Modeling station-based and free-floating carsharing demand

Test case study for Berlin

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Francesco Ciari, Benno Bock, and Michael Balmer

Carsharing, in any form, is still growing around the world. One of the effects is the increasing number of cities in which multiple carsharing operators are competing. The carsharing industry has never been as competitive as it is now: the present is a good time for researchers to invest efforts in providing tools for the assessment and planning of carsharing programs. Nevertheless, efforts in this direction are still scarce, in particular for some of the newest forms in which carsharing has been implemented, such as free-floating carsharing. This paper reports on a study that made use of MATSim, an agent-based simulation software that had already been used to model station-based carsharing, to evaluate different carsharing scenarios for the city of Berlin. The main findings are the existing high potential to extend carsharing services further in Berlin and the apparent complementarity of station-based and free-floating carsharing. On the methodological level, the work introduces a new tool for the modeling of free-floating carsharing along with improvements of the previously existing station-based carsharing model.

The basic idea of carsharing has already existed for more than 60 years: a fleet of cars can be shared by several users, who can drive a car when they need it, but they do not have to own one (*1*). This basic concept can be implemented in many ways and in the past few years several new business models have come to the market. From an operational perspective, free-floating carsharing is probably the most innovative. Free-floating can be seen as a particularly flexible form of one-way carsharing. There are no stations and users can pick up and drop off the vehicles freely within a predefined service area. This carsharing form hit the market only few years ago and has grown quickly ever since.

Free-floating is an interesting concept because it removes the main limitations of traditional carsharing: the need to reserve a car in advance and bring it back to the same station. This limitation obviously restricts spontaneous travel and implies that the rental is concluded when the car is back at the original station. This requirement has a huge impact on the type of activities typically carried out with traditional carsharing. Station-based carsharing is usually associated with "short" activities because the time spent in the activity is part of the rental and therefore needs to be paid for. Some operators offer flat rates for longer rentals, somewhat blurring the difference with traditional rentals, but these rates are mostly intended for multiday rentals. The bulk of station-based carsharing is made up of rentals of a few hours.

Removing this obligation, free-floating carsharing can be used regardless of the length of the activity involved and might capture different customers. Going to work with carsharing might become normal. There is no need to pay while the car is parked during work, which is the main reason why station-based carsharing is not attractive for commuting. Clearly, this flexibility comes at a cost. From a customer perspective, free-floating carsharing implies no guarantee to find a car on the way to the next activity or back home. Thus the use of this type of carsharing for activities such as work depends on the likelihood of finding a car on the way back or on the availability of a viable alternative. This latter observation, however, does not subtract from the revolutionary potential of free-floating carsharing. Indeed, it points to a rather important open question: Under what terms will increasingly larger free-floating carsharing systems be used and what impact will they have on the transportation system of a city as a whole? The limited availability of empirical data—free-floating is still very young—is the main barrier for this kind of evaluation. Other methodologies, however, can help answer this kind of question.

This paper presents an analysis based on an agent-based simulation. The study, conducted as part of a German project called "elektroMobil," uses the metropolitan area of the city of Berlin as a test case, a city with multiple carsharing operators on the market offering both station-based and free-floating carsharing, and three different scenarios have been simulated. The basis scenario mimics the actual transportation system and assumes a station-based carsharing offer. Two simulations are based on a population forecast for 2015 and various changes in the offer are assumed. In the first, a larger station-based carsharing is tested, while in the second, a large free-floating carsharing supply is added. The work presented here is by no means a substitute for an empirical data analysis, but it does gives precious hints on the behavior of the system and can be used as a planning or policy tool. In this case, it shows how station-based and free-floating carsharing compare, and the results can help find strategies to extend the carsharing offer in Berlin as well as how to combine free-floating and station-based carsharing.

RELATED WORK

Carsharing has been investigated in many scientific reports, especially in the past decade. The work presented here relates to two distinct streams of literature: research on free-floating carsharing and modeling

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of carsharing as a mode. It is no surprise that few papers specifically deal with free-floating carsharing considering that car2go (*2*), arguably the first free-floating program, only started operations in Ulm, Germany, in October 2008. Previously, few experiments were made on this particular carsharing form (*3*). It is somewhat more surprising that not many research efforts have focused on the modal share of carsharing. Apparently, the fast growth of carsharing has not yet fostered the creation of suitable modeling tools. Firnkorn and Müller used data from car2go in Germany to assess the environmental impact of free-floating carsharing in absolute terms and compared it to traditional carsharing (*4*). Free-floating sharing should have a much larger positive impact because it would be able to attract more customers. Although this might well be the case, there are studies coming to similar conclusions for one-way carsharing (*5, 6*); their conclusions appear biased by rather rough assumptions on the availability of traditional carsharing. In another study, Firnkorn and Müller analyze how some carmakers are moving from selling cars to selling mobility and observe that this change of paradigm might have a positive environmental impact because it would lessen the overall number of vehicles (*7*). Other researchers have focused on relocation strategies by proposing various algorithms to cope with the wide variety of situations that can happen in a free-floating carsharing system (*8*). The motivations for becoming a free-floating carsharing user have also been investigated (*9, 10*). One of these studies, for example, uses a hierarchical means–end chain analysis method (*10*). The main motivations found (value for money, convenience, lifestyle, and environmental benefits) are consistent with similar findings for traditional carsharing (*11*).

The work of Shaheen and Rodier is probably the first attempt to estimate carsharing demand and evaluate how different policies might affect it (*12*). However, they used a modeling framework that allowed only a very simplistic representation of carsharing. They observed that reliable tools for the estimation of innovative mobility services and policies are missing and overcoming this lack might be crucial for their success, but apparently their call largely went unheeded among the carsharing community, at least until very recently. In the work of Le Vine, for example, there is a forecast of carsharing usage under different program specifications, station based or one-way, for the city of London (*5*). On the basis of a sophisticated stated choice exercise, he concludes that one-way would have a much larger diffusion for membership and would generate more carsharing journeys. The main limitation of this work is that the model does not capture how the availability of the different carsharing options might reshape mobility patterns. Finally, a recent report is probably the only example of a free-floating carsharing demand estimation, thus belonging to both strands of the literature treated here (*13*). The authors justify the use of rather simple regression models, based on spatial characteristics, over other modeling options (i.e., discrete choice models), with the low share of carsharing trips. This use is likely correct for reproducing modal shares with a reasonable accuracy for the area studied and for any area where a similar offer would be put in place. However, this modeling option limits the possibility of using it as a planning tool in that it does not offer the possibility to test different carsharing schemes.

