Commuting Behavior of Hawaii State Workers in Honolulu: Implications for Transportation System Management Strategies

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A survey of state employees working in downtown Honolulu was conducted to determine what measures could be undertaken to help reduce traffic congestion. The results of this study suggest that several transportation system management (TSM) strategies be implemented, including the expansion of existing high occupancy vehicle (HOV) lanes and changes in parking rates to encourage carpools and vanpools. High interest in express bus service among workers and their willingness to pay extra for a guaranteed seat indicate a possible market for paratransit services such as commercial vanpools and subscription buses. Given the high rate of family carpooling in the population studied, it is believed that restructuring the work schedules of state employees by staggering hours or initiating a 4-day work week will have only a minimal effect on peak-hour traffic congestion.

Like most major cities throughout the United States, Honolulu suffers severe weekday traffic congestion along the major arteries into its downtown area during the morning and evening commuting hours. With only one or two routes into town from each direction, and virtually no alternates because of the topography of Oahu, the island on which Honolulu is located, peak-hour traffic congestion is far worse than might be expected for a city with a population of less than 1 million people. A typical 10-mi commute into the city, for example, takes 45 to 60 min during the rush hour. And recent data show that the average time of work trips is roughly half an hour. This is more than a third longer than the national average (*1*), even though Oahu is only 45 mi long at its widest point.

With traffic congestion being the major concern of the voting public, several government proposals have been made to reduce congestion by changing the work schedules and commuting habits of state workers on Oahu, the most populous island in the state. Since information on the commuting behavior of state workers was needed to assess the potential effects of such plans, a survey of state employees was conducted to provide the necessary data base.

METHODS

Questionnaire

The questionnaire was designed to obtain three types of data: demographics, travel behavior, and the interest and attitudes of commuters toward various transportation alternatives. The questionnaire, which was developed from previous survey instruments reported in the transportation literature (*2, 3*), was distributed to a random sample of state workers in December 1986.

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Sampling

The population of interest was the approximately 11,000 state employees working in government offices in downtown Honolulu. Cluster sampling was used to achieve a representative sample of this population by randomly selecting a number of downtown offices from each of the state's departments. The number of offices selected from each department was roughly proportional to the number of downtown offices in each department. A predetermined number of questionnaires was sent to each office with instructions to distribute them in alphabetical order by last name, skipping every other employee. A total of 1,005 questionnaires were distributed, 739 of which were completed and returned, yielding a response rate of roughly 74 percent.

Statistical Analyses

The overall sampling error for the study is approximately ±1.8 percent. Since this is only a crude estimate of the standard error of measurement for those measures in which participants are classified into dichotomous categories, various statistical tests were used to analyze the data more thoroughly. Frequency data, such as the percentage of people using different modes (mode split), were analyzed by chi square (χ^2). Continuous variables, such as miles traveled to work, were analyzed using parametric statistical tests, which use the standard error of the mean (SEM) to assess differences between group means.

Many of the questionnaire items required participants to rate their attitudes and opinions on a scale of 0 through 10. These were analyzed in two ways: first, as dichotomous variables in which respondents who gave a zero rating were contrasted with respondents who gave ratings of 1 through 10 for the item; second, respondents' ratings of 1 through 10 were analyzed separately as continuous variables. In this way, a question such as, "How interested are you in commuting by express bus?" was broken into two logical and statistically independent components for analysis: "Are you interested in commuting by

bus?" and "If you are interested, how interested are you?" The first analysis gives the proportion of people who are interested to some degree (ratings between 1 and 10) versus those who are not interested (rating = 0). The second analysis gives a measurement of the degree of interest of those people who express an interest.

There were three advantages to this approach. It allowed a simplification of the questionnaire by eliminating the need for many two-part questions. It permitted a determination of people's strength of interest or likelihood of engaging in some behavior, which cannot be assessed by commonly used, forced-choice questions. And it provided two independent measures of people's attitudes and behavioral inclinations.

