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Shared-Use Vehicle Systems

Framework for Classifying Carsharing, Station Cars, and Combined Approaches

Matthew Barth and Susan A. Shaheen

In recent years, shared-use vehicle systems have garnered a great deal of interest and activity internationally as an innovative mobility solution. In general, shared-use vehicle systems consist of a fleet of vehicles that are used by several different individuals throughout the day. Shared-use vehicles offer the convenience of the private automobile and more flexibility than public transportation alone. These systems are attractive since they offer the potential to lower a user's transportation costs; reduce the need for parking spaces in a community; improve overall air quality; and facilitate access to and encourage use of other transportation modes such as rail transit. Shared-use vehicle systems take many forms, ranging from neighborhood carsharing to classic station car models. Given the recent proliferation in system approaches, it is useful to establish a classification system or framework for characterizing these programs. The classification system presented here outlines key program elements that can help policy makers and practitioners characterize and evaluate various aspects of this rapidly evolving field. Further, it helps researchers analyze and compare the various models, including their similarities, differences, and benefits. A shared-use vehicle classification system is provided that describes existing and evolving models; examples are provided of each. It is argued that carsharing and station car concepts can be viewed as two ends of a continuum, sharing many similarities, rather than as separate concepts. Indeed, many existing shared-use vehicle systems can be viewed as hybrid systems, exhibiting key characteristics of both concepts.

In recent years, shared-use vehicle systems have generated increased interest and enthusiasm as an innovative mobility solution. The basic premise of shared-use vehicles is to move away from individual vehicle ownership exclusively; instead, a fleet of vehicles can be shared throughout the day by different users to provide an additional mobility option. There are many potential advantages of shared-use systems, including that

1. They can improve transportation efficiency by reducing the number of (private) vehicles required to meet total travel demand; as a result, vehicles spend a lot less idle time in parking lots and are used more often by several users;
2. Individuals can save on transportation costs since vehicle expenses (e.g., payments, insurance, maintenance) are shared among all system users (many carsharing organizations claim that significant cost savings are achieved by members when their corresponding private vehicle mileage is less than 10 000 km annually);
3. An energy and emissions benefit is achieved when low-polluting (e.g., electric, hybrid-electric, natural gas) cars make up the shared-use vehicle fleet; and
4. Transit ridership is increased when individuals use shared vehicles either through a direct transit linkage or indirectly because users are now more conscious in their trip making and modal choices.

Further information is available on the history and benefits of shared-use vehicle systems (*1–3*).

Over the last several years, there has been a proliferation of shared-use vehicle systems around the world. Many of these systems reflect different business models and purposes; nevertheless, they have common elements such as a shared fleet, transit linkages, and advanced technologies (*1, 2, 4*). Indeed, this is a rapidly growing field, spawning several conferences and workshops that encourage practitioners, researchers, and enthusiasts to gather and discuss shared-use vehicle system practices and approaches (e.g., the First North America Carsharing Conference held in Atlanta, Georgia, in March 2001, and the Shared-Use Vehicle and Station Car Summit held in Irvine, California, in July 2001). Shared-use vehicle systems are often described with various terms, emphasizing key attributes such as flexible fleet services, short-term car rental, time-shared vehicles, instant rent-a-car, commuter carsharing, station cars, and transit-based carsharing.

To characterize and evaluate the various models or systems, it is useful to establish a classification system for shared-use vehicle programs. The rationale for this classification system is to create a more formal structure that will aid policy makers, researchers, and practitioners in describing, contrasting, and analyzing such aspects as environmental and social benefits with regard to shared-use vehicle models and approaches in this rapidly changing field. Developing a structured framework helps to clarify key terms and their usage. In addition, it identifies existing and evolving models along the shared-use vehicle continuum, key attributes, and success factors. A historical approach was taken toward developing this framework, building on the earliest carsharing and station car concepts.

First, a brief review is presented of several shared-use vehicle system models that are in place today. Next, the shared-use vehicle classification system is described, outlining various models and providing examples of each. In addition, model differences are discussed. By establishing such a framework, more systematic identification and tracking among a wide range of shared-use vehicle models can occur with regard to

- Common elements and differences,
- Success factors,

M. Barth, College of Engineering, Center for Environmental Research and Technology, University of California, Riverside, CA 92521. S. A. Shaheen, California Department of Transportation and California Partners for Advanced Transit and Highways (PATH) Program, University of California, Berkeley, 1357 South 46th Street, Building 452, Richmond, CA 94804-4603.

- Economic viability,
- Institutional and policy-related issues, and
- Societal and environmental benefits such as potentially lowering total vehicle kilometers traveled (VKT) and improving air quality.

Finally, the issue of developing standards for shared-use vehicle systems is addressed.

