to currently 100 organizations that offer the mobility service in 250 German towns and municipalities (status quo 01.01.2006; bcs – Federal Association of Car Sharing). In comparison to

Switzerland, with one nationwide provider, the German market is characterized by a diversity of institutions with highly varied levels of progress. Whereas some organizations still work on a basic level with the support of volunteers, others work very professionally. In general, car sharing in Germany can be described as grassroots initiatives without governmental funding. Although efforts have been made within the last years to cooperate and to harmonize the offers, the fragmentation of German car sharing organizations still remains.

Car sharing is a fast changing market. A recent phenomenon is the market entry of big transport companies. In December 2001 the German railway company *Deutsche Bahn (DB)* started to offer shared-use vehicles as an additional component to their customers on the basis of franchise contracts with existing car sharing organizations. At present customers of *DB* can use shared vehicles in 79 German cities and – due to the co-operation with the company *Mobility CarSharing Schweiz* – about 2,000 vehicles in Switzerland (www.dbcarsharing-buchung.de). In September 2003 the mineral oil company *Shell* entered the car sharing market under the name *Shell Drive*. At the beginning of 2006 *Shell Drive* had 20,000 customers who they provide with 550 vehicles in 20 German cities (press release, January 19, 2006). In January 2006, *Shell Drive* was sold for strategic reasons to the Dutch car sharing provider *Greenwheels*.

Car sharing offers are particularly concentrated in large cities whereas the diffusion rate in rural areas is low. All cities with a population of 200,000 and more and three quarters of all cities with a population of 100,000 to 200,000 hold car sharing offers. In contrast, shared-use vehicle systems are only available to 1.3 % of all municipalities with a population below 100,000. As 70 % of the German population lives in cities below 100,000 inhabitants, it can be stated that a large majority of the population has no access to this kind of offer.

In general, the basic conditions for running a profitable car sharing service in small and medium sized cities are more complex as the quality of public transport is poorer than in an urban agglomeration and the mobility styles are more focused on a personal vehicle. Despite these problems, there are good examples that demonstrate that the diffusion of car sharing in rural/ low density areas is possible. In Switzerland, for example, car sharing is found in 93% of the cities with a population between 10,000 and 50,000. Likewise, car sharing has taken hold in several towns and villages surrounding Freiburg in southwestern Germany due to the activities of *Car-Sharing Südbaden – Freiburg e.V.*, the local car sharing organization.

2.2 State of the art / research

Car sharing has been an important topic in the English as well as in the German (academic) transport related discussion. In Germany, the first comprehensive study was carried out by Baum/ Pesch in 1994 (3). The focus of the study was the ecological impact and the market potential of shared-use vehicle systems. Since then the scope of topics within German literature has expanded. It ranges from empirical analyses of mobility behavior of car sharing users and their reasons for becoming a member (e.g. 4, 5, 6) to the investigation of the ‘de-motorization potential’ (reduction of private cars in households of car sharing users; 7), the analysis of economical questions (8) and specific business car sharing offers (9) as well as the examination of the benefits linked with co-operations of car sharing organizations and public transport companies (10). Finally, special car sharing offers have been investigated (e.g. Cash Car; car usage with the option to return the vehicle to the car sharing organization at certain times on the basis of a full-service-leasing contract; 11). Most of these studies treat car sharing directly or indirectly as a mobility alternative that is restricted to urban

areas. Only lately, some studies focus explicitly on the requisite circumstances to set up car sharing successfully outside of an urban agglomeration (12, 13). The last comprehensive study about car sharing in Germany (14) was completed in 2004. Parts of this study are presented in this paper.

A comprehensive overview of the worldwide development and the benefits of car sharing were given by Britton et al. (15) and Shaheen et al. (16). Looking at the international literature it can be seen that most of the studies confirm the positive effects of car sharing. Several studies in the United States, Germany, and Switzerland (17, 18, 15, 19, 20,21, 5, 22, 4, 23) consistently reveal sizable modal shifts from car usage to sustainable modes of transport (public transport, walking, cycling), a reduction of the annual car-mileage as well as a reduction of vehicle ownership. Further proven effects are a reduced drive-alone mode share, energy/ emission benefits and cost savings to the user. But, as the number of car sharing users is small, so far the positive social and environmental impact of shared-used vehicle systems remains limited.

