

Table 1. Results of two surveys of shared-ride taxi operations at Union Station.

Time	AVO		Average Passenger-Trip Distance (straight-line km)	Average Wait Time per Passenger (min)
	Effective	Maximum		
2-h average	2.19	2.53	2.24	1.9
	2.17	2.47	2.15	2.1
Metroliner peak	2.26	2.74	2.17	2.2
	2.31	2.77	2.15	2.4

Note: 1 km = 0.62 mile.

of time. The Metroliner peak represents an hourly demand rate of 800.

Air-line travel distance for each passenger was computed from digitized geographic locations of destinations, and computer graphic maps of trip destinations were produced for each taxi and various groups of taxis. An example is shown in Figure 8. These maps reveal that the apportioning among taxis of patrons with compatible destinations was efficient. Most taxis used an SO-MD type of ride-sharing policy.

Effective average vehicle occupancy for each taxi was computed from the ratio of passenger straight-line distance to maximum straight-line distance (circuitry was neglected). Table 1 gives a summary of the performance measures that were assessed in the two surveys at Union Station. Note that the large difference between effective AVO and maximum AVO implies that the ride-sharing policy is serving multiple destinations to a significant extent. Figure 9 shows the distribution of the number of taxis as a function of the maximum number of passengers. Figure 10 shows the cumulative distribution of passenger waiting time. Note that 22 percent of the users received immediate service and 98 percent were served within 5 min.

## Car-Pooling Programs: Solution to a Problem?

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Information from 26 car-pool programs is reported that suggests that appeals to self-interest made through work organizations are more effective than other means of encouraging car pooling because employees of work organizations form a known population with a common destination and, typically, a similar work schedule. It is proposed that such appeals should focus on the benefits of car pooling for the individual rather than on general values such as patriotism. Interviews of selected long-term car-pool participants (2 or more years) indicated that work organizations provide a setting in which personal information about potential participants can be obtained and that this information facilitates the formation of car pools. These interviews further suggested that the intimacy of the private automobile may limit the size of car pools as well as the willingness of some individuals to participate in them. Ride-sharing programs that present alternative transportation modes may be more effective than car-pool matching programs in changing current patterns of work travel.

In the 1970s, with the advent of the energy crisis, transportation patterns became a national issue. Rising U.S.

## CONCLUSIONS

The Union Station dynamic ride-sharing taxi operation results in substantial improvements in vehicle productivity. The a.m. peak-period ride sharing results in services being provided by 60 percent fewer taxis that consume 55 percent less energy than if the service were offered by non-ride-sharing taxis. In addition, the cost of the taxi is distributed among the ride sharers, which results in reduced fares per passenger. The reduction in level of service was found to be minimal when it was compared to the additional benefits derived from ride sharing.

The implications of the Union Station demonstration for the operating feasibility of a dynamic shared-ride AGT system are substantial. They may be the determining factor in the economic feasibility of AGT systems. What is certain is that the implications were obtained from a cost-effective demonstration; it cost less than \$500 to conduct the study and analyze the results.

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consumption of petroleum involved increasing energy-related dependence on foreign countries. In late 1973, attention focused on changes in the policies of major oil-producing nations. Automobile gasoline consumption was recognized as inefficient. The U.S. Department of Transportation proposed saving gasoline by increasing the number of car pools. In December 1973, federal legislation was enacted that provided funds for car-pooling programs. Programs were instituted in many places in January 1974, e.g., Austin, Texas; Charlotte, North Carolina; Norfolk, Virginia; and Phoenix. Mass-media campaigns tried to mobilize voluntary energy-conservation behavior, i.e., car pooling to work.

The success of specific programs and general media promotions is difficult to measure because of the lack of local baseline data, unspecified definitions of car pools, and inconsistent measures of car-pooling levels. In this

paper, a car pool is considered to exist when any two or more individuals ride together in an automobile on a regular basis. The relative success of car-pooling programs or campaigns should be measured by the percentage increase in the number of pools after program or campaign activities have begun to reach the target population (based on a survey of commuters). Vehicle occupancy counts, in which counters determine the number of occupants in automobiles traveling at specific times on selected days, produce different statistics and thus generate confusion about the relative prevalence of car pooling. Thus, although in 1974 the U.S. Department of Transportation found that 47 percent of commuters shared rides to work with at least one other person (2), others report 83 percent of private vehicles traveling to work are occupied only by the driver (14). Another measure of the effectiveness of car pooling is the calculation of the liters of fuel saved annually or the vehicle kilometers of travel saved (9).

