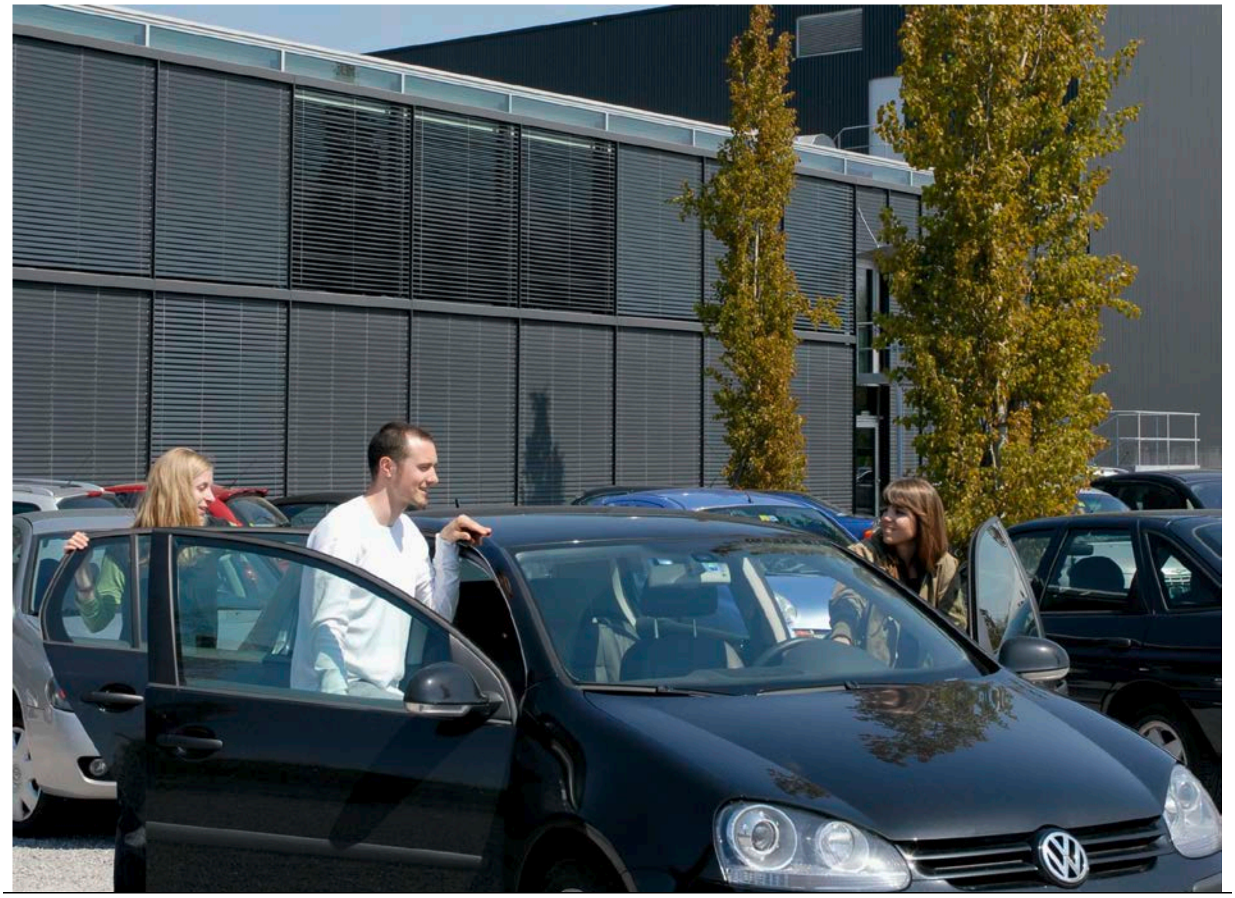

Potential of car-pooling in Switzerland

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Abstract

Car-pooling (or ride-sharing) can be defined as the activity in which a person takes other persons in his own car during a trip which he needs to carry out in any case, that is, these individuals are pooling to use one single car for their travel. Despite some success in the last decades it is commonly believed that the potential of car-pooling is far from being fully exploited, letting unused a simple but possibly effective way to improve mobility efficiency and sustainability.

In a research project funded by the Swiss Federal Roads Authority it was the aim to determine the potential of car-pooling in a larger urban area in Switzerland. For this a completely new research method was used, combining surveys (including stated preferences) and simulation. In this way it has been possible to consider both objective and subjective aspects of car-pooling.

The result is that with an extensive implementation of car-pooling about 30% of individuals who usually travel with their own car, would car-pool. This generates various benefits with respect to the transportation system and the environment (i.e. travelled kilometres, CO2 emissions, etc.) with reductions in the range of 10-20%.

One focus of the project was on car-pooling among commuters. It turns out that also in small companies, with less than 100 employees willing to participate to car-pooling, a large potential exists. Unfortunately, the pre-conditions today are not favourable and, therefore, under the existing circumstances, the potential can be only exploited in a very limited way.

Keywords

Car-pooling – ride-sharing – potential – mobility survey – stated preference – simulation – Switzerland

1. Introduction

1.1 The Relevance of Car-Pooling

Car-pooling means that people share a car to travel together to their destination. Taking a look at today's use of the road network, it is obvious that car-pooling is one of the last highly relevant options to improve the efficiency in the transport domain: whereas goods transport, air transport and public transport are already optimized to a large degree, there is still plenty of empty space in private cars. What is the reason for this?

Car-pooling could become very relevant on the ecological level. Sharing rides means saving car transport, thus lowering the energy consumption and the environmental impact, including a positive effect with respect to the climate change problem. Certainly a vast majority of the population would agree that car-pooling has a positive ecological impact. Nevertheless only a small minority makes the step from conviction to practice.

On a first thought one would say that bringing together drivers and passengers is an information problem. People not knowing each other have to get the information that their rides match for a car pool. In fact hundreds of car-pooling services exist all over the world. But even with the most up-to-date means of information technology no one succeeded so far in making car-pooling a mainstream application [Sfcarshare].

There might be a psychological problem. The car might be considered as something very personal not to be shared with strangers. Or the trip with one's own car is considered as a piece of individuality, where people don't want to depend on others. But sitting close to each other in a train and sticking to timetables doesn't seem to be a real problem. Why should the transport by car be so different?

May be the benefits are not obvious. The low mobility costs might not cause enough incentives to share rides [Brownstone 1992]. In fact the acceptance of car-pooling seems to be higher in times of economic crisis and in areas with higher mobility costs as compared to the average income [Galizzi 2004, Huang 2000].

