Car Sharing: A New Approach to Urban Transportation Problems

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Running Head: Car Sharing

Abstract

The concept of car sharing is introduced as an innovative approach to the growing transportation problems of the major metropolitan areas of the United States. After sketching the history of car sharing in Europe and North America, three studies of the early adopters of Car Sharing Portland (CSP), the first commercial car sharing organization in this country, are reported. Study 1 found that these individuals were primarily motivated to join CSP because of their occasional need for a vehicle and secondarily by the financial savings they expected to realize by becoming a member. Study 2 found that the two most important predictors of CSP trip usage were distance to the nearest vehicle station and length of membership and that both factors had more influence on vehicle owners rather than non-owners. Study 3 found that while members did not drive fewer vehicle miles after they joined CSP, 26% sold their personal vehicle and 53% were able to avoid an intended purchase. In addition, a majority of members reported increasing use of public transit, walking and cycling. The results are discussed in terms of the potential environment consequences of car sharing and the effects of the car sharing experience on mobility behavior.

This report is designed to introduce the concept of car sharing to social researchers concerned with environmental issues, especially those relating to the transportation problems currently facing many of our urban communities. It is written in the belief that car sharing represents an innovative approach to lessening these increasingly serious problems.

The private automobile, despite its numerous benefits, is largely responsible for many of the most serious environmental and social problems in the United States today. Automobile usage is a major source of air and noise pollution in the major cities of this country. It also contributes 70 percent of the carbon monoxide, 45 percent of the nitrogen oxides and 33 percent of hydrocarbon emissions in these cities (Kearney and De Young, 1995-96). The transportation sector consumes 67% of the petroleum used in the United States--approximately 12 million barrels per day, far more than the 9 billion barrels produced domestically (Gordon, 1991). The economic and political consequences of this dependence on important oil have profoundly influenced American society ever since the first Arab oil embargo in 1973.

Automobiles are also a major source of carbon dioxide, the so-called greenhouse gas, that many claim is the principal source of global warming. According to Walsh (1993), motor vehicle usage is responsible for approximately 25 percent of the carbon dioxide emissions in the United States. The automobile has drastically reshaped the environment with large portions of the urban landscape devoted to the highways, parking spaces and the service facilities that vehicle usage demands. Traffic congestion is also an increasingly serious problem in many cities. Traffic tie-ups, especially during commute times, are estimated to cost the United States 1.2 billion hours of lost time and 2.2 billion

gallons of gasoline each year, to say nothing of the estimated $30 billion annual loss in productivity alone (Gordon, 1991; Shute, 1991). Finally, oil spills, traffic fatalities, congestion induced stress, aesthetic pollution in the form of automobile junkyards, highway billboards and endless suburban strip developments must also be added to the increasing number of environmental and social costs of automobile usage.

In response to this situation numerous efforts have been made to encourage Americans to drive their cars less and to try instead to walk, take the bus or ride their bicycles more often. Despite the fact that these long-running campaigns have been carried out throughout the country and even though most incorporate attractive incentives for reducing solo driving, their results have been consistently disappointing.

This is revealed by recently released 2000 Census data comparing patterns of commuting between 1990 and 2000 (U. S. Bureau of Census, 2001). During this period the proportion of commuters driving alone increased from 73 percent in 1990 to 76 percent in 2000. Nationally, transit ridership remained fairly stable at approximately 5 percent of the commuters. Ridesharing or carpooling also continued to be an unpopular commute mode, declining from 13 percent in 1990 to 11 percent in 2000. In short, while these alternative modes decreased in absolute numbers and as a proportion of total travel, virtually all of the growth in personal travel in the last two decades is a results of an increase in single occupancy vehicle travel.

Can anything be done to reverse these trends? Many approaches have been tried in this country, including car and van pooling, alternative work scheduling, transit passes, employee parking cash out incentives, congestion pricing, and increased parking fees. Unfortunately the evidence indicates these programs, like the ongoing information

campaigns, have had very little effect on curbing solo driving. (Kearney and de Young, 1995-96l; Wachs, 1991).

Somewhat more promising results have been reported in Europe, most notably with an increasingly popular approach known as car sharing, a transportation alternative that originated in Switzerland and Germany more than twenty years ago. The evidence indicates that those who belong to the European car sharing organizations drive considerably less than they did before they had become members (Steininger, Vogl, & Zettl,, 1996; Munheim, 1998; Meijkamp, 2000). At the same time, their use of public transit and other alternative travel modes, such as walking, and bicycling increases. Many members also report that once they became car sharers, they were able to sell their private automobile(s) or avoid purchasing one.

A car sharing organization, formed as either a cooperative or for-profit business, consists of a group of individuals who share a fleet of cars with other members although they tend to use the two or three located within a few blocks of their residence or workplace. It may also comprise a group of subscribers who share several cars, known as station cars, located at central locations, such as transits hubs, airports, or rail stations. Vehicles in membership-based groups are used almost exclusively for short, local trips, whereas station cars are most commonly used for trips to and from the workplace.

In the station car application homebound commuters can pick up a car from the transit station, drive it home and then return it to the station the next morning for their trip to work in the city center. In turn, while the cars are at the station during daytime hours, reverse commuters can use them to drive to their workplace in the suburbs and then back

to the station for their return home (Bernard, 1998; Shaheen, 1999). In both applications the fleet of cars is used for multiple trips by several individuals throughout the day.