2.3 Trends in Mobility behavior and car ownership rate in Germany

The success of the market entrance and diffusion of shared-used vehicle systems depends largely on the capability to convince people to change their current mobility behavior. The more people are attached to the car – emotionally and behaviorally – the more difficult it is to win them over as customers. Therefore, car ownership and the mobility patterns of people form an important basic condition for the car sharing market. The actual use of transport modes can be seen as an indicator for opportunities as well as impediments to successfully increasing the number of shared-used vehicle systems on the market.

The mainstream trends in German mobility are as follows:

- Since the early sixties, the ratio of car owning and car free households exactly reversed. In 1962 the share of car owning households amounts to 27 %, whereas today the share is 75 % (24, 25).
- Within the last decades, the number of people possessing a driving license increased. Nowadays, about 70 % of the 18 to 19 year olds and more than 90 % within the 20 to 50 years age bracket have a driving license (26). Especially young women who in the past were less often able to drive a car are catching up with men (27).
- In the last decades, the dominant role of the car has increased. In 1976, the car accounted for 46 % of all trips and 74 % of passenger kilometers traveled (2). Nowadays, 61 % of all trips and 80 % of all covered passenger kilometers are made by car (28).
- In the western part of Germany, the absolute number of trips rose from 190 million trips daily in 1989 to 225 million trips in 2002. In the same time, passenger kilometers traveled grew by 20 % to almost 2.5 billion kilometers daily (26).
- For the majority of trips, only small distances are covered. 60 % of all trips are shorter than five kilometers, 10 % of the trips are even below one kilometer (26). Despite the short distance, most of these trips are made by car. That means, in many cases the car could be replaced by other modes of transport.

Against the backdrop of this car-oriented mobility behavior and the low number of car sharing users, the present paper provides answers to the following questions:

How well known is car sharing in this car-oriented society? Who knows what car-sharing is? Do the “right” people (potential car sharing users) know about the service? Taking subjective (attitudes) and objective criteria (current mobility behavior) into account, how big is the potential for car sharing?

3. RESEARCH DESIGN

The analysis presented in this paper is based on the study “Inventory and possible development of car sharing” that was funded by the German Federal Ministry of Transport, Building and Housing.¹ The study consists of three parts: a questionnaire sent to all German car sharing organizations to analyze the supply side, a household survey carried out to analyze the demand side and an overview of the international development status of car sharing. The results of the study were used to formulate recommendations by addressing the different players who have influence on the further development of car sharing.

This paper focuses on the results of the household survey that was carried out as computer assisted telephone interviews (CATI) in December 2002. The sample size is 1,000 randomly chosen respondents. The target population are all German-speaking residents in the Federal Republic of Germany aged 18 and over who live in cities with 20,000 inhabitants and more. The sample was stratified by socio-demographic and geographic attributes. Furthermore, sampling weights were applied. Thus, the results can be seen as representative for the target population and can be projected up to a total of 34.8 million people, which corresponds to 42 % of the German population.

To verify the data quality, the results of the sample were compared with the results of the nationwide study *Mobility in Germany 2002*. The sample covers 25,848 households and 61,729 persons who reported more than 190,000 trips (28). The comparison shows that on basis of the comparatively small sample of 1,000 respondents, similar results can be reached for questions that have been asked in both studies. Therefore, the sample represents a good basis for the calculation.

The restriction on municipalities with 20,000 inhabitants and more is attributed to the assumption that car sharing is more likely to be used by persons with urban lifestyle. On the basis of these considerations the decision was made to exclude small municipalities when calculating the market potential of car sharing and therefore to space the population of municipalities of this size out of the sample.

The interviews contained questions concerning four topics:

- the general awareness of car sharing and the knowledge of the existence of local car sharing organizations,
- the acceptance of the idea to share a car with others and possible impediments to use shared vehicles systems,
- current availability of transport modes and mobility behavior of the respondents,
- attitudes towards different transport modes.