In this paper a variety of data are used to describe problems that occur in the promotion and evaluation of car-pooling programs. Specific concerns are the types of promotional appeals selected, the organization of local car-pooling programs, strategies used to enhance car pooling, and the evaluation of program effectiveness. Recommendations are developed for future car-pooling promotion and evaluation efforts.

#### TECHNIQUES USED IN PROMOTING CAR POOLING

Before specific problems with car-pooling campaigns are discussed, the general appeals used in the campaigns are reviewed and critiqued. Mass-media appeals for voluntary energy conservation by individuals were ineffective for several reasons. Media promotions appealed to widely shared societal values, particularly patriotism, social responsibility, and savings. These appeals failed to recognize individuals as rational decision-makers concerned about their own self-interest. Other appeals treated individuals as rational decision-makers but failed to recognize the social contacts characteristic of urban life.

##### Appeals to Patriotism

One set of media appeals focused on general societal values, e.g., patriotism. The nation was described as being confronted with an energy crisis that individuals could help to "cure" by consuming less gasoline and helping to make the nation less energy dependent. Thus, individuals were asked to be altruistic and to modify their existing transportation patterns, as well as other energy-consumption patterns, for the good of society. At the same time, congressional debates over the necessity of rationing gasoline or establishing high gasoline prices suggested that if individuals did not voluntarily behave in the national interest gasoline consumption might be restricted. Restriction of prime parking locations and of vehicle access to central business districts has also been suggested. Coercive measures other than the mandatory 88.5-km/h (55-mph) speed limit generally were not implemented; such measures not only could be difficult to enforce but could also produce undesired effects if the need for them were not perceived as real. For example, rationing lends itself to the development of black markets, which would penalize lower income groups. In addition, the growth and popularization of citizen's band radio use in automobiles suggest the possibility of the emergence of antiregulation behavior.

Two specific sets of problems are involved with socially based appeals. One set of problems involves

the perceptions of individuals as to whether or not they should be responsible for meeting the social need. Appeals to patriotism were questioned by many people who felt that others in society were not being asked to alter their behavior or to alter it to an equal or greater degree. For example, some individuals perceived their own gasoline consumption as minuscule compared with that of corporations, and some felt that they did not waste as much gasoline as did other individuals (or family units) with larger automobiles or more than one automobile (8).

Another set of problems resulted from perceptions of the nature, the extent, and the basis of true national crisis (social need). Was there, in fact, enough gasoline or were oil companies withholding it in order to increase their profits or to force independent dealers out of business or both? A weekly study of household units made between January and April 1974 by the National Opinion Research Center showed that from 28 to 43 percent of people interviewed in a given week felt the oil and gas companies were most responsible for the current energy shortage and that from 28 to 45 percent of people interviewed in a given week held the government in Washington most responsible (13). Individual consumers, environmentalists, big business, Arabs, Israelis, and Russians were much less likely to be seen as most responsible (12). Rumors circulated that while the consumer was being told there was a shortage there were vast quantities of gasoline being stored. Some people believed that the energy crisis was proposed to divert the public's attention from other societal problems, e.g., the Watergate scandal.

A general problem with appeals to individual responsibility was that the crisis rhetoric implied that the energy problem was temporary although the apparent goal of policy makers was to alter permanently the level of gasoline consumption by individuals. As Davis (4) notes, "Talk of a crisis connotes that the problems are novel and transitory, when in fact they are the same problems the U.S. has faced many times." Some individuals may have maintained their existing patterns of gasoline consumption assuming that the crisis would end relatively soon if other individuals and units in society voluntarily cooperated and changed their behavior or new technology was developed. The failure of the federal government to establish a national energy policy may have confirmed the perception that the problem was transitory. (The public perception of a crisis was apparently short-lived, for in May 1976 the Federal Energy Administration announced that gasoline consumption had almost risen back to the peak level of August 1973, before the oil-producing countries changed their energy policies.)