Shared fleet organizations differ from ride-sharing or carpooling in that they are not designed to transport a group of individuals to a common destination at the same time. Instead, they represent an alternative to private vehicle ownership that provides access to a car when walking, cycling or public transit is not possible or convenient. Car sharing also differs from automobile renting in that it gives individuals access to a car for brief trips, in some case as short as a half hour, charging only for the time and duration of each trip. In contrast, rental agencies charge the full daily rate, regardless of the duration or distance of travel. In addition, renters must pay for the gasoline required to fill the vehicle's tank at the time it is returned, while the car sharing organization pays all the costs of fuel, as well as insurance, vehicle maintenance, service and repairs. Vehicles in the car sharing fleet are usually located close to the user's residence, while those belonging to the rental firm are parked in central city areas or major transportation hubs. Finally, renters are required to complete time-consuming paper work before they can drive the vehicle, while car sharers need only phone or go online to reserve a vehicle prior to using it.

The concept of car sharing is based on the distinction between automobile *access* and *ownership*. Car sharing divorces the notion of automobile use from ownership by providing individuals with convenient access to a shared fleet of vehicles, rather than a single privately owned one. In this sense car sharing is an example of the growing number of alternatives to private ownership of property in what Rifkin (2000) has called the Age of Access. He suggests that we are moving from a market-based economy to

one where private possessions are no longer as important as having access to them. Time-share condominiums, office equipment leasing and agricultural cooperatives are examples of this growing trend. Services are also replacing ownership, so that instead of purchasing a set of the encyclopedias or music CDs, we pay to access and download them on the Internet.

In order to drive one of the vehicles in the fleet, car share members simply telephone the organization's reservation system or book it online. To pick up the car, they need only walk a short distance to the nearest site of the organization's cars. A variety of vehicle types are usually available in the fleet to give members an efficient way to meet infrequent needs, such as hauling, moving, and transporting large groups. The car sharing organization pays all of the costs of vehicle maintenance, service and repairs. The same is true for insurance coverage, parking, and the cost of gasoline.

While friends and family members have shared vehicles ever since the automobile was developed, the first formal car sharing organizations were established in Switzerland and Germany in the 1980s. Today Mobility Car Sharing Switzerland has approximately 60,000 members and 2000 vehicles in over 900 locations and 400 communities throughout Switzerland (Orski, 2002). In Germany, there are about 75 organizations that serve approximately 40,000 members, with other rapidly growing groups in the Netherlands, Austria, Sweden and France.

Car sharing has taken root more slowly in the United States with the first commercial car sharing organization established in Portland, Oregon in 1998. It had been preceded by two pilot projects—the Mobility Enterprise field test at Purdue University (Doherty, Sparrow & Sinha, 1987) which operated as a research study from 1983 to

1986 and the Short Term Auto Rental (STAR) demonstration project in San Francisco (Walb & Loudon, 1986) which ended in 1985 after operating for 18 months. More recently car sharing organizations have been formed in Seattle, San Francisco, Boston and Washington, D.C, with other smaller groups operating in several areas of the country and still others in the planning stages. It has been estimated that as many as 11,000 individuals currently belong to car sharing groups in the United States (Shaheen & Meyn, 2002), with the number increasing rapidly as the concept spreads throughout the country. There are also several car sharing organizations in Canada, including Montreal, Quebec City, Vancouver, Toronto and Victoria which taken together have almost 5,000 members at the present time (Shaheen & Meyn, 2002).

Car sharing is predicated on the notion that the number of vehicles required to meet the demand of a group of individuals is *less* when they share a single vehicle than when each has their own. Further, it is widely acknowledged that individuals use their automobiles only a small portion of each day, as little as an hour or less during a normal 24 hour day (Shaheen, Sperling and Wagner 1998). As a result of this typical demand pattern, most organizations have established a ratio of between 10 -15 members to each vehicle in their fleet. Thus, only a single shared vehicle, instead of 10 to 15 that are privately owned, are required to meet the normal level of demand for a group of this size.

Car sharing is also based on the premise that the relatively high fixed costs of owning a car are usually ignored when individuals decide whether or not to drive by car. If they think about the cost of travel behavior at all, individuals tend to focus on the low variable costs associated with each trip. This leads them to travel by car more often than they would if they had to pay for each trip, as they do when they drive a car share

vehicle. In this way, once individuals become more mindful of the variable costs of each trip, car sharing is expected to reduce the overall level of vehicle miles of travel. Since members are also required to reserve a vehicle in advance and to a certain extent plan their travel route, they will less likely to take spur of the moment trips than they are in a privately owned car. Finally, when a private vehicle is no longer available, it is anticipated that car share members will be motivated to rely more on alternative travel modes, such as carpooling, biking, and public transit. The following study was designed to test each of these anticipated outcomes by examining the travel behavior of the early adopters of the car sharing concept in the United States—the first year members of Car Sharing Portland.

Study 1: The Adoption Process

Given the strong American attachment to their private automobiles, there was a good deal of uncertainty about how many people would join a car sharing organization in this country, as well as what factors would motivate them to consider becoming a member. In Europe the early adopters of the car sharing concept have been largely motivated by environmental concerns and financial savings. For example, members of the Leiden car sharing group in the Netherlands, Meijkamp (2000) ranked the increasing costs of automobile driving as the primary reason they joined the organization. The excessive time public transport takes ranked number two, while residential parking problems and age of car ranked third and fourth, respectively.