BASIC SHARED-USE VEHICLE SYSTEM MODELS

Generally, there are three basic shared-use vehicle system models. The historical approach taken toward defining these approaches includes neighborhood carsharing, station cars, and multinodal shared-use vehicles.

Recently, the first two models have begun to develop significantly from their original visions, largely because of advanced technologies (e.g., electronic and wireless communication systems) that facilitate system management and vehicle access. Thus, the initial carsharing and station car concepts have evolved to include common elements of each model (e.g., commuter carsharing). The multinodal approach is also explored below.

Neighborhood Carsharing Model

The current concept of neighborhood carsharing started most aggressively in Europe 15 years ago. Carsharing efforts emerged primarily from individuals who wanted the mobility benefits of automobiles but could not justify the cost of vehicle ownership, parking, and other associated costs. As a result, several carsharing organizations were initiated consisting of a few vehicles used by a group of individuals. Several of these early carsharing organizations failed for various reasons, but many grew beyond the initial grassroots, neighborhood-based program stage. Today there are hundreds of successful carsharing organizations in many cities (*1*). For a recent listing of these carsharing organizations, the reader is referred to several active websites that focus on carsharing activities (*5, 6*).

Today's typical carsharing organization places a network of shared-use vehicles at strategic parking locations throughout a dense city (see Figure 1). Members typically reserve shared-use vehicles in advance. At the time of the rental, the user gains access to the vehicle, carries out the trip, and returns the vehicle back to the same lot from which it was originally accessed (this is also known as a "two-way" rental because the user is required to rent and return a vehicle to the same lot during one continuous rental period). Participants pay a usage fee (typically based on time and mileage) each time a vehicle is used. The carsharing organization as a whole maintains the vehicle fleet (including light trucks) throughout a network of locations, so that users in neighborhoods and business areas have relatively easy vehicle access. Usually there is also a small subscription fee paid on a monthly basis or a one-time deposit or both.

Carsharing organizations are the most prevalent type of shared-use vehicle system. The vehicles are most often placed in residential neighborhoods; less frequently, they are located in downtown business areas and rural locations. To summarize, the premise of carsharing is that vehicle costs and usage are shared among a group of individuals. Lots are located so carsharing users can conveniently access vehicles for trip making. Often carsharing results in increased transit ridership (as well as other alternative modes, such as biking), as users become much more conscious of the individual costs of each automobile trip.

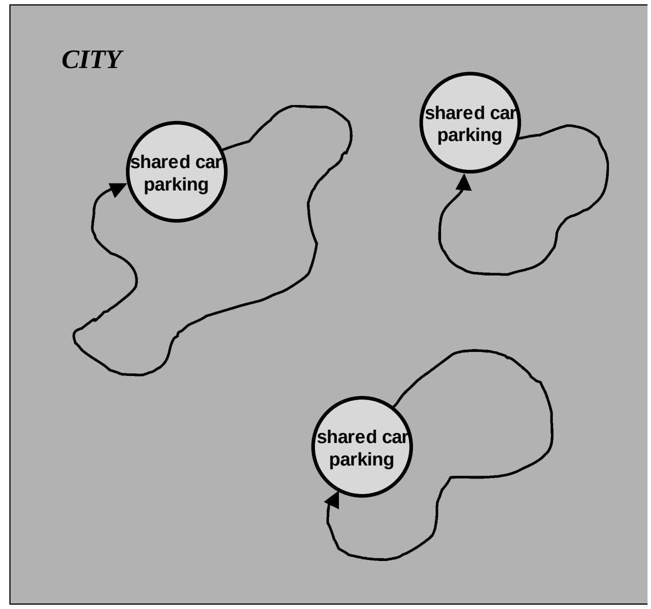

FIGURE 1 Neighborhood carsharing model.

Station Cars

The station car is another shared-use vehicle system model. The station car concept has been implemented internationally, but has been most actively tested in the United States (*4*). The earliest and predominant station car model consists of a fleet of vehicles deployed at passenger rail stations in metropolitan areas that are used by rail commuters primarily on the home- and work-end of a trip. A majority of these systems have been initiated by rail transit operators seeking to relieve parking shortages and increase transit ridership. A typical station car scenario is depicted in Figure 2. When station cars are placed at major rail stations along a commuting corridor, they can serve as a demand-responsive transit feeder service on both ends of a commute (*7*). For example, a user can drive a station car from home to a nearby transit terminal, parking it at or near the station while at work. The user then commutes by rail or bus to the destination. After arriving at the destination station in the morning for work, a second station car could be rented to travel from the station to the office, and during the day the individual might use that same vehicle to make business and personal trips. In the evening, the user again drives the station car to travel from work to the station. At the end of the transit commute, this same individual again takes a station car to drive home. In this scenario, "reverse" commuters often use the same dedicated station car for their station-work/station-home trips. Furthermore, noncommute trips can also be made by other users during the day when the vehicles would otherwise sit idle at a station (*8*). Recently, the concept of station cars has now grown to be much broader, so that stations may also be placed at areas of high use not necessarily linked to transit.

