Peer-to-peer carsharing: Market analysis and potential growth

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Peer-to-Peer Carsharing

Market Analysis and Potential Growth

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Many studies show that carsharing reduces transportation costs for a large segment of the population. Carsharing also reduces the number of private vehicles on the road because carshare members do not purchase their own cars. However, the traditional carsharing business model is difficult to scale geographically to neighborhoods with lower population densities because the operator must bear the upfront fixed cost of purchasing or leasing the vehicles in the fleet. In contrast to traditional carsharing, peer-to-peer (P2P) carsharing allows car owners to convert their personal vehicles into shared cars that can be rented to other drivers on a short-term basis. This model helps to improve the situation in which most privately owned vehicles sit idle more than 90% of the day. P2P carsharing alleviates upfront costs and thus is more economically consistent with lower-density neighborhoods than is traditional carsharing. As a result, P2P carsharing provides greater potential for car accessibility than traditional carsharing does. Several new service companies are dedicated to P2P carsharing. A methodology was developed to assess the market feasibility of P2P carsharing. The methodology was applied to develop a case study of P2P carsharing in Pittsburgh, Pennsylvania. The market for P2P carsharing was found to be economically viable. However, uncertain and fragmented public policy and car insurance regimes threatened the growth and investment in P2P carsharing.

National priorities are focused on reducing the energy consumption and greenhouse gas emissions from the transportation sector. Many potential supply-side and demand-side solutions exist. Carsharing is one such demand-side energy saving innovation. Carsharing reduces the environmental impact of driving and reduces private transportation costs for some drivers with only intermittent need for vehicle transportation (*1*). Previous studies have demonstrated that each new share car added to existing carsharing fleets removes 4.6 to 20 private vehicles from the road (*1*). This reduction occurs because members of carsharing services are much less likely to purchase their own cars and may even sell a car after joining a carsharing service (*2*). Carsharing changes the economics of driving by converting vehicle transportation from a fixed cost into a variable cost. Carsharing has been shown to reduce mode adjusted vehicle miles traveled by members by 67% (*3*). The average member of the City CarShare carsharing service in San Francisco, California, spends only about $540 per year on automotive transportation (*4*). This represents a tenfold cost savings when compared with owning a small sedan (*5*).

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Market demand studies conducted in the United States and Europe have estimated cost savings alone would drive between 3% and 25% of the driving population to forego car ownership, or to replace their privately owned cars, and instead take up membership in a carsharing service (*6*). Other research estimated that if a sufficient number of conveniently located vehicles were available, then 10% of the individuals over the age of 21 in metropolitan areas of North America would adopt carsharing (*2*).

Today, despite the enormous potential environmental benefits and despite considerable consumer demand, adoption rates for carsharing are currently 12 to 30 times lower than projected by market research (*6*). The researchers argue that the current carsharing business model is not flexible enough to capture the entire carsharing demand. The traditional carsharing business model is difficult to scale geographically. In the traditional carsharing model, the business that manages the share car fleet must bear the upfront, fixed cost of leasing or purchasing all of the vehicles in the fleet. Each new share car must be located in a high population density area with many potential members to drive use of that vehicle and offset these costs. Even within the largest metropolitan areas, only so many viable share car locations are available. For the fleet operator to realize a profit on its initial investment, about 25 active members must live within ¼ mi of each vehicle to ensure sufficient use of the share car (*4*). The five largest U.S. carsharing services maintained member-to-vehicle ratios of 66:1 in 2005 (*2*). Even when acceptable locations are found, and vehicles are placed into service, there is still substantial risk that membership will never reach sufficient levels to drive enough use to offset the capital costs associated with those vehicles (*7*).

PURPOSE AND ADVANTAGE OF PEER-TO-PEER CARSHARING

This paper explores the feasibility of a scalable form of carsharing, called peer-to-peer (P2P) carsharing. P2P carsharing allows car owners to convert their personal vehicles into share cars that can be rented to other drivers on a short-term basis. As of 2007, more than 237 million private vehicles were owned and operated in the United States (*8*). This business model helps to alleviate the situation in which most privately owned vehicles sit idle over 90% of the day (*9*). The utilization requirements are greatly reduced, and much of the risk of geographic expansion is removed with P2P carsharing.