Furthermore, the socio-demographic data of the respondents were collected.

¹ The project was carried out by the Eco-Institute e. V. (project coordinator) and the DLR – Institute of Transport Research. The final report (I4) is available in German under the following address: <http://www.oeko.de/dokum.php?setlan=&vers=&id=247&PHPSESSID=00292a009bf>

4. RESULTS OF THE HOUSEHOLD SURVEY

4.1 Awareness of car sharing

The reason for investigating the awareness of car sharing is quite simple: a service that is not known can't be used. Therefore, one of the main questions is: do people know what the term 'car sharing' stands for? And if local shared-vehicle systems exist, are people aware of this offer?

4.1.1 General awareness of shared-used vehicle systems

To measure the awareness of car sharing, the respondents were asked whether they know what the term car sharing means. 53 % had no idea what this term stands for. People saying that they know the expression (47 %) were asked to explain it in their own words. Their answers have been classified in 13 categories. They demonstrate the wide scope that varies from people who can give a detailed description of the service to people who have wrong associations. Looking at the total sample, awareness can be described as follows:

- 5 % of the respondents could describe car sharing in a detailed way as a professionally offered mobility service.
- The share increases to 15% if all answers are included that seemed to refer to some kind of organized form of sharing a car.
- If the definition of awareness is widened to include the answers of people who talk about private car sharing or generally about renting, borrowing and common use of a car – even though the latter answers can't be clearly distinguished from car pooling and car rental – the awareness rises to 33 %.

The ability to explain the term car sharing differs as a function of several factors. To verify the influencing factors, cross tabulations combined with Chi-square-tests were carried out. Furthermore, a logistic regression model was estimated using the binary indicator 'awareness of car sharing' as the dependent variable. This variable is 1 for the 15 % share referred to above and 0 otherwise. Table 1 presents the variables used in the model, the standardized coefficient estimates and significance levels. The influence of socio-demographic variables and different characteristics concerning the mobility behavior can be summarized as follows:

- Age has a positive influence on the awareness of car sharing. Looking at the results of the cross tabulations, it can be seen that especially young people (18 to 25 year olds) but also people older than 65 years are not aware of this service. The awareness of car sharing significantly increases with increasing education and tends to increase with household income and the size of the municipality. In cities with more than 500,000 inhabitants, the awareness is far above average.
- Concerning the mobility behavior, a high use of public transport has a significant positive effect, whereas a high number of cars in the household and a high frequency of car use tend to have a negative effect on awareness. People who are a main user of a car with a low annual mileage often know relatively little about shared-used vehicle systems. The latter means that people for whom car sharing could especially be a good alternative to their own car aren't aware of the service.

When the respondents were asked how they came to know about car sharing (only taking into account people who could explain the expression), two answers emerged as noteworthy: Media as well as friends and colleagues play a crucial role.

4.1.2 Awareness of local car sharing offers

The participant's knowledge of car sharing organizations in their local area was examined by comparing the postal code of each participant's residence with the postal code of cities with an existing shared-use vehicle system. By only taking into account people who live in a city with a car sharing offer (55 % of the sample), the results clearly indicate that the majority is not aware of this service.

- Only 23 % of the respondents knew about existing offers in their hometown.
- Even among those people who know what car sharing is, the existence of a local service is not well known. Provided that people know the term using the wide definition (also people who generally talk about renting, borrowing are included), 47 % of them know of the service. If the strict definition is used and only people are taken into account who could explain car sharing as a professionally organized form of sharing a car, the share reaches 55 %.

These results are consistent with the finding that many car sharing organizations still have a poor comprehension of public relations, marketing and how to address target groups (14).

4.2 Sharing a car with others: acceptance and hindrances

Another goal of the study was to measure the acceptance of the general idea to share a car with other people and the readiness to personally use a car sharing offer. In the context of this study, acceptance is defined as the positive appreciation of an innovation that is linked with a high disposition to act (29).