Multinodal Shared-Use Vehicles

A more generalized shared-use vehicle system is one in which shared vehicles are driven among multiple stations or nodes to travel from one activity center to another. Such systems may be located at resorts,

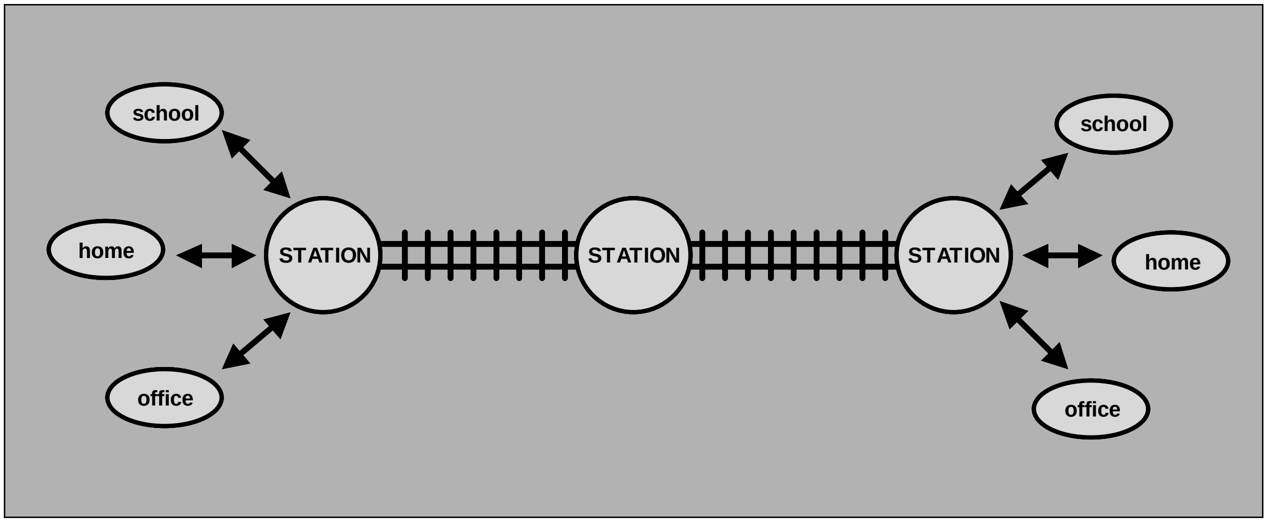

FIGURE 2 Classic station car model.

recreational areas, national parks, and at corporate and university campuses. As the example depicts in Figure 3, a user may arrive by rail or plane, then rent a shared-use vehicle to drive from the station or airport to a hotel. Later on, the same individual may travel from the hotel to a shopping mall or tourist attraction. In this way, the trips are more likely to be one-way each time in contrast to the typical round-trips made in a traditional commuter station car system or neighborhood carsharing program.

Because there are many more one-way trips in a multiple station scenario, the number of shared-use vehicles at each station can quickly become disproportionally distributed among the stations (*9–11*). At different times throughout the day, some stations will have an excess of vehicles whereas other stations will have a shortage. As a result, it is sometimes necessary to relocate vehicles periodically each day so that the system operates efficiently and (most) users' travel demands are satisfied. Multinodal systems could also be directly linked to transit, although they have not traditionally been so in the past. Users share vehicle costs and usage, similar to carsharing. However, an advantage of a multinodal system is that vehicle trips can be one-way versus only two-way trips. One-way rental introduces significant flexibility for users but management complexities, including vehicle relocation. Advanced technologies can make multinodal systems much easier to manage and cost-effective as well.

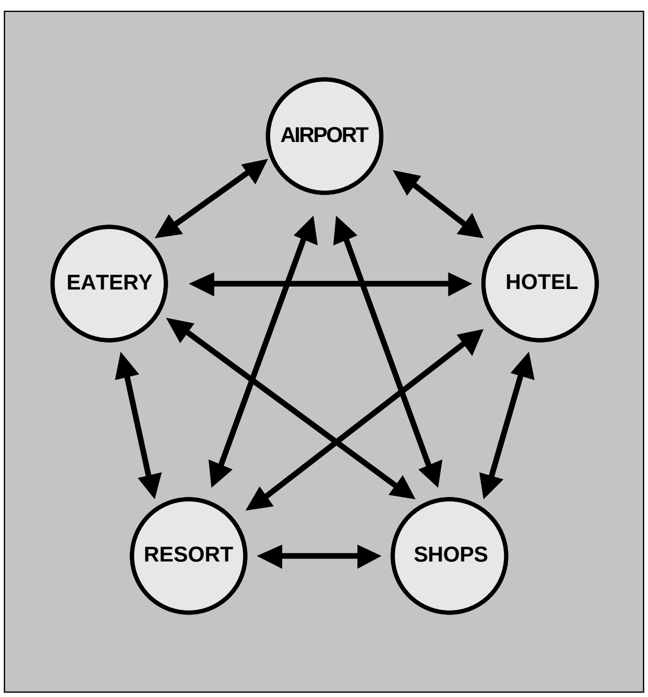

FIGURE 3 Multinodal shared-use vehicle model.