It is generally accepted that car-pooling has a critical mass problem. As long as there are only few users of a car-pooling service with disperse rides to be shared, the probability of finding a match with another user is very low. At this stage the service is not very attractive and therefore it is hard to acquire new users. Only with a critical mass of users, the matching probability and with it the success of the service is big enough to attract more users. Car-pooling might already be successful in some niches, but obviously no platform so far has reached the critical mass to become relevant for every day's transport.

There might also be a matching problem. Rides have to fit with respect to their starting point and destination, as well as in time. Even if only these parameters are considered, the number of matching candidates is limited. Could it be that even on a large scale the probability of finding a matching partner to establish a car pool is not high enough to end up with a significant increase in car occupancy?

Many projects in the past tried to implement and promote car-pooling. For instance within the R&D programme of the European Union projects like CARPLUS, ICARO, TECAPSY and TAPESTRY had this goal. There has been a significant amount of research on various social aspects of car-pooling [Buliung 2009, Buliung 2010, Ozanne 1999, Winn 2005], including the question, under what condition people would share their rides and what are the main obstacles. But when it comes to the potential of car-pooling, nobody so far could answer the question, how large it is.

This research project combines a number of innovative methods and follows a completely new approach, not to add some theoretical thoughts, but to come up with a practically approved answer on what is the potential of car-pooling in a specific area in Switzerland. It determines the potential not under the assumption of a certain behaviour of potential car-pooling candidates, but on a realistic behavioural model derived from stated attitudes of an average Swiss population towards car-pooling.

1.2 The Method of Investigation

The main ingredients to the new approach chosen for this research project are simulations and surveys. Let’s start with the simulations.

The simulation setup was an area given by a circle with a radius of 30km around the city centre of Zurich and a typical weekday. All rides of people within the area, with origin or destination inside the area or in transit through the area were considered. In the simulation, the people were represented by agents, with a chain of activities (staying at home, working, education, shopping or leisure) throughout the day being assigned to each agent. The spatial distribution and times of the activities were selected such that they are in good coincidence with the real-life activities and that the amount of traffic caused by moving from one activity to the next corresponds to the measured traffic volumes within the area. A mode of transport was assigned to each ride between two activities on a random basis, with the overall distribution among transport modes again corresponding to the real-life situation.

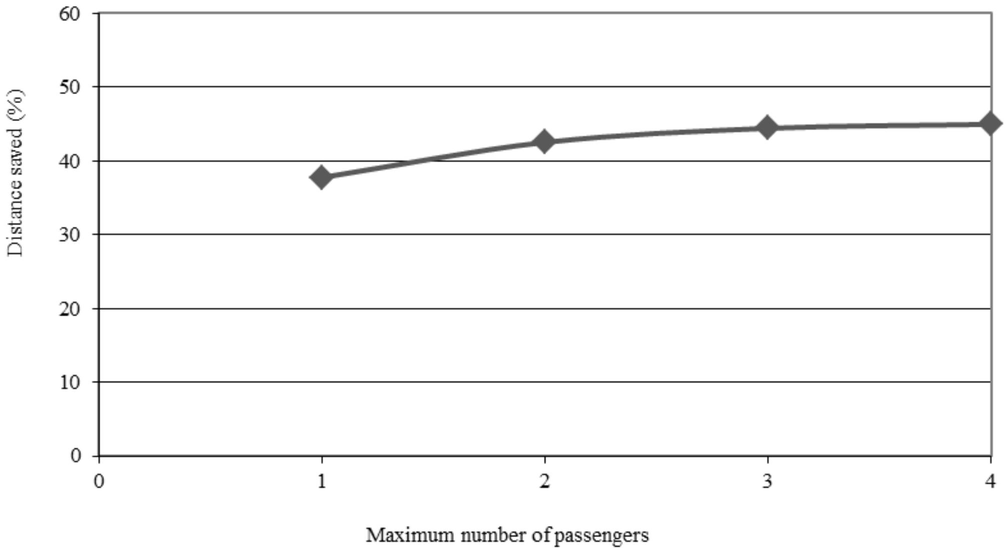
The data on this setup were generated using the mobility simulation tool MATSim [MATSim]. Then the data were handed over to an automatic matching process generating candidate couples of drivers and passengers for car pools. The matching software is part of the car-pooling platform RideShare developed by PTV SWISS AG [RideShare]. Only rides originally executed with the private car were considered. The reason is that the highest (economic and ecologic) benefit is caused when an individual joins a car pool instead of using its own car. Priority should therefore be on this type of modal shift. A second round of matching between remaining drivers and users of other transport modes (like public transport, bike rental etc.) may be beneficial in some special cases, but in general would not cause a major contribution to the positive effect of car-pooling.

To start with, the matches were generated purely based on technical parameters like the detour time of the driver to pick up the passenger at his origin and to drop him off at his destination, and the temporal coincidence of the two rides. A number of simulation runs were executed, each of them having slightly different matching properties. For instance one run was executed with the additional condition that the origin and destination city (i.e. the zip code) of the driver ride and the passenger ride had to be the same. In general, this is not required as there are useful car pools where the ride of the passenger is only on a section of the driver's ride. The aim was to find out how much this less sophisticated matching algorithm decreases the matching probability.

The whole list of rides was processed in sequence. Having generated a list of candidates to share one of the rides, the question was if the agents involved would opt for the car pool. To decide, a behavioural model was used. This model will be described in more details further down. To complete the description of the process first: If there were candidates matches that would fit – based on the outcome of the behavioural model – the one that would fit best was selected and the corresponding car pool was added to the car pool list. The driver ride and the passenger ride in the car pool were both deleted from the input list, such that they could not be selected for another car pool. Then the procedure was repeated for the next ride, etc. In the end there was a final list of car pools that could be evaluated with respect to the impact on traffic volumes, parking demand and the environment.

It is obvious from the process description that all car pools listed have only one passenger. The reason for this was purely technical. The handling of car pools with several passengers would have been too complex on the large scale. But on a smaller scale additional simulation runs were executed, investigating in detail, among others, on the effect of car pools having more than one passenger. These simulations were based on lists of employees of selected Swiss companies. The rather surprising result was that the effects of car pools being open for more than one passenger is only minor, as can be depicted from Figure 1.

Figure 1 Simulation of potential car pools among 385 employees of a company for their travel to work. Several simulation runs were executed, each of them with a different maximum number of passengers in the car pools. The total distance saved with all car pools is evaluated for the various simulation runs.