Zipcar reported total operating expenses of $137 M in 2009. Fleet operations constituted $93 M, or 68%, of those expenses in that year. The item fleet operations consists principally of costs associated with operating vehicles, such as lease expense, depreciation, parking, fuel, insurance, gain or loss on disposal of vehicles, accidents, and repairs and maintenance, as well as some employee-related costs (direct labor on vehicles). During 2009, Zipcar operated a fleet of about 7,000 vehicles (*7*). Assuming Zipcar fleet's achieved fuel economy comparable with the U.S. fleet average of 25.4 mpg (*10*), an average fuel price of $2.75 per gallon of gasoline, and an average trip duration of 3.93 h and average trip distance of 21.2 mi (*3*), then total annual fuel expense can be estimated at around $14 M, or 10% of total operating expenses. Similarly, assuming that the annual insurance premium for each of Zipcar's 7,000 vehicles was equivalent to the $1,480 per year average reported by Shaheen et al. (*11*), then total annual insurance expense can be estimated at $10 M, or 8% of total operating expenses. Therefore, it is not unreasonable to assume that the P2P model could reduce the cost of operating a carsharing service by 50% or more. The P2P carsharing model eliminates all of these expenses except insurance, fuel, and telematics for tracking and reserving the vehicles. The researchers are aware of four P2P carsharing organizations in the United States: Getaround, Go-Op, RelayRides, and Spride Share; and one in England, WhipCar.

Data from the Longitudinal Employer-Household Dynamics program and the U.S. Census are used to develop a methodology to assess the market feasibility and economic incentives of P2P carsharing (*12, 13*). The methodology is then applied to develop a case study of P2P carsharing in Pittsburgh, Pennsylvania.

First, literature on market segmentation and demand estimation for carsharing is reviewed, and key success factors are summarized. Next, a methodology is presented to assess the feasibility of P2P carsharing from both the demand and supply side. A queueing theory–based analysis is used to match supply and demand to determine the viability of P2P carsharing in a given area. Next, the economic case is presented for car owners and renters to participate. Then P2P feasibility methodology is applied to Pittsburgh. Finally, the legal and insurance regimes that affect P2P carsharing are discussed.

SUCCESS FACTORS FOR CARSHARING

For the sake of clarity, in this paper a traditional carsharing service will be defined as this: "A membership program intended to offer an alternative to car ownership under which persons or entities that become members are permitted to use vehicles from a fleet on an hourly basis" (*14*). Because P2P carsharing is largely indistinguishable from traditional carsharing when viewed from the vantage point of a prospective renter member, the methodology employed in this paper to assess the potential renter demand for P2P carsharing is based on the current state of practice for assessing demand for traditional carsharing services.

The commercial success of any carsharing operation, be it a community-based service or a for-profit service, is directly tied to the level of vehicle utilization. Utilization rate is the primary indicator of a carsharing organization's financial health; therefore, achieving a high level of vehicle utilization is the primary driver of selecting point-of-departure (POD) location (*4*). Utilization rate is generally measured by revenue hours per vehicle day. Successful carsharing services have achieved utilization rate as high as 40%, meaning that the average vehicle in the operator's fleet is being driven by a paying customer for more than 9 h of every 24-h day (*4*).

To select appropriate locations for PODs, locations where high use can be achieved, operators of carsharing services must perform careful market segmentation. Market segments for carsharing can be usefully divided into two categories: geographic markets—neighborhoods where carsharing vehicles can be placed to best effect (*15, 16*); and demographic markets—groups that are most likely to join a carsharing program (*14*). The phrase geographic market refers to the macroscale characteristics of the neighborhood in which a shared car is located. The phrase demographic market refers to the individual characteristics of carsharing users themselves.

Geographic Markets

Previous literature describes the geographic markets where carsharing has taken root, and several common market characteristics have been identified (*15, 16*). Residential density is generally cited as an important success factor for carsharing, for high residential density is often closely connected with quality and availability of transit and neighborhood walkability (*4*). If the geographic reach of existing carsharing services is any indication, then clearly density is a strong predictor of carsharing success. In 2004, 94% of carsharing membership was concentrated in eight densely populated metropolitan regions: Boston, Massachusetts; Chicago, Illinois; New York; Philadelphia, Pennsylvania; Portland, Oregon; San Francisco; Seattle, Washington; and Washington, D.C. (*17*).

Density is also important because it indicates the size of the potential customer base of a POD. The geographic area served by each individual POD is very small. About 80% of all members of City CarShare's carsharing service live within ½ mi (or 10-min walk at 3 mph) of the nearest POD (*3*). More than half live within ¼ mi of the nearest POD (*3*). Doubling density around a POD doubles the number of potential users for the vehicles located at that POD (*4*). In the City CarShare publication, *Bringing Car Sharing to Your Community—Long Guide*, Sullivan and Magid indicate that 50 to 100 members living within a ½-mi radius is threshold for a successful two to three car POD (25 to 33 members per car) (*4*). They also provide a table indicating the levels of market penetration required to achieve 25 members per vehicle living within a 5-min (about ¼ mi) of a POD at various population densities as a guide for assessing location feasibility.