Finally, socially based appeals failed to consider the bases of individual behavior. Individuals were asked not to do what might be most rewarding for themselves but instead to invoke some vague conception of the national interest as the basis for their behavior. Rational decision-making models of human behavior (7, 11) as well as the social-psychological literature on such phenomena as bystander intervention (10) suggest that individual action in the public interest is rare. In addition, if some others engage in (or can be expected to engage in) behavior supportive of the national interest, the individual may be less motivated to change his or her own behavior pattern.

##### Appeals to Self-Interest

Even if individuals support societal values, they may express personal dislike for a specific form of car pooling or for car pooling in any form for themselves. Olson

(15) argues that special incentives such as appeals to self-interest are crucial if coercion is not used in attempts to generate desired behavior. He further states that

If the members of a large group rationally seek to maximize their personal welfare, they will not act to advance their common group objectives unless there is coercion to force them to do so, or unless some separate incentive distinct from the achievement of the common or group interest is offered to the members of the group.

Some campaigns have attempted to educate (persuade) individuals about the benefits car pooling would offer them. The Pool It and Double Up America campaigns have emphasized how individuals could benefit if they changed their commuting patterns. One frequently emphasized benefit is that the individual could save money by joining a car pool. Various statistics have been used in advertisements to demonstrate to the individual the savings that would result from car pooling, depending on the distance of the work trip and the number of individuals in the pool. The costs avoided and the rewards gained from not having to drive to work every day (e.g., relaxation) and from riding with others (e.g., camaraderie with fellow riders) have been pointed out. The potential disadvantages, such as inflexibility of work hours, earlier departure from and later arrival at home, and lack of freedom to make stops on the work trip, have been deemphasized.

Individuals may come to view car pooling as in their own interest but, unless other facilitative conditions exist, they may not change their behavior patterns. Social scientists recognize the existence of more than one level in the flow of communication. Personal influence modifies the direct effects of mass communication. Although people have individual characteristics that affect their receptiveness to and perception of media communication, they are also affected by the responses of friends and acquaintances (16). Personal acquaintances must reinforce media appeals if an innovation is to be adopted.

Car pooling, particularly when it is organized through computer or other matching programs, is an innovation that requires being accepted by other people. To be matched with others by computer and to receive a print-out of names, addresses, and phone numbers is impersonal, and to be expected to establish a relationship with strangers is unusual. Although social units have attempted to increase public acceptance of car pooling, they have failed to use personal contacts in most instances.

#### Involvement of Social Units

In their efforts to organize car pools, policy makers engaged in "attempts at informal and formal cooperation of specialized elites" (3). On the local level, governmental units and work organizations participated to varying degrees in the promotion of car pools (5). Local governmental units were encouraged to participate because car pooling could reduce local transportation and pollution problems. The media were approached as public service agents responsible for informing the community. Work organizations were asked to serve as markets in which car pooling could be displayed and sold.

One local governmental response to the energy crisis was the establishment of transportation programs, often with the aid of federal energy funds. Programs based in governmental units had limited success. In late 1973 the local government of Cincinnati, Ohio, began using a data processing organization to match citizens interested in car pooling. After 1 year there had been only 100 responses and none of them could be matched. Local de-

partments of transportation and transit authorities approached work organizations and asked them to encourage and support employee car pooling. Another local governmental response was to reward poolers by providing privileged access lanes—for example, an express highway lane in Dade County, Florida—and reduced toll fees.

Local media appealed to individuals to car pool. They did this perhaps to fulfill their public service requirements as well as to appeal to and increase their audiences. National car-pooling campaign messages were carried by local radio stations, and some stations and newspapers conducted independent campaigns.

Media campaigns in various cities promoted computer matching programs that asked individuals to call in to a radio station or to mail in a newspaper form and be matched with other individuals interested in pooling. The city of Columbus, Ohio, for example, offered to match by computer individuals interested in car pooling. The local chamber of commerce and a radio station publicized the service on the radio and in other local media for more than a month. Extensive efforts resulted in only 40 inquiries about the project.