METHODOLOGY

The world of carsharing is evolving fast. The actors involved are increasingly large and include, among others carmakers Daimler, VW, BMW, and Peugeot; traditional car rental (Avis, Sixth), and public transport operators (DB Flinkster, owned by the German national train operator). The level of competition on the market is increasing as cities with multiple carsharing operators, once an exception, are becoming common in Europe and North America. Therefore, predictive models, instrumental for the optimization of operations and for demand estimation, can be expected to draw increased attention from operators. Ciari et al. have already suggested in a previous paper that agent-based simulations might be appropriate for model carsharing (*14*) and explained the rationale. In this section that argument is reviewed and the models used in the present study are described.

Modeling Carsharing with an Agent-Based Approach

Classic travel demand (four-step) models have evolved in a world dominated by car mobility. Public transit, buses in particular, was the only “competitor” for road infrastructure in most industrialized countries. It is no surprise that these models were typically taking only two modes into account, cars and public transport. Recent efforts account for other modes (i.e., bicycle and walk), but integrating carsharing has not yet been attempted, not to mention free-floating carsharing. The lack of carsharing models is understandable because, despite its impressive growth, carsharing still accounts for a low proportion of overall travel. However, the absence of these models should not hide the inherent limitations of traditional modeling tools to represent carsharing. The very nature of carsharing, the importance of its availability at precise points in time and space, does not fit with models using vehicles-per-hour flows. Free-floating carsharing especially does not fit with these models because it has no stations. It is crucial to represent the availability of vehicles at the local level and therefore represent individual travel with high spatial and temporal resolution.

In transport modeling when it is important to represent time-dependent mobility patterns at an individual level, models are based on activity data. Travel is the result of an individual need to perform out-of-home activities at different locations. Agent-based modeling is a natural way to implement this paradigm. Agents are software abstractions acting in an artificial environment; they have learning capability and are goal oriented. Activity chains are linked to specific individuals based on sociodemographic attributes and the availability of specific mode types. The verisimilitude of the entire representation is guaranteed by the fact that the artificial population is based on census data and on travel diary surveys. Multiagent models can deal with complex research questions regarding time-dependent spatial demand or variations in carsharing supply, but are computationally intensive. Additionally, the richness of detail does not imply the accuracy of the model, particularly at the microscale level. However, it is important that such a level of detail is possible because it allows introducing simple behavioral rules at the micro-level that determine the macrobehavior of the system. The key is to use behavioral rules that are easy enough to observe from real-world experience, but are also fundamental enough to induce a plausible behavior in the agents, not only for a particular activity or for a particular mode of transport, but in general. The use of behavioral rules at the microlevel will show an emerging behavior at the macroscale level that is caused, but not directly implied, by the rules at the lower level. This result is the main reason why agent-based simulation is a suitable tool for modeling innovative transport systems.

Carsharing Models

For this work, the multiagent traffic simulation MATSim was used (*15*). MATSim implements the concepts described in the previous paragraph and can be applied to large-scale scenarios in which millions of agents, representing the population of a predefined study area, are modeled. It produces complete daily schedules for all the individuals in the scenario, which comprises various types of activities and travel with several modes. Station-based carsharing was already a modal option in the software, although with several limitations, while free-floating carsharing was not.

Simulation Model

For station-based carsharing, the simulation of carsharing travel is subtour based. A subtour is a sequence of trips starting and ending from the same location, but not necessarily from home, and it is quite realistic. The following steps are simulated:

1. Walk from start activity to the next station.
2. Get the car.
3. Drive to the next activity (interaction with other vehicles is modeled).
4. Park the car close to the next activity.
5. Take the car again and drive to the next activity.
6. From the last activity of the chain, drive to the initial station.
7. Drop off the car.
8. End the rental (and make the car available for other rentals).
9. Walk to the next activity.
10. Carry out the rest of the daily plan.

For free-floating carsharing, the list is slightly shorter, reflecting the fewer hurdles in its use:

1. Rent the closest car.
2. Walk from start activity to the rented car.
3. Drive to the next activity (interaction with other vehicles is modeled).
4. Park the car close to the next activity.
5. End the rental (and make the car available for other rentals).
6. Walk to the next activity.
7. Carry out the rest of the daily plan.

These models addressed some limitations of the previously existing carsharing model of MATSim in that (*a*) the capacity of the system is taken into consideration and (*b*) carsharing vehicles are physically simulated.

Behavioral Model

The behavior of the agents is expressed by a function that evaluates all the components of their daily activity plan. In principle, activities are evaluated positively (provide utility) and travel is evaluated negatively (generates negative utility). The specific components of carsharing travel are as follows:

- Time cost for walking (access and egress),
- Constant for carsharing (minimum cost),
- Rental time,
- Distance cost,
- Monetary cost of rental time, and
- Maximal time cost (after that, only the distance is paid).

The only difference for free-floating carsharing is that a lower limit for the rental cost also exists (there is a minimum fare in which a given amount of time and 20 km of travel are included). The functions are used by the agents to evaluate their mobility options (i.e., they are used during the iterative process of the simulation, similar to a discrete choice model, by the agents to compare different modal options and choose the one that fits their needs better). A formal description of the utility functions can be found in Ciari et al. (*14*). The availability of the other modal options is an attribute of the agent. It is assigned based on its sociodemographic characteristics and reflects the actual distribution observable in census data.

Carsharing Membership

In the simulation, only members of the carsharing program are allowed to use the service. A specific model [e.g., the one in Ciari and Weis (*16*), already used in another MATSim experiment] was not estimated, but it was possible to analyze customer data of DB Flinkster to get an insight into the station-based carsharing users' profile. Membership was then assigned (or not) to agents using iterative proportional fitting to obtain a distribution close to the real one. The number of customers was equal to that of DB Flinkster customers. The iterative proportional fitting used age, gender, and distance from the closest station. Membership of free-floating carsharing was assigned on the basis of the observation that the number of approximately 100 customers per vehicle is stable since the service is available in Berlin, independent of increases in the number of cars. In other words, the size of the service was established and the number of customers set accordingly. Indeed, the total number obtained is fairly consistent with studies estimating the potential for free-floating carsharing in Germany (*17*). Membership was then assigned with a process similar to that used for traditional carsharing. A part of the agent ended up having access to both services, which reflects the current situation (*18*).

SIMULATIONS

In this section, the scenarios are described and the results obtained running the simulation of scenarios are presented and interpreted.

Scenarios

The simulation was run on a scenario reproducing the metropolitan area of Berlin. About 4.5 million inhabitants are currently living (2012) in the region on an area of 30,370 km^2 (11,726 mi^2). The first scenario used is based on census data, and a population of 4,422,012 agents mimics the real number of inhabitants in the region. The others are based on a population forecast for 2015, an increase up to 4,506,058 persons, and the simulation reflects that. It includes changes in the population structure and in travel demand and supply. Three different carsharing scenarios were tested on the basis of these premises; they are briefly described below.