In addition to density, both Martin et al. (*1*) and Celsor and Millard-Ball (*14*) found that vehicle ownership has a strong correlation to the level of carsharing service membership. Car ownership rates of less than one car per household were strongly predictive of the presence of carsharing in a neighborhood. In fact, 66.8% of the U.S. members lived in households with no cars (*6*). Several other factors also predict the success of carsharing:

1. Parking difficulty and cost.
2. Mix of land uses. People who use carsharing for work need cars during the weekday versus the weekend for other uses.
3. Transit access and commute mode split. Carsharing requires people to be able to replace their car with a combination of walking, cycling, transit, taxis, and rental cars; therefore, high neighborhood walkability is important (*4*).
4. Household composition. A survey of carsharing members revealed that although 64% lived with at least one other person, children were present in only 24.4% of households (*6*).

Demographic Markets

Demographic markets are closely interrelated with geographic markets, for demographic characteristics in a neighborhood are generally influenced by the geographic characteristics of the neighborhood and vice versa. Regardless of the direction of causality, several demographic characteristics correlate with participation in carsharing. The survey results of Martin et al. (*1*) and Celsor and Millard-Ball (*14*) estimate the demographic variables of age and education. A survey of North American carsharing participants found that 37.6% were in the 20- to 30-year old age group, and 27.6% were in the 30- to 40-year old age group (*1*). A resident of POD neighborhoods is also far more likely to hold a bachelor's degree or higher than is the average person (*12*). Forty-three percent of participants held a bachelor's degree, and an additional 43% reported some postgraduate work or an advanced degree. Only 2% of respondents had less than some college education.

FEASIBILITY OF PEER-TO-PEER CARSHARING

In this section, a methodology is presented to assess the feasibility of P2P carsharing in a given geography. The analysis first considers the total supply of parked cars. Next, total demand is estimated. Finally, the minimum total number of P2P cars needed to support demand while maintaining a quality renter experience is calculated. This minimum required number of P2P cars is compared with the estimated number of parked cars to determine the feasibility of P2P carsharing in a given study area.

Supply of Available Parked Cars

The fundamental difference between determining the feasibility of P2P carsharing and traditional carsharing is the need to estimate the number of parked cars. In this section, a methodology is described to estimate the total supply, or number of parked cars per hour, in car hours for an area. Cars parked owing to work trips and cars parked at residences both are considered. The number of cars parked owing to employment is estimated with data from the 2008 Longitudinal Employer-Household Dynamics program of the Bureau of the Census (*12*). The number of cars parked in regard to residences is estimated with data from the 2000 U.S. Census (*13*). The Longitudinal Employer-Household Dynamics program combines data from federal and state sources on employers and employees to provide job counts on the census block level. The total number of jobs on a block multiplied by the mode share of driving to work is a proxy for the total number of cars parked in regard to employment (*13*). To estimate the temporal arrival and departure of parked cars, time of departure to work data were used, at the county level from the Census Transportation Planning Products (*13*). Here it is assumed that the arrival to work temporal behavior on the individual block level is consistent with the arrival to work behavior at the county level.

The U.S. Census provides data on the total number of vehicles available to households at the block level. Also, means to work columns in the census give the total number of vehicles driven to work per block. To estimate the temporal arrival and departure of parked cars at residences, gain the Census Transportation Planning Products data were used, on the time of departure to work (*13*). For simplicity, all cars that are not driven to work are assumed to be parked.

This method may be extended in two directions. First, the parked cars of unemployed people may be estimated from the census and the current unemployment rate. Second, the rate of home-based nonwork trips over the day may be estimated from the National Household Transportation Survey (*18*). The nonwork trips are then subtracted from the total supply of residential parked cars.

Peer-to-Peer Carsharing Demand

To determine if a sufficient level of demand exists within a given area to support a P2P carsharing service, the analysis first projects the number of potential carsharing service members in that area and then compares that number with the area's total residential population. The ratio of potential renter members to the total residential population was considered the maximum achievable market penetration within that area. Population density in each area, measured in persons per acre, was then calculated by dividing the total residential population by the geographic area in acres. Next, the maximum achievable market penetration was compared with the required level of market penetration necessary to support a single car POD at the calculated population density. If the maximum achievable market penetration for an area was found to exceed the required level of market penetration for achieving 10 members within ¼ mi of a single car POD, then the area was determined to have sufficient renter demand for P2P carsharing.

