# Who Chooses to Carpool and Why?

## Examination of Texas Carpoolers

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**The debate over high-occupancy vehicle (HOV) and high-occupancy toll lane efficiency has raised questions about whether HOVs should be given preferential treatment on managed lanes and the potential impacts of different preferential treatments. This research questions why people choose their mode of travel by examining characteristics of carpoolers and single-occupancy vehicles, reasons for their travel mode choice, and carpool formation, on the basis of a survey of travelers in Dallas–Fort Worth and Houston in Texas. Carpool users rated the ability to use HOV lanes as the most important factor in their decision to form a carpool. Enjoying traveling with others ranked second, followed by reasons such as saving time, helping the environment and society, and sharing vehicle costs. Carpool partner matching programs, employer carpool incentives, and preferred parking at work were generally the least important factors in travelers' consideration of carpooling. The importance of various factors changed significantly if the respondent was on a work or commute trip versus other trip modes. Travelers on work or commute trips ranked travel time savings and cost sharing much higher, as expected, because of their frequent travel during peak hours. The data also support evidence of a significant amount of "fampooling," with nearly 75% of carpools consisting of family members. The implications of these findings are discussed.**

After much enthusiasm and hope for carpooling in the 1970s, the practice declined during the 1980s and 1990s. This decline happened even as policies were in place to encourage carpooling, culminating with the passage of the Intermodal Surface Transportation Efficiency Act in 1991, which favored high-occupancy vehicle (HOV) lane construction (*1–4*). The increasing number of HOV lane miles, coupled with a decline in carpooling during the 1990s, led to a broad perception of underutilization of HOV lanes as well as for calls to open up the lanes to general traffic (*3, 5–10*). At the same time, historic budget constraints had produced a backlog of needed transportation improvements. These combined factors were the impetus for transportation agencies to consider applying road pricing principles—long considered the optimal solution by transportation economists—to HOV lanes. With advances in electronic tolling technology, these trends have coalesced to make managed lanes a reality in the last several years (*10–12*).

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Managed lanes are facilities in which usage eligibility is controlled by pricing policies and other considerations. Operation of managed lanes involves, among other things, setting desired objectives for the facility and determining user eligibility and pricing policies. Most managed-lane facilities in the United States are high-occupancy toll (HOT) lanes, in which single-occupancy vehicles (SOVs) are charged a toll for using the facility, but HOVs travel on the facility for free. Current research has found inefficiencies in HOT lanes and called for eliminating HOV preferential treatment, either by opening up HOV lanes to all traffic or by imposing a toll on all lanes (*7, 13, 14*). However, supporters of HOT lanes argue that the policy promises a number of benefits, including promoting non-SOV modes, especially carpools and transit; generating needed transportation revenues; easing political opposition; and improving air quality (*4, 11, 15–22*).

The debate raises a series of questions about whether managed lanes are the appropriate choice, whether HOVs should be given preferential treatment, and what the potential impacts of different HOV preferential treatments may be. A fundamental question related to these inquiries is why people choose a particular mode of travel. Many mode choice studies have approached the issue indirectly by inferring factors that determine mode choice decisions. Most of them focus on one or a few specific types of trips (*23–29*). However, few have directly studied the issue.

Building on research by Teal (*30*), Pisarski (*31*), Poole and Balaker (*4*), and some regional commute profile studies, this paper explores the issue directly by examining reasons behind people's travel mode choice decision through a survey of travelers in Dallas–Fort Worth (DFW) and Houston, the two largest metropolitan areas in Texas. Specifically, this study focuses on four questions:

- What are the main reasons people carpool?
- How important are these factors in their decision?
- How do responses of carpoolers (to congestion pressures) compare with those of SOV users?
- How are carpools formed?

The analysis focuses on carpool formation and comparison with the SOV mode, because SOV and HOV users constitute the majority of expected managed-lane users. In addition, the effectiveness of policies related to HOV preferential treatments, particularly the operational efficiency of the facility, and the ability of pricing to control facility demand toward extra efficiency policy purposes, depend primarily on actions and decisions made by HOV and SOV users in response to managed-lane policies and pricing. By answering these questions, this study not only can verify the findings of previous work but also can fill in some of the gaps in this area. The findings will provide useful information for agencies to develop effective HOT lane policies. The next section briefly discusses the literature

related to the HOT lane policy debate. Then the survey process and data are described, and results of the data analysis are presented. The final section summarizes the findings and discusses their implications for managed-lane efficiency and policy.