RESULTS AND DISCUSSION

Mode Choice

As expected, the automobile proved to be the most commonly used travel mode with 78.3 percent of the employees surveyed commuting daily to and from work by car (includes trucks and vans). Approximately 12.5 percent of workers in the sample make the daily work trip by bus, which is the only public transit. Another 7.2 percent commute by car less than 5 days per week, using the bus to get to or from work when they do not travel by car. The percentage of workers who walk, or ride a bicycle or motorcycle, to work is very small (2 percent). Roughly 47 percent of the workers in the sample who regularly commute by automobile travel alone. About 31 percent share a ride with one other person, and nearly 23 percent commute with three or more people. Thus, as found in other urban areas (*4*), a majority of carpools consist of only two people.

To examine carpool composition, carpools were divided into three categories: carpools whose members are all from the same household (family carpools); carpools composed of people who are not from the same household, such as friends and coworkers (nonfamily); and carpools composed of some combination of the two (mixed). These data reveal that a vast majority of carpools with two or more people are composed of people from the same household, with family carpools accounting for a significantly higher percentage of all carpools (80.7 percent) than the two other categories combined ($\chi^2 = 123.6$, $df = 1$, $p < 0.001$). The percentage (14.7 percent) of nonfamily carpools in the sample was also reliably greater than the percentage (4.6 percent) of mixed carpools ($\chi^2 = 17.28$, $df = 1$, $p < 0.001$). No difference was found in the sizes of family and nonfamily carpools, which contained, on average, 2.6 and 2.3 people, respectively.

Of those carpools with three or more people, it was found that over 78 percent are made up solely of family members, and that this percentage is reliably greater than that of other types of carpools ($\chi^2 = 42.12$, $df = 1$, $p < 0.001$). The percentages of nonfamily (10 percent) and mixed (11.5 percent) carpools with three or more people are comparable.

Travel Distance

The daily one-way commute distances of all participants in the survey are shown in Figure 1. About 32 percent of employees living within 5 mi of work commutes by bus, 2 percent uses a bicycle or walks, and the remaining 66 percent is split almost evenly between carpoolers and solo drivers. The proportion of transit users decreases to 15 to 20 percent at distances over 5 mi. No reliable differences were found in the percentage of solo drivers and carpoolers at various distances.

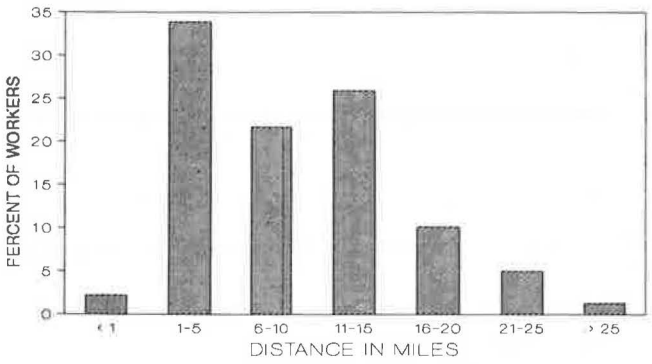

FIGURE 1 Distribution of the one-way commute distances of workers.

The mean commute distance for the entire sample is 9.7 mi, very close to the national average of 10 mi (*1*). Analysis of variance revealed that mean commute distance differs significantly across travel modes ($F = 5.23$, $df = 2, 686$, $p < 0.001$). On average, state workers who commute by bus travel a significantly shorter distance each way (mean = 7.7 mi, SEM = 0.6) than workers who carpool (mean = 10.3, SEM = 0.4) or drive alone (mean = 9.7, SEM = 0.6; $t = 3.09$, $df = 687$, $p < 0.001$). These figures are also comparable with national averages (*1*), although it would be expected that the average commute distance of carpoolers would be greater than that of solo drivers (*1, 5, 6*). The absence of any difference in the work-trip distances of solo drivers and carpoolers in the present sample may be explained by the fact that most of the carpoolers in the study belong to family carpools, which, according to Richardson and Young (*7*), are more similar in their travel characteristics to solo drivers than to nonfamily carpools.

Travel Time

The one-way commuting time for all employees averages 31.4 min, which is almost 10 min longer than the national average. The average travel time at various distances is presented in Table 1. Based on these data it is calculated that average commuting travel speed lies between 10 and 20 mph, which is far below the national average of 29 mph.