Appeals were made to work organizations to respond to the energy crisis by supporting ride sharing as (a) responsible units of society and particularly of the local community, (b) profit-making organizations, and (c) employers concerned about their employees. Community responsibility could be demonstrated more through alleviating local traffic congestion than decreasing energy consumption. Profit-making organizations were appealed to primarily by suggesting that increased car pooling would reduce the need for employer-provided parking facilities. A stronger appeal suggested that organizations could improve employer-employee relations by facilitating employee car pooling. The appeal for employer support probably has been most effective among companies concerned about their employer-employee relations and their public image and those whose employees have parking and transportation problems. (Some firms are faced with a potential loss of skilled employees if they relocate and do not facilitate employee transportation.)

Supportive employer behavior in Los Angeles, Knoxville, and Omaha included a variety of activities (5). Employers provided company time for completion of questionnaires. The minimal information obtained was the individual's name, home address, work address, time of arrival at work, and time of departure from work. Matching lists were distributed by the employers to those who expressed interest in car pooling. Promotional information on saving money and other benefits was disseminated through company channels, e.g., bulletin boards and employee newsletters.

Both logistical problems and interpersonal considerations suggest that the matching process could be more satisfactory to potential consumers if specific social organizations such as companies or plants are used. Work locations are closer together, work schedules are more similar, and information about potential poolers is more easily accessible within a single organization. In most communities the large variety of residential and work locations, as well as work schedules, necessitate a substantially larger number of individual file entries for successful matching than are necessary in a single company or among geographically proximate companies. In addition, communitywide matching programs generally ask individuals to volunteer to ride with others who share similar work locations and schedules but whose other characteristics are unknown. Given the intimacy of the private automobile, individuals may desire to take more personal characteristics into account. Matching programs should approximate the model of the

**Table 1. Car-pooling programs responding to survey (by geographic region).**

East	South	Midwest	West
Connecticut Motor Club	Dade County, Florida	Grand Rapids	Los Angeles
Connecticut Department of Transportation	Raleigh, North Carolina	Omaha	Los Angeles Commuter Computer
Dover, Delaware	Houston	St. Paul	Sacramento
Rhode Island	San Antonio	Topeka, Kansas	San Diego
Scranton-Harrisburg	Phoenix	Kansas City, Missouri	San Bernardino
Washington, D.C.	Tucson	St. Louis	San Francisco
			Portland, Oregon
			Seattle

marriage broker more than the computer assignment of students to classes.

Appeals transmitted through work organizations are perhaps more effective because the employee can use existing social networks to obtain information about others, there is a greater homogeneity of work schedules, and other characteristics (6). Common work locations are also essential because they shorten the home-to-work trip by eliminating drop-offs and they ease the establishment or alteration of car-pool arrangements for members of a pool, e.g., by accommodating overtime workers.

#### SURVEY OF CAR-POOLING PROGRAMS

A limited survey of car-pooling programs revealed support for the desirability of using employers to increase car pooling. In September 1975, car-pooling programs in various parts of the United States were sent questionnaires about the nature and the effectiveness of their programs. The 26 programs that responded are given in Table 1. With the exception of the Dade County, Florida, program, which only involved provision of an express highway lane, all the programs involved computer matching.

Approximately two-thirds of the program directors (17) said that, because their programs were rapidly implemented, they had no measure of how many or what types of people were car pooling when their programs were instituted. Because baseline data were lacking, the impact of these programs on commuting behavior could not be measured. Many of the respondents expressed concern about how effective their programs were. The programs with data on preprogram pooling levels had estimates based on survey questionnaires, telephone surveys, and vehicle occupancy counts.

In response to a question about how programs might be reorganized or modified to make them more successful, respondents advocated working with local employers. On the basis of experience with a program aimed simply at individuals in a geographic area (Connecticut Motor Club), the director concluded that areawide programs have only limited appeal and suggested that greater participation could possibly be obtained if employees of work organizations were the targets. Similarly, a large city's program personnel determined that in their area only employer-based programs could be successful. In Dover, Delaware, something was learned about the importance of employer efforts when employers had to coordinate employee work hours to facilitate car pooling. In the Rhode Island and the Los Angeles programs, staff members found it necessary to go to employers to sell their programs.

The use of work organizations can facilitate both the formation of car pools and the evaluation of car-pooling programs. Data obtained on the work force of an organization are more accurate for establishing the effectiveness of programs because employment records establish a known population. That is, the percentage of an organization's work force that participates in ride-

sharing activities at a particular time and the changes in that percentage over time can be computed more exactly than they can for areawide efforts.