## DEBATE ABOUT HOV AND HOT LANE EFFICIENCY

Several recent studies have dealt with the efficiency of HOV and HOT lanes. Poole and Balaker (*4*) found that the trend of increasing HOV lane miles stood in sharp contrast to the trend of decreasing percentages of carpoolers among commuters in the nation between 1980 and 2000. Even with the casual carpooling or "slugging" practice in some metropolitan areas such as San Francisco, California, and Washington, D.C., carpooling in these areas has shown a decline.

In her study of the circumstances under which HOV and HOT lanes should be implemented, Dahlgren (*7*) argued that, although HOT lanes perform a little better than HOV lanes—factoring in low carpooling and SOV payment to fill excess capacity—they do not enhance efficiency as much as a general-purpose (GP) lane. She concluded that adding a no-charge GP lane is most often the best option for improving traffic flow. Her findings are reinforced by another important recent study. In a study of traffic data on HOV and GP lanes on I-880 in California, Varaiya (*13*) concluded that HOV restrictions increase congestion in two ways: a capacity penalty on single-lane HOV facilities due to the inability of faster vehicles to pass slow traffic, and a congestion penalty imposed on the GP lanes by excluding non-HOVs from using HOV lanes. Small et al. (*14*) supported this discussion by arguing that HOT lanes are not an efficient solution to the current dilemma because the congestion penalty is operative, especially when prices are set to ensure free flow on HOT lanes and thus effectively maintain a state of underutilization of the facility. They concluded that overall efficiency will be higher by having all lanes free, and that both efficiency and welfare will be even higher if all lanes are priced.

Supporters of HOT lanes argue that HOT lanes allow the concept of congestion insurance, a choice to avoid traffic congestion by paying a toll, coming into play while still providing an incentive to increase vehicle occupancy and generate much-needed transportation revenues (*11, 15, 17, 21, 22*). Closely related to congestion insurance is the idea that a free-flow alternative can enhance the intermodal capacity of congested corridors by providing connectivity to transit routes or by using pricing to reserve space on the managed lane for vanpools and virtual exclusive busways (*4, 11, 16–20*).

In addition, supporters of HOT lanes recognize that there is stiff political opposition to converting all lanes of congested corridors to toll lanes, even if tolling all lanes may be the most efficient scenario and could lead to greatly enhanced air quality. They view HOT lanes as a way to ease political opposition to tolls and concerns of equity and double taxation (*10, 11, 15, 17, 21, 32*).

## SURVEY DATA

To better understand HOT-lane and managed-lane use, an Internet survey was conducted from May to July 2006. The survey, tailored for the two cities in Texas mentioned, was available in English and Spanish at www.houstontravelsurvey.org for Houston and at www.dallastravelsurvey.org for Dallas. The Internet survey customized questions so that only relevant questions were asked to each respondent.

The survey began by asking survey respondents about the travel mode for their typical trips and other trip-related questions. On the basis of the travel mode response, they were asked questions about why they chose that mode or why they did not choose other modes. For example, if respondents chose HOV as the travel mode for a typical trip, questions about why they traveled by HOV were prompted. Additionally, HOV and vanpool users were asked to rank the importance of the factors that influenced their mode choice on a scale of 1 to 5, with 5 indicating a very important factor and 1 indicating the least important factor. Sociodemographic information about the survey respondents was also collected.

Various outreach efforts were made to increase public awareness of the survey and to encourage participation from low-income and minority groups. Some outreach efforts included push cards to give potential survey participants, e-mails, press releases, and on-site surveys at carefully selected Department of Public Safety offices and community centers. A complete description of the survey method and data collection process, as well as efforts involved in data collection, is provided by Toycen et al. (*33*).

The survey generated 4,634 responses, with 2,026 from DFW and 2,562 from Houston. (There were 46 responses with unknown locations.) The primary travel mode of respondents included 69.2% SOV, 13.3% HOV2, 4.4% HOV3+, 2.3% vanpool, and 2.0% motorcycle users. [A typical vanpool is defined as a commuter program in which six to 15 people share the ride to work for a fixed fee, divided among all riders; the program provides the van, insurance, and operating costs (*34*). In this survey, vanpool was listed as one mode for people not traveling by car, train, bus, and motorcycle.] Bus and rail transit users made up the remaining 8.8%. Of the valid cases, about 41% were females and 59% were males. White respondents constituted about 76% of the sample, and about 59% had an annual household income of $75,000 or higher. Income groups were divided into eight categories from less than $15,000 to $200,000 or more. Most respondents were professionals (about 55%) and lived in married households (about 65%). More than 79% respondents were between the ages of 25 and 54. About 91% had vocational certificates or college degrees.