TABLE 1 TRAVEL TIME OF STATE EMPLOYEES AS A FUNCTION OF COMMUTE DISTANCE

	Time in Minutes	
Miles	Mean	SEM
<5	17.9	0.7
5–10	26.7	0.9
10–15	40.3	1.0
>15	51.6	2.0

Since mode of travel obviously affects travel time, the travel times for car and bus users were compared. Surprisingly, the average travel time of people who drive less than 10 mi to work

is only 1 min (or 4.5 percent) less than that for people who take the bus the same distance (car = 21.5 min, bus = 22.6 min). For workers who commute more than 10 mi each way, taking a car reduces travel time from 53.5 to 44.1 min, or 17.6 percent, compared to taking the bus. These data are striking because national statistics indicate that trips by public transit take twice as much time, on average, as trips by private vehicle. Of equal interest is the fact that commuters think they save far more time by traveling by car than they actually do. It was found that workers who commute less than 10 mi by car believe that they achieve a 39 percent savings in time by doing so, and those who drive more than 10 mi estimate a 27.6 percent time savings over traveling by bus.

Express Bus Service

Because it was suspected that the additional time (real or perceived) associated with bus travel deters transit use, participants were asked how interested they would be in express bus service. Specifically, they were asked to rate how likely they would be to use express bus service, on a scale of 0 through 10.

A significant percentage of respondents (57.9 percent) said they might use express bus service if it were available (χ^2 = 15.0, df = 1, $p < 0.001$). The average interest rating for those who reported that they were interested (i.e., rated their likelihood of taking the bus as 1 or higher) was 5.8 (SEM = 0.2) out of 10. Significantly more transit commuters (78.1 percent) than car commuters (53.2 percent) expressed a willingness to use an express bus (χ^2 = 27.12, df = 1, $p < 0.001$). Although the percentage of car commuters expressing an interest was reasonably high, those who said they were interested gave significantly (t = 3.89, df = 425, $p < 0.001$) lower interest ratings (mean = 4.8, SEM = 0.2) than did regular bus users (mean = 8.7, SEM = 0.2). Further analysis of these data revealed that a significantly higher percentage of carpoolers (56.6 percent) than solo drivers (47.4 percent) had a positive interest in commuting by express bus (χ^2 = 4.75, df = 1, $p < 0.05$). The two groups did not differ reliably with regard to their ratings of interest.

Thus, the primary market for express bus service consists of people who already use the bus. However, carpoolers provide a second potential market segment for such service. Although the overall interest is not as great as that among regular bus users, because carpoolers represent a larger proportion of the commuting population, this market may be substantial. It would therefore be valuable to provide the kind of transportation service that appeals to this market. To more clearly define the demand for express bus service, participants were asked to rate their interest in such service if the fare were increased by $0.50, or $1.00 round trip. A hypothetical fare increase of $0.50 round trip did not appreciably affect respondents' interest in the express bus; a significant majority (57.1 percent) still reported some degree of interest. The proportions of respondents who were and were not interested were essentially reversed when a $1 increase in the round-trip fare was posed, with 42.9 percent giving a positive interest rating and 57.1 percent rating their interest as zero. Overall, these findings indicate that demand for express bus service is relatively inelastic within this price range. To put these results in perspective, it should be noted that the current one-way fare for city buses on Oahu is $0.60, but most residents purchase bus passes that allow unlimited travel on the bus for $15 per month.

Value of a Bus Seat

Because comfort is considered an important—albeit, little studied—service characteristic favoring automobile use (2), and because buses on Oahu are extremely crowded during peak-hours, an attempt was made to gauge people's interest in an express bus if riders were guaranteed a seat at an additional cost of $1 to $5 round trip. These data were examined in two ways: first, in terms of people's present commute mode, and, second, in terms of commute distance. People's interest in express service if the fare were increased $1 round trip (without a guaranteed seat) provided a baseline against which to assess the value of a seat.