In their survey of 138 members of the Austrian car sharing organization Steininger, Vogl, and Zettl (1966) also found that financial considerations were the principal reason members gave for joining the organization, with the environmental benefits of car sharing

ranked as their second most important consideration. In an in-depth focus group study of 39 Swiss drivers, Harms and Truffer (2000) found that major changes in the member's personal life or mobility situation were the principal reasons they were motivated to join the car sharing organization. For example, several reported they could no longer afford their vehicle because of rising insurance costs or the lack of funds to replace a vehicle than had broken down. Others lost their vehicle because of a divorce or no longer needed one because of a change in their job or residence.

The following study was designed to study the adoption process of the first-year members of Car Sharing Portland. Evidence was sought on the factors that motivated them to join the organization and whether or not their decision was based on the same factors that held for European car sharers.

Method

Participants. A total of 120 individuals joined CSP during its first year. Eighty seven members completed the initial Pre-Membership Survey yielding a 72.5% return rate, while sixty four completed the Year End Survey with a 53.3% return rate.

Procedure. The Pre-Membership survey consisted of 19 questions covering basic demographic and travel behavior information and was given to all incoming members during their orientation meeting. At the completion of the first year, all active members were mailed a Year End Survey that sought further travel information and an overall appraisal of the organization including vehicle availability, service satisfaction, financial savings, and the advantages and disadvantages of belonging to CSP.

Results

Size. The year end total of 120 members was comparable to the first year totals of other North American car sharing organizations. Indeed, at the end of its first year, the Co-operative Auto Network in Vancouver, BC had an identical number of members (Axelsson, 1997), while Auto-Com in Quebec City had 160 members (Robert, Leblanc & Morisette , 1996).

Demographics. Respondents ranged in age from 22 to 75 years, with a mean of 37.24 years. The sample was fairly evenly divided between females (47) and males (40). Most were college graduates with an average highest completed grade in school of 16.4 years. In addition, the majority of respondents held professional positions with their median monthly income level equal to $3,000 - $4,000.

Vehicle Ownership. The majority (59%) of CSP members said they did not own a personal vehicle at the time they joined the organization, while less than half (41%) indicated they were owners. Other investigations (Steininger, Vogl & Zettl, 1996) have shown that vehicle ownership is closely associated with the effect of car sharing on overall mobility behavior, a relationship to be examined in Study 2.

Motivation. On the Pre-Membership Survey the majority of respondents said they were primarily motivated to join CSP because of their periodic need for an additional vehicle. When asked for the second most important reason, the majority said it was due to the financial savings they expected to derive by avoiding the cost of owing and operating a private vehicle or by making it unnecessary for them to purchase one.

These findings were confirmed on the Year End Survey, where, as before a sizeable majority of the members indicated they were largely motivated to join CSP

because it met their periodic need for a vehicle or that they didn't own one or didn't want to. These results are shown in Table 1. Many members reported that their need for a vehicle occurred because of an unexpected change in their life, such as their car broke

Insert Table 1 About Here

down, they obtained a new job, or they faced a sudden increase in their automobile insurance premiums. No one reported they joined because they did not have convenient access to public transit. Unfortunately, we did not obtain an independent measure of the distance between the member's departure point and the nearest transit station. However, all first year CSP members lived in the inner city areas of Portland where, because of its excellent public transit system, a bus or light rail carrier station was never more than a short walk from their home or workplace.

Discussion

Taken together, this evidence indicates that the early adopters of car sharing in Portland were a highly educated, relatively affluent group of individuals who were primarily employed in professional occupations. They were not restricted to any single age group nor represented by one gender more than the other. The findings also suggest that the factors governing the adoption of car sharing in America may be much the same as they are in Europe. While the evidence reveals that environmental factors were important goals for some members, the majority indicated that these factors were of lesser importance than their need for a vehicle and the financial savings they expected to realize by becoming a member.

Comparable findings have been report by Muheim (1998) who, in tracing the history of the car sharing organization in Switzerland, noted that in the early days of the

car sharing movement ecological motives were very important. However, "as early as 1995 and 1996, the proportion of those who joined for ecological reasons fell to 9%, while in 1997 it even fell to 6%. Practical reasons have become much more important…" (Muheim, 1998, p. 20).

Like the members of the Austrian car sharing organization reported by Steinnger et. al (1996), many CSP members said they joined because of financial considerations. In addition, as was true in Harms and Truffer's (1999) qualitative analysis, the early adopters of CSP often found themselves needing a vehicle because of a change in their life circumstances. The role of such factors in the adoption process is illustrated by the comment of one CSP member who wrote that when he and his wife need to buy a home, they deliberately purchased one that was close to a CSP vehicle station. He reported that the money they would save by not owing a car made it possible for them to afford to buy a house that otherwise would not have been possible.

Study 2. Trip Behavior

When people first hear about car sharing, their most widely voiced concern is that a car will not be available when they want to drive one. They presume that demand for the vehicles in the fleet will not be evenly distributed throughout the day and that during the weekend, when the demand for vehicles will be high, vehicle shortages will often occur. Since there was virtually no prior evidence on this matter, it was difficult to know if these concerns were well founded.

Further, on the assumption that a large number of personal trips are usually based on “spur-of-the-moment” decisions, it was also anticipated that many reservations would

be booked shortly before departure time. If this were the case, it would constitute an additional factor limiting vehicle availability.