The existence of a positive appreciation was measured by using statement batteries. On a four step answering scale the respondents could indicate whether they agree or disagree with 13 statements concerning car sharing. In designing the study, it was assumed that the high appreciation of personally owning a car has a negative influence on the acceptance of shared-used vehicle systems, whereas a positive estimation of sustainable modes of transport (public transport, walking, cycling) promotes the acceptance of car sharing. To verify whether a correlation of the specified relationship exists, the interview also contained 20 statements concerning the different means of transport.

The results show that both statements with positive assessment of car sharing and statements signifying the preference for owning a car reach high affirmation. Car sharing is accounted by the majority of people as an innovative service and a good alternative to owning a car. Three quarters of the respondents would find it good if many people use car sharing and this way fewer vehicles were necessary. On this general level, car sharing is highly appreciated. However, their own preparedness to use car sharing is low. Most of the respondents can't imagine sharing a car with other people and clearly state a preference for owning a car rather than sharing one. The results reflect the gap between attitudes and actual behavior / willingness to act that is common knowledge from the research on environmental awareness and behavior (*e.g.* 30). Positive attitudes are a necessary condition but not sufficient to generate a certain behavior as they have to compete with other attitudes and preferences.

The same effect can be seen when looking at the statements concerning cars. 75 % of the respondents confirm that it would be good if we had fewer cars that were used at higher capacity.

About the same proportion of people says that they like driving and that car driving represents freedom and independence. Furthermore, most of the respondents can't imagine life without a car and think that owning a car is simply part of life. This positive appreciation of cars generally goes along with a low estimation of public means of transport. Even though positive aspects are seen (e.g. better use of time) the majority don't like using public means of transport.

To reduce the high number of statements and to identify the underlying constructs two factor analyses were performed. Using the car sharing items, three factors could be identified that have eigenvalues greater than one: 'Car sharing affinity', 'skepticism towards car sharing' and 'interest in information about car sharing'. The factors explain 43.3 % of the variance. The second factor analysis performed with the statements regarding different means of transport produced 7 factors with an explained variance of 62.4 %. Most of the factors summarize only statements of one transportation mode. This can be interpreted as follows: If a car item is assessed in a specific way using the four step answering scale (1=agree fully; 4=agree not at all), the probability is high that the other car items are assessed in a similar way. Generally, the correlation among statements of the same mode is higher than the correlation with the statements of other modes.

In this paper, the factors are used to answer the following questions: Who are the car sharing inclined people? Is there a correlation between the appreciation of different transport modes and affinity towards car sharing?

To answer these questions, a linear regression model was estimated using the factor 'car sharing affinity' as dependent variable. This variable can take on any value between -3 (low car sharing affinity) and +3 (high car sharing affinity). Table 2 presents the variables used in the model, the standardized coefficient estimates and significance levels.

The most notable result is the positive effect of the variable 'affinity towards public transport' and the negative effect of 'car affinity' as well as the frequency of car use. All three variables are statistically significant. In terms of the car, the influence is clearly negative. An unexpected result is the negative but not significant influence of the frequency of public transport. This result is surprising, as a linear regression model without socio-demographic variables reveals a highly significant positive effect of both attitudes and use of public transport. Running several linear regression models, it can be seen that the socio-demographic variables age, education, and employment status have an underlying influence when not including them in the model. Without these variables the frequency of public transport is overestimated. In general, it can be seen that the variable car sharing affinity correlates more strongly with variables expressing attitudes than with variables reporting behavioral aspects.

The results show that young people are to a higher degree inclined to car sharing than older people. Using cross tabulations, it can be seen that this is not a linear effect. The highest share of car sharing inclined people is found within the youngest age bracket – the group of the 18 to 25 year olds – , whereas the lowest share can be found for the 26 to 35 year olds. This change of attitudes from one to the other age bracket is probably attributed to the fact that young people often can't afford a car. This assumption is consistent with the result that people of the youngest age bracket state more often to have the experience of sharing a car with others. Once employed, a notable and severely negative change of attitudes toward car sharing seems to take place, decreasing in higher age brackets.