As shown in Figure 2, a large percentage of commuters reported an interest in taking an express bus if they were guaranteed a seat, even at a fare of $1 extra round trip. Overall, the percentage of respondents who appear to be willing to pay the additional dollar for a seat is almost as high as that interested in express bus service at the regular fare. Moreover, the concept of a guaranteed seat increased the number of people willing to pay an extra dollar for express bus service by over 20 percent.

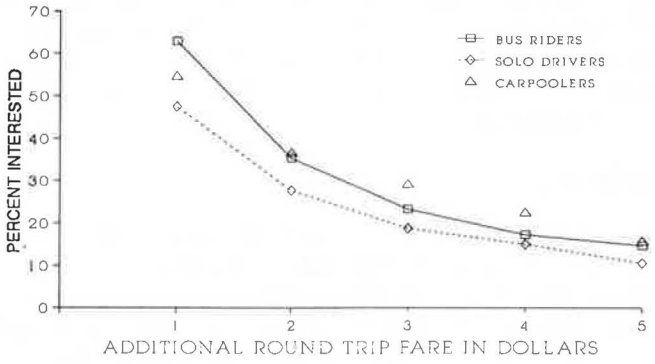

FIGURE 2 Percentage of workers interested in paying extra for a seat on an express bus, as a function of present mode.

Proportionally, regular bus riders showed the largest interest in express bus service at a fare increase of $1 round trip, followed by carpoolers and solo drivers, and this difference among groups was statistically reliable (χ^2 = 8.41, df = 2, $p < 0.02$). Increasing the price of a seat produced a systematic decline in the percentage of respondents interested in the service regardless of travel mode, although consistently fewer solo drivers expressed interest, at any fare, than other commuters.

A 3 × 5 analysis of variance, with repeated measures, showed that respondents' ratings of interest follow a similar decline as the fare is increased from $1 to $5, regardless of their usual mode of travel to work (F = 380.3, df = 4, 1,692, $p < 0.001$). Across groups, interest in taking the bus was highest if a seat cost only an extra $1 (mean = 6.0, SEM = 0.2). When the proposed round-trip fare was $5, interest was extremely low (mean = 0.6, SEM = 0.03).

If the value of a seat is viewed from another perspective, it can be seen that interest in paying extra for a seat is directly

related to commute distance (Figure 3). This is true in terms of both the percentage of people who commute various distances and their ratings of interest. Overall, the farther people travel to work, the greater their interest in a guaranteed seat, regardless of price ($F = 7.01$, $df = 3, 421$, $p < 0.001$).

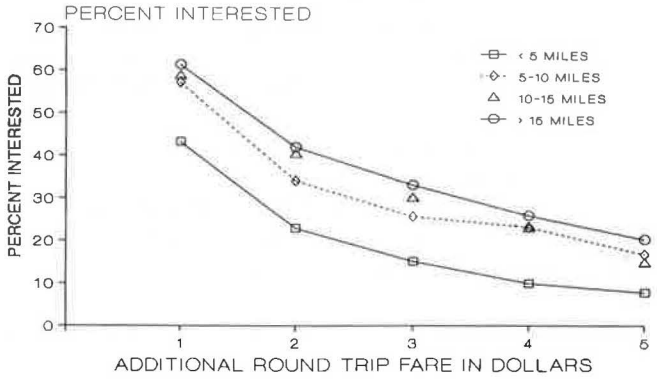

FIGURE 3 Percentage of workers interested in paying extra for a seat on an express bus, as a function of one-way commute distance.

Taken together, these analyses suggest that providing an alternate kind of bus service that ensures the rider a degree of comfort not guaranteed by the existing bus system could attract new riders, especially among those commuters who now drive farthest to work. The demand for express bus service with a guaranteed seat appears to be sufficiently large, even at higher fares, that such a service might be able to operate without governmental subsidy.

HOV Lanes

Because the state plans to expand the system of HOV lanes along the highways leading to downtown Honolulu, it was of interest to find out how useful people think HOV lanes are and how likely they are to use them. Specifically, participants were asked to rate (a) how much an HOV lane along the route they take to work would reduce their travel time and (b) how likely they would be to use it. Present and future HOV lanes on Oahu are intended for use only by carpools with three or more people, and this was explicitly stated in the survey instrument.