Data taken from the 2000 U.S. Census was used to determine maximum achievable market penetration in each area analyzed. The literature on carsharing documents the demographics of users, with the following data being significant:

1. Percentage of the population who live in an urban setting within each area,
2. Percentage of the population 25 to 40 years old within each area,
3. Percentage of households (family and nonfamily) with two or fewer people within each area, and
4. Percentage of workers older than 16 who do not use a car, van, or truck to get to work.

Merely multiplying these columns from the census may underestimate the potential renters. This stems from the correlation between these factors. Ideally, an analysis that measures the joint distribution of these factors is needed.

The total population of each area was multiplied by the percentage in an urban area, the percentage of those aged 25 to 40, the percentage in households with two or fewer people, and the percentage of workers that do not drive to work. The resulting population was classified as the number of potential carsharing service members in the area. To calculate the maximum achievable market penetration, the calculated number of potential carsharing service members in each area was divided by the total population in that area.

To determine the required levels of market penetration to which the calculated maximum achievable market penetration should be compared, Sullivan and Magid's table showing required penetration rates for achieving 25 members within ¼ mi of a single car POD is expanded to include required penetration levels for achieving 50, 20, 15, 10, and 5 members in a ¼-mi radius of a single car POD (*4*). This was done by scaling Sullivan and Magid's required penetration rates linearly with the required number of members. The expanded table is presented in Table 1. Traditional carsharing organizations operate their service at member–vehicle ratios much closer to 50 members within ¼ mi.

A penetration threshold of 10 potential renter members living within a ¼-mi radius of each single car POD is selected based on the projection that a P2P carsharing model would lower a carsharing provider's costs by 60% (*7*). Geographic information system files were used to calculate the geographic area of each area of interest. Population density in persons per acre was calculated with the total population data obtained from the 2000 U.S. Census data.

TABLE 1 Penetration Rates Required to Achieve Members per Vehicle

Density (persons/acre)	Penetration Rate Needed (%)					
	50 members	25 members	20 members	15 members	10 members	5 members
10	4.00	1.99	1.59	1.19	0.80	0.40
15	2.7	1.33	1.06	0.80	0.53	0.27
20	2.0	0.99	0.79	0.59	0.40	0.20
25	1.6	0.80	0.64	0.48	0.32	0.16
30	1.3	0.66	0.53	0.40	0.26	0.13

Finally, Table 1 is used to look up the required level of market penetration based on the calculated population density with the 10-person threshold.

Determination of market viability (in regard to demand) for P2P carsharing is based on the possibility of achieving an effective member–vehicle to ratio of 10 renter members per car at a given area's population density. Therefore, in each viable area, one can say that the maximum number of cars for which there is sufficient demand is equal to the number of potential carsharing service members divided by 10. This assumes that each set of 10 members may reserve only the car closest to him or her, and that all shared cars are made available for reservation 24 h per day.

With these simplifying assumptions, if the maximum numbers of cars are supplied in each area (consistent renter member–vehicle ratio of 10:1), then the expected use of each vehicle can be calculated. Cervero et al.'s 5-year study of the impacts of City CarShare's carsharing service in San Francisco found that the average renter completed 1.31 trips each month (*3*). The average duration of each trip was found to be 3.93 h, during which time approximately 21.2 mi were covered (*3*). Millard-Ball et al.'s survey of carsharing members in North America found that members completed an average of 3.34 trips per month, and that the median number of trips taken per month was 2 (*6*). Assuming an average trip frequency of 2.33 trips per month (the average of 1.31 and 3.34 trips per month); an average trip duration of 3.93 h; and an average trip distance of 21.2 mi, then the average owner supplied vehicle would be rented 23 times per month (280 times per year); driven 494 mi per month (5,928 mi per year); and occupied by a renter for 92 h per month (1,099 h per year). Given that P2P carsharing is more feasible in less dense areas not studied in previous carsharing literature, the trip characteristics may ultimately prove to be different from those of traditional carsharing. However, data from traditional carsharing are all that are available currently.

Matching Supply and Demand

In this section, the minimum number of P2P cars needed in each target area to accommodate the demand generated by target renters in that area is computed. Given that users share access to a common pool of vehicles and that demand occurs randomly throughout the day, one must consider contention for reserving a vehicle. For P2P carsharing to be viable, car availability needs to be commensurate with that of traditional carsharing.

To achieve this goal, a simplified queueing theory is analyzed (*19*), which allows estimating the number of cars needed to support user demand while providing the same vehicle availability level of traditional carsharing. Queueing theory is the study of delays in shared resource systems; thus, it is ideally suited for this goal. This analysis could also be conducted via a simulation study or empirically measured from existing carsharing operator data.