Scenario 1. Station-Based Carsharing

The first scenario reproduces the current situation; the population is based on the actual census. Only station-based carsharing is available in this scenario and the location and number of vehicles reflect that of DB Flinkster with 175 vehicles at 82 stations and 20,000 registered members.

Scenario 2. Larger Station-Based Carsharing

The second scenario represents a possible enhancement of the service in the near future and therefore the characterization of the population is based on the above mentioned forecast. Here as well only station-based carsharing is available, but additional stations were added to (*a*) increase density in the already served areas and (*b*) extend the service to other parts of Berlin. The scenario consists of 329 vehicles at 152 stations with 38,000 registered members. The additional stations are located at places where a high density of activities is observed. The actual availability of a parking lot was not considered.

Scenario 3. Station-Based and Free-Floating Carsharing

The third scenario is also projected into the future and is therefore based on the forecast. The carsharing offer of Scenario 2 (329 vehicles, 152 stations) is extended by adding a free-floating service with 2,050 vehicles. This service is accessible to 194,000 agents. These are in addition to the agents who were already members. The latter can use both services. The initial locations of the flexible service vehicles are picked where a high density of members' planned activities is available.

Results

A nice feature of such a detailed representation of travel is that all persons and all vehicles can be tracked during the simulation (e.g., observing rental duration, distance, purpose of the trip, etc.) and this wealth of data can be used for a virtually unlimited number of analyses.

Scenario 1. Station-Based Carsharing

The temporal and spatial distributions of carsharing activities in the first scenario are shown in Figure 1. The lines in the graph represent carsharing departures (blue), arrivals (red), and the number of vehicles currently on the road (green) over 1 day in the simulation. A peak of carsharing use early in the morning is observed. The number of vehicles traveling is in tune with departures and arrivals, which means that those rentals are mostly of very short duration. Conversely, in the afternoon, the curves seem to suggest that there are a fair number of longer rentals.

In the map, the colors represent the carsharing share with respect to all trips made by carsharing members (not of the whole population) in a municipality (identified by the zip code). The map shows the intensity of carsharing use by members in a neighborhood. Some of the peripheral municipalities also show a high usage, which is somewhat surprising. Probably, it is an artifact of the map caused by the low number of members in those municipalities.

Scenario 2. Larger Station-Based Carsharing

Figure 2 shows that the increased number of cars has an effect on absolute numbers: the curves are at higher levels all the day, and the temporal distribution of carsharing use indicates more cars in use in the late afternoon. A peak around 8:00 a.m. is still observable, but now this is not the absolute peak during the day anymore. It seems that with more cars available, carsharing use intensifies more during the late afternoon than it does during the morning. This finding might reflect a higher latent demand in this part of the day. The map shows that increased density brings increased intensity in the use. Most of the municipalities where carsharing trips were already on offer are now a notch or two higher. Some other municipalities where no carsharing trips were registered now have some. There are nevertheless exceptions, since there are a few municipalities where carsharing use is reduced. Overall, the map seems to indicate that the increase on the supply side is particularly effective in peripheral regions.

Scenario 3. Station-Based and Free-Floating Carsharing

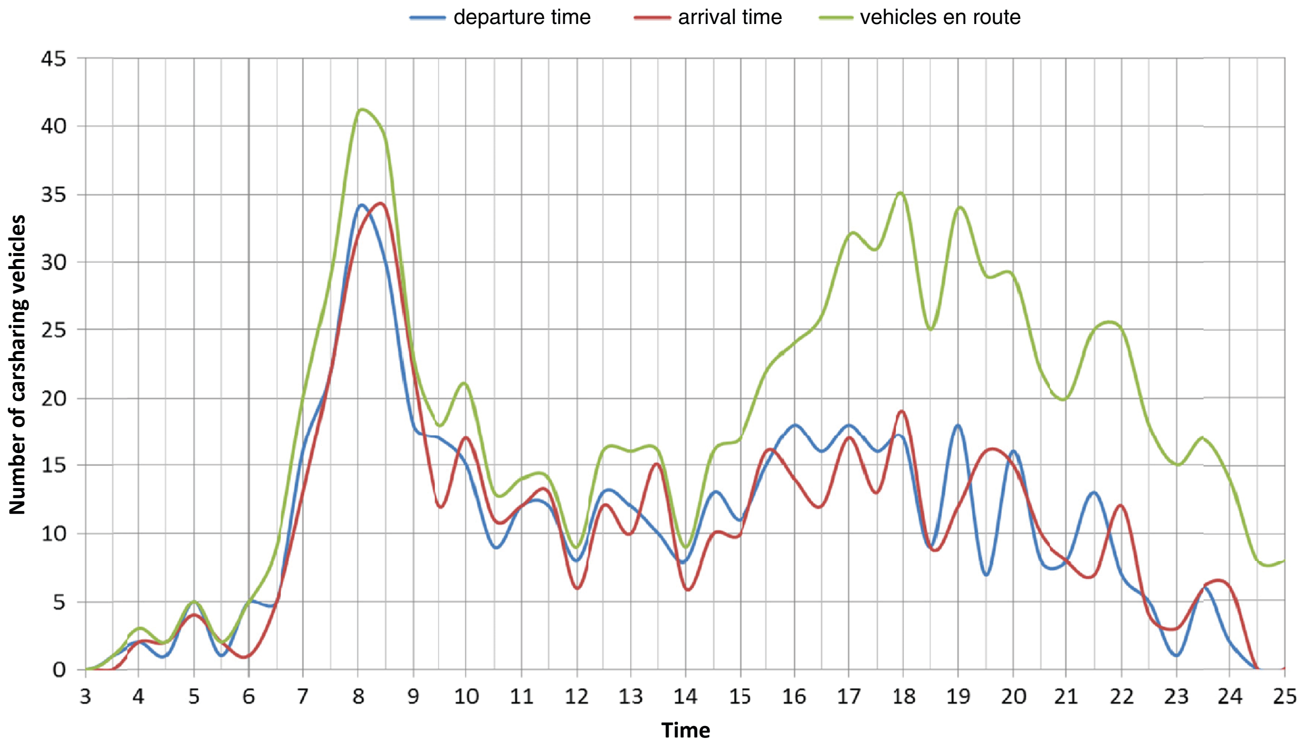
In this scenario, a large free-floating service is added on top of the station-based carsharing offered in Scenario 2. At a first glance, Figure 3 seems to show that station-based carsharing use is not greatly affected by the introduction of its free-floating counterpart. The curves are similar to those in Figure 2. Nevertheless, there is one impact that should not be ignored. There is a new lowest point in all the curves at around 14:00, which roughly corresponds to a peak in free-floating use. A possible interpretation is that some of those trips were previously made by traditional carsharing, but free-floating is better suited for them. Many free-floating trips are concentrated in the morning and in the afternoon, meaning that the highest untapped potential is likely there.