Despite all efforts, the sample still overrepresented white and middle- to high-income travelers compared with data from the 2005 American Community Survey (Table 1). Although the sample is not representative of the general population in these areas, it does catch the population most likely to be affected by managed-lane policies, because middle- and high-income users are choice carpoolers. Research on carpool decisions and formation of this specific population will provide useful information for managed-lane policy making. For this reason, unweighted data were used for analyses in this paper.

## CHARACTERISTICS OF HOV AND SOV USER GROUPS

Numerous studies have found that traveler characteristics, trip characteristics, and other factors affect mode choice. Some important characteristics identified previously include attitudes, personality, and habit (*25–27, 35–38*) and income and demographic changes (*24, 39, 40*). These findings suggest that certain characteristics are associated with different modal users. This section compares HOV and SOV user-group profiles to provide an overview of characteristics associated with particular mode choices. The two aforementioned groups are the focus because they are central to managed-lane policy decisions in Texas.

**TABLE 1 Comparison of Survey Sample and the 2005 American Community Survey (ACS)**

| | Dallas | | Houston | |
|---|---|---|---|---|
| | Survey % | ACS2005 % | Survey % | ACS2005 % |
| Race and ethnicity[a] | | | | |
| White | 78.00 | 57.45 | 75.00 | 47.89 |
| African American | 8.10 | 13.24 | 7.30 | 15.72 |
| Hispanic | 7.00 | 23.11 | 10.60 | 29.46 |
| Asian | 3.00 | 4.77 | 3.90 | 6.00 |
| Native American | 1.30 | 0.53 | 0.80 | 0.45 |
| Others | 2.60 | 0.91 | 2.40 | 0.48 |
| Total | 100 | 100 | 100 | 100 |
| Income | | | | |
| Less than $15,000 | 4.35 | 12.07 | 3.77 | 14.08 |
| $15,000 to $24,999 | 2.64 | 11.17 | 2.42 | 12.36 |
| $25,000 to $34,999 | 4.63 | 11.58 | 5.42 | 11.53 |
| $35,000 to $49,999 | 10.68 | 15.40 | 10.64 | 14.78 |
| $50,000 to $74,999 | 17.24 | 18.98 | 19.41 | 17.55 |
| $75,000 to $99,999 | 19.00 | 12.19 | 18.94 | 11.07 |
| $100,000 to $199,999 | 34.42 | 14.93 | 33.18 | 15.02 |
| $200,000 or more | 7.05 | 3.66 | 6.23 | 3.62 |
| Travel mode[b] | | | | |
| SOV | 74.8 | 80.3 | 64.8 | 78.3 |
| HOV2 | 12.4 | 8.7 | 14.1 | 9.2 |
| HOV3+ | 3.4 | 3.0 | 5.3 | 3.5 |
| Transit | 7.0 | 1.5 | 10.0 | 2.8 |
| Other | 2.4 | 6.5 | 5.8 | 6.2 |

[a]ACS race–ethnicity distributions are based on population aged 18 and older for comparability with survey population of this study.
[b]Travel mode in the survey refers to a mode used for typical trips at the time of survey. ACS travel mode refers to commute mode for workers aged 16 and over.

The data described in this section were analyzed using the cross-tabulation technique as well as mean comparisons where appropriate. The HOV2, HOV3+, and SOV categories were cross-tabulated by trip purpose, gender, and household type. First, these modal groups were compared and contrasted based on trip purpose, which was divided into commute, work, school, and recreational or other. Commute trips were defined as those made between the workplace and home. Work-related trips were distinguished from commute trips. Recreational trips included social, shopping, personal errands, entertainment, and all other trips. The groups were then compared by gender and finally by household type. Household types included married with children, married without children, single, single parent, and unrelated.

The comparison of modal groups by trip purpose indicated that most trips reported by SOV respondents were commute and work-related trips, and the percentage of these trips was higher for SOV than for HOV respondents. For example, about 73% of SOV trips were commute trips compared with 50% of HOV2 and 43% of HOV3+ trips. Reinforcing findings in the literature, the situation was different for recreational trips. Only about 11% of SOV trips were for recreational purposes, but 33% of HOV2 and 39% of HOV3+ trips were for recreation. As might be expected, work-related trips such as deliveries made up only a small proportion of the HOV2 and HOV3 trips, 12% and 10%, respectively. However, about 14% of SOVs were on work-related trips, slightly higher than those of HOVs. School trips made up no more than 5%, of the HOV2 and HOV3 trips, and only about 1% of the SOV trips. A $\chi^2$ test indicated that differences in trip purpose among the three groups are statistically significant at the .001 level.