First, random temporal arrival of requests from target renters is characterized. The average carsharing member takes 2.33 trips per month. For simplicity, it is assumed that these 2.33 trips per month are requested uniformly throughout days of a 30-day month. The average hourly demand rate per renter is taken to be 2.33/(30 ∗ 24), in which each trip has an average length of 4 h. It is reasonable to assume that traditional carsharing companies place roughly one share car for 50 renters living within ¼ mi of the car. The availability of a single car POD is then estimated by the utilization of a single-server queue (ρ, i.e., the ratio of supply to demand):

$$\rho = \frac{\lambda}{\mu} = \frac{2.33 \text{ trips/month} \cdot 50 \text{ members/car}}{30 \text{ days/month} \cdot 24 \text{ h/day}} \cdot 4 \text{ h/trip} = 0.647$$

where λ is the hourly demand rate and 1/μ is the average reservation length. The utilization also has the interpretation as a renter having a 64.7% chance of being blocked from reserving the car. If one considers a multicar POD, then single-server analysis can be extended to a multiserver queueing analysis. The Erlang C formula (*19*) is a standard tool for computing the availability of a service with more than one shared resource and is the probability that all the resources are occupied:

$$\gamma(C,\rho) = \frac{\left(\frac{(C\rho)^C}{C!}\right)\cdot\left(\frac{1}{1-\rho}\right)}{\sum_{C=0}^{C}\frac{(C_\rho)^C}{C!} + \left(\frac{(C_\rho)^C}{C!}\right)\cdot\left(\frac{1}{1-\rho}\right)}$$

where C is the number of shared resources. The probability that a two-car POD is unavailable (γ) is estimated by γ(2, ρ) = .1582. The probability of unavailability decreases in a nonlinear way as the number of cars at a POD increases.

Now the number of P2P cars needed in a target area is computed, such that rental availability is identical to that of traditional carsharing. In this way, P2P sharing provides a quality of service identical to that of traditional carsharing. For each target area, it is assumed that all cars are indistinguishable and desirable to every target renter in that target area. In this simplified setting, the probability that a car is not available when a renter requests a reservation is given by the Erlang C formula (*19*) with

$$\rho = n\frac{\lambda}{\mu} = n\frac{2.33 \text{ trips/month} \cdot 10 \text{ members/car}}{30 \text{ days/month} \cdot 24 \text{ h/day}} \cdot 4 \text{ h/trip}$$

where n is the number of target renters in a study area, which is taken as a census block group. The minimum number of cars needed per target area is then the smallest number of cars, C, given a total demand rate that keeps the probability of a blocked request less than or equal to that of traditional carsharing. This type of calculation has a unique solution and is routine in the management of call centers (*20*). The resulting minimum number of needed P2P shared cars is compared with the total supply of cars available to determine viability of the study area.

Also, sensitivity analysis may be easily performed, assuming different values of user hourly demand or target availability. The foregoing analysis may also be extended to consider peak periods of demand during the day. This is accomplished by replacing the hourly arrival rate as given with that of the peak demand. The resulting number of P2P cars would then be an upper bound on the number of participating P2P cars.

ECONOMIC INCENTIVES

For P2P carsharing to function, an economic incentive must exist for renters and car owners to participate. For the purposes of the analysis presented, rental pricing of \$5.50 per h, plus \$0.35 per mi is assumed. This pricing is consistent with that offered by San Francisco's City CarShare as part of its ShareLocal and SharePlus pricing plans, and it is selected because data taken from Cervero et al.'s study of that service are used to project frequency of usage (*3*).

Economic Incentives to Owners

The economic benefit to the car owner equals the sum of all payments made by renters less any transaction fees paid to the P2P provider who coordinates the network, cost of additional depreciation incurred, and opportunity cost of time invested by the owner when managing the rental process. This calculation ignores income taxes and assumes that the costs of insuring and fueling the vehicle are borne by the P2P service provider. Until better data are available, it is assumed that the service provider coordinates the network in exchange for a 30% transaction fee.

If the owner's vehicle is assumed to be a small sedan, then the American Automobile Association estimates the cost of depreciation for a vehicle driven 10,000 to 15,000 mi per year at \$0.17 to \$0.22 per mi (*5*). Determining opportunity cost requires determining both the owner's personal income and the search time invested in each rental. According to Martin et al., the median income of a carsharing member is \$50,000 (*1*). The economic benefit is \$2,395 for an owner with a small sedan and a personal income of \$50,000 per year who invests ½ h of search time in each rental assuming use of 5,928 mi and 1,099 h per year. Rental payments are based on usage charges of \$5.50 per h and \$0.35 per mi.