The spatial distribution map shows that in municipalities of high levels of station-based carsharing use, free-floating is more successful. It seems that the presence of this additional service helps traditional carsharing to be more successful in general, because the number of municipalities with an intense level of carsharing activities appears to have increased. It might be that in view of finding good mobility options for a whole day, and this is basically what agents in the simulation do, the additional presence of free-floating allows some agents to change mode, maybe because they use both services over the day. Say for instance that an individual has a typical 9 a.m. to 5 p.m. workday and that during lunch break he or she needs to do some shopping. Because station-based carsharing is not suitable for such a work activity, the individual will likely take his or her own car and use it for shopping too. However, the presence of free-floating carsharing allows leaving the car home and using station-based carsharing for shopping.

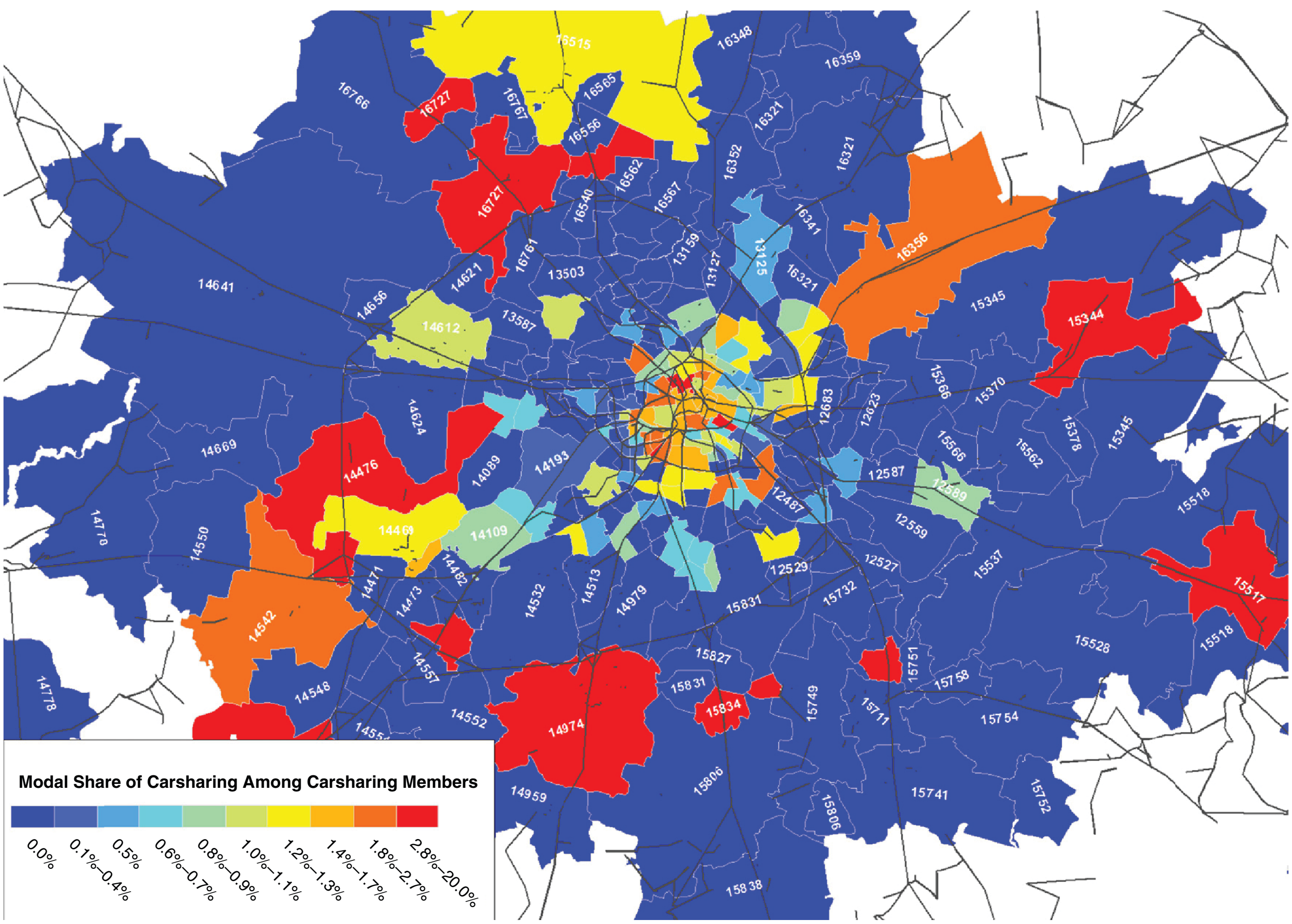
Discussion of Results

The graphs presented so far give a broad idea of what happens in the different scenarios. Table 1 summarizes some key variables that illustrate the differences between the scenarios.

The most striking occurrence is the increase in the rentals between Scenarios 1 and 2. The number of stations and vehicles is slightly less than doubled, as well as the number of members, but the number