CLASSIFICATION FRAMEWORK FOR SHARED-USE VEHICLE SYSTEMS

Again, the authors have tracked many variations in the shared-use vehicle system models described above, particularly in recent years and in the United States. Shared-use vehicle systems are beginning to take on many forms to suit various mobility objectives and new market niches. Because of the recent proliferation in systems and model approaches, this paper introduces a classification scheme for shared-use vehicle systems to help identify similarities and differences and to establish common definitions and references to aid in evaluating these approaches.

There are many different ways to develop a classification system, depending on how the framework is to be used. For example, there may be separate classification systems for analyzing overall mobility affects, advanced technologies, and business models. As mentioned earlier, this paper reflects a historical perspective, building on initial concepts (some over 80 years old), to establish a common set of shared-use vehicle elements (or reference points) for describing, contrasting, and evaluating more consistently the range in approaches and evolution to date. Several different models have already been introduced; these models serve as the cornerstones of the classification system described below.

Key Elements of Classification System

To create this classification system, it is necessary to first identify the key elements that define such systems. Key characteristics include the following (*3*):

- Definition of basic objectives, which may include whether the system is intended for public service or for some known target group; for example, whether it is a research demonstration project, a for-profit local group, a corporate project, or a franchise.
- Links with other travel modes. One key feature of shared-use vehicle systems is whether or not the service provides a direct linkage to other travel modes such as rail and bus systems.
- Size of target area and target group served. Targeted areas range from small neighborhood clusters to several countries [e.g., mobility carsharing in Switzerland, Germany, and Italy (*12*)].
- Organization, services offered, business models. Many systems are organized differently and include various services (e.g., transit discounts, premium parking, and access via residential developers) and packages (e.g., deposits, monthly subscriptions, pay-per-use); for example, some systems may be tailored toward short-term vehicle use (a few hours) whereas others may allow longer-term usage (more than 24 h).
- Vehicles. Central to all shared-use vehicle systems are the vehicles themselves. In most cases, they are automobiles, but shared-use vehicle systems can also include bicycles and other transportation modes (e.g., Segway). Vehicle comparisons are often made on the basis of the number, kind, and propulsion system of the vehicles offered.
- Customer service. Systems range from a minimal amount of customer service features to a high level of service; service quality is also important (e.g., 24-hour roadside assistance, smartcard vehicle access, and online reservations).
- Technological sophistication. Technology plays a very important role in providing user convenience and system manageability; these technologies can be used on board the vehicle in supporting system operations (e.g., fleet management) and for the customer interface (e.g., reservations and billing).
- Sources of support. Relatively few shared-use vehicle systems are yet self-supporting from user fees; most depend on financial support from government (e.g., federal, state, and local) and more recently private investors (e.g., venture capital, angel investors, and automakers).

On the basis of these and other characteristics, the shared-use vehicle classification system has been developed as depicted in Figure 4. Before describing this classification system in detail, a few points are made.

First, many have viewed station cars and carsharing as separate concepts. These two concepts have developed somewhat simultaneously and independently over the last several decades, but they have far more similarities than differences (*13, 14*). It can be argued that carsharing and station cars share many similarities. Rather than treat these concepts as separate mobility options, they can be regarded as two ends of the same spectrum (as shown in Figure 4) in which many "hybrid" models of the station car, carsharing, and multinodal concepts are emerging (*13*).

Second, classic car rental companies technically could be included in this classification scheme and would extend the continuum further. However, in this approach, the focus is more exclusively on innovative shared-use vehicle models that generally include a short-term rental component rather than the longer-term rental period characteristic of classic car rental.

Third, in most cases, automobiles are considered to be the "vehicle" in shared-use systems. However, this is not necessarily the rule; these systems can include other transportation modes such as bicycles