Recognizing the crucial function of employers in facilitating car pooling, respondents at the same time affirmed the continuing need to persuade individuals to try car pooling. The Omaha program, for example, which is a part of the metropolitan transportation authority, stresses the need to know how to motivate employees to use the service and to recognize its importance.

#### FORMING AND MAINTAINING CAR POOLS

Energy conservation is the national goal that car pooling is supposed to help achieve, but the success of car-pooling programs depends on (a) convincing individuals that it is in their self-interest to car pool and (b) bringing individuals together to form pools (assisting them in personal contacts). The basis for matching potential car poolers in most programs is the sharing of a common point or origin, work schedule, and destination. Although these are parameters for establishing pools, certain social characteristics are important to the development of car pools. Thus, another factor involved in the development of successful car-pooling programs is the awareness that these programs create social groups.

The dynamics of car pooling were studied by intensively interviewing 25 long-term car poolers in Knoxville (6). The interviews focused on how the car pools the individuals belonged to were formed, maintained, and changed.

A common pattern of membership selection was indicated by these car poolers: When they were contacted by a person interested in joining their car pool, they would try to obtain some additional information about that person. People at work and in the residential subcommunity were sources of information about potential new members (1). According to one respondent, after you know the new person's work schedule,

The next thing you want to know before you let someone in a car pool is whether the person is agreeable. You find this out by asking other people who have been in pools with him or by asking people at work if he is dependable or agreeable.

Another respondent stated,

We've been selective about who is in the pool. Most of us are neighbors, work on this floor, and work the same schedule.

A third respondent said,

We don't advertise. Someone always knows of someone. Everybody who comes in is a fairly good acquaintance of someone else. In a way the person who brings him in is responsible.

Data from the Los Angeles Commuter Computer and Knoxville follow-up studies indicate lack of interest in riding with strangers. This is illustrated by the fact that only about 6 percent of persons who received a list

of potential car poolers (others who lived and worked in similar locations who were interested in car pooling) actually used the list as a means of contact. In Knoxville, a random sample of 150 persons (5 percent of the work force of the Tennessee Valley Authority) were surveyed from May to June of 1974 to determine the effectiveness of various efforts, particularly matching lists. The preference for "known others" as car-pooling members is shown in that, of the 150 people surveyed, 48 percent were car pooling with fellow workers, 15 percent with a relative, and 14 percent with a neighbor.

Matching programs that simply provide a list of people with similar work and home locations fail to deal with the car pool itself as a social unit or with why known others are preferred as members. As people consider the rewards and the costs associated with their current and possible alternative modes of transportation for the work trip, social factors as well as more practical factors (e.g., gasoline and parking costs, vehicle depreciation, convenience) enter into the assessment. One car pooler indicated concern for shared social characteristics by saying, "I try to make sure people are compatible beforehand, compatible by age, locality, similar interests." Another factor, the desire for sociability, is expressed in the statement, "It's more of a get-together than a carpool. It's a friendly thing. It's more a car pool of friends than a car pool of convenience." In fact, a number of car poolers indicated a preference for viewing their car pool as a friendly group that shared rides rather than as an economic convenience.

Poolers deemphasized the economic basis of their relationships by not keeping driving records and having no rules for making up missed driving turns. One pooler who stated that the pool was an amiable group said, "We always swap days but if someone isn't paid back, no one worries about it because they figure they'll be paid back sometime." Another pooler indicated that the pool did not keep records because it all came out even over the long run. Poolers explained that car pools are based on trust and the willingness to believe that no one will take advantage of anyone else.

Unfortunately, the desire for informality and sociability can mean that the full capacity of car-pooling vehicles is not used; some individuals only share rides with their spouse or with one friend or neighbor. One pooler who rode with only one other person indicated, "We wouldn't want it to get above three because I think that's the number where you can remain informal." The limited size of many car pools was shown in a U.S. Department of Transportation national probability survey (2) in which 83 percent of those who shared rides rode in automobiles with three or fewer occupants (58 percent of the automobiles had only two occupants).