The aim of the behavioural model was to determine, if an agent would share one of his specific rides. The behaviour of the agents determined with the model should, on the average, correspond to the expected behaviour of the population in the considered area. How was the behaviour of the population determined? Through a stated preference survey: For each person included in the survey a ride was selected, which took place in the week before the interview. For this ride, several situations were generated, with each situation including several options with different transport modes to perform the ride. The options were described in terms of a number of parameters like travel time or travel costs, and in each situation these parameters for the various options were different. The person had to decide in each situation, which option and therefore which transport mode he or she would select. The options included, among others, rides with the private car and car pools with both the driver's and the passenger's role.

This was the input for the behavioural model. It should be pointed out that this input is not an abstract decision in an abstract situation, but a real decision of individuals in a real-life situation. The model as such indicates benefit values, as viewed by the agent, for the various options under specific circumstances. Only the three options non-shared ride with one's own car, car-pooling as driver and car-pooling as passenger were considered. The model is linear, which means that each parameter describing the circumstances, in which it is applied, is multiplied with a significance value to yield the contribution to the benefit. For instance travel costs have a negative significance value, which means that higher costs cause a decrease of the benefit.

The model was fine-tuned such that in the situations used as input for the survey, the option with the highest benefit corresponds in a maximum number of cases to the option selected by the respondent. Parameters where only kept in the model when they had a significant influence. It turned out that besides some parameters describing the circumstances of the ride, properties of the agents like gender or the education were also relevant. Furthermore the survey included a number of general questions, for instance on the attitude of the respondent towards car-pooling. It turned out that some of these questions were also relevant in the sense that the answer given on the question correlates with the choice made on the transport options. The possible answers to the questions were also included in the behavioural model as a parameter.

The application of the model in the simulation was as follows: Values for all person-related parameters included in the model were assigned to the agents on a random basis, but such that the value distribution corresponds to the real-life distribution. For parameters relating to the circumstances of the rides, the values were taken from the rides of the car pool candidates in the simulation or, where this was not possible (like for instance the parking costs), were assigned with a random distribution leading to realistic values. Based on the parameter values, the benefit was calculated both for the option of driving with one's own car and the option of car-pooling (in the role assigned to the agent in the match considered). Only if the sum of the car-pooling benefit of the driver and the passenger was higher than the sum of the benefits of the two agents when travelling alone, the match was kept in the candidate list for a car pool. It was assumed that even if one of the agents had a negative benefit balance for car-pooling, but the other agent had a larger positive balance, the car pool would be installed and the agent with the positive benefit balance would pay the other one such that as a result both would be favourable to the option of car-pooling. In the end the car pool selected from the list of the remaining candidates was the one with the largest overall benefit for the car-pooling option.

2. The General Survey

The survey executed in the framework of the research project had two parts: a general survey and the stated preference part. Let's concentrate on the general survey first. It was clear from the beginning that it was required to find out how many of the possible shared rides found in the simulation would really take place. But it was unclear at this stage, which factors would influence the choice. Therefore the decision was taken to make a broad survey, including questions about all aspects of car-pooling. In the end, it turned out that only four questions had a significant influence on the behavioural model used in the simulation. The results on these questions will be presented first, before picking out some other questions that lead to interesting insight in how car-pooling is perceived.

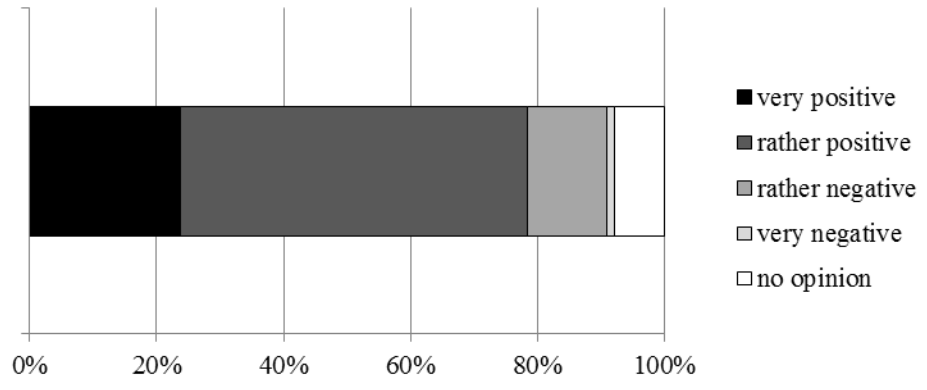
In Switzerland, there is a continuous survey on personal mobility on behalf of the Swiss Federal Railways (SBB) [Schweizerische Bundesbahnen 2001]. It is executed via telephone interviews. This survey was used to recruit the candidates for the specific car-pooling survey of the research project. A question was added temporarily to the continuous survey, asking if the respondent would be willing to answer a list of additional questions on car-pooling. Between August 2010 and April 2011, a total of 1,683 candidates could be recruited. The questionnaire was sent to them via post mail and a total of 881 questionnaires were received back. The respondents are from the whole of the German and French speaking part of Switzerland. Of course it would have been better to restrict the survey to the area investigated in the simulation, but then the size of the sample would have been too small for a reliable evaluation.

The general survey included a total of 15 specific questions about car-pooling and a number of general questions. The following presentation of results concentrates on the car-pooling questions. The four that turned out to be relevant for the behavioural model were as follows:

"What is your attitude towards car-pooling based on a matching service?"

The possible options for the answer were "*Very positive*", "*Rather positive*", "*Rather negative*", "*Very negative*" and "*No opinion*".

Figure 2: Evaluation of the question on the attitude towards car-pooling.



The result is shown in Figure 2. It turns out that almost 80% of the respondents have a very positive or rather positive attitude towards car-pooling.

"*What is your experience with car-pooling?*"

The answering options were the same as in the first question except that "*No opinion*" was replaces by "*No experience yet*".

Figure 3: Evaluation of the question on the experience with car-pooling.