Method

Evidence on service usage was obtained from Trip Ticket records that were filled out by members at the beginning and conclusion of their CSP trip. Each vehicle in the fleet contained a booklet of Trip Tickets that provided the organization with billing and trip usage information. Members were asked to indicate their ID Number, the vehicle number, the start and end time of their trip and odometer mileage readings, the purpose of their trip, as well as additional information relevant to vehicle performance. If they were required to purchase fuel, this was also to be noted so their account could be credited. The booklet was organized in dual copy format, with one copy for the organization and one for the member.

Results

Demand Pattern The availability of vehicles was rarely a problem during CSP's first year, when the ratio of members to vehicles was maintained at 13/1. While members tended to drive slightly more on the weekends than weekdays, there were always enough vehicles in the fleet to satisfy the level of demand. In addition, trips were sufficiently distributed throughout the 24 hour time period to insure a consistently high level of vehicle availability. The majority of member trips took place during the morning (37%) or afternoon hours (39%), while the remaining trips occurred in the evening (19%) or early morning (midnight to 6am) hours (5%). With respect to seasonal variations in usage, it seemed premature to examine this possibility, since the data available for such an analysis was of necessity limited to a single full year cycle.

The evidence also indicated there was very little basis for concerns about excessive last-minute bookings, as 60% of the reservations were made at least 1 or 2 days prior to usage. In contrast, only 13% were made 30 minutes or less before the requested departure time. This suggests that, as members became more familiar with the service, a fair amount of planning preceded their decision to book a CSP vehicle.

Usage Predictors The results indicated that the members varied widely in their service usage patterns. On the average the members took between 2.5 – 3.5 trips per month. The trip behavior of members also varied a great deal from month to month, as a member might be a low user one month and a high user the next. Indeed, it was not uncommon for some members to go an entire month without taking a single CSP trip. During the first year, the monthly average of CSP members who did not book a single reservation was 30.6%.

To more accurately reflect this variation, each member was classified into one of the three user group categories, low, medium and high, in terms of the *average number of trips they took each month* after joining the organization. Table 2 lists the number of members in each user group. There were unexpected and significant differences between

Insert Table 2 About Here

the three user groups in the length of time they belonged to CSP, $F(2,471) = 5.10$, $p = .006$. Follow up t-tests revealed that members of the Low User group had been members for a significantly longer period than the Medium, $t(328) = 3.01$, $p = .002$ group. They had also belonged longer than the High User group, although this difference was not significant. This provides suggestive evidence that the longer individuals belong to CSP, the *fewer* trips they are likely to take.

Utilization of CSP vehicles was also a function of the distance from the member's household to nearest vehicle station. In response to a question on the Year-End Survey, members reported they lived on the average 14.35 blocks to the nearest CSP station. They also reported it took them an average of 10.75 minutes to get to the nearest station. This value was influenced by the fact that while slightly more than three-quarters (76%) reported they walked to the station, 15% said they regularly biked there.

To determine the impact of proximity on usage, an independent measure of the member's distance to each of the CSP stations was calculated by converting their block estimate to miles. Miles to the nearest station was a significant predictor of the frequency of usage, as the further members lived from the nearest station, the fewer trips they took, r = -127, p = 003. This relationship was significant even though not all trips were taken from the station closest to the member's household residence. For example, reservations were sometimes made for a vehicle at the station nearest the member's place of work.

The relationships between membership length and distance to station on CSP trip usage can be more clearly understood by considering how both *interacted* with vehicle ownership. By itself, CSP usage was not influenced by whether or not a member owned a vehicle. But it was influenced by the way in which vehicle ownership moderated the effect of membership length and distance to station.

This can be seen by considering the interaction shown in Figure 1 between the average number of trips per month and the length of CSP membership. It is evident that the impact of membership length varied as a function of whether or not a member owned a personal vehicle, F (4, 434) = -2.85, p = .005. Figure 1, reveals that the longer a member had belonged to CSP, the fewer trips they were likely to take. This relationship

was strongest when members owned a personal vehicle. And while it was also true, if they did not own one, with the limited data available, the relationship here was not statistically significant.

Insert Figure 1. About Here

Similarly, vehicle ownership also interacted significantly, $F(4, 434) = -3.15$, $p = .002$, with distance to station. This interaction is shown in Figure 2, which depicts the relationship between the average number of trips per month and distance to the nearest station as a function of vehicle ownership. Figure 2 reveals that if a member owned a car, the frequency of CSP trips decreased the further away he or she lived from the nearest station. But if a member did not own a car, frequency of usage was not affected by distance to station.

Insert Figure 2. About Here

Discussion

Taken together, this evidence suggests that the impact of both membership length and distance to station on CSP trip usage depended critically on whether or not a member owned a personal vehicle, with these factors playing a far more important role for vehicle owners than non-owners. Perhaps, those who owned a vehicle came to conclude that they might as well arrange to use their personal vehicle more often, given the additional cost of a CSP trip or the long walk to the vehicle station.

The role of membership length on CSP vehicle usage was not expected. Rather, it was anticipated that growing familiarity with the service would foster greater use. This was based on the belief that over time individuals would *learn* to appreciate the

convenience and cost savings of car sharing. In turn, this would increase the likelihood that they would make greater use of the service to meet their mobility needs.