At first glance, this result seems to contradict the fact that the group of the 26 to 35 year olds is an especially strong one among current car sharing customers. A closer look at the phenomenon reveals that the 26 to 35 age bracket represents a period of life during which many decisions that highly influence the future mobility are made (e.g. choice of working place and place to live, decision

of buying a car or not). Due to these general changes, people of this age group are often found among car sharing customers even though the group as a whole is comparatively less inclined to car sharing. To gain customers among people of older age brackets is generally more difficult, as many mobility related decisions are made and people are less open-minded towards new mobility services (particularly when they are generally confident with their current mobility). This is known in the literature as the “funnel thesis” (31). The thesis suggests that mobility routines become stronger with age and that the perceived mobility choice narrows for most of the people resulting from their car dependence. Once car sharing has a longer tradition on the market, and assuming that car sharing organizations will be able to keep their customers, the age distribution of car sharing customers can be expected to become more even in the long run.

The other variables used in the regression model have no significant influence. Therefore, there is only a slight tendency for females, the higher educated and those with a high net-income to be inclined to car share. A high number of cars in the household has a negative effect on car sharing affinity.

4.3 Acceptance of car sharing among persons with multimodal mobility patterns

The results reported in the previous sections demonstrated the strong correlation of current mobility behavior and acceptance/ awareness of car sharing. As it is difficult to change strong car-oriented mobility routines, this section will focus attention on people who currently practice a multimodal behavior. For this group flexible decisions between different transport modes are more common and part of daily life than for people who exclusively use the car. Therefore, car sharing seems to be a more suitable alternative for them than for monomodal car users.

If persons with multimodal mobility behavior are seen as an important target group, several questions arise: How large is the group of multimodal persons? Who behaves multimodal? Are they aware of shared-use vehicle systems?

Strictly speaking, it is impossible to differentiate monomodal from multimodal mobility behavior as each person will use a variety of transport modes if the regarded period is long enough. For a working definition, the period of one week seems to be appropriate as this is a typical social and cultural time unit that builds the framework for recurrent activity patterns of daily life (32). Therefore, in the context of this study, all persons who within one week use at least two different transport modes are defined to be multimodal, whereas people who use within that time no other means of transport than the car are classified as monomodal car users.

The general question, how often different transport modes are used, provided the basis to calculate the share of mono- and multimodal persons. 56 % of the respondents solely use the car. The share of multimodal persons amounts to 29 %. Whereas the mobility behavior of car users is quite consistent, the one of multimodal persons varies in terms of the combination of transport mode. Most of them use the car combined with either bike or public transport. Only one fifth uses bike and public transport or combines all three transport modes.

The following results are based on two logistic regression models, the one using monomodal car use, the other using multimodal behavior as a dependent variable. Table 3 presents the variables used in the model, the standardized coefficient estimates and significance levels. In the regression model ‘monomodality’, more than half of the variables are stated to have a significant influence. As the constant is very small and stated to be not significant, the variables of the model explain to a high

degree whether a person is a monomodal car user or not. Statistically significant factors that enhance monomodality are: part or full time work, a high net-income, small community size, a high affinity towards cars and a low affinity towards public transport. Monomodal car users are less often aware of car sharing than the rest of the sample. Furthermore, monomodal car users are more likely to be male and to have no interest in using a car sharing service however, the variables 'gender' and 'willingness to use car sharing' have no significant influence.

Multimodal users are the counterpart to monomodal car users. In comparison to the model 'monomodality', the model 'multimodality' calculates for each of the variables a coefficient with an opposite sign. As the mobility behavior of multimodal persons varies more than that of monomodal persons, the model is less explanatory. Only two variables are statistically significant. Nevertheless, the results demonstrate that multimodal persons are an important target-group. 80 % of them live in a car owning household. As they tend to have a low car affinity and positive attitudes towards public transport as well as a high preparedness to use car sharing service, it seems to be more likely that they replace a car by using car sharing than it can be expected for other groups. Developing target-oriented concepts, it has to be taken into account that multimodal persons are not a homogeneous group. A closer look at the multimodal sub-groups is necessary.

4.4 Market potential of car sharing

The market potential of car sharing was calculated by filtering out all persons of the sample who fulfill a certain number of criteria.² The criteria used below are based on the following assumption: all persons not too strongly fixed on the car in terms of their behavior as well as their attitudes are potential candidates for car sharing. To reveal the German car-sharing potential the identified sub-sample was extrapolated to the total population of Germany.