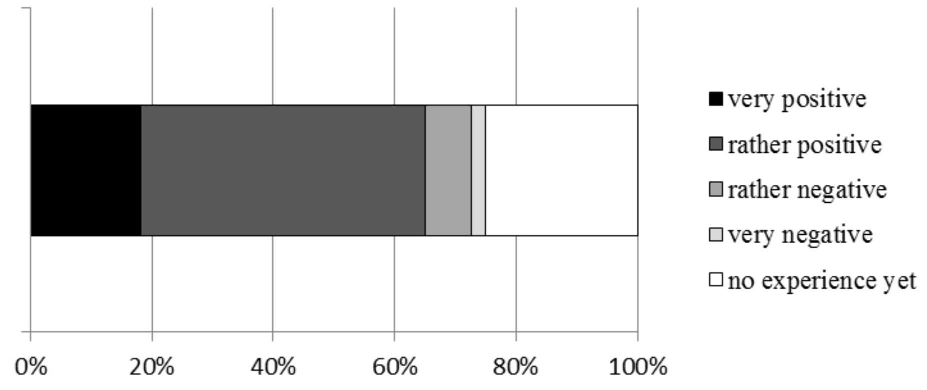
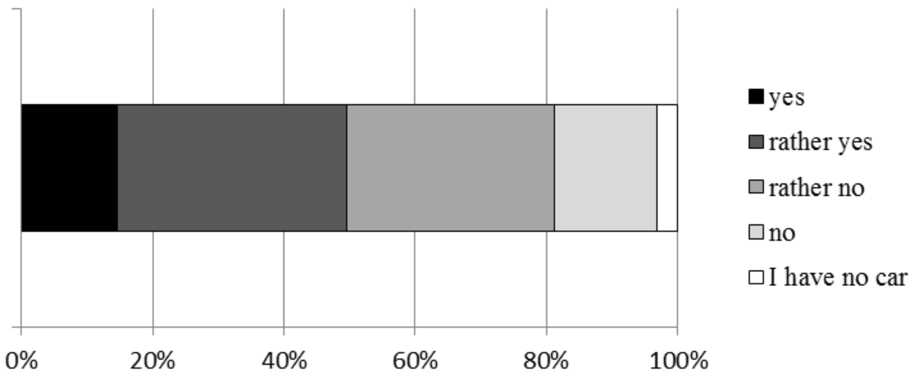


Figure 3 shows the result. It should be pointed out that this question was asked in a context, where rides shared with colleagues were explicitly included. This might be the reason that about three quarters of the respondents indicated that they had experience with car-pooling. This experience was mostly positive.

"*Would you be ready to share a ride in your own car with a person found via a car-pooling platform?*"

Here the options to answer the question were "*Yes*", "*Rather yes*", "*Rather no*", "*No*" and "*I have no car*".

Figure 4: Evaluation of the question on the willingness for car-pooling as driver.

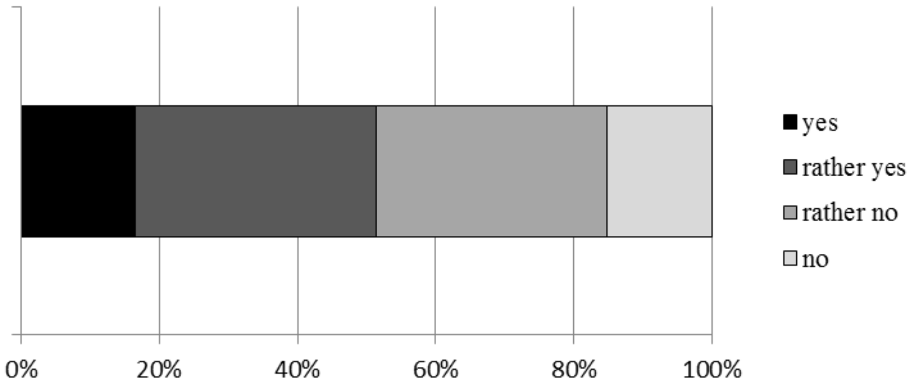


As is shown in Figure 4, only about half of the respondents are ready for car-pooling as drivers. Quite a significant percentage has a positive attitude towards car-pooling, but thinks that it is only something for the others.

"*Would you be ready to travel with a person found via a car-pooling platform in his car?*"

Here the respondents had the same options to answer as in the previous question, except that the last option was missing.

Figure 5: Evaluation of the question on the willingness for car-pooling as passenger.



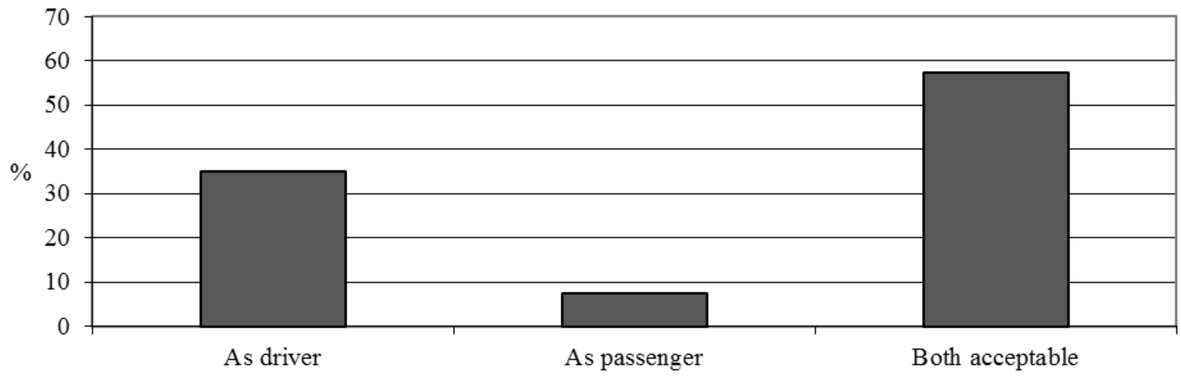
There is no significant difference between the answers on this question (Figure 5) and the previous one.

The following four questions have no direct relevance for the behavioural model and therefore the main result of the research project. But evaluating them is useful to get a more complete picture on the opinions about car-pooling.

"*If a shared ride is possible both with you being driver and with you being passenger, which option would you prefer?*"

The possible answers were "*As driver*", "*As passenger*" and "*Both acceptable*".

Figure 6: Evaluation of the question on the preferred role.