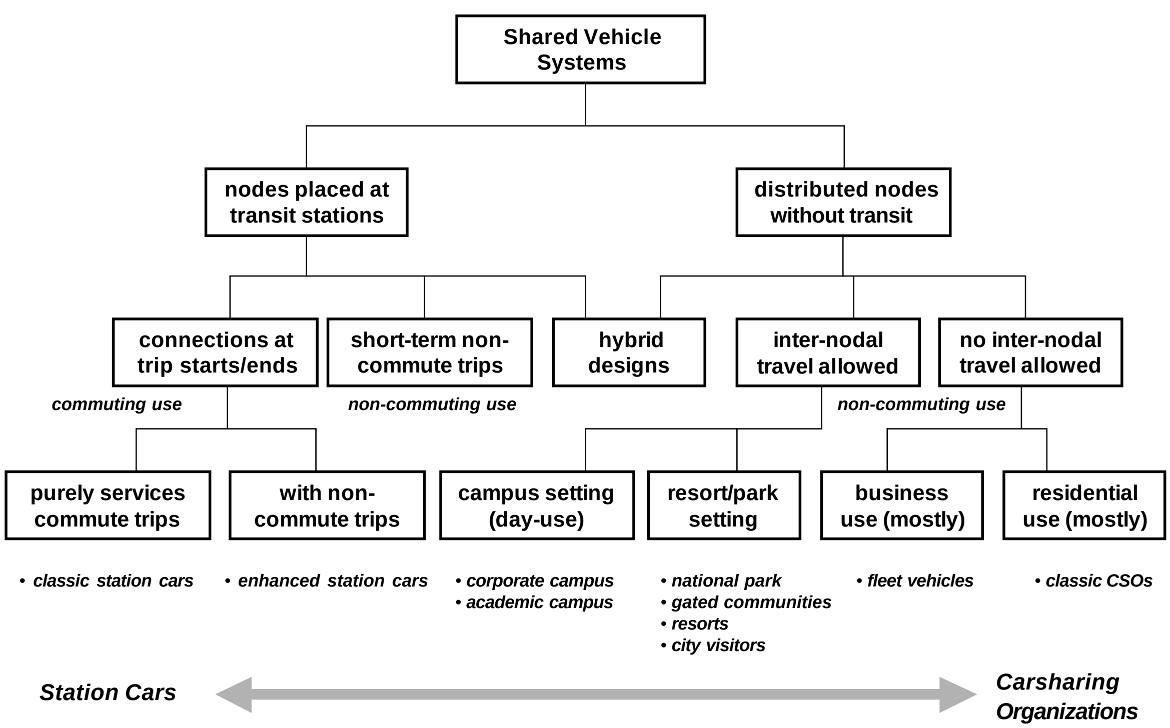

FIGURE 4 Shared-use vehicle classification system (CSO = carsharing organization).

and scooters. In fact, shared-use bicycle systems often come to mind when individuals are first introduced to the carsharing concept (e.g., the "yellow" bike system in Amsterdam).

Referring to Figure 4, a key model differentiation can be made between carsharing and station car systems (i.e., whether the system is directly linked to transit), as indicated by the first split near the top of the classification tree. This distinction is rooted largely in the historical approach taken in this particular framework. In the future, such a distinction may no longer be used to differentiate approaches (e.g., carsharing and station cars), as many carsharing organizations are now directly linked to transit stations (or located within just a few minutes walking distance from transit terminals). As carsharing or mobility services grow in scale throughout a region, the term "station car" could be used to designate those fleet vehicles that are located at or near a transit station specifically. Other system vehicles may be based from office parks, apartment complexes, neighborhoods, and resorts.

It is also important to note that most programs assign a term to indicate where the shared-use vehicles are located; examples of these terms include "stations," "ports," "hubs," "lots," and "pods." Shared-use vehicle systems can be identified as mobility networks, as they are in this framework; thus, these locations are referred to as nodes in a network. The systems on the left of Figure 4 include nodes placed at or near transit stations.

Next, the transit-based systems have been divided into different categories on the basis of trip type (e.g., commuting or occasional use). The original station car concept envisioned a vehicle fleet linked to transit stations that would aid travelers in making connections at the beginning and end of their commute (i.e., a demand-responsive transit feeder service).

Also, a second branch has been created on the basis of systems that are not directly linked to transit stations (i.e., either at or nearby a terminal). As mentioned earlier, it is critical to note that shared-use vehicle systems are now beginning to evolve into dense transportation networks that facilitate mobility throughout a region. These systems will continue to expand and provide vehicle access in key locations, based on customer demand and needs. Increasingly, these systems will include direct linkages to transit as well many other key activity locations (such as offices, residences, and resorts). Thus, a high-level transit distinction (or classification branch) will likely become less important in such a shared-use vehicle framework in the future. Rather, the transition distinction will be used to describe key locations in a shared-use vehicle network that link larger transportation systems (e.g., highways and transit). Nevertheless, there are still many programs today that reflect clear distinctions between the classic neighborhood carsharing and station car approaches, hence the historical perspective of this framework. In the next sections, three key models in this shared-vehicle classification are explored: station cars, carsharing, and multinodal systems. These models ultimately intersect, resulting in what can be referred to as "hybrid" models.