'Objective' criteria used for the calculation are:

- having a driving license,
- low frequency of car use,
- car predominantly used for maintenance and leisure activities (in other words: car is not used for regular trips to work as the barrier to acquire customers among this group were seen to be too high),
- low annual mileage,
- residence in larger municipality or town.

'Subjective' criteria taken into account are:

- rational and functional-oriented attitudes towards cars,
- positive attitudes towards public transport,
- open-mindedness to the idea of sharing a car.

² Similar criteria have been used for the estimation of the German car sharing potential that was carried out by Baum/ Pesch (3). The calculation came up to a potential of 2.45 million car sharing users. The problem at that time was the lack of an eligible data set that included all variables needed. Instead, different data sets were used whereby, it was impossible to consider all necessary variables at once.

The car sharing potential varies greatly, depending on the exact definition of the single criterion. Therefore, the result is not a single value but a margin of the possible amount of car sharing users in Germany.

The criterion 'residence in larger municipality or town' is fulfilled given that people living in municipalities with less than 20,000 inhabitants have been excluded from the sample (cp. section 3).

The theoretically largest potential for shared-use vehicle systems are all persons owning a driving license. 85 % of the respondents fulfill this criterion. Extrapolated to the target population (34.8 million people) this corresponds to a market potential of 29.6 million persons. This figure constitutes the basic value for the following considerations.

The first part of Table 4 demonstrates the reduction of the initial value of 29.6 million caused by each of the 'objective' criterion using different specifications. The criterion with the highest effect on the initial value is the frequency of car use. If defined as a maximum of several times a month, the share drops down to 17 % (5.2 million people). If all three 'objective' criteria are combined, the values vary from 4.2 to 9.1 million depending on the exact definition of a low frequency of car use and the annual mileage.

For the next step, consideration was given to 'subjective' criteria (second part of Table 4). To measure whether the respondents fulfill these criteria, the results of the factor analysis described in section 4.2 were used:

- The factor 'car-affinity' was used to measure the criterion 'rational and functional-orientated attitudes towards cars';
- the factor 'affinity towards public transport' stands for the criterion 'positive attitudes towards public transportation' and,
- the factor 'car sharing affinity' was used for the criterion 'open-mindedness to the ideas of sharing a car'.

In variant 1 only one 'soft' criterion – positive attitudes towards the idea of sharing a car – is required. In contrast to that variant 3 is the strictest one as all three factors described in the list above are included. After balancing the different calculations, variant 3 is regarded as the most convincing one for the following reasons:

- Using shared vehicles means that for most of the daily trips other vehicles than cars are used. Public transport plays a crucial role in this context as it becomes the backbone of daily mobility for many car sharing users. Therefore, positive attitudes towards these kind of transport modes are important.
- Besides, a relatively rational disposition to the car as well as a general openness towards the idea of sharing a car with others seems to be a necessary condition.

On the basis of these considerations, the market potential of car sharing amounts to 1.5 to 2.0 million persons. This potential refers to all 683 German municipalities with 20,000 inhabitants and more. As not all of these cities possess car sharing offers, two time frames can be pointed out to reach this potential. In the medium-term – based on the today's distribution of shared-used vehicle systems – 1.1 to 1.4 million of the above mentioned customer potential can be realized. Therefore, the highest potential can be achieved on the basis of currently existing car sharing services. The rest of the potential can only be realized by extending the offer in cities where at present no offers exist.

In comparison to others, potential car sharing users can be described as follows: they cycle and use public transport more often, they have more experience in sharing a car with others, they are less often the main user of a privately owned car and they more frequently hold season-tickets for public transport. With regard to socio-demographic features, women are slightly more likely to be potential customers of car sharing services. The potential of car sharing is especially high in big cities. About half of the potential car sharing users lives in cities with more than 500,000 inhabitants. Among the 26 to 35 year age group, the proportion of potential car sharing customers is especially low.

5. CONCLUSIONS

An important policy question is how the wide gap between the current number of car sharing users and customer potential can be closed. The results of the study reveal several starting-points.