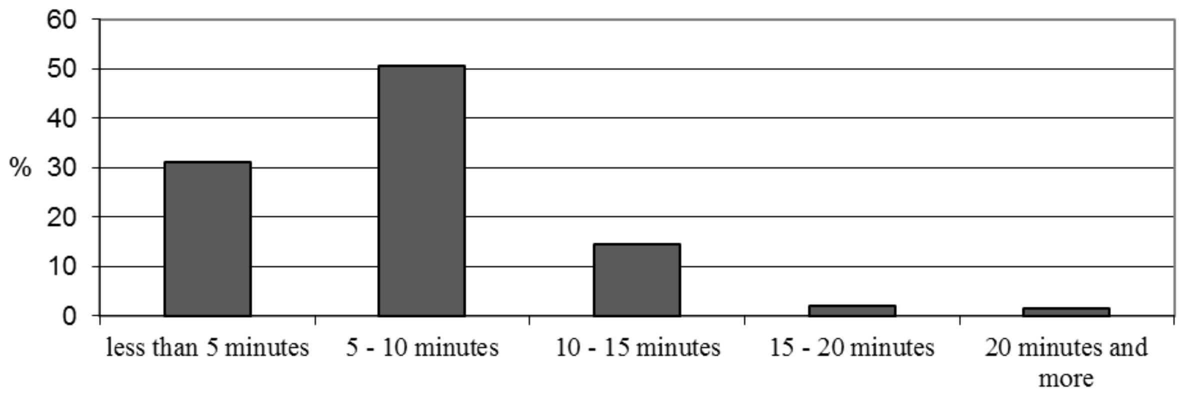


The answers to this question are interesting because they seem to be in conflict with those to the last two questions. The majority of respondents would accept both roles, which is positive, because it enhances the flexibility when searching for ride matches. But from those respondents preferring one role, the vast majority would like to be driver. This is unexpected, because on the level of the willingness to participate, both roles had about the same number of positive answers.

"*What detour time would be o.k. for you to pick up somebody in a car pool?*"

For this question the options were "*Less than 5 minutes*", "*5 to 10 minutes*", "*10 to 15 minutes*", "*15 to 20 minutes*" and "*20 minutes and more*".

Figure 7: Evaluation of the question on the maximum detour time.

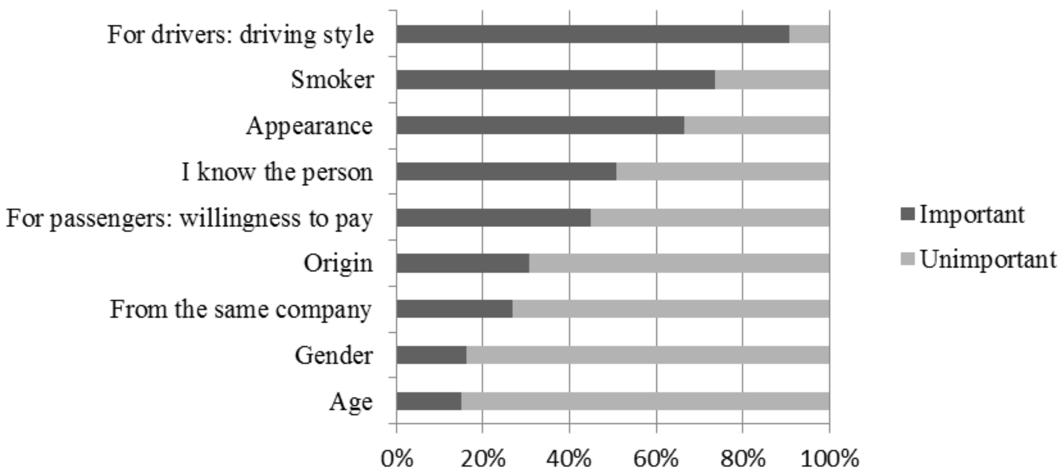


This question was included in the survey, among other reasons, because it contains an implicit measure for the willingness to participate in shared rides. As can be depicted from Figure 7, this willingness is rather modest. For most respondents the detour time must be less than 10 minutes.

"*What properties of a car-pooling partner are important for you?*"

Respondents could indicate for the following list of properties, if they were considered as important or as unimportant: "*Gender*", "*Age*", "*Origin*", "*A person I know*", "*From the same company*", "*Appearance*", "*In case of drivers: driving style*", "*In case of passengers: willingness to pay*".

Figure 8: Evaluation of the question on the properties of the car-pooling partner.

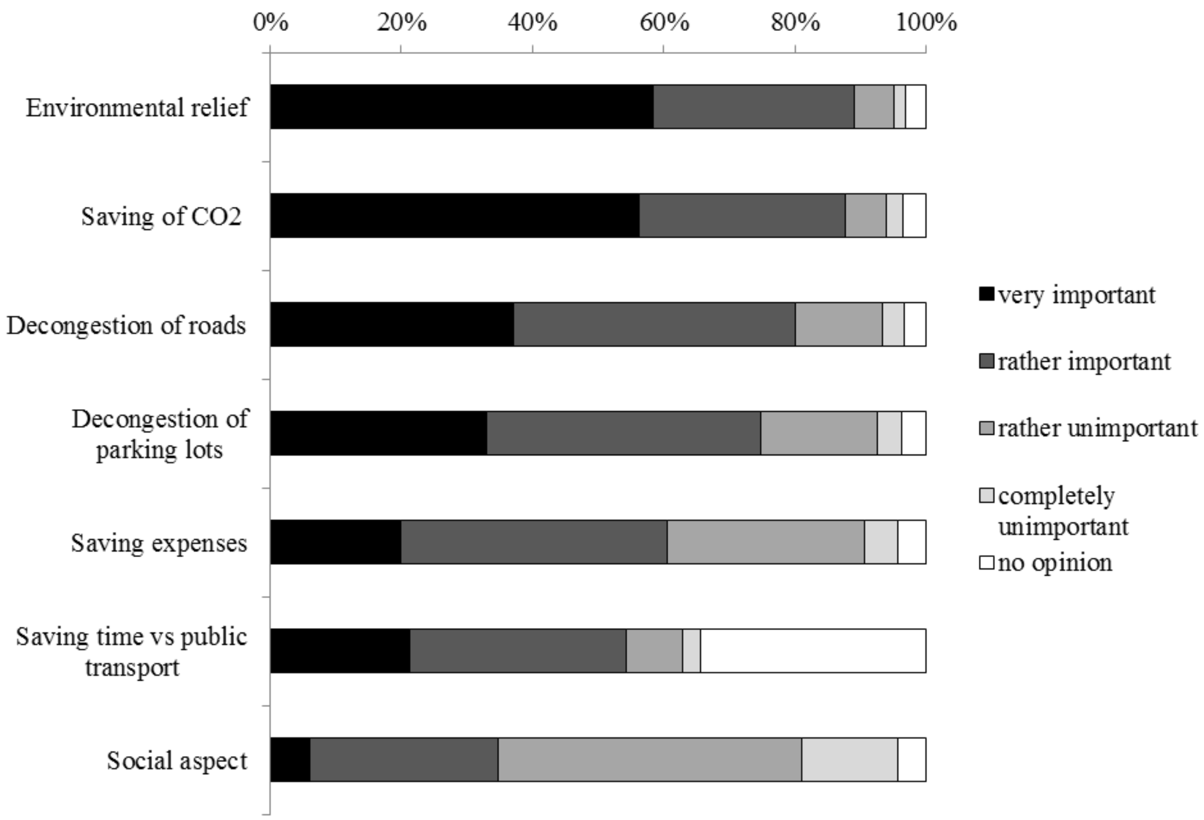


The favourite property (c.f. Figure 8) is quite a surprise: the driving style. People seem to be afraid of a rude way of driving. On car-pooling platforms, there is usually the option to indicate a preferred gender of the ride partner. But according to the result of the survey, this property is almost the least important!