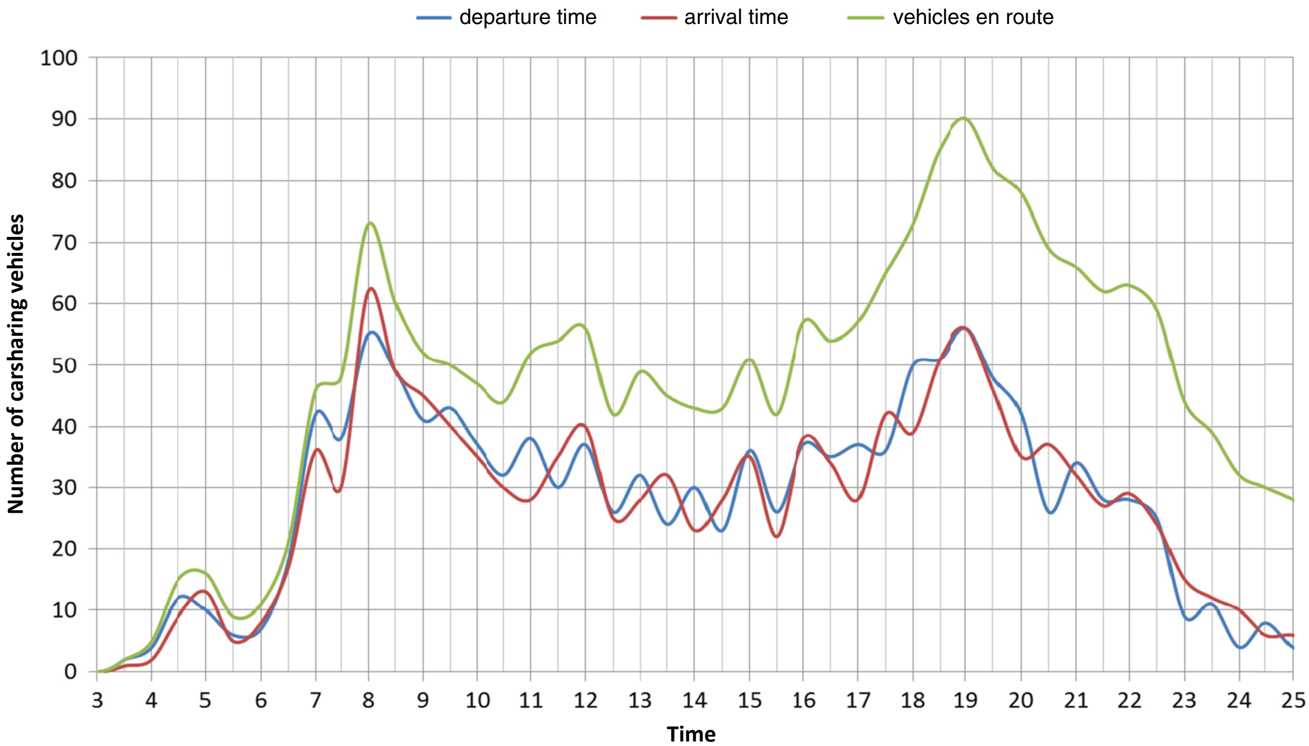


(a)

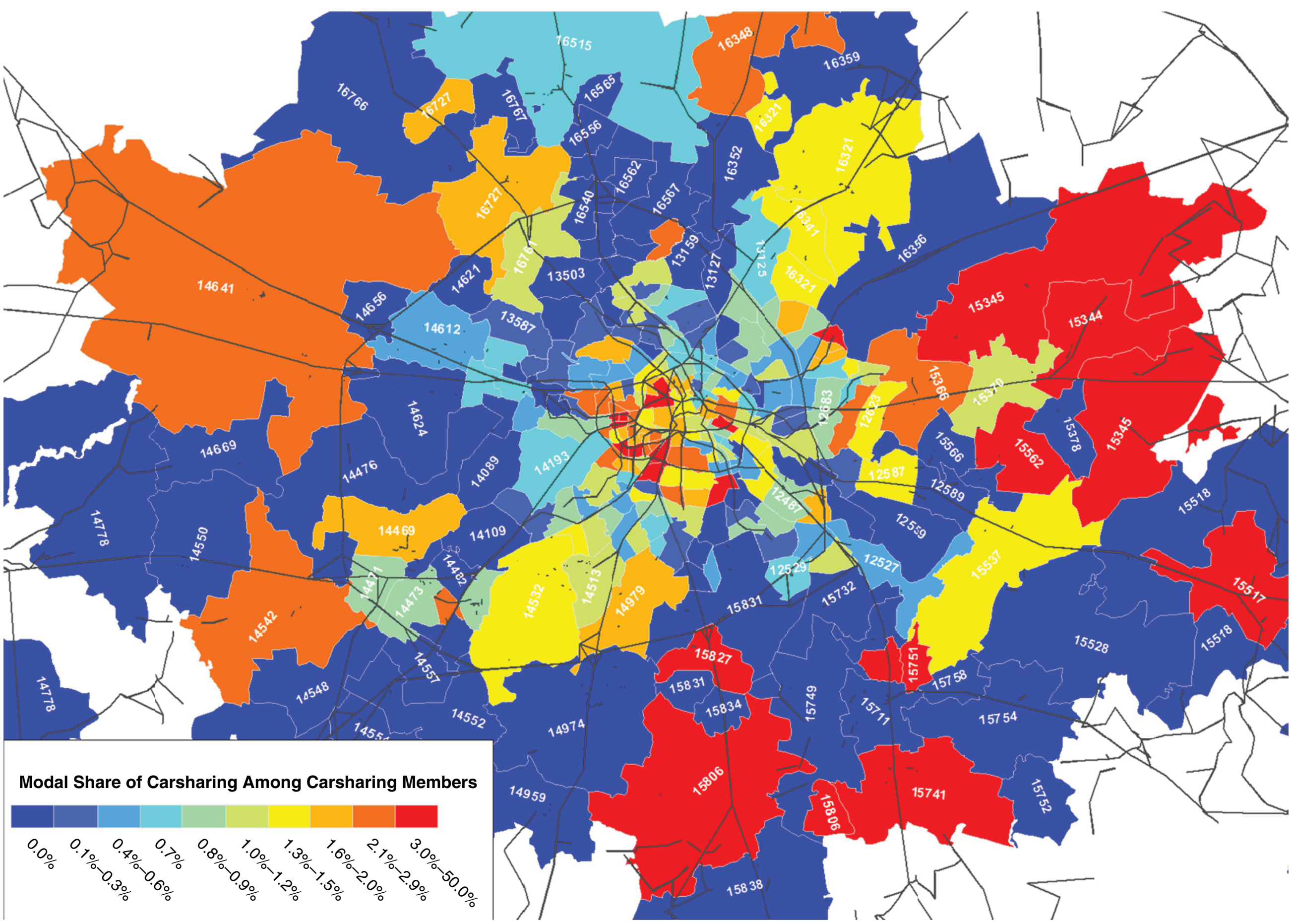


(b)

FIGURE 1 Scenario 1: (*a*) departure time, arrival time, and vehicles en route and (*b*) spatial distributions of rental events.