First of all, part of the potential is lost as shared-use vehicle systems have a low profile. Even when people who are generally open-minded towards sharing a car become aware of this service, it is a far step before actually using it. Buying and giving up cars are long-term decisions affecting daily life in many ways. They occur only in longer intervals and usually take some time to consider. All the more, it is important that within these situations people are aware of this alternative to owning a car. In this context, car sharing organizations should pay attention especially to people with multimodal mobility behavior.

People aware of or already using shared-use vehicle systems share the same profile, including higher than average educational and net-income levels; people with low income, for whom car sharing is especially interesting, are often not aware of this service. This is one of the reasons for car sharing organizations to professionalize their public relations, marketing and their way of addressing target groups.

The 18 to 25 year age bracket is another important target-group. They are highly car sharing inclined but often don't know what shared-use vehicle systems are. The low awareness of car sharing among young people could easily be changed if car sharing would be part of the education in driving schools. Special offers for young people could help to win them over as customers and to convince them of the advantages of car sharing before buying their own car. At least in Germany, car sharing organizations are not really interested in getting young people as customers, due to their higher accident rate.

The importance of considering the 18 to 25 year olds becomes even more obvious when looking at the subsequent age group. The 26 to 35 year olds have the lowest share of car sharing inclined people. Thus, in a period of life during which many mobility relevant decisions are made (cp. section 4.2) car sharing is of little importance. For car sharing organizations, it is clearly important that people are aware of the service and, moreover, that they make use of it as an alternative to the private car before they reach the age of mobility relevant decision making.

The positive effects of car sharing can only contribute to solving traffic problems if the number of car sharing customers grows. For this reason it is important to promote car sharing as one element of an overall transport concept. As cycling and public transport become more important when using car sharing, the promotion of these modes is just as significant as the work of car sharing organizations. This way, the range of players with influence on further development of car sharing widens. Apart from car sharing organizations as a provider of mobility services, public transport companies and local authorities are important partners for car sharing organizations. Additional

important players are the National Car Sharing Association (*Bundesverband CarSharing - bcs*) as a lobby organization, and finally, the legislators at the federal and regional level.

There are several examples that demonstrate that a specific measure – even in strongly car-oriented society – can result in a much higher share of car sharing users. One of these encouraging examples is the district Vauban in the city of Freiburg (South-West Germany). For large parts of the residential area Vauban, the development plan prohibits the building of parking space on private property. Instead, private cars are parked in a communal car park located at the periphery of the residential area. Residents without cars are exempted from financing the communal car park when signing a contract and a ‘car-free declaration’ which has to be renewed annually. Almost 50 % of the households are car free. An evaluation of the concept (33) revealed that 33 % of all adults in the district are members of the local car sharing organization. Taking into account car ownership, 59 % of the people living in car-free households and 11 % of the people living in car-owning households take part in car sharing. The latter value is still remarkably high considering only 0.17 % of all a driving license holders in Germany use car sharing. The example proves that it is well worth promoting car sharing and that it is important to integrate the service in an overall concept.

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TABLE 1 Awareness of car sharing (basis wide definition, 33 %), Logistic regression model

Socio-demographic Variables	Regression coefficient	p-value	Exp(B)
Gender (0=female, 1=male)	-.544	.022	.581
Age	.018	.040	1.018
Education (1 = low; ... 5 = high)	.255	.020	1.290
Employment status (0= not employed; 1 = part time or full time employed)	.300	.237	1.350
Household net-income (1 = < 500 EUR; ... 7 = 3,000 and more)	.140	.083	1.151
Community size (1 = 20,000 to <50,000 inhabitants; ... 4 = 500,000 inhabitants and more)	.050	.627	1.051
Frequency of car use (1 = never; ... 6 = daily)	-.014	.926	.986
Frequency of public means of transport use (1 = never; ... 6 = daily)	.262	.001	1.300
Distance driven per year	.003	.508	1.003
Number of cars (0 = no cars; ... 4 = four and more cars)	-.005	.980	.995
Experience in sharing a car (0 = no; 1 = yes)	.162	.490	1.176
Constant	-4.634	.000	.010