#### RIDE SHARING: A BROADER PERSPECTIVE

A broader approach to increasing vehicle occupancy considers all the modes in which persons can share rides. Ride-sharing modes differ in vehicle characteristics, trip characteristics, and collectivity characteristics. Some modes of ride sharing are car pools, van pools, express buses, and fixed-route public transit, each of which has advantages and disadvantages for potential ride sharers. For example, because the dominant form of financial arrangement in car pooling is trading rides or sharing driving responsibilities, one must usually have an automobile to participate. Van pools (8 to 15 people riding together in a van) are not economical when operated over a one-way trip length of <16 km (<10 miles). Express buses require that approximately 40

persons ride from a given location to another given location at specified times. Express buses are usually less expensive than other modes when enough persons use them. Both the express bus and public transit modes require less personal involvement on the part of the rider than does the van or the car pool. Such factors as maintenance requirements and driver characteristics vary by ride-sharing mode.

The patrons of different modes appear likely to differ in personal characteristics, collective characteristics, and work-related characteristics. Individuals should be more interested in ride sharing if driving alone creates costs in other parts of their lives. For example, early in the family life cycle, heads of households frequently can afford only one automobile. Joining a pool can generate rewards by freeing an automobile for the spouse to do errands and escort children or by providing transportation so that the spouse can work. Individuals who live greater distances from their place of employment and thus encounter greater commuting costs than others might be interested in van pooling as a means to reduce those costs. More generally, individuals whose commuting costs take a greater share of their expendable income should be more interested in ride sharing. Workers who earn lower wages may need to share rides to make a job profitable (17), whereas more affluent workers value the avoidance of heavy traffic. Individuals who have limitations such as no driver's license or no access or irregular access to an automobile may have no choice of mode of transportation.

Ride-sharing programs, unlike car-pooling programs, promote several transportation modes and can potentially assist more commuters. The brokerage demonstration project in the Knoxville area has sought to match the most economical or most preferred modes to commuters willing to try ride sharing. In addition to assisting in the formation of car pools, the program matches available vehicles (vans or express buses) and drivers to commuter routes with concentrations of passengers sufficient to support the service on at least a break-even basis (18). A ride-sharing program is more desirable because it can deal with differences in trip characteristics, vehicle preferences, and social characteristics of commuters.

#### CONCLUSIONS AND RECOMMENDATIONS

Although car pooling existed in American society for some time before the energy crisis, no one knew its nature and extent. The institution of car-pooling programs was a decision of policy makers for which they had to develop interest and support. Mobilization of individuals into car pools as a result of mass appeals was limited for two reasons: (a) Appeals to patriotism and other social values did not treat the individual as a self-interested decision-maker and (b) the current social situations and preferences of individuals were not recognized in the mass appeals.

Car-pool matching programs reported greater effectiveness when they used large work organizations as a base. A major reason for this greater effectiveness is that people in the same work organization would most likely meet the minimal qualification for pooling (similar work schedules and destinations) and could use existing social contacts to obtain information about other potential poolers.

The following actions are recommended for future car-pooling programs:

1. Collect baseline information. Baseline information provides two important benefits: (a) Estimates of current levels of ride sharing in car pools and other

modes establish the potential market level and (b) the relative effectiveness of various programs can be evaluated.

2. Follow up on list distribution. Car-pooling efforts should recognize that potential poolers want to obtain information about one another before establishing a car pool. Simply distributing lists of names results in little use of the lists. Some opportunity for contact between potential poolers or personal follow-up by a "match-maker" could increase the number of pools formed.

3. Use work organizations as targets. Work organizations provide known target populations who share common destinations and other characteristics. Informal interaction networks among employees establish a basis of contact among potential poolers. Promotion can be handled through company communication systems. Follow-up and evaluation efforts are easier if there is a well-defined target population.

4. Investigate the preferences of car poolers. The factors people consider when they ask other people to car pool with them should be studied. Most matching programs assemble a list of potential ride sharers based on common origins, destinations, and trip times. Data could be collected on preferences for certain types of people, for passenger and driver etiquette, and for financial or barter arrangements. Use of such preference data in preparing matching lists could increase the number of pools formed and maintained.

5. Recognize social processes. Because car pools involve social activity (interpersonal relationships) as well as economic activity, car-pooling programs involve efforts to form or add to social groups. Groups recruit members and individuals seek to join groups. In addition to marketing a product, car-pooling programs must facilitate human relationships.

6. Emphasize a multimodal approach. Programs that promote multiple ride-sharing modes can increase vehicle occupancy because they satisfy more individual preferences.

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