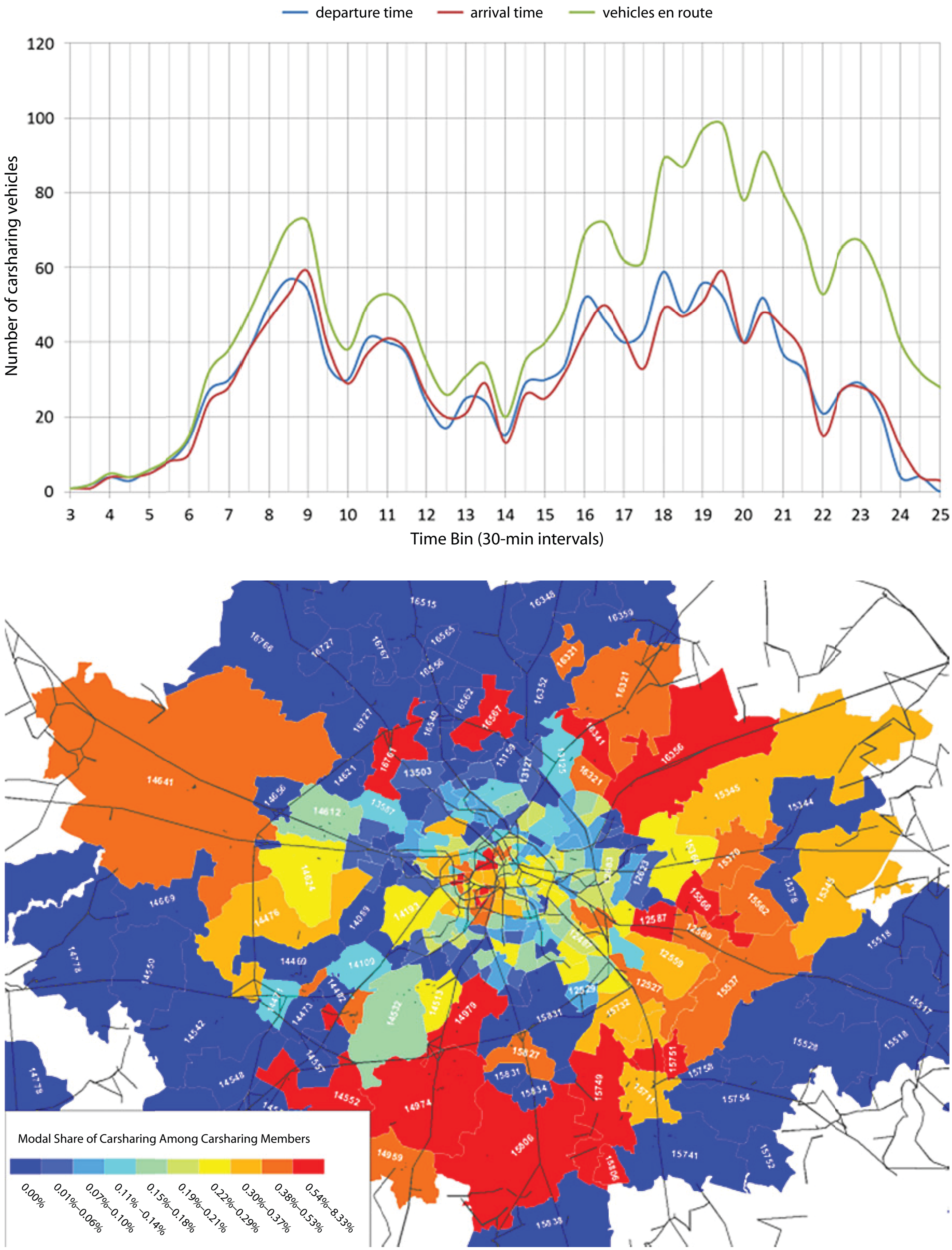


(a)



(b)

FIGURE 2 Scenario 2: (*a*) departure time, arrival time, and vehicles en route and (*b*) spatial distributions of rental events.



(a)

FIGURE 3 Scenario 3: (*a*) departure time, arrival time, and vehicles en route for station-based carsharing.

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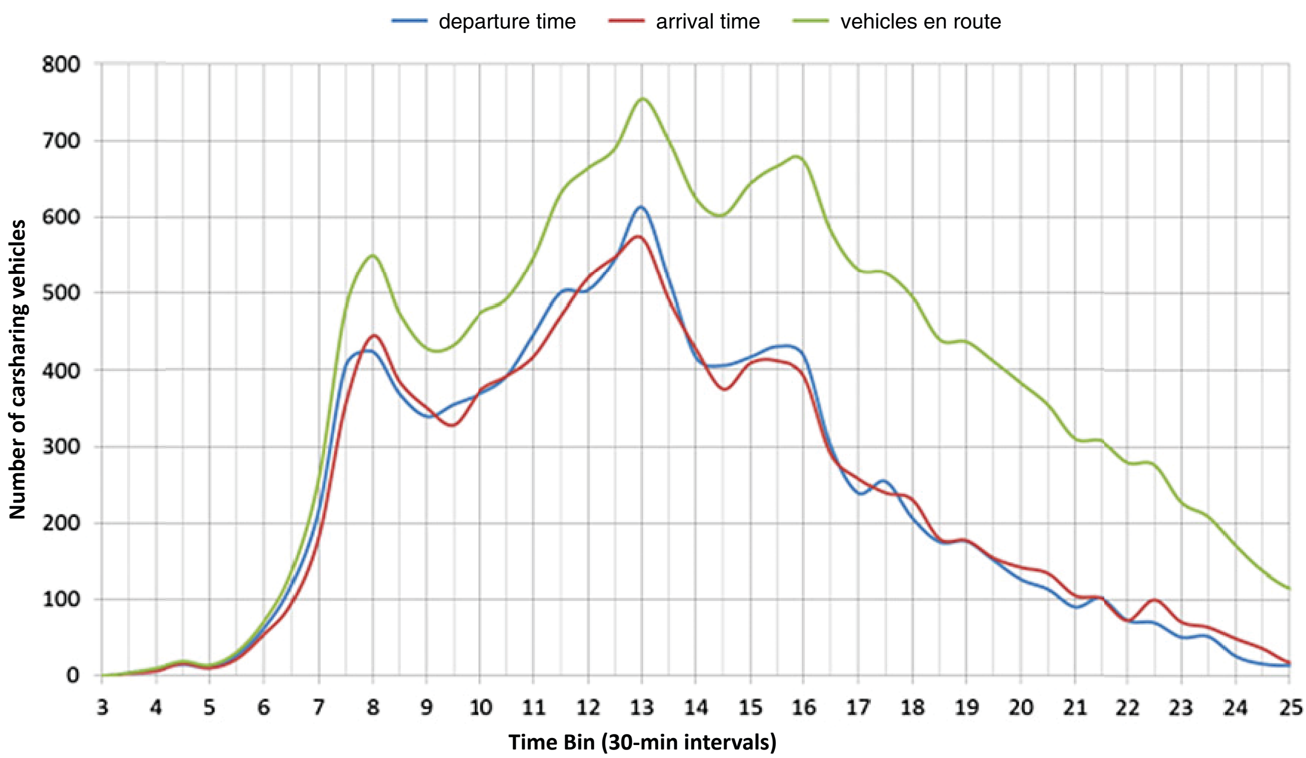