Station Cars

The classic station car system, illustrated in the bottom left of Figure 4, includes a fleet of vehicles that serve commuters who travel to and from transit stations. An example of this type of system is the Bay Area Rapid Transit (BART) District-Hertz station car program currently operating in San Francisco, California (*15, 16*). In the BART-Hertz program, from 6 to 36 vehicles, including two Ford Th!nk city-class electric vehicles, are located at the BART Fremont station. The Hertz-BART Program has been running from the Fremont Station since 2000. Hertz is responsible for most costs and operations and recently took steps to start a new operation at the Colma BART Station. As of March 2002, there are six regular subscribers that use the station cars for commuting to work. Occasionally, other individuals use the vehicles to travel between the station and their homes. Each day, approximately 25 to 30 individuals arriving at the BART station via the train use the vehicles to travel to meetings. These individuals, who sign up for approximately 1 week of service, typically visit the region for work-related conferences or meetings.

This station car or transit-based shared-vehicle model can be enhanced by providing additional "day use" of shared-use cars for noncommute purposes to travelers arriving at the end station throughout the day. For example, when station cars are parked at the "home" transit terminal in the morning, they may sit idle at the station for the rest of day until the commuter returns home. In an enhanced system, vehicles are used by "reverse" commuters (i.e., commuters who are traveling in the opposite direction to get from home to work) to drive from the transit station to their office park. However, residential and business locations are rarely distributed evenly along mass transit networks, so a "forward" and "reverse" commute balance can be difficult to achieve. To provide more use and program revenues, the system can be further enhanced to include noncommute trips for both home- and work-based users. For example, employees could use the shared vehicles to run errands during the day. Further, on the home end, shared-use vehicles could be available for households and neighborhoods to share for noncommute trip making on evenings and weekends. Examples of this can be seen in the CarLink I and II programs (*13–16*) in Dublin-Pleasanton and Palo Alto, California, as well as in the Ebina station car program near Yokohama, Japan (*17*) (also see discussion that follows on hybrid models).

Another station car model, albeit rare, is the placement of shared-use vehicles at various rail stations for noncommute purposes (e.g., CarSharing Mobility Switzerland and Hertz-BART). In this way, the vehicles are used primarily for short local trips after a traveler has reached the destination station. There are several shared bicycle systems that operate similarly. Not surprisingly, there has been some initial discussion about linking shared-bike and shared-scooter systems with shared-use cars along the Yamanote ring rail line that circles Tokyo, Japan, and in CarLink II.

Carsharing

On the right side of Figure 4, the focus is on shared-use vehicle systems that are not typically linked to transit systems, namely, neighborhood carsharing. (It should be noted that even though traditional neighborhood carsharing systems are not directly linked to transit, many carsharing organizations claim carsharing encourages the use of other transportation modes.) In this case, vehicles are located throughout a dense network of nodes (also known as parking lots, pods, and ports) around the community. These locations typically have a high degree of activity and are easily accessible by residential or business users. A primary characteristic of many of these systems is that most do not allow internodal travel (i.e., they are based on a two-way rental model). Internodal travel (or one-way rentals) makes it possible for customers to pick up a vehicle at one location and return it to a different location. Again, almost all carsharing organizations are operated such that members must pick up and drop off a short-term rental vehicle at a single location (for example, Flexcar Portland and City CarShare currently operate this way (*1, 18*). However, larger carsharing organizations are beginning to experiment with internodal vehicle travel, such as Mobility Carsharing in Switzerland.

For those systems that do not allow internodal travel, further division in the classification framework has been created that reflects system purpose (e.g., residential, business, or resort and recreational travel). Many systems are still targeted at one market niche primarily (e.g., residential or business use). (The majority of carsharing organizations cater to residential use, of which there are many examples, see a listing at www.carsharing.net.) There are many examples of business use, including traditional vehicle pools maintained by large corporate and government entities. In this scenario, employees can rent a pooled vehicle during the day to travel to another location for business purposes. Business-use shared vehicle systems have been established in downtown areas to serve many employers, such as the Minato-Mirai 21 demonstration system in Yokohama, Japan (*19*).

Multinodal Shared-Use Vehicle Systems

Another type of a traditionally nontransit-based shared-use vehicle system is the multinodal model in which stations are distributed at different locations throughout an area, and vehicle trips can be made between the different locations. Such multinodal systems facilitate internodal trips and are logistically more complicated to manage, since there is the possibility of vehicle imbalance (i.e., too many vehicles may end up at one station and not enough vehicles at another). The system balance issue is being investigated both in simulation and real-world demonstration systems (*9, 10, 20*).