However, the early adopters of car sharing in Portland did not behave this way. Instead they seemed to have learned something quite different, namely the true cost of each automobile trip they took. Prior to reserving a CSP vehicle, they may have spent some time thinking about the cost of their forthcoming trip in a way they were not accustomed to. This may have led them to think twice about whether or not to travel by car and, instead, consider deferring their trip or choosing other means of transport.

This reasoning suggests that the impact of membership length on usage would be most clearly exhibited by those who had been members for the longest period. This is confirmed by the trip data of those who joined during CSP's first month. Of the 12 CSP members who belonged throughout the first year (12 months), 9 took more trips during their first three months than they did during the last three.

It was premature at the end of the first year to analyze the effect of membership length on the entire group of CSP members, since most had been members for only a short time. In fact, at the end of the first year, more than 2/3 of CSP's then-current members had belonged for 6 months or less. It appears that the tendency to take fewer and shorter trips in CSP vehicles develops gradually. Thus, a more powerful test of this relationship will be possible over time, with increasing length of membership.

Study 3. Mobility Effects

Do individuals drive less after joining a car sharing organization than they did before becoming members? Such a reduction has frequently been reported for members of the car sharing organizations in Europe. For example, Munheim (1998) reports that

members of Mobility Car Sharing Switzerland who owned a car drove 72% fewer kilometers in the first year after joining than they had the year before. In an extensive study of several German car sharing groups Baum and Pesch, as reported in Shaheen, et al. (1998), found that car sharers reduced their vehicle mileage by 42% and increased their use of public transport s by 39% after joining a car sharing organization. In Meijkamp's (2000) study of four car sharing organizations in The Netherlands, members drove on the average 33% fewer kilometers per year after becoming car sharers. And, Lightfoot (1997) in a study of 4 other car sharing groups in The Netherlands reported that annual train ridership among members increased 7%, bicycle use 5% and bus use 18%.

A decline in vehicle ownership is also one of the most widely observed effects of car sharing in Europe. In a review of four commercial car sharing projects in The Netherlands Lightfoot (1997) reported a 44% decrease in the number of car owners among the 847 members of these organizations. Muheim (1998) reported that 60% of the early adopters of Mobility Car Sharing Switzerland sold their vehicles after becoming members. In Canada Robert (personal communication, 2001) reported that 25% of the members of Auto Com, which operates in Montreal and Quebec City, sold a vehicle and 58% were able to avoid purchasing one.

Would similar effects be observed for members of the newly emerging car sharing organizations in North America? Since there are wide differences between Europe and North America in transportation infrastructure and the conditions of urban living, it is not entirely clear they would be. The following study was designed to begin to obtain evidence on this question by investigating the mobility behavior of Car Sharing Portland members during the first year they belonged to the organization.

Method

CSP members were asked to record their travel behavior in a one-week Trip Diary before they began using the cars in the fleet and at the end of the first year. Thirty-three members completed both forms of the diary. This provided a measure of the member's travel behavior during a representative week before and after they had become car sharers.

The Trip Diary recorded five measures for each day (weekdays and weekends) of the week it was completed, with the exception of the last measure which was the member's *estimate* of their total *yearly vehicle* miles of travel.

- Frequency of *personal* vehicle trips only
- Frequency of all *other* vehicle trips (bus, taxi, CSP vehicles)
- Frequency of *non-vehicle* trips (walking, biking, etc.)
- *Vehicle* miles only (all vehicles, including the CSP vehicle)
- Yearly vehicle mileage *estimate*

Additional mobility behavior information was obtained from both the Pre-Membership and Year-End Survey where evidence was obtained on the member's transit ridership, non-vehicle travel, and changes in personal vehicle ownership.

Results

Trip Diary Measures. Thirty three members of CSP completed the Trip Diary during both test periods. The Pre-Membership and Year End measures shown in Table 3 are differentiated in terms of whether or not a member own a personal vehicle at the time they completed the Pre-Membership Survey.

Insert Table 3 About Here

As expected, CSP vehicle owners drove significantly more vehicle miles than non-owners during both pre ($F(1, 28) = 18.87$, p , .001) and post ($F(1, 31) = 4.27$, $p = .047$) test weeks. CSP vehicle owners also took more personal vehicle trips (F (F (1 31) = 17.92, p <.001); ($F(1, 31) = 5.90$, $p = .021$) and *estimated* they traveled more yearly vehicle mileage than non-owners (f (1, 31) = 13.99, $p = .001$); ($F(1, 31) = 7.29$, $p = .011$) during both periods. In addition they also took fewer non-vehicle trips during both administrations of the Trip Diary (F (1, 31) 14.97, $p = .001$; $F(1, 31) = 5.88$, $p = .021$). However, the groups did not differ on the remaining Trip Diary measure, other vehicle trips, either before or after they had joined the organization.

Table 3 also reveals there was very little *change* on the Pre-Membership and Year End Trip Diary measures. This was true for both vehicle owner and non-owner members. The single exception to this pattern is on the measure of vehicle mileage for the non-owners which increased sharply ($F(1, 17) = 9.84$, $p = .006$)) on the second Trip Diary assessment. This change can be attributed to the newly available CSP vehicles that served as a catalyst for the non-owners to travel by car.

Some of the additional comparisons between the two periods were consistent with the evidence reported by the European car sharing organizations. For example, the owners took *fewer* personal vehicle trips, *more* other vehicle trips, and drove *fewer* miles at the end of the first year of their CSP membership. Similarly, the members who did not own a vehicle took *more* other vehicle trips (presumably in a CSP vehicle) and estimated they drove *more* miles during the year. But in each case, the differences were small and not statistically significant.