"*In your opinion, how important are the following properties of car-pooling?*"

A number of properties were listed and for each property there was a choice among the five options "*Very important*", "*Rather important*", "*Rather unimportant*", "*Completely unimportant*" and "*No opinion*". The properties were as follows: "*Saving costs*", "*Establishing and fostering social contacts*", "*Saving time as compared to public transport*", "*Decongestion of roads*", *Decongestion of parking lots*", "*Environmental relief*" and "*Saving of CO2*".

Figure 9: Evaluation of the question on the properties of car-pooling.



The results on this question are shown in Figure 9. It is obvious that the expected benefit of car-pooling is considered to be rather on the society level than on individual advantages. There are two possible interpretations of this result: Either society aspects are generally considered to be more important or people believe that car-pooling has no major personal advantages.

3. Sated Preferences and Behavioural Model

The stated preferences part of the survey was a little bit broader than needed as input for the behavioural model used in the simulation. The reason was mainly that in this way it became partly comparable to other stated preference surveys, thus enhancing the confidence in the results achieved [Ciari 2012]. For instance public transport was included as a transport mode option. The following presentation of results restricts to those aspects being important for the further investigation, namely on the transport modes private car, car-pooling as driver and car-pooling as passenger.

The private car option was described by the following parameters: fuel costs (calculated based on the length of the ride), parking costs (assumed values, as no information about it was available), driving time (calculated with a routing tool, also considering the typical traffic situation at the given time of the day) and walking time (to get to the car before the ride and from the car to the destination after the ride).

The parameters used for the car-pooling as passenger were travel costs (contribution to be paid to the driver, in the average 50% of the fuel costs), travel time (including 5 minutes of waiting), walking time (average of 5 minutes), the type of driver (colleague, previously known person, previously unknown person) and the risk to miss each other. For car-pooling as driver, the parameters were a mixture of those assigned to the private car option and those of the car-pooling as passenger. They included costs (fuel costs minus contribution from the passenger), parking costs, travel time (including 5 minutes waiting time), walking time, type of passenger (same options as in the car-pooling as passenger case) and the risk to miss each other.

All parameter values varied in the 9 situations presented, making the different options more or less attractive, such that the preferences no always tended to the same option. The software tool Biogeme was used for the evaluation and the construction of the behavioural model [Bierlaire 2003]. The model was set up step by step. In the beginning, only few parameters were included. Then further parameters were tested for inclusion, only selecting them if they had a significant impact, meaning that the benefits of the various options heavily depended on their value. The final model included 23 parameters for the three options considered. For each of these parameters, a sensitivity value and a p-value were determined. The p-value is a measure to indicate the significance of the parameter in the model: lower p-value means higher significance.

Table 1: Sensitivity values and p-values for the various parameters considered in the behavioral model. * means that the parameter is less significant (as indicated by the higher p-value), but still kept in the model.

Option	Parameter type	Parameter name	Sensitivity	p-value
All in common	Variable	Travel costs	-0.0569	0
	Variable	Waking time	-0.0438	0
Private car	Property	Constant[1]	*-0.335	0.23
	Variable	Travel time	-0.03	0
	Variable	Parking costs	-0.065	0.04
	Property	Gender male	0.652	0
	Property	Car always available	0.401	0
	Property	Inertial value[2]	0.767	0
Car-pooling as driver	Property	Constant	*0.23	0.3
	Variable	Driving time	-0.0348	0
	Variable	Parking costs	-0.154	0
Car-pooling as passenger	Variable	Travel time	-0.0379	0
Car-pooling both roles in common	Property	Positive experience with car-pooling	*0.104	0.24
	Property	Gender female	-0.639	0
	Property	German speaking	0.167	0
	Variable	Size of household	0.089	0
	Property	Ride to/from work	*0.0553	0.42
	Property	Positive attitude towards car-pooling	0.981	0
	Property	Higher education	*0.101	0.13
	Property	Car pool mate is previously known	0.268	0
	Property	Car pool mate is colleague	0.296	0

[1] Indicates the higher benefit assigned to this option independent of any other properties.

[2] Indicates the higher benefit assigned to this option due to the fact that it was used in the real-life ride investigated.

Variable	Risk to miss each other	-0.0487	0
Property	Readiness for car-pooling	0.371	0

The calculated sensitivities and p-values are shown in Table 1. The parameters travel costs and walking time, appearing in all three options, in fact had almost the same sensitivity everywhere. They were therefore only listed once. Furthermore a number of parameters appeared in both car-pooling options and had almost the same sensitivity there. They were listed only once for the two options. In time-related parameters the sensitivity indicates the increase/decrease of the benefit value for one minute of additional time. For the cost related parameters the sensitivity indicated the increase/decrease for costs augmented by one Swiss franc.

It's worth noting that the private car is more attractive for male respondents by the benefit amount of 0.652 and car-pooling is less attractive for female respondents by the benefit amount of -0.639. Looking at the benefit difference of car-pooling as compared to the private car, both genders have a negative contribution of about the same value, meaning that the perception of the attraction of car-pooling is about the same for both genders. As could be expected, car-pooling is generally less attractive as driving alone in the private car, but a positive attitude towards, experience with and readiness for car-pooling can almost outweigh the difference.

4. The Simulation

To cover the area with a radius of 30km around Zurich, a total of 601,788 Agents was generated, with a total of 2,014,993 rides, in which initially the private car was used. The total distance of these rides is 23,540,957km, corresponding to an average route length of 11.68km.

The agents were listed in a random sequence and starting with the first agent, a search for car pool candidates was executed. Both the maximum detour time of the driver (assuming that he picks up the passenger at the location of his last activity before the ride and drops him off at the location of his next activity) as well as the temporal deviation of the two rides was restricted to 30 minutes, assuming that matches not fulfilling these two criteria would be so unattractive that they can be excluded in advance. As a third criterion, the detour distance of the driver had to be shorter than the ride distance of the passenger, as else the car pool would lead to an increase in the total distance travelled.