These multiple station systems (sometimes referred to as a "star configuration," which is illustrated in Figure 3) can be applied to several settings. For example, these systems potentially fit well into resort communities and large national parks in which there are a number of attractions that visitors can travel among. These multiple station systems are also a logical design for campus settings, either corporate or academic. A large corporation may have buildings (offices, factories) located throughout an area among which employees must travel. An example of this type of corporate campus shared-use vehicle system is the Crayon system located in Toyoda City, Japan (*21*). In this demonstration system, Toyota automobile company employees use small electric vehicles to drive between different locations. These multiple station systems can also work well on university campuses. There is often a great deal of trip making around a campus, such as traveling among various offices, teaching halls, and research labs. An example of a university-based shared-use vehicle system located at the University of California, Riverside (UCR) campus is UCR IntelliShare (*11, 20*).

Hybrid Models

The future of shared vehicle systems lies in the final category—hybrid systems. Hybrid systems have characteristics of many of the systems described thus far. For example, a shared-use vehicle system may be linked to transit but at the same time allows its members to use the same vehicles for day-use trips (i.e., noncommuting purposes). Both business and residential applications may also be targeted in the same model. Examples of a hybrid carsharing/station car system are the CarLink I and II programs (*13*). CarLink II is a "smart" [which indicates the use of intelligent transportation system technologies (ITS)] transit-based, commuter carsharing program, with three different user groups: home-based users, work-based commuters, and work-based day users. This pilot program—based on a partnership of Caltrans, Honda, the Institute of Transportation Studies at the University of California-Davis and Partners for Advanced Transit and Highways, and Caltrain—uses a fleet of 20 vehicles consisting entirely of 2001 ultra-low emission vehicle (ULEV) Honda Civics. These vehicles are based out of reserved parking spaces at the California Avenue Caltrain Station in Palo Alto and are shared by residents of the Palo Alto area and employers of the Stanford Research Park (*16*). Another hybrid system that is in the planning stages is located in the downtown area of Denver, Colorado, near Union Station. This program will include the following markets: (*a*) transit commuters, (*b*) residents of downtown neighborhoods, (*c*) downtown commuters and employees, and (*d*) visitors. The program will include two electric vehicle stations and many shared nodes in neighborhoods, commercial buildings, and mixed-use structures (unpublished data, M. Bernard, 2001).

These types of hybrid systems pull together many of the key characteristics of shared-use vehicle systems and maximize vehicle use and program revenues. By maximizing the number of ways that shared-use vehicles are deployed, the more effective each individual system will be in eliminating idle parked vehicles and promoting transit use, as well as in lowering emissions.

Key Model Elements: Smart Technologies and Vehicles

It is important to mention that all shared-use vehicle models can benefit from ITS technologies. There are several advantages to employing highly automated and integrated systems for reservations, billing, fleet and parking management, and vehicle access. One advantage is that the systems become much more user friendly (or convenient), which attracts subscribers. Another distinct advantage is that the systems are far easier to manage, particularly when the size of these programs gets to be quite large (*1–11*). The core components of ITS technologies applied to shared-use vehicle systems are similar among all models, but a certain degree of customization is needed for specific implementations.

Another commonality among systems is the type of vehicles used. Most shared-use vehicle systems described here are based on the concept of short-term rental (i.e., as mentioned earlier, typically less than 24 h). Short-term use often implies that the distance traveled for each trip is also relatively short. For this reason, many have seen a complementary match between electric vehicles and shared-use systems, particularly commuter station cars (*8, 9, 11*). Electric vehicles are plagued by issues having to do with inadequate range; they can only be driven relatively short distances between charges (relative to a regular internal combustion vehicle) and require longer periods to recharge. These limitations are somewhat alleviated in a shared-use vehicle scenario, since trips are often shorter and vehicles can be recharged when idle at holding locations. Furthermore, most carsharing providers employ several different types of vehicles to provide users with as much convenience and choice as possible. If electric vehicles are integrated into a more diverse fleet (e.g., compacts, station wagons, light-duty trucks, etc.), operators and customers do not rely exclusively on one vehicle model or propulsion system. Thus, in a carsharing program, trips and vehicles can be well matched to purpose, range, and lifestyle.

Given the many synergies among clean-fuel vehicles, carsharing, and station car programs, in 2001 the California Air Resources Board (CARB) proposed to award additional zero-emission vehicle (ZEV) program credits for clean cars introduced into shared-use vehicle systems (*22*), as also discussed by Shaheen et al. in another paper in this volume. The ZEV program requires large-volume automakers in California to produce clean-fuel vehicles for sale, starting in 2003. Clean cars covered by the mandate range from pure electrics to super ULEV with no evaporative emissions. CARB's linkage of technology and demand-management strategies is based on the belief that a significant environmental benefit can arise from shared-use vehicle systems, particularly when low-polluting (e.g., battery electric, compressed natural gas, and hybrid electric) vehicles are introduced into transportation systems (e.g., carsharing systems linked to transit).

SHARED-USE VEHICLE SYSTEM STANDARDS

With the proliferation of various shared-use vehicle systems worldwide, there is a question as to whether shared-vehicle standards might be beneficial. In this context, three aspects common to shared-use vehicle system models—vehicles, customers, and system operations—should be considered. Standards can play a major role in shared-use vehicle systems, particularly those that employ a high degree of technology. Not surprisingly, standards would likely have a lesser effect on smaller scale and low-technology implementations.