The SOV respondent population was 38% female and 62% male. Distributions were similar although somewhat narrowed for the HOV2 group, at 44% female and 56% male. The order was flipped, however, for the HOV3+ mode, with 60% of the HOV3+ respondents being female and 40% male. This leads to the observation that, overall, more females than males traveled in HOVs. A $\chi^2$ test revealed that the differences in gender composition among the three groups were statistically significant at the .001 level.

Of the 3,022 SOV respondents, about 37% were married with children, 25% were married without children, and 25% were single. Single parent and unrelated households made up most of the remainder for the SOV population. About 42% of the HOV2s were married with children, and 33% were married without children, making up almost 76% of the entire HOV2 population. Similarly, but more striking, about 65% of the HOV3+ population was married with children, but only 11% of the HOV3+ population was married without children. The $\chi^2$ test results indicated that modal differences by

household type were statistically significant at the .001 level. These numbers suggest a presence of fampooling (see the fampooling section of this paper for more detailed analysis), a term referring to family members who travel together regardless of existing HOV lanes (*30, 31*). This has implications when compared with trip purpose because many fampools tend to be social and recreational in nature—and outside of normal commuting times.

## REASONS FOR MODE CHOICE

This section examines reasons for choosing a travel mode and the importance of these reasons reported by SOV and HOV respondents. Aside from traveler characteristics, previous studies cite various trip and other factors, such as costs, value of time and time savings, and travel time reliability (*30, 41, 42*); stop-making and trip chaining patterns (*28, 29*); employer and other public programs, land use policy, and urban form (*2, 23, 29, 43*). Several of these factors were investigated directly by having survey respondents select and rank the factors they considered in their mode-choice decisions. Respondents who identified themselves as carpool users were given a list of literature-based reasons that might affect decisions on carpool formation. They were asked to rate them on a scale of importance from 1 to 5, with 1 indicating the least important and 5 being the most important. SOV travelers were asked to identify their main reason for not carpooling.

### Why Do People Carpool?

Table 2 summarizes HOV respondents' mean rankings of importance among the 14 potential options proposed. There were between 84% and 89% response rates on most of the potential factors in their decision. Access to HOV lanes and relaxation while traveling had the top two mean scores at 3.77 and 3.60, meaning these factors were between somewhat important and important in carpooling decision making. Although relaxation was important to those who marked a response to it, almost 90% of HOV respondents did not rate its importance. Access to HOV lanes, however, was a strong factor with more than half of carpoolers giving it a very important rating and another 16% rating it as somewhat to very important. Only 17.5% rated HOV lane access as not at all important in their decision to carpool. This finding was similar to that of the 2005 Bay Area annual commuter survey in California, in which about 54% of commuters with a carpool lane available on their route to work reported that a carpool lane influenced their decision to use the HOV mode (*44*).

**TABLE 2 Reasons for Carpooling**

| Factor | Frequency Selected | % of Total ($N = 789$) | Mean |
|---|---|---|---|
| Access to HOV lanes | 699 | 89 | 3.77 |
| Relaxation while traveling | 77 | 10 | 3.60 |
| Enjoy travel with others | 691 | 88 | 3.26 |
| Help environment and society | 684 | 87 | 3.23 |
| Travel time saving | 690 | 87 | 3.16 |
| Other | 109 | 14 | 3.16 |
| Sharing vehicle expenses | 703 | 89 | 3.15 |
| Reliability of arrival time | 666 | 84 | 2.93 |
| Splitting tolls on toll roads | 159 | 20 | 2.38 |
| Get work done while traveling | 79 | 10 | 2.24 |
| Drop off kids at school/day care | 674 | 85 | 2.23 |
| Carpool partner matching program | 680 | 86 | 2.07 |
| Encouraged by program at work | 677 | 86 | 2.00 |
| Preferred parking at work | 687 | 87 | 1.94 |

The results also indicate that enjoying travel with others, environmental and social consideration, travel time saving, and vehicle cost sharing carried slightly more weight on average than somewhat important. The distribution of importance given to enjoyment of traveling with others was relatively even with about one-fifth of HOV respondents rating it at no importance, and just 8% rating it less important; 21%, 23%, and 27%, respectively, rated it from somewhat important to very important.

Environmental and social considerations were at least somewhat important 80% of the time and not at all important to only 20% of HOV respondents. Those who ranked it with a 3, 4, or 5 were relatively evenly distributed at 22%, 23%, and 25%, respectively.