The net economic benefit varies with the owner's income and with the setup time invested. Table 2 shows the net economic benefit calculated for various levels of income and various per rental setup times.

TABLE 2 Net Economic Benefit (Loss) at Levels of Income for Setup Times

Setup Time (h)	Owner per Capita Annual Income (\$)				
	10,000	30,000	50,000	70,000	90,000
0.25	5,420	4,748	4,076	3,404	2,731
0.5	5,084	3,740	2,395	1,051	(292)
0.75	4,748	2,731	715	(1,300)	(3,317)
1	4,412	1,723	(964)	(3,653)	(6,341)

Economic Incentives to Renters

Cervero et al.'s study of City CarShare's service found that members reduced mean mode-adjusted vehicle miles traveled by 67% (*3*). Similarly, the survey of North American carsharing members found that they reduced their mileage driven by 63% after joining a service and reduced their car transportation costs to just \$720 dollars per year (*6*). At levels of use projected in this paper, the average renter will spend \$811 dollars per year for carsharing with City CarShare's pricing plan. The cost of carsharing is significantly less than the cost of owning a vehicle, even accounting for the situation that carsharing members drive much less than typical drivers do. The cost of car ownership including depreciation and fuel expenses is estimated at \$2,503.83, assuming that depreciation and fuel expense are reduced relative to a 10,000-mi per year driver at a rate of \$0.19 per mi and \$0.12 per mi, respectively. The net economic benefit realized by an average renter with an annual income of \$20,000 who invests ¼ h of search time in each rental is \$1,624.80. The net economic benefit varies with the renter's income and with search time invested. Table 3 shows the net economic benefit calculated for various levels of income and various search times per rental.

CASE STUDY OF PITTSBURGH

Applying the methodology outlined here to analyze the potential demand for P2P carsharing service in Pittsburgh finds that up to 14,460 potential members live in viable markets there. Spatial distribution of these markets is shown in Figure 1. Also, Figure 1 shows the minimum number of full-time cars needed to be supplied in each market as determined by the queueing analysis described in this paper. Spatial distribution of parked cars available, in regard to full-time car equivalents is computed for each census block group. Each full-time car equivalent represents 24 car hours. The required level of market penetration amongst car owners who live in or work in, or both, each census block group was calculated and found to range from a minimum 0.06% to a maximum of 25%. The spatial distribution of this car owner market penetration required is shown in Figure 2.

TABLE 3 Net Economic Benefit at Levels of Income for Search Times

Search Time (h)	Renter per Capita Annual Income (\$)				
	10,000	30,000	50,000	70,000	90,000
0.25	1,658	1,591	1,523	1,456	1,389
0.5	1,624	1,490	1,355	1,221	1,087
0.75	1,591	1,389	1,187	986	784
1	1,557	1,288	1,019	751	482