Vehicle Standards

Currently, there are many automobile standards in place that are important for safety, consistent operation, and the interoperability of components. When automobiles are placed in shared-use vehicle systems, standards might play a key role in how vehicles communicate with the overall system and how potential intelligent transportation technologies (ITT) can be interfaced with the vehicle. As described earlier, ITT can be employed in shared-use vehicle systems for smartcard (or key fob) access, automatic door locks, system communications, and navigational aids.

Adopting some degree of standardization could be beneficial to automakers, since their vehicles could easily integrate into and operate more consistently among many shared-use vehicle programs. Standards would also benefit the manufacturers of shared-use vehicle system ITT, since they could develop uniform components for the growing shared-use vehicle market segment. Nevertheless, it may be too early for standards setting in a market that is still not yet well defined.

At a minimum, shared-use vehicle operators and vendors should take advantage of the intelligent (transportation) data bus (IDB) standards development, which is already underway. IDB is a family of specifications designed specifically for the deployment of ITS and in-vehicle multimedia devices (*23*). All IDB technologies can be networked to achieve optimum performance in low-, medium-, and high-speed applications within the vehicle. Shared-use vehicle electronics can also be considered a "telematics" application, which is a specific target of IDB market development.

Customer Interface Standards

From the customer's perspective, it is beneficial for shared-use vehicle system operators to provide a high degree of interoperability and consistency among various shared-use vehicle systems, as well as with transit. A key example in this case would be a single access mechanism (e.g., smartcards or key fobs) that could be used among many shared-use vehicle systems and other mobility services (e.g., transit, parking management). Billing could also be made uniform across many programs, so that one monthly bill is received rather than several from various organizations.

Further, customer operational procedures should also be as consistent as possible. Customers do not want to relearn a whole new set of operational procedures to use a new carsharing system in another region, for example. As shared-use vehicle systems expand and as more emerge (e.g., Mobility CarSharing in Switzerland and Germany), user interoperability and consistency will play more critical roles in market expansion.

Operational Standards

The last area to consider is system operations. As described earlier, many shared-use vehicle system models operate inherently differently on the basis of their purpose, location, and other key characteristics. Therefore, it would be difficult to introduce one operational standard that could span the range of various models. Also, it is important that the introduction of standards not stifle new, innovative operational methods prematurely.

Nevertheless, there is still a need to measure shared-use vehicle system effectiveness. Program effectiveness spans many areas, including modal connectivity, air quality, energy efficiency, and economic viability. Thus, it is critical to collect appropriate data on system operations to document net benefits. These data include information on vehicle use, system operation, and user behavior. If data are collected in a relatively uniform fashion among programs (while acknowledging proprietary interests), it will be possible to compare systems, document lessons learned, and identify the effectiveness of each. Thus, standards can also play an important role in defining the types of data needed for monitoring and evaluation.

SUMMARY

A classification framework has been presented for shared-use vehicle systems. This classification system can aid policy makers, researchers, and practitioners in better understanding the various aspects of this rapidly growing and evolving field. Originally, the two primary concepts of carsharing and station cars emerged separately, but these concepts are now merging.

As demonstrated above, the differences between the station car and carsharing concepts are blurring as many new systems are evolving and include characteristics of both. Many new shared-use vehicle systems today are indeed hybrid models. Although carsharing and station cars have somewhat different origins, both are based on the concept of short-term vehicle use as a means of improving transportation efficiency. The overall effectiveness of these systems can be enhanced by combining key characteristics of both models.

A primary goal of shared-use vehicles is to maximize use. One means of doing this is to serve as many market segments as possible in a single system. In comparing systems, often the ratio of vehicles to subscribers is used as a unit of measurement. These ratios can provide one means for determining how effective a shared-use vehicle system is in eliminating the need for parking spaces and achieving better land use. To date, carsharing organizations have had much higher user-to-vehicle ratios than station car systems, for instance. Other measures are needed to capture VKT reductions, increased transit use, vehicle ownership changes, emission reductions, and program viability.

Furthermore, many believe that clean-fuel vehicles are a good match for shared-use vehicle systems because of the potential for increased air quality benefits that might arise from combined approaches (i.e., alternative fuel vehicles and demand-management strategies). Not surprisingly, a more extensive database on shared-use vehicle system models, their corresponding social and environmental affects, and their economic potential is needed to truly evaluate the value of such systems to individuals and society. A shared-use vehicle classification system has been presented here, using a historical approach. This can be considered as a starting point to more formally characterize the range of shared-use vehicle models and related services, identify data needs, and document lessons learned to foster the research, policy, and market understanding of this innovative mobility arena.

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