When applying the behavioural model (see section 3), some assumptions had to be made with regard to some of the parameters. For instance the parking costs were assigned on a random basis, assuming a parking duration between 0 and 4 hours (equally distributed) and average parking costs of 1 Swiss franc per hour. For parking at work a fixed price of 100 Swiss francs per month was assumed, the parking lot being used at 17 days per month on the average. For distances travelled by car a price of 0.7 Swiss francs per km was assumed.

A total of 5 simulation runs were executed:

- **Standard**: In this simulation run the inertial value of the behavioural model was not considered. The run should represent the long-term perspective, in which it is not relevant any more if the agents initially had travelled alone in their own car. There was the additional assumption that an agent would only accept the role of passenger in a car pool, if for the ride back he could also find a car pool, again with the role of passenger. In fact, the benefits were added up for the whole roundtrip to find out, if there was a net benefit for car-pooling.

- **Transition**: The difference between this run and the standard run was that the inertial value was included. In fact, as the initial situation considered for all agents was driving their own car, the benefit of car-pooling was lowered by the constant value of 1.534 for each car-pooling candidate (once the inertial value for the driver and once for the passenger). The interpretation of this run is that it represents the short-term potential of car-pooling.

- **Critical mass**: In the other runs, when searching for matches to a certain ride, all rides of the other agents were considered (as long as they had not yet been included in a car pool). For the critical mass run only those rides could become candidates that had already been investigated before and where no car pool was found yet. This corresponds to the situation where people start using a matching service, with the first user finding no car pool (as no other ride is registered), the second user only having the rides of the first one as potential candidates, the third only those of the first and second one etc.

- **Independent sections**: In this run, car pools in the role of the passenger were possible, even if no corresponding car pool for the trip back was found. The interpretation of this run is that in any case where there is no car pool available, some other attractive transport offers are available and can be used for the ride back (like for instance public transport or bike rental).

- **Same cities**: This run was based on the additional condition that the origin and destination of the two rides to be matched, had to be in the same city (i.e. have the same zip code). This run was included to find out, how much the car-pooling success was diminished by this non-optimized type of matching algorithm.

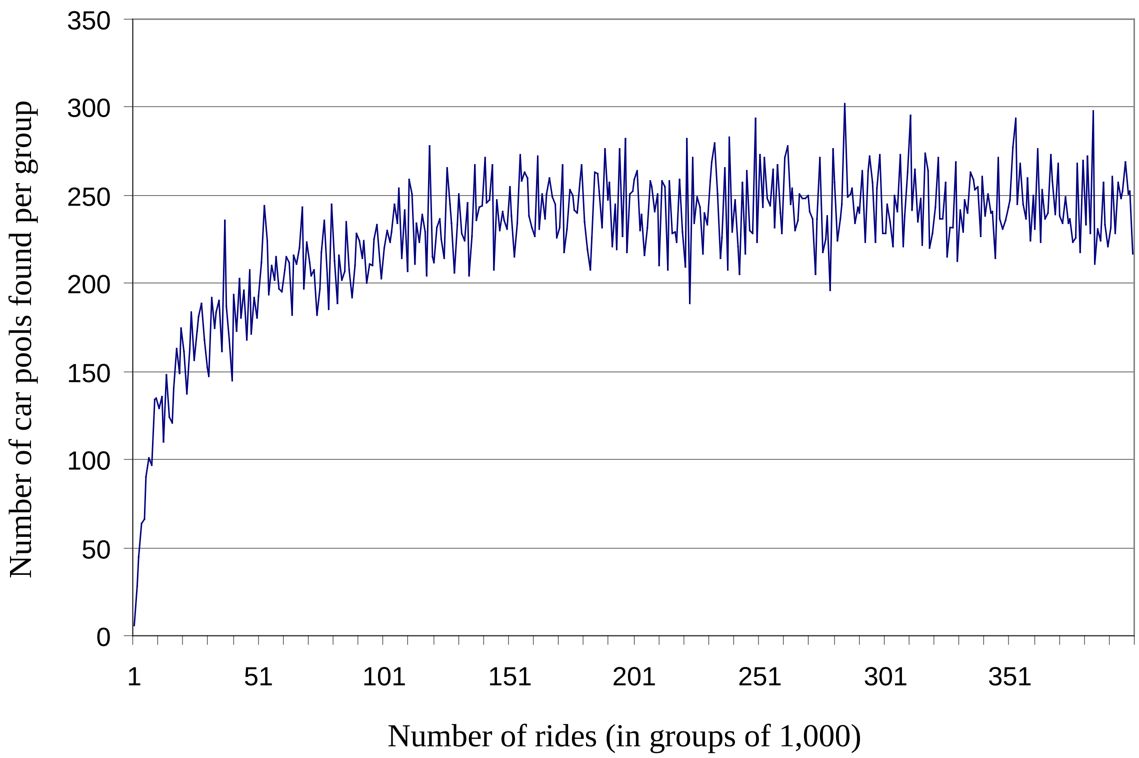
Table 2 shows the result of the simulation runs in terms of the percentage of car pools found (corresponding to the percentage of parking lots saved, as in every car pool the passenger doesn't need to take his own car with him), the percentage of rides being part of a car pool (i.e. twice the percentage of car pools as every car pool includes two rides), the increase of vehicle occupancy, the percentage of distance saved (being the relevant value for traffic volume decrease and environmental effects) and finally the savings in carbon dioxide emissions as an indicator for the ecological benefits.

Table 2: Result of the simulation

Simulation run	Percentage of car pools	Percentage of rides in a car pool	Increase of vehicle occupancy	Percentage of distance saved	CO2 savings per day (t)
Standard	29.7%	59.3%	0.42	17.5%	742.0
Transition	5.8%	11.7%	0.06	13.1%	554.4
Critical mass	31.3%	62.6%	0.46	14.4%	609.4
Independent sections	35.1%	70.3%	0.54	24.6%	1041.7
Same cities	9.4%	18.8%	0.10	2.6%	108.4

Taking the standard run as the reference, one may stay that almost 30% of the rides can be saved by car-pooling, leading to a decrease in the distance travelled of 17.5%. The remarkable fact is that even if the attraction of car-pooling is assumed to be much lower, like in the transition run, the distance saved is still almost the same. This is because the remaining car pools are those with a large positive impact, which means a large distance saved. As expected, the single sections run produced the best results, but the deviation from the results of the standard run was not dramatic. It is obvious that a good matching algorithm is crucial for the success of a car pooling service, as the distance saved with a less sophisticated algorithm drops by almost a factor of 7 (2.6% in the "same cities" run as compared to 17.5% in the standard run).