Travel time savings showed a bipolar importance distribution, with 31% ranking it not important at all and 35% ranking it very important. Some carpoolers clearly perceived travel-time savings offered by HOV lanes but others did not. A further analysis of ranking by trip purpose shows that 45% of commute and work-related trip makers gave the highest mark to the timesaving factor, whereas only 17% of other trip makers did so.

Finally, of the highest overall rated factors, sharing vehicle costs had a bipolar distribution similar to that of travel time savings. About 31% of HOV respondents rated this decision factor not important at all and 36% rated it very important.

Two factors—splitting tolls on toll roads and getting work done—did not appear to be important for carpool formation, with mean scores of 2.38 and 2.24, respectively. In addition, there were only small proportions of responses, 20% and 10%, respectively, to these two reasons.

Although there is no direct comparison because of differences in research design, data sources, and geographic locations, these findings by and large support the notion that individual attitude factors such as perceived social and environmental benefits, along with economic factors, play an important role in mode choice decisions (*30, 44, 45*). For example, based on the 1977–1978 Nationwide Personal Transportation Survey (NPTS) data, Teal (*30*) found that trip length, automobile availability, and commuting cost burden had a major influence on carpooling. In a study of 15 vanpool programs in southern California, Ferguson et al. (*45*) concluded that perceived reliability, social, relaxation, economic, and environmental benefits were significant factors for vanpool satisfaction.

All three factors that are typically thought of as carpool-encouraging policies were ranked low. Small numbers of carpoolers rated carpool matching programs, work programs, and preferred parking at work with some amount of importance, 57% to 63% expressed that these potential factors were not at all important to their decision to carpool. The means of these factors were about 2.0 as indicated in Table 2, which indicates that either such programs were not widespread enough to be effective or there were structural inhibitors that outweigh the incentives such programs offer. Answers summarized in the section on why SOV users do not carpool suggest that structural factors, such as difficulty in forming carpools and the need for flexibility, are potential reasons.

To investigate variation among carpoolers in the rating of factors that influence their mode choice decisions, the reasons for carpooling were

**TABLE 3 Differences in Reasons for Carpooling**

| | Gender | | Trip Purpose | | Fampool | |
|---|---|---|---|---|---|---|
| Factor | Female | Male | Commute and Work | Other | Yes | No |
| Access to HOV lanes | 3.88[a] | 3.68[a] | 4.06[c] | 3.28[c] | 3.64[b] | 4.07[b] |
| Relaxation while traveling | 3.69 | 3.50 | 3.46[a] | 4.13[a] | 3.57 | 3.65 |
| Enjoy travel with others | 3.44[b] | 3.11[b] | 3.17[a] | 3.42[a] | 3.29 | 3.20 |
| Help environment and society | 3.38[b] | 3.09[b] | 3.36[b] | 2.99[b] | 3.13[b] | 3.45[b] |
| Travel time saving | 3.33[b] | 3.01[b] | 3.50[c] | 2.58[c] | 2.97[c] | 3.58[c] |
| Other | 3.45 | 2.98 | 3.07 | 3.21 | 3.23 | 2.97 |
| Sharing vehicle expenses | 3.33[b] | 2.98[b] | 3.53[c] | 2.47[c] | 2.89[c] | 3.74[c] |
| Reliability of arrival time | 3.19[c] | 2.71[c] | 3.27[c] | 2.33[c] | 2.75[c] | 3.36[c] |
| Splitting tolls on toll roads | 2.40 | 2.36 | 2.60[b] | 1.95[b] | 2.05[c] | 3.17[c] |
| Get work done while traveling | 2.34 | 2.05 | 2.04[a] | 2.79[a] | 2.32 | 2.04 |
| Drop off kids at school/day care | 2.61[c] | 1.89[c] | 2.21 | 2.26 | 2.43[c] | 1.78[c] |
| Carpool partner matching program | 2.14 | 1.99 | 2.18[b] | 1.86[b] | 1.97[b] | 2.28[b] |
| Encouraged by program at work | 2.08 | 1.93 | 2.10[b] | 1.82[b] | 1.88[b] | 2.26[b] |
| Preferred parking at work | 2.10[b] | 1.79[b] | 2.00 | 1.84 | 1.82[b] | 2.21[b] |

Comparisons of male versus female, commute and work versus other, fampool versus other.
[a] $p < .05$
[b] $p < .01$
[c] $p < .001$

further analyzed by gender, trip purpose, and carpool composition. The results are summarized in Table 3 and are discussed next.