In examining the responses of car commuters (Table 2), it was found that ratings of time savings rose systematically as commute distance increased ($F = 27.14$, $df = 3, 608$, $p < 0.001$). There was, in addition, a significant effect of travel mode: carpoolers rated the time savings nearly twice as high as solo drivers ($F = 57.03$, $df = 1, 608$, $p < 0.001$).

Significant effects of distance ($\chi^2 = 42.14$, $df = 3$, $p < 0.001$) and mode ($\chi^2 = 45.68$, $df = 1$, $p < 0.001$) were also found for the proportions of people who said that they were at least somewhat likely to use an HOV lane and their ratings of how likely they were to use it (mode: $F = 131.68$, $df = 2, 576$, $p < 0.001$; distance: $F = 15.36$, $df = 3, 576$, $p < 0.001$). As seen in Table 2, both carpoolers and solo drivers are more likely to use an HOV lane the farther they live from work ($F = 18.76$, $df = 3, 608$, $p < 0.001$), but carpoolers say they are more likely to do so ($F = 107.62$, $df = 1, 608$, $p < 0.001$). Although the percentage of people belonging to two-person carpools who said that they were likely to use an HOV lane was substantially higher than that for people who drive alone, their likelihood of doing so is not very high, it appears. This, in part, appears to be a result of the composition of existing carpools, in that people in family carpools showed less interest than those in nonfamily carpools.

TABLE 2 PERCENT OF STATE EMPLOYEES SAYING THEY ARE LIKELY TO USE HOV LANES AND THEIR LIKELIHOOD RATINGS AS A FUNCTION OF TRAVEL MODE AND COMMUTE DISTANCE

		Miles			
Present Mode	Measure	<5	5–10	10–15	>15
Drive alone	%[a]	23.5	34.3	37.9	36.4
	$\bar{x}$[b]	3.1	2.6	3.6	4.7
Two-person carpool	%[a]	22.8	51.0	55.6	70.8
	$\bar{x}$[b]	4.5	5.2	5.1	4.8
Three-person carpool	%[a]	54.8	73.7	90.0	90.9
	$\bar{x}$[b]	5.3	8.9	8.1	9.0

[a] % = Percent of respondents saying that they are likely to use HOV lanes, that is, those giving ratings of 1 through 10.
[b] $\bar{x}$ = Mean rating of "how likely" they are; means are based on those respondents giving ratings of 1 through 10.

In sum, respondents who belong to carpools composed of three or more people are clearly the most likely to use HOV lanes, and their ratings are significantly higher than other carpoolers regardless of commute distance ($t = 9.15$, $df = 307$, $p < 0.001$). This difference between carpoolers is not surprising, since people traveling in three-person carpools could immediately use such lanes if they were available, whereas those in two-person carpools would have to find another rider before they could use the lane. The low likelihood ratings given by people in two-person carpools suggest that they are not inclined to seek additional riders in order to gain the benefits of using an HOV lane. This may reflect resistance on the part of family carpools to seeking additional riders from outside their own household.

A related series of questions helps to explain these results. These questions asked participants how likely they were to join a three-person carpool if doing so would reduce their travel time by 10 percent, 25 percent, or 40 percent. The data from people who drive alone and those who ride in two-person carpools are given in Table 3. As found for ratings of HOV lane use, which were presented in Table 2, solo drivers gave significantly lower ratings of their likelihood of carpooling ($F = 6.49$,

TABLE 3 RESPONDENTS' MEAN RATINGS OF THEIR LIKELIHOOD TO JOIN A THREE-PERSON CARPOOL IF DOING SO REDUCED THEIR TRAVEL TIME

		Reduction in Travel Time		
Present Mode	Miles to Work	10%	25%	40%
Drive alone	<5	3.2	3.9	5.3
	5–10	3.4	3.9	5.1
	10–15	3.2	4.4	6.3
	<15	4.8	5.9	7.4
Two-person carpool	<5	3.5	4.4	5.5
	5–10	3.3	4.1	6.0
	10–15	3.9	4.7	6.7
	>15	4.4	5.3	6.7

NOTE: Means are based on the data from those respondents saying they are likely to do so, that is, giving ratings of 1 through 10.