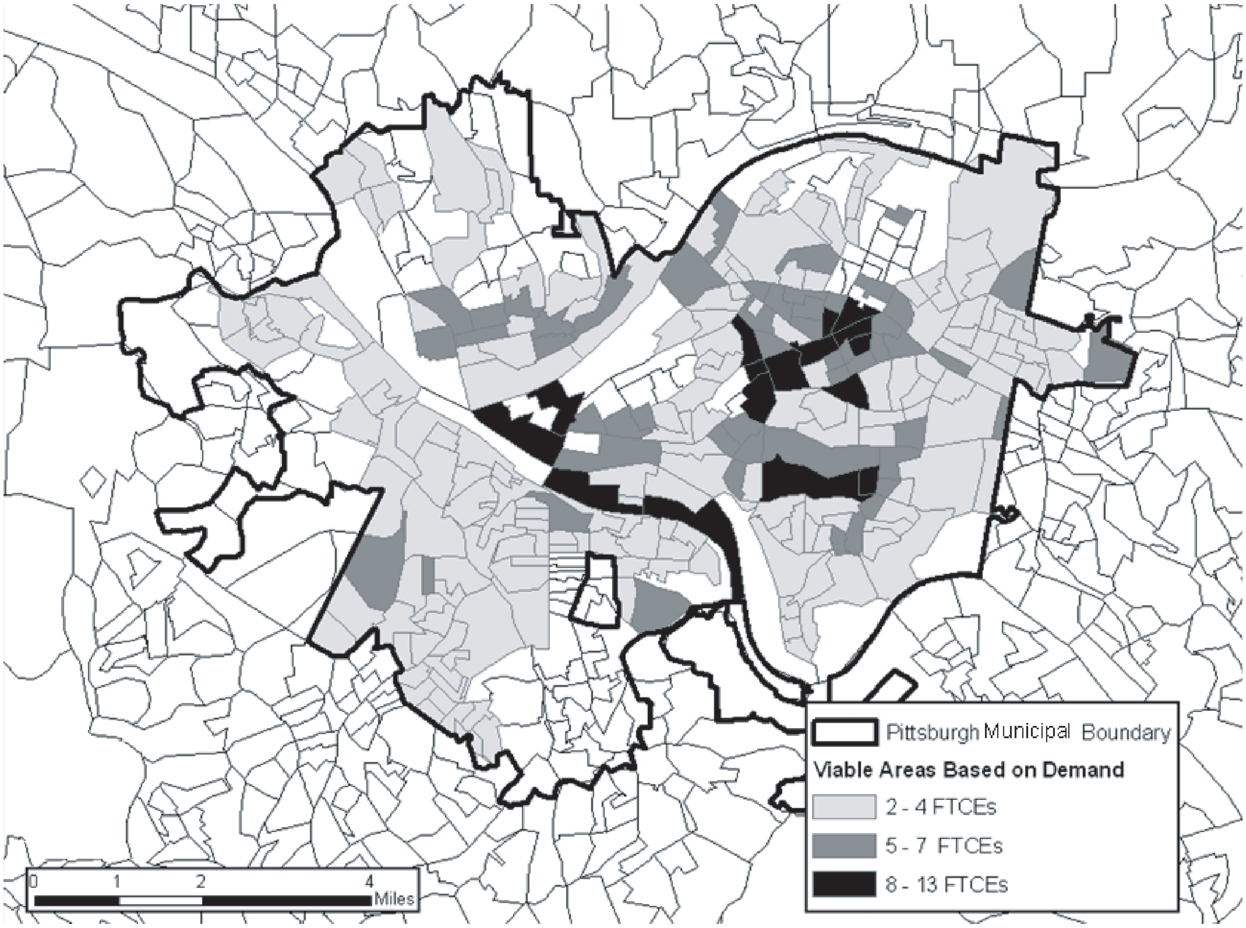

FIGURE 1 Demand viable areas and number of required full-time cars (FTCEs = full-time car equivalents).

CONSIDERATIONS OF PUBLIC POLICY AND INSURANCE

In their 10-year review of carsharing in North America, Shaheen et al. identify public policy issues influencing the carsharing market (*11*). Included are taxation, parking, and insurance. Many cities apply a rental-car excise tax to carsharing. It is currently uncertain if P2P carsharing is subject to the same tax treatment. Additionally, the tax treatment of personal income derived from participating in carsharing is not well defined. Shaheen et al. identify a range of parking policies supportive of traditional carsharing (*11*). Policies include

- Parking reduction,
- Parking substitution,
- Exemption from parking limits,
- Provision of on-street and off-street parking, and
- Universal parking permits.

Parking policy is also critical to P2P carsharing, and similar parking policies have yet to emerge.

Shaheen et al. also describe the evolution of insurance availability and premiums for carsharing (*11*). They note that insurance was an early barrier to entry for providers. However, as insurance companies gain more experience with carsharing, premiums have declined. An unambiguous insurance regime is particularly important to the development of P2P carsharing. Currently, in most states, accepting payment for the use of one's private vehicle voids the owner's personal insurance, unless the vehicle is classified as a livery or taxi service. Insurance rates for livery services are typically much higher than those for private automobile insurance, making P2P carsharing prohibitively expensive. The state of California has taken the lead in clarifying the insurance regime governing P2P carsharing (California AB 1871, Feb. 12, 2010). This statute formally defines a P2P carsharing service, and it prohibits insurance companies from classifying an automobile as a livery service, solely on the basis that the car is part of a P2P carsharing service. Further legal clarity is needed to understand the interaction between the car owner's private insurance policy and the P2P shared policy on his or her vehicle.

These public policy and insurance issues as are critical now to the development of P2P carsharing as they were during the beginning of traditional carsharing.

CONCLUSION

Given the increasing costs of private car ownership and the increasing worldwide focus on reducing greenhouse gas emissions attributable to transportation, development of both supply-side and demand-side innovations are required. One such demand-side innovation is mainstream adoption of carsharing. An established