### *Gender Differences*

Table 3 indicates that females consistently gave higher scores than males to almost all factors and that gender differences are statistically significant at the .05 level for most factors studied. For instance, it is notable that 33% of females rated enjoyment as a very important reason compared with 23% of males. But, only about 18% of females rated the factor as not important at all compared with 24% of males who did so. A similar, though more defined, pattern emerged for travel time savings. There was a 10% difference between females and males in rating this factor as very important, 40% of females versus 30% of males. In comparison, about 27% of females and 34% of males rated it as not important at all. Environmental and societal considerations reveal roughly the same pattern but with a less bipolar distribution, and sharing vehicle expenses matches the pattern, too. Consistent with the overall rating, males and females gave the factor of access to HOV lanes the highest average rating scores among all the factors, as indicated in Table 3. A $\chi^2$ test demonstrates that females and males have statistically different ratings, at the .05 level, for access to HOV lane.

Although the average rating scores for dropping off kids at school or daycare by females and males were lower than many other factors, there was a significant gender difference in the ratings of this factor, with an average of 2.61 for females and 1.89 for males. For example, about 26% of females rated this factor as very important compared with about 12% of males. On the other hand, about 47% of females considered this factor as not at all important compared with 66% of males. These findings are consistent with previous findings in gender differences in family roles, travel patterns, and effects of travel demand management strategies. For instance, in a study of travel demand management programs in Tucson, Arizona, Rosenbloom and Burns (*46*) found that females were more likely than males to recognize potentials of policies encouraging alternatives to cars, especially those options that would affect their children's travel or provide flexibility in carrying out domestic obligations.

The genders were relatively united in their assessment of carpool programs, as both gave these factors the lowest average rating scores among all the factors. In fact, 50% to 67% of both females and males stated that all three of these reasons carried no importance for them.

### *Trip Purpose Differences*

For this analysis, commute and work-related trips were combined into one category and all other recreational, social, and personal business was in the other category (Table 3). There was a statistically significant difference between carpoolers making commute or work trips and those making noncommute or work trips in the ranking of most carpool-enticing factors. The exception was for a few factors, such as dropping off kids at school or daycare, preferred parking at work, and other. Results of the analysis indicate that commute- and work-related trip makers tended to rate certain factors, such as access to HOV lanes, travel time saving, sharing vehicle expenses, reliability of arrival time, and helping the environment and society, higher than other trip makers. For instance, access to HOV lanes was very important for 62% of commute and work carpoolers but only for 32% of nonwork purpose carpoolers. For commute and work carpools, travel time savings were cited as very important 45% of the time, whereas for nonwork, they were rated that highly only 17% of the time. In contrast, only 23% of commute and work carpools said time savings were not important at all, whereas 43% of nonwork carpoolers did not care about time savings. Similar patterns were also found in the reliability of arrival time factor, vehicle and toll cost-sharing factors, and helping the environment and society.

As expected, nonwork carpoolers gave higher ratings to factors such as enjoyment, traveling with others, and relaxation while traveling than did commute and work carpoolers, as indicated by the average rating scores of these factors in Table 3.

Mirroring what was found with the analysis by gender, carpoolers with different trip purposes were also united in their assessment of

carpool incentive program factors. Both commute and noncommute trip makers gave low ratings to the importance of these factors, ranging from 2.0 to 2.18 for commute and work trip makers, and with values less than 2.0 for other trip makers. However, there was a statistically significant difference in the rating of carpool partner matching programs and carpool programs through work. This was expected, because most carpool incentive programs have been provided to target commute trips.

### *Fampool Differences*

Analysis of variation in decision factors by carpool composition indicates that fampoolers tend to rate a number of factors higher than nonfampoolers. These factors are dropping off kids at school or daycare and enjoying travel with others. But, nonfampool respondents on average rated other factors higher, especially travel time and cost-related factors. For example, the average rating of the access to HOV lane factor was 4.07 by nonfampoolers compared with 3.64 by fampoolers. Similarly, the mean score on importance of the travel timesaving factor was 3.58 by nonfampoolers and only 2.97 by fampoolers. Similar comparisons between nonfampoolers and fampoolers can be found in the average rating scores of factors such as vehicle cost sharing, travel time reliability, and toll-cost sharing. Differences in mean scores are significant for most factors, except for those such as relaxation, enjoying traveling with others, getting work done while traveling, and other (Table 3).

Again, overall ratings for the three carpool incentive programs were low. But nonfampoolers on average tended to rate them higher than fampoolers, with ratings of 2.21 to 2.28 by nonfampoolers as opposed to 1.82 to 1.97 by fampoolers. A $\chi^2$ test indicated that these differences were statistically significant at the .01 level. These differences can be attributed to the observation that fampool trips are more social and recreational than nonfampool trips. For example, about 79% of nonfampool trips were commute and work related, whereas 51% of fampool trips were for the same purpose.