Figure 10: Simulation of the critical mass. For each ride, the search for car-pooling partners restricts to those agents previously investigated. The number of car pools established for groups of 1,000 rides is indicated.

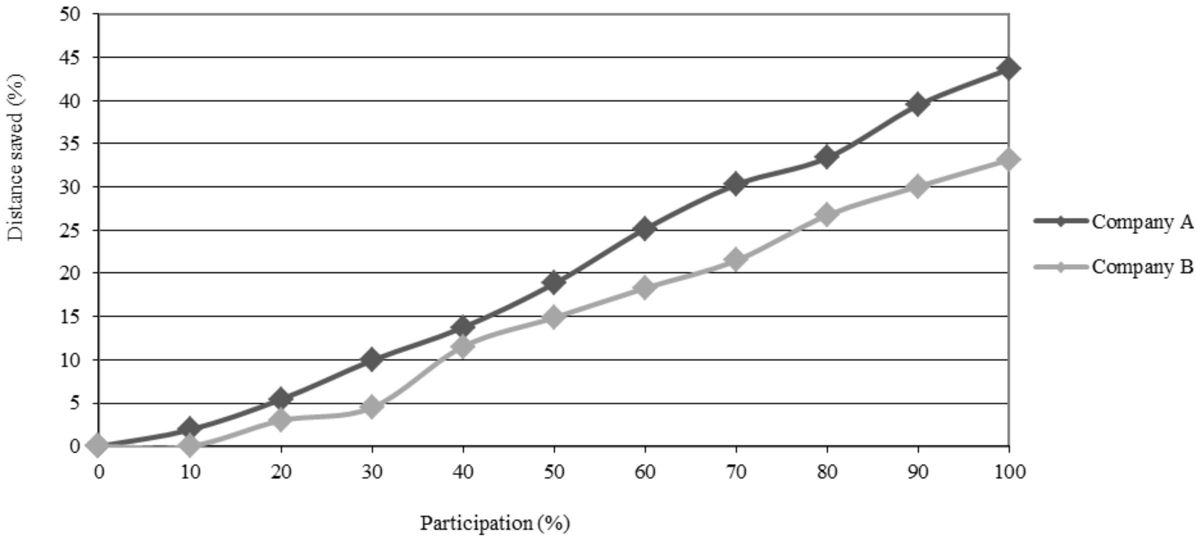


In the "critical mass" run, it is not the overall result requiring attention, but the amount of car pools in the beginning. To investigate on this, groups of 1,000 rides were built and for each group the number of car pools found was determined. As Figure 2 shows, the probability of finding a car pool is very low in the beginning, but already with 10,000 rides it is around 10% (100 car pools on 1,000 rides). 20% probability to find a car pool is reached at about 50,000 rides and above 200,000 rides (which is about 10% of the total number), there is no significant increase in this probability any more.

The number of several ten thousands of car-pooling users in the Zurich area to get the critical mass is quite large as a target. It is not a surprise that no car-pooling platform so far has reached it. The research project included an investigation on a specific way to avoid the critical mass problem: car-pooling among the employees of a company for their travel to work. A number of simulations were executed for five companies based on the home addresses and – as far as known – the working hours of the employees. One of the simulations considered different levels of participation in car-pooling. The surprising result was that there was no clear indication of a critical mass. Already with around 20 to 30 participating employees, the probability to find a ride-sharing partner was almost as high as with large numbers of participants.

Figure 11 presents the finding in a slightly different way: For two companies of different size, the distance saved with car-pooling is plotted against the percentage of participation. Even for the small company with only 73 employees there is an almost linear relation between the two parameters down to low participation rates.

Figure 11: Simulation of car-pooling for the travel to work in two selected companies. For company A, 385 employees were included, for company B the number of employees was 73. The figure shows the distance saved with car-pooling, depending on the percentage of car-pooling participation.



5. Conclusions

The potential of car-pooling in Switzerland might not be quite as big as assumed with a first optimistic estimation, but it is certainly considerable. If the potential is exploited, the impact on traffic volumes and on the environment is not to be neglected. In other words: it is worth making some serious thoughts on how to exploit it. The return on invest could be fantastic, as no major new infrastructures would be required.

Despite the failures in the past when trying to implement car-pooling on a large scale, this mode of transport still has a very positive perception. There is no need to further convince people that it is a good idea to join in. But it seems to be a long way from acceptance to implementation. A behavioural change is needed and this usually takes its time. Organisational issues have to be resolved and sort of a car-pooling culture has to be established.

The problem is that car-pooling can only be set up, if a lot of people decide to participate within a short time. The critical mass cannot be established with a long-term strategy. There are several options to solve this problem:

- Incentives can be used to make car-pooling attractive despite all existing obstacles. Ideally the incentives are all introduced at the same time and are massive enough to cause the intended short-term behavioural change. Cost benefits and shorter travelling times could be factors influencing the decision for car-pooling. It is worth mentioning that the massive incentives are only required in the beginning, to achieve the critical mass. Once car-pooling is successful on the large scale, it is attractive enough to become a self-seller.

- It is possible to implement car-pooling on a small scale, in especially favourable local situations first. Once established, it would certainly be easier to extend it. The first targets in such a strategy must be the companies. Each site of a company is basically such a favourable situation. Unfortunately, today there are many obstacles when trying to introduce car-pooling in this framework, like flexible working hours, a parking regime not adapted to car-pooling etc. On the other hand there is little interest to change this situation. As long as implementing car-pooling has no big advantage for the company as such, little will happen.

- There are too many car-pooling platforms. It is not attractive for users to search on 10 or 20 different platforms for a matching ride. Those promoting car-pooling should join their forces and agree on linking all existing platforms, such that all candidates for shared rides can be found in one step.

- Combining car-pooling with other transport modes might be a good implementation strategy. Shared rides have the big advantage that they are low-cost (as no separate driver is required). They have the disadvantage that they are not available everywhere at all times. For other modes of transport like taxis or car rental, it is the other way round. They are rather expensive, but have a high availability. Integrating the different transport modes in the sense that for each requested ride the best option is selected (or maybe even a combination of different options in a multimodal transport chain) would be the ideal solution.

Information technology creates many new opportunities, also in the mobility domain. To exploit them, an overall mobility strategy is required. Car-pooling may change the world, but as long as it is left to private initiative, it is not very probable that this will happen. As part of an overall strategy for sustainable mobility, car-pooling might finally play its adequate role.

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