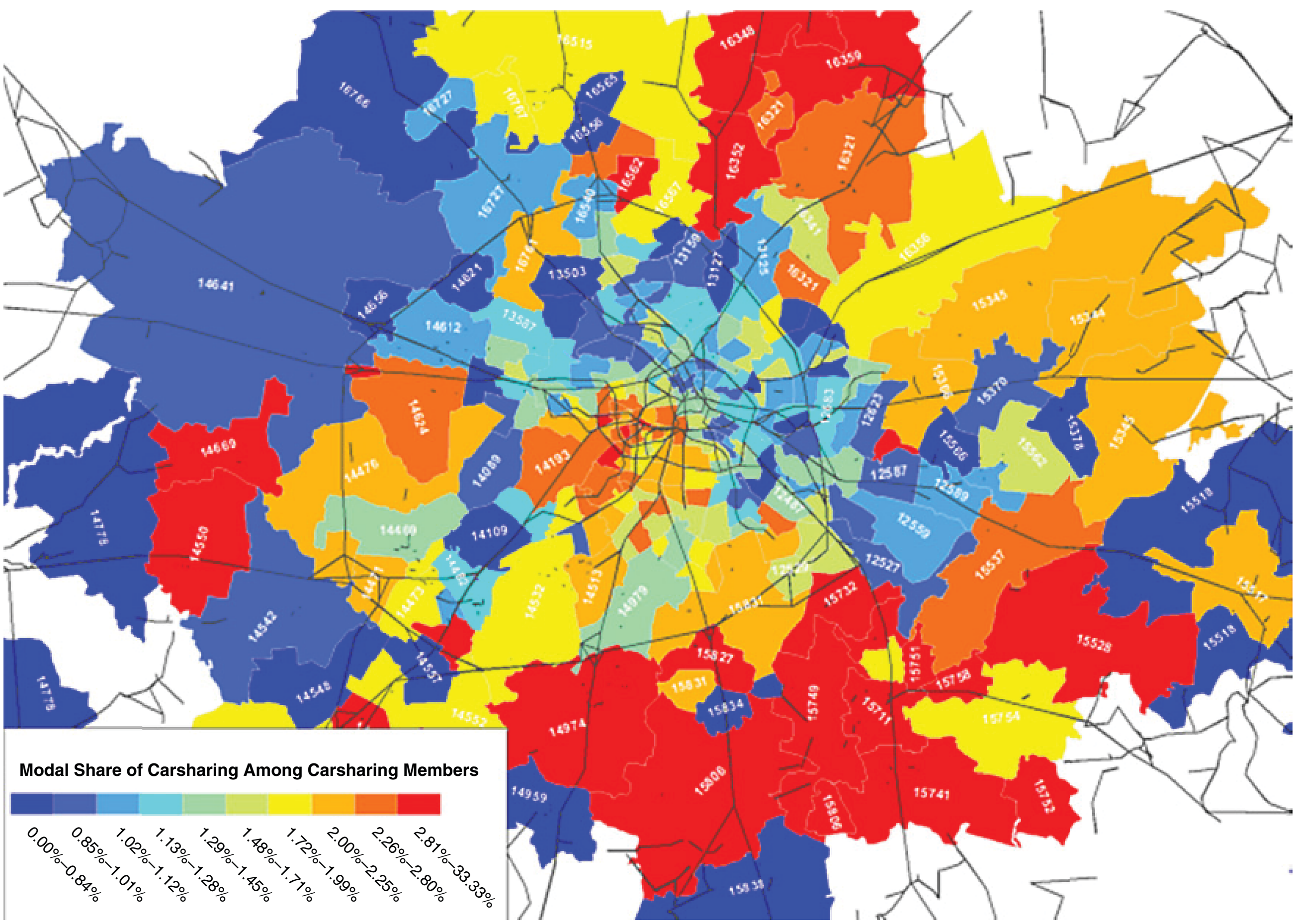

(b)

FIGURE 3 *(continued)* Scenario 3: (*b*) spatial distributions of rental events for free-floating carsharing.

TABLE 1 Summary of Simulation Results for Three Scenarios

Variable	Scenario 1	Scenario 2	Scenario 3
Population	4,422,012	4,506,058	4,506,058
Number of members (station-based and free-floating)	20,000	38,000	38,000
Number of members (free-floating)	NA	NA	194,000
Number of carsharing stations	82	152	152
Number of vehicles (station-based)	175	329	329
Number of vehicles (free-floating)	NA	NA	2,500
Number of members (traveling any mode)	16,489	31,358	191,819
Number of users	183	473	4,967
Number of rentals (station-based)	190	481	512
Number of rentals (free-floating)	NA	NA	10,708
Number of used vehicles (station-based)	124	266	267
Number of used vehicles (free-floating)	NA	NA	2,185
Station-based carsharing			
Number of trips	496	1,298	1,379
Average trip duration (min)	22.9	23.5	27.5
Average O-D distance (km)	5.8	5.3	5.3
Total travel time (days)	7.9	21.2	26.5
Total distance (km)	2,900	6,900	7,300
Free-floating carsharing			
Number of trips	NA	NA	10,708
Average trip duration (min)	NA	NA	20.1
Average O-D distance (km)	NA	NA	5.7
Total travel time (days)	NA	NA	149.8
Total distance (km)	NA	NA	60,600
Peak in station-based carsharing			
Morning	40 (08:00)	75 (08:00)	75 (08:50)
Evening	35 (18:00)	90 (19:00)	100 (19:50)
Peak in free-floating carsharing			
Morning	NA	NA	550 (08:00)
Noon	NA	NA	760 (13:00)
Evening	NA	NA	690 (16:00)

NOTE: NA = not available; values in parentheses indicate the times at which carsharing peaked (O-D = origin–destination).

of rentals increases by a factor of 2.5. The characteristics of the trips, distance and travel time, are essentially unchanged, which means that the type of trips is unchanged. Additional stations seem to perform particularly well, meaning that a sizable additional potential is still available for station-based carsharing. The addition of 2,500 free-floating cars in Scenario 3 generates more than 10,000 additional trips. Remarkably, the number of rentals of station-based carsharing also increases. This finding confirms what was stated in the previous section and suggests that the two carsharing types can be complementary. Another observable effect is that station-based carsharing in Scenario 3 is used for longer trips than in Scenarios 1 and 2, while free-floating carsharing seems to specialize on shorter and faster trips. This finding probably reflects the slight difference in the cost structure of the two services; free-floating carsharing has no distance costs up to 20 km.

To understand better the difference in the type of trips made with the two carsharing services, the authors looked at the activities carried out after the trips. As Figure 4 shows, activity type distributions for station-based carsharing are quite similar across scenarios.