## Why SOV Users Do Not Carpool

The respondents who indicated SOV as their primary mode choice were later asked to rate their most important reasons for not carpooling and were allowed to check all that applied from the list in Table 4.

**TABLE 4 Reasons for Not Carpooling**

| Main Reason | Frequency | % of Total SOV Users Who Selected[a] |
|---|---|---|
| Location and schedule limitation | 1,682 | 55 |
| Travel flexibility | 1,394 | 45 |
| Need a vehicle during the day | 1,190 | 39 |
| Need to make other stops during trip | 862 | 28 |
| Appreciate alone time | 567 | 19 |
| No program to encourage me | 417 | 14 |
| Like to listen to radio that others do not | 175 | 6 |
| Potential partners have disagreeable traits | 125 | 4 |
| Other | 248 | 8 |

[a]The sum exceeds 100% as respondents could select multiple reasons.

The potential reasons offered by this survey were mainly chosen from related literature (*2, 47, 48*).

The most important reasons cited were difficulty of finding someone with the same location and schedule, flexibility of driving alone, and needing a vehicle during the day; with 55%, 45%, and 39% of SOV respondents, respectively, attributing primary importance to these in their decision making. The need for making chain trips was perhaps a little less important, but still notable, with 28% choosing it. Again, these findings are also factors cited more frequently by NPTS survey respondents (*30*) and commuters in the Bay Area (*49*).

## CARPOOL FORMATION

In addition to investigating motivations for mode choice, the nature of carpooling was examined. In examining the 1977–1978 NPTS data, Teal (*30*) found that more than 40% of carpoolers commuted with household members. This notion of fampooling was supported by Pisarski (*31*) and later studies. As summarized by Poole and Balaker (*4*), commute surveys from 1998 and 2003 in the San Francisco Bay Area estimated that fampools make up 35% and 33% of carpools, respectively. A 1994 study in southeastern Wisconsin also estimated 33% fampools. In southern California, fampooling increased from 49% in 1996 to 55% in 1999, and a recent Minneapolis–St. Paul study found it to be 67%. In Houston, a previous study found that between 70% and 75% of carpools were fampools (*50*). A nationwide estimate of all work commute carpools chronicled an increase of fampools from 75.5% to 83% for 1990 to 2001. In addition, two of these studies estimated just 2% and 8% of the type of work carpools between strangers that HOV policies supposedly encourage (*4*). The results in this paper support these earlier findings.

In this survey, carpoolers were asked with whom they traveled on their most recent trip. The results are presented in Table 5. Results exceeded 100%, as survey respondents could check more than one passenger type when appropriate. Carpoolers were usually family members. When the rates of adult family member and child carpools are combined, 75% of responses included those two. The second most popular type of carpool was between coworkers or someone who worked in a nearby office building. The prevalence of this type of carpool was about 26%. Casual and neighbor carpools were both marked 4% of the time, and examples of other types of carpools, which made up 9% of the responses, include boyfriends and girlfriends, roommates and housemates, and significant others. One possible

**TABLE 5 Types of Carpools**

| | HOV2 | | HOV3+ | |
|---|---|---|---|---|
| Type of Carpooler[a] | Frequency | % of Valid Responses | Frequency | % of Valid Responses |
| Adult family member | 335 | 57 | 94 | 48 |
| Coworker, nearby office building | 141 | 24 | 51 | 26 |
| Child | 91 | 15 | 95 | 48 |
| Casual carpooler | 22 | 4 | 14 | 7 |
| Neighbor | 17 | 3 | 10 | 5 |
| Other | 33 | 6 | 7 | 4 |

[a]Survey respondents were asked to check all that apply, therefore the sum exceeds 100%.

**TABLE 6 Carpool Formation Time**

| Extra Time for Forming Carpool | HOV2 | | HOV3+ | |
|---|---|---|---|---|
| | Frequency | % of Valid Responses | Frequency | % of Valid Responses |
| 0 min | 278 | 55 | 69 | 42 |
| 1–5 min | 100 | 20 | 37 | 23 |
| 6–10 min | 56 | 11 | 23 | 14 |
| 11–15 min | 41 | 8 | 17 | 10 |
| 16–30 min | 29 | 6 | 12 | 7 |
| 31–90 min | 5 | 1 | 6 | 4 |

reason for a higher percentage of fampooling in these data is that this sample includes all types of trips, whereas most previous studies focused on commute trips only. It may also be an implication of location difference.