In short, the observation that individuals who did not own a personal vehicle drove more vehicle miles after they joined Car Sharing Portland was only significant change at the end of the first year. While these members drove more, those who owned a car did not drive much less. In fact, in some cases the easy access of the additional vehicle in the CSP fleet may have led some to drive more. When combined with the increasing mileage of the non-owners, *the aggregate net effect of membership in CSP was either no change or a slight increase in VMT.*

Survey Measures. While it did not represent a major shift in their customary travel behavior, many members reported they used alternative modes (transit, walking & bicycling) more often for commuting, shopping, and personal errands during the first year of their CSP membership. Compared with the Pre-Membership Survey data, members reported on the Year End Survey a significant increase in the *number of days per week* they traveled by bus, $F(1\ 46) = 26.06$, $p < .001$, walking, $F(1\ 43) = 106.68$, $p < .001$, and by bicycling $F(1\ 35) = 6.62 = .014$. These findings are consistent with a comparable trend observed on the Trip Diary data, where there was a small increase in the number of "non-vehicle" trips taken by both vehicle owners and non-owners after they had become CSP members.

Finally, of the 64 Year-End Survey respondents 17 (26%) reported that they had sold their personal vehicle after joining the organization. In addition, 34 (53%) reported they were able to avoid a planned vehicle purchase as a result of their membership in CSP. Indeed, almost all of the individuals (N = 16) who said on the Pre-Membership Survey that they intended to sell a personal vehicle did, in fact, do so in the year after they joined CSP.

Discussion

Contrary to expectations the members of Car Sharing Portland did not drive any less after joining the organization than they did before they became members. There was no evidence from either the Trip Diary or surveys to indicate a decline in vehicle miles of travel, although members reported greater use of alternative transportation once they had become car sharers. In addition, 17 (26%) of the respondents to the Year End Survey reported they had sold their personal vehicle, while another 34 (53%) said they were able to avoid purchasing one. This finding is consistent with recent results from Zip Car, the car sharing organization in Boston, where 14% of the members reported selling their personal vehicle and 44% said they were able to avoid or delay purchasing one after becoming car sharers (R. Chase, personal communication, October 26, 2001), as well as the previously cited results from Europe and Canada (Lightfoot, 1997; Muheim, 1998; Robert, 2001).

In their evaluation of the Short Term Auto Rental (STAR) program that operated in San Francisco for eighteen months, Walb and Loudon (1986) also reported the overall level of vehicle ownership among STAR members declined by 15%, as 8.2% of the households sold one of their two vehicles and 9% sold their only vehicle. In addition, as many as 43% of the households reported they delayed or cancelled a planned vehicle purchase as a result of being able to use those in the STAR fleet.

While Walb and Loudon did not collect Trip Diary data on total vehicle miles of travel, their survey results indicated that STAR members took an increasing number of vehicle trips as a result of the availability of the vehicles in the fleet. In addition, their data also indicated that STAR membership was associated with a decrease in both transit

ridership and carpooling. These findings, like those reported for CSP, suggest the strong possibility that there may have also been "an increasing level of vehicle miles of travel" (Walb & Loudon, 1986) after individuals joined STAR.

These results stand in contrast to those widely reported for the European car sharing groups. They are also are consistent with preliminary findings from the ongoing evaluation of City Car Share, the recently established car sharing cooperative in San Francisco (Cervero, Creedman, Pohan, Pai & Tsai, 2002). Based on evidence collected during City CarShare's first nine months Cervero et al. concluded that access to the vehicles in the fleet stimulated automobile travel relative to a control group of individuals who expressed interest in joining but had not yet become members. They write: "…those using City CarShare vehicles drove farther, longer, and logged more VMT than members driving private vehicles" (p. 18). And later they conclude: "City CarShare also appears to be inducing motorized travel. This should not be unexpected given that over two-thirds of members come from carless households" (p. 47). These findings are all the more impressive since they replicate the findings of the STAR evaluation that was conducted in San Francisco more than 15 years earlier.

General Discussion

Before CSP was launched, there was considerable uncertainty about whether the market potential of car sharing in this country would be as promising it has been in Europe. After CSP had completed its first, most of these doubts had been largely dispelled. More than 120 individuals had joined during the first 12 month period, with an average of 33 new members each quarter. Interest in the car sharing concept began to spread throughout the local community, as well as in the rest of the country. In the three

and a half years since then, the organization has continued to grow at an even more rapid pace so that it now has well over 1,200 members who have access to a fleet of 38 vehicles located at 25 locations throughout the metropolitan area. This pattern of growth indicates that car sharing meets the transportation needs of a growing number of individuals and that those who belong to the organization are satisfied with the services it offers. This was confirmed on the Year End survey (Katzev, 1999) where a sizeable majority rated each service feature to be "excellent." Additional results indicated that 81% of the members felt that the organization had measured up to their initial expectations and 75% said they had achieved their anticipated transportation costs savings by joining.

In 2002 Flexcar, a public/private partnership that two years earlier had started a car sharing organization in Seattle, purchased Car Sharing Portland. In addition to Seattle and Portland, Flexcar currently operates car sharing organizations in ten other North America cities. Flexcar has pioneered in attracting corporate and nonprofit groups to join its growing nationwide network. For example, at the present time 40 business have joined their branch in Portland. Recently Flexcar has established a program for the students, faculty and staff at the University of Washington in Seattle.