The distribution is different for free-floating carsharing; work is substantially higher and leisure is lower. This finding makes perfect sense because commuting is more attractive with free-floating carsharing, working time does not translate into rental time, and station-based carsharing is suitable for leisure because it usually does not last so long. Figure 5 indicates which modes were substituted by free-floating carsharing by comparing Scenarios 2 and 3, which is important because there are still open questions on the real impact of free-floating carsharing on the transportation system as a whole. With the spontaneity permitted by the system, there is a debate on whether free-floating carsharing is substituting public transit or bicycling or even walking, which might generate more car travel overall.

Car travel is actually the mode that is reduced the most; well above 30% of the free-floating trips were car trips before its introduction. However, bike travel is the second contributor, followed by public transport and walking. Overall, car travel did indeed increase with free-floating carsharing compared to the station-based carsharing scenario. Obviously, since MATSim simulates only one average day, it cannot capture the effect of reduced car travel by carsharing users over the long term. This might well offset the growth resulting from modal substitution and overall car travel might be reduced. Nevertheless, this finding is important because it suggests that modal substitution patterns for free-floating carsharing might substantially differ from those of traditional carsharing. Relatively few agents changed from station-based carsharing to free-floating carsharing. (Note that only previous station-based users could use both despite the high number of free-floating cars available in the third scenario.) This finding can be interpreted as a further confirmation that free-floating carsharing is not inherently better than station-based carsharing through its additional flexibility, as one might tend to think, but simply more suitable for some specific situations, and the two systems are rather complementary.

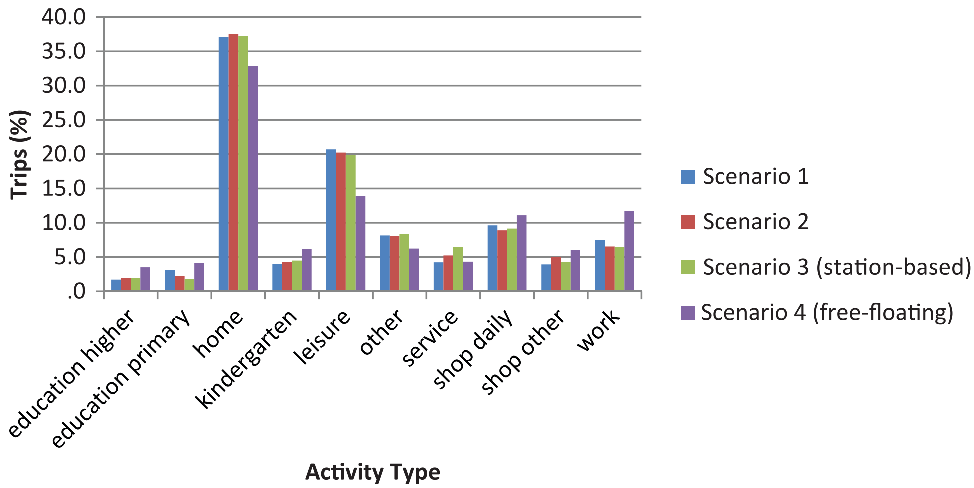

FIGURE 4 Activity after carsharing trip.

SUMMARY AND OUTLOOK

Overall, it seems clear that carsharing still has a huge potential in Berlin, especially for station-based services. In the meantime, the carsharing offer in the city has been massively enhanced. Regarding the simulation, perhaps the most striking result is the overproportional growth of carsharing use with respect to the carsharing service extension (involving number of cars and stations) from Scenario 1 to Scenario 2. This result suggests that, at least for the level tested, there is a positive scaling effect in the accessibility to carsharing that makes a denser network more attractive. The introduction of free-floating carsharing apparently does not reduce the overall attractiveness of the station-based option and seems complementary to it. In geographical terms, station-based carsharing use appears to have a smoother distribution among the municipalities when alongside free-floating carsharing use. It seems as if in some municipalities the presence of the new option reinforces the other. The absolute numbers are more or less stable, actually slightly higher, but the main effect seems to be a change in the type of trips and in the time of the day. Free-floating carsharing is used for shorter trips on average and predominantly during the early afternoon. Further analysis confirms occurrences that have been hypothesized regarding free-floating carsharing, but have not yet been supported by empirical data. The first is that free-floating carsharing is, unlike station-based carsharing, potentially suitable for commuting. A substantially larger number of trips to work activities confirms this. The second is that free-floating carsharing competes with public transit, walking, and biking and not only with car. Many free-floating trips in Scenario 3 were made with one of those modes in Scenario 2. This would mean that the overall effect of free-floating carsharing might be less beneficial than that of station-based carsharing for reduction of car travel. Obviously, this is not a definitive answer on the issue, but detecting this effect suggests nevertheless that planners should be aware of that aspect in their future analyses.

It is important to note that MATSim was used in this study for the first time to assess free-floating carsharing. The analyses presented are only a small taste of the virtually infinite number of analyses possible with this tool. Additional experience using the tool, as well as a more solid base of knowledge on free-floating carsharing provided by studies based on empirical data, will help to figure out which are the most important dimensions to watch. In addition, it will help discover if the software as it is now still has flaws or limitations that need to be addressed. Applying the tool for analysis on new scenarios, possibly relying on new empirical data, is the main point on

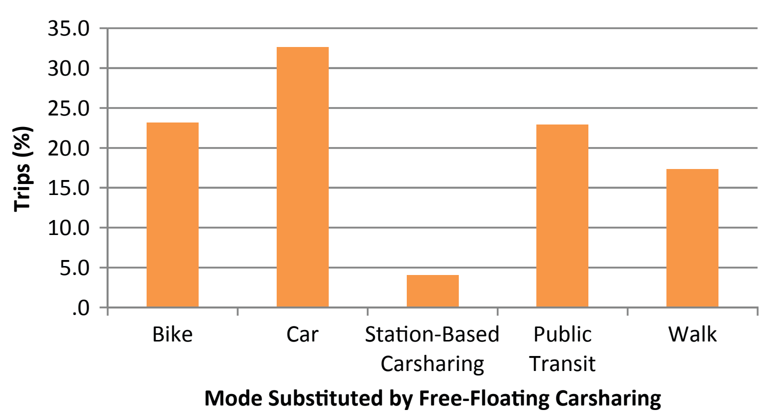

FIGURE 5 Mode used for trip before introduction of free-floating carsharing.

the research agenda for the near future. The goal of this research is to build a predictive and policy-sensitive model that can be used by practitioners and policy makers to test different scenarios, including any type of carsharing. MATSim is well suited for that because it can naturally cope with transportation issues in which accessibility and availability are time dependent and need to be represented at the microscale. The introduction of free-floating carsharing is an important additional step in this direction.

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