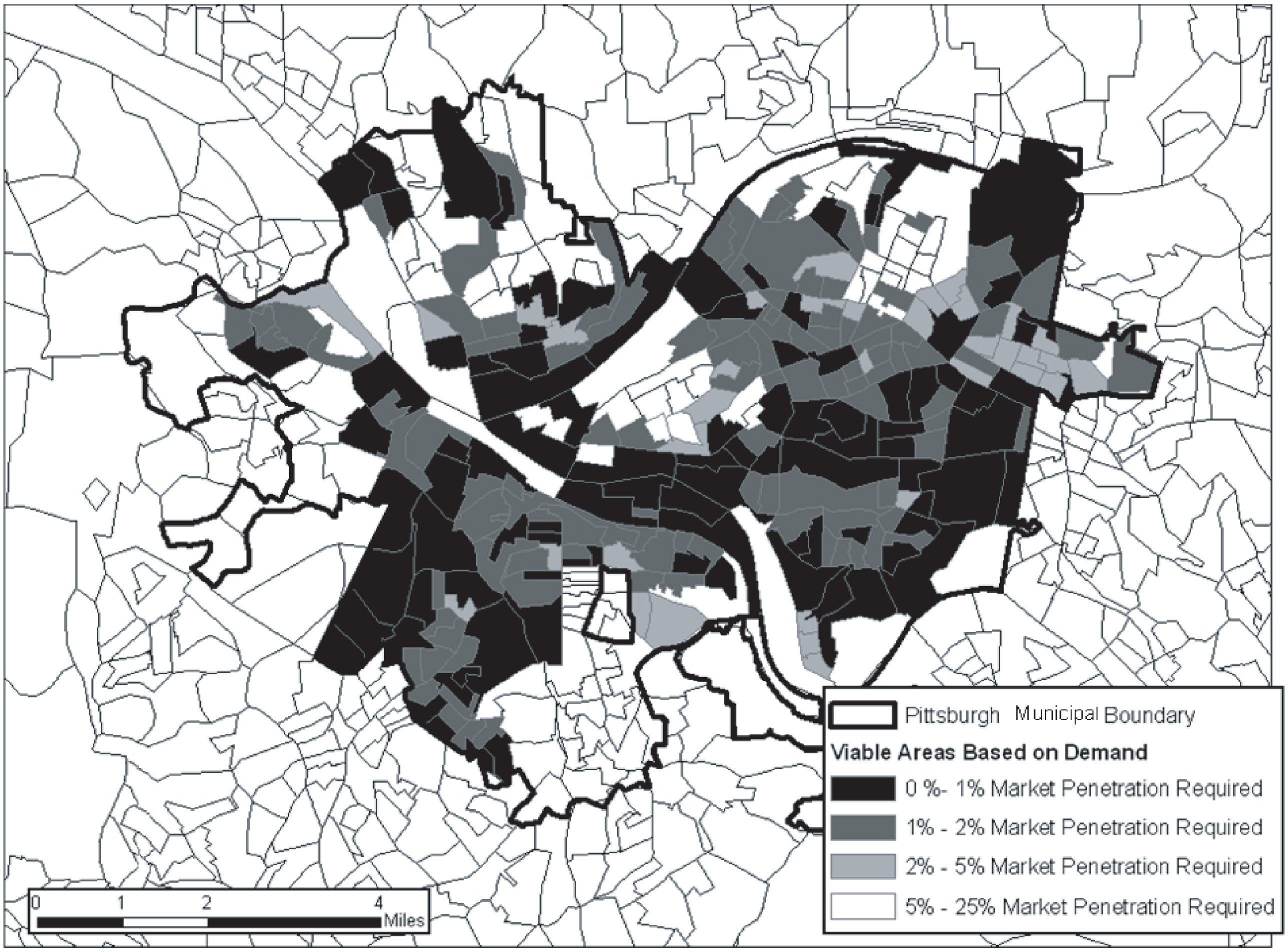

FIGURE 2 Demand viable areas and required market penetration.

stream of literature has documented the many benefits of carsharing to individuals and the planet. However, current business models of traditional carsharing providers hinder their scalability to areas with less dense populations.

P2P carsharing aims to provide a scalable form of carsharing, with the potential to address both the high costs of private vehicle ownership and decrease greenhouse gas emissions. This paper develops a methodology to assess the feasibility of P2P carsharing in a given area and the economic incentives to market participants.

The framework developed in this paper is a first step at setting a rigorous framework to analyze the feasibility of P2P carsharing. For the sake of simplicity, assumptions have been made about the temporal distribution of demand, availability of parked cars, and other factors. Reexamining these assumptions in further works is planned. Ultimately, the main contribution of this paper is providing a framework to assess the feasibility of P2P carsharing and delineating the major factors in that analysis.

The case study of Pittsburgh shows that P2P carsharing market is viable, requiring a .06% to 25% adoption rate of car owners at the census block level to provide a service with availability comparable with existing traditional carsharing services. Predictions from the case study are exploratory and could differ from empirical findings in the future. Finally, uncertain public policy and insurance laws are an obstacle to the growth and investment in P2P carsharing.

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