Carpoolers were asked to enter the amount of time, in minutes, it takes them to form their carpools. In other words, how much extra time do they spend in picking up and dropping off their passengers that they otherwise would save by traveling straight to work? In line with the findings about fampools, 55% of HOV2 and 42% of HOV3+ users reported they spent no extra time due to their carpools (Table 6). Another 20% of HOV2 and 23% of HOV3+ took 5 min or less to do so, indicating that either their passengers lived very close to their routes to work, or they made some special arrangements to minimize time for carpool formation. An additional 11% of HOV2 and 14% of HOV3+ spent 6 to 10 min, meaning that a full 86% of HOV2 respondents and 76% of HOV3+ respondents spent 10 min or less in carpool formation. The average time of carpool formation was about 5 min with a standard deviation of 8.3 for HOV2s, and 7.8 min with a standard deviation of 13.1 for HOV3+s. The short time for carpool formation was mainly attributed to fampool, as about 65% and 54% of HOV2 and HOV3+ fampools took no extra time for carpool formation. These results dovetailed with the reasons for carpooling given the importance attributed to travel-time savings and access to HOV lanes, the latter of which probably contains at least some amount of timesavings motivation. They also fit with the two main reasons SOV users gave for not carpooling—namely, location or schedule limitations and travel flexibility.

## CONCLUSION

This paper investigated some reasons behind carpool formation, along with how some carpools are formed. In addition, the paper compared reasons for carpooling with those for driving alone using survey data from the DFW and Houston areas. Survey findings included that the ability to use HOV lanes was rated by carpool users as the most important factor in their decision to form a carpool. Enjoying traveling with others was the second most popular factor for carpool formation. Other factors such as travel time savings, helping the environment and society, and sharing vehicle cost were also highly ranked. Results of data analysis also indicate that among the 87% of carpoolers who gave ratings for travel demand management options—such as a carpool partner matching program, encouraged by a program at work, and preferred parking at work—as factors for consideration of carpooling, most ranked them as the least important factors in mode choice decision making.

Results of data analyses also indicate that differences existed in rating carpool mode choice factors by gender, trip purpose, and carpool composition. Female carpoolers gave higher scores than male carpoolers to all reasons for carpooling. There was a significant gender difference in ranking of travel time- and family-related factors for carpooling. Commute and work-related carpoolers and nonfampoolers tended to rank higher factors such as access to HOV lanes, travel time saving, and sharing vehicle cost. In comparison, noncommute carpool trip makers and fampoolers tended to rank factors such as enjoyment of travel with others and relaxation higher. Although travel demand management options were consistently ranked as less important factors, females, commute and work-related trip makers, and nonfampoolers tended to rate them higher than their counterparts. The most commonly selected reasons for not carpooling given by SOV users were limited to location and schedule for carpooling, followed by flexibility of driving alone and needing a vehicle during the day. By and large, the findings on gender, trip purpose, and carpool composition differences confirm previous findings.

The data also conform to the fampool findings by Teal (*30*), Pisarski (*31*), Poole and Balaker (*4*), and other regional studies. Carpooling with adult family members and children was the most popular type of carpool formed by the survey respondents. Casual carpool partners and neighbors were the least common in this sample. In addition, the data showed that the average time taken to form a carpool was about 5 min for HOV2 and about 8 min for HOV3+. The short time for forming a carpool was due to a large portion of fampools.

The findings on carpool formation appear to support the arguments that many carpools are formed regardless of HOV policies and that taking away HOV preferential treatment may affect only a small portion of carpoolers. However, the findings on why people carpool suggest that one should be cautious about HOV preferential treatment and other carpool incentive policies. The finding of HOV lane access as the most important reason for carpooling implies that giving HOVs certain preferential treatment does provide an incentive for carpoolers, especially commute and work trip makers, as is evident in the findings on differences in rating of reasons between commute and work trip carpoolers and other carpoolers. Those specific policies related to HOV preferential treatment in managed lanes require further investigation after implementation, because current attitudes are based on existing perceptions instead of actual experiences. As such, future HOV policies for managed lanes should be continuously reviewed for possible changes and improvements to meet new opportunities. Although arguably not the most efficient facility, HOT lanes can reduce the capacity penalty and congestion penalty of HOV lanes by introducing a pricing concept. The key is to set a price that can minimize the penalties. Furthermore, there may be social justice reasons for considering HOV preferential treatment, as evidenced in this paper and other studies that females, minority, and the economically disadvantaged make up a larger proportion of HOVs than their counterparts. Similarly, the notion of dominating fampools, along with findings of relatively higher rating of carpool incentive programs by females and by commute and work trip makers, suggest the need to search for effective policies that can address the needs of female and fampool commuters.

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