Corporate and university memberships provide a convenient alternative to owning and maintaining a fleet of cars or reimbursing employees for driving their personal vehicles on business trips. In addition, by giving employees access to vehicles for their personal use, they make it feasible for workers to commute by transit, biking, or walking instead of relying on their private automobile.. This, in turn, can reduce the organizational costs of building and maintaining employee parking facilities. Flexcar

allows anyone approved to drive on one of their organizational accounts to establish a personal account as well and any Flexcar member is also eligible to use the vehicles in any of their other locations throughout the country.

Mindfulness of Transportation Costs

Earlier it was suggested that the apparent decline in service usage with increasing membership length might be attributed to the member's growing awareness of the true costs of each automobile trip, as they are now required to pay for both the duration and distance of each CSP trip. When CSP members were asked about this matter on the Year End Survey, 75% reported they had become more aware of travel costs since they had joined the organization. In turn, 62% said this awareness had influenced either "somewhat" (N = 24) or "greatly" (N = 16) the likelihood that they would book a CSP vehicle. Many reported that were doing a good deal more trip planning, errand "bundling," and avoiding spur-of-the-moment trips as a result of their membership. These results are consistent with a similar observation reported by Muheim (1998) for the members of Mobility Car Sharing Switzerland. According to Muheim:

> The longer clients are with Car Sharing, the less they drive a Car Sharing car because the Car Sharing principle promotes this behavior actively. It brings transparency to the cost of a car. This leads to an economical use of the car and to taking full advantage of alternatives. The clients often take better advantage of public transportation, use the bicycle more often, or combine several trips into one (p. 21).

Growing member trip cost "transparency" may account for the observed relationships between CSP trip usage and both membership length and distance to station. These relationships depended critically on whether or not a member owned a vehicle, with both variables exerting much greater influence on owners rather than non-owners. Perhaps, those who owed a vehicle concluded that they might as well arrange to use their own car more often and thereby avoid the additional cost of a trip taken with a car in the CSP fleet.

Mobility Effects

During its first year, Car Sharing Portland attempted to have a positive impact on the environment by reducing the vehicle ownership needs of members and the number of vehicle miles its members traveled, as well as well as encouraging them to make greater use of alternative modes of travel. It was most successful in achieving the first goal, as 17 individuals sold their personal vehicle and another 34 said they were able to avoid purchase one. However, a reduction of vehicle ownership did not lead CSP members to drive any less. Unlike the evidence from the European car sharing organizations, there was nothing in the CSP Trip Diary or survey data to indicate a decline in member VMTs.

Methodological Issues In trying to interpret these differences, it is important to note that, with the exception of Steininger, Vogl & Zettl, (1996) the published travel behavior data from Europe is based on retrospective estimates of selective samples of the members of a variety of car sharing schemes. Such reports, like those of the American survey respondents, are not immune from any of the potential sources of error and bias that can intrude on their accuracy. In commenting on the difficulty of making these judgments Harms and Trufler (2002) note: "…participants were asked to indicate the

number of kilometers they drove by car before joining the car-sharing organization and also to indicate how many kilometers they now made by car-sharing and other cars. People's reaction to this question was unanimously helpless" (p. 12).

It is clear that like other recollections of distant events that are not normally coded with numerical precision, estimates of vehicle miles of travel should be viewed cautiously. This is also true for self-reported information obtained from individuals who had expected to drive less or who, because of their positive attitudes about car sharing, might thereby wish to avoid the appearance of driving more after becoming a member of a car sharing organization.

Transportation Systems In addition, there may be some very real transportation-based constraints in this country that make it difficult at this time to replicate the European car sharing mobility effects. One need only point to the dense transit infrastructure that exists within and between European cities to suggest how much easier it is to take public transit and avoid traveling by car there than it is in most American cities. As a result, members of European car sharing organizations are much less dependent on vehicles, either those they own or those in a shared fleet. In short, changes in mobility attitudes and shifts to alternative means of transport that develop after one becomes a member of a car sharing organization, can be translated into action much more readily in Europe than in the United States. Perhaps it is inevitable, then, that until the transportation infrastructure in this country begins to approximate conditions in Europe, it will be some time before the robust VMT reductions that have been so widely reported by car sharing organizations there can be replicated in the United States.

Psychology of the Car Sharing Experience

In a provocative challenge to the introduction of car sharing in the United States, M. Bernard (personal communication, September 3, 1998) has suggested that car sharing starts out with at least six negatives: (1) A user has to plan their trips in advance. So in most cases spontaneity is lost. (2) The user has to remember and take the time to make a reservation. (3) The car is probably parked further from the user's residence than their personal car would be. (4) The user has to leave it clean, every time, even if he/she is in a hurry. (5) The user has to deal with some form of paper work, pin numbers, lock boxes, etc, every trip. (6) The user has to worry about getting the car back on time—another loss of spontaneity.

With such a set of hurdles to overcome, it is hard to imagine that car sharing would ever appeal to very many people. Yet, these "negatives" did not deter the members of Car Sharing Portland from joining the organization. Nor did they find them terribly burdensome after experiencing the service. On the Year-End Survey the majority of Car Sharing Portland members did not report being distressed by the requirements of booking and using a car in the fleet. While a small number thought that trip planing and returning the car in time for next user were "somewhat inconvenient" in both instances almost as many members said they were not inconvenienced by having to perform them. Whatever concerns they might have had about these "negatives" before joining never developed into serious problems after they had been members for awhile. To be sure, a number of new tasks had to be learned during the initial period of their membership. But the learning process appears to have been rapid so that virtually all of the members adapted quickly to these requirements. And however burdensome they may have felt them, most

did not let that interfere with the satisfaction they derived from the car sharing experience.