N = 624; Nagelkerkes $R^2 = 0.116$

TABLE 2 Linear Regression analyses with factor ‘car sharing affinity*’ as dependent variable

	Beta	p-value
Gender (0 = female; 1 = male)	-.050	.184
Age	-.144	.001
Education (1 = low; ... 5 = high)	.062	.123
Employment status (0= not employed; 1 = part time or full time employed)	-.104	.011
Household net-income (1 = < 500 EUR; ... 7 = 3,000 and more)	.051	.244
Number of cars (0 = no cars; ... 4 = four and more cars)	-.044	.358
Car affinity*	-.176	.000
Affinity towards public means of transport*	.248	.000
Frequency of car use (1 = never; ... 6 = daily)	-.143	.005
Frequency of public means of transport use (1 = never; ... 6 = daily)	-.059	.235
Constant	.948	.001
N	633	

N = 633; * The values expressing affinity vary from -3 (no/ low affinity) till +3 (high affinity).
 $R^2 = 0,162$

TABLE 3 Logistic regression model with mono- and multimodal mobility behavior as dependent variable (N = 558)

	Monomodal car use		Multimodal mobility behavior	
	Regression coefficient	p-value	Regression coefficient	p-value
Gender (0 = female; 1 = male)	.125	.529	-.043	.829
Age	.000	.966	-.001	.905
Education (1 = low; ... 5 = high)	-.159	.127	.153	.130
Employment status (0 = not employed; 1 = part time or full time employed)	.821	.000	-.522	.014
Household net-income (1 = < 500 EUR; ... 7 = 3,000 and more)	.183	.003	-.048	.433
Community size (1 = 20,000 to <50,000 inhabitants; ... 4 = 500,000 inhabitants and more)	-.273	.001	.312	.000
Car affinity*	.576	.000	-.150	.168
Affinity towards public means of transport*	-.556	.000	.151	.141
Car sharing affinity*	-.032	.761	-.076	.473
Awareness of car sharing (0 = no; 1 = yes)	-.528	.044	.341	.179
Readiness to use car sharing (0 = no; 1 = yes)	-.154	.461	.062	.767
Constant	.026	.966	-1.604	.008

N = 558; * The values expressing affinity vary from -3 (no/ low affinity) till +3 (high affinity).

Monomodal car use: Nagelkerkes $R^2 = 0.256$

Multimodal car use: Nagelkerkes $R^2 = 0.086$

TABLE 4 Calculation of the market potential of car sharing

True for all following values: Those possessing a driving license and living in cities with 20,000 inhabitants or more. These criteria apply to 29.6 million people in Germany (basic value)			
‘Objective’ criteria	Specification of variable	Share of people fulfilling the criteria	Projection of total value (in million)
Car predominantly used for maintenance and leisure activities	A car is not used for regularly trip to work	51 %	15.1
Low frequency of car use	B.1 maximum car use several times per week	40 %	11.9
	B.2 maximum car use several times per month	17 %	5.2
low annual mileage	C.1 <= 15,000 km	72 %	21.3
	C.2 <= 10,000 km	53 %	15.7
Combination of all three objective criteria	A, B.1, C.1	31 %	9.1
	A, B.2, C.1	15 %	4.4
	A, B.1, C.2	25 %	7.3
	A, B.2, C.2	14 %	4.2
True for all following values: Those possessing a driving license and living in cities with 20,000 inhabitants or more. Car is not or only rarely used on the way to work (or person does not work). In case the person is a main user of a car, the annual kilometers driven is below 10,000 km.			
‘Subjective’ criteria	Car use: less than a) Daily b) Several times a week	Share of people fulfilling the criteria	Projection of total value
Variant 1: Positive attitudes towards car sharing	a)	14 %	4.3 million
	b)	9 %	2.6 million
Variant 2: Positive attitudes towards car sharing and rational attitudes towards cars	a)	10 %	3.0 million
	b)	7 %	2.0 million
Variant 3: As variant 1, additional positive attitudes towards public transport	a)	7 %	2.0 million
	b)	5 %	1.5 million