Conclusion

This report was written in the belief that the mounting transportation crisis in our urban communities deserves to be more fully addressed by social/environmental researchers than it has in the past. That is particularly true for investigators concerned with fostering more sustainable transportation behaviors. Largely because of its potential for decreasing dependence on private vehicle ownership and travel, the concept of car sharing was introduced as a possible mechanism for achieving this goal.

Although not all of its environmental objectives were realized, Car Sharing Portland did reduce the vehicle ownership needs of its members and promote more trip planning, trip "bundling" and greater use of alternative transportation, such as bus riding, bicycling and walking. However, reduced vehicle ownership was not followed by a corresponding reduction in vehicle miles of travel. On the contrary, car sharing induced greater automobile travel among formerly car less individuals. Further research will reveal whether or not these findings will be replicated by future car sharing organizations. The difficulty of generalizing from the findings reported herein emphasizes the need for such replications. The results from both the Pre-Membership and Year End Surveys, as well as those based on the Trip Diaries are based on relatively small, self-selected samples. It is impossible to know whether these participants differ from the non-participating members of Car Sharing Portland, or whether they are representative of the larger population of individuals who join other car sharing organizations.

In the long run increasing reliance on sharing cars rather than owning them privately may turn out to be the greatest environmental benefit of car sharing. This will be true for both individual, corporate and non-profit group members of car sharing organizations. If each car share vehicle removes anywhere from 5 to 6 vehicles from the road, it could yield considerable savings in the resources required to manufacture, maintain, operate and store the existing automotive fleet in this country. Additional benefits can be expected from improved vehicle maintenance and the use of more energy efficient, clean running late model cars including hybrid and electric vehicles. In this way, it is hoped that the growing nationwide acceptance of car sharing will be able to make a positive contribution to the transportation problems that currently exist in this country.

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Table 1

Most Important Reason for Joining CSP

Response	Frequency
Needed vehicle	17
Don't own a vehicle	11
Don't want to own a vehicle	8
Support concept	7
Environmental reasons	5
Save money	7
Convenient to use	5
Other	3
Missing or N/A	1
Total	64

Table 2

Three User Groups

Group	Average Monthly Trips	Number (%) of Members
Low User	1 or fewer trips/month	36 (33%)
Medium User	2-3 trips/month	48 (44%)
Hi User	4 or more trips/month	25 (23%)

Table 3

Pre-Post Mobility Comparisons of Car Owners and Non-Owners

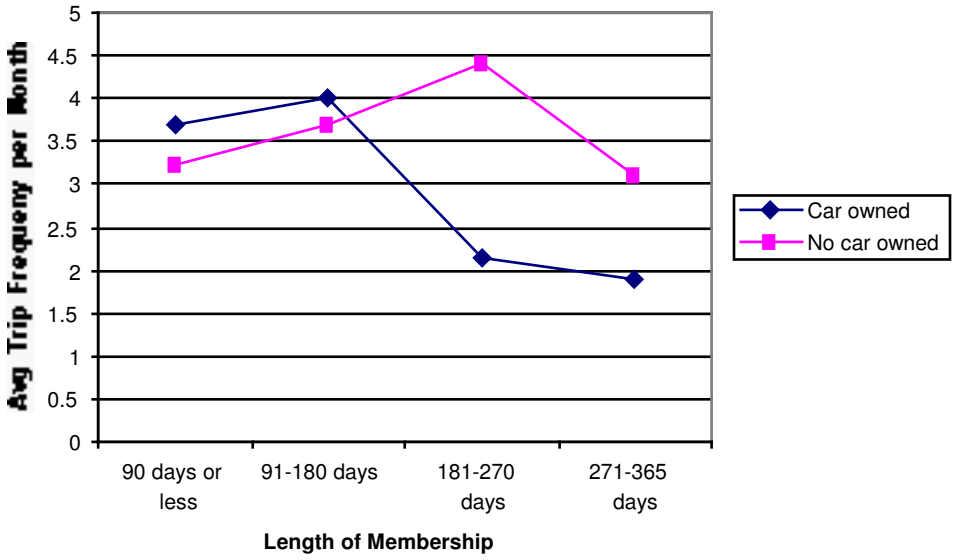
	Car Owners (N = 15)		Non Car Owners (N = 18)	
Travel Measure	Pre Mean	Post Mean	Pre Mean	Post Mean
Personal-vehicle trips	9.53	6.733	0.00	0.33
Other-vehicle trips	13.46	16.06	10.00	13.05
Non-vehicle trips	8.86	11.00	20.22	21.11
Vehicle mileage	103.33	84.38	0.33	24.92
Year mileage estimate	5790.90	7230.00	50.00	138.88

Figure Captions

Figure 1 Depicts the average number of trips members make in CSP vehicles as a function of the length of time they have belonged to the organization and whether or not they owned a personal vehicle.

Figure 2 Depicts the average number of trips members make in CSP vehicles as a function of the distance from their home to the nearest vehicle station and whether or not they owned a personal vehicle.

Richard Katzev Figure 1



Richard Katzev Figure 2