$df = 1, 434, p < 0.05$). More to the point, however, examination of the ratings of both groups to a 10 percent reduction in travel time shows that they are very close to their ratings of HOV lane use at all four commute distances (compare Tables 2 and 3). By contrast, their likelihood ratings for carpooling, if doing so could reduce travel time by 40 percent, consistently exceed their likelihood ratings for using HOV lanes. What these findings appear to indicate is that respondents who are not already in three-person carpools do not think that HOV lanes will save them enough time to make carpooling worth their while. Although the ratings increase with time savings ($F = 143.79$, $df = 2, 868$, $p < 0.001$), a significant interaction found between commute distance and amount of time savings (percent reduction) indicates that the effects of these two factors are additive ($F = 2.29$, $df = 2, 868$, $p < 0.05$), that is, the greater the distance traveled, the greater the value of the time savings to the commuter.

Parking Incentives and Disincentives

While access to an HOV lane provides some incentive for carpooling, it does not appear to be a strong incentive for many solo drivers, or even for those carpoolers who would have to find additional riders to use it. Because it was expected that this might be the case, participants were asked about the price they pay for parking and what changes in parking costs (decreasing costs for carpools or increasing costs for noncarpools) would alter their interest in carpooling. The three-person criterion of a carpool was used based on state policies and the legislative definition of carpooling pertaining to HOV lane use and parking at state facilities. It is state policy to provide preferential parking to employees who carpool with at least two other people, but it is not well known and has not been promoted.

It was found that 27 percent of the respondents who take their cars to work do not pay for parking. Roughly 68 percent of those who drive to work pay less than $10, whereas fewer than 11 percent pay over $10 per week. Because free parking is not provided for employees, many workers must be parking on residential streets situated a half mile or more from state offices. Those paying $10 or less per week probably park in state facilities or in commercial parking lots just outside the downtown area, while those paying more than this park in downtown commercial lots.

The responses of the sample to hypothetical increases and decreases in parking costs, respectively, are given in Tables 4 and 5. Only data from people who drive alone or commute in two-person carpools are presented since the interest was in seeing if the proposed incentives and disincentives would encourage the formation of carpools with three or more people. Ratings data were analyzed by analysis of variance, with mode (solo or two-person carpool) and present price paid for parking (zero, <$10, >$10) as between factors, and the hypothetical changes in cost as a within factor. Because present price paid for parking was not found to have an effect in any of the analyses, the data are collapsed across this factor in the tables.

As indicated in Table 4, both the percentage of people expressing an interest in carpooling and their ratings of interest increase with increases in hypothetical parking costs ($F = 46.68$, $df = 3, 1,287$, $p < 0.001$). Although people who currently commute in two-person carpools expressed somewhat greater willingness to form three-person carpools, no significant differences between modes were found for either measure.

TABLE 4 LIKELIHOOD OF JOINING A CARPOOL OF THREE OR MORE PEOPLE IF WEEKLY PARKING COSTS WERE INCREASED

		Rate Increase			
Present Mode	Measure	None	$10	$20	$30
Drive alone	%[a]	45.6	50.9	56.9	59.2
	$\bar{x}$[b]	2.9	3.9	5.0	6.3
Two-person carpool	%[a]	49.7	57.7	66.3	67.4
	$\bar{x}$[b]	3.2	4.3	5.1	6.0

[a] % = Percent of respondents saying they are likely to join a carpool with three or more people.

[b] $\bar{x}$ = Mean rating of "how likely" participants are to join a carpool of three or more people; means are based on those respondents giving ratings of 1 through 10.

TABLE 5 LIKELIHOOD OF JOINING A CARPOOL OF THREE OR MORE PEOPLE IF WEEKLY PARKING COSTS WERE DECREASED FOR SUCH CARPOOLS

		Rate Increase			
Present Mode	Measure	None	25%	50%	100%
Drive alone	%[a]	49.8	53.3	61.3	67.5
	$\bar{x}$[b]	3.0	3.9	4.9	6.4
Two-person carpool	%[a]	47.9	66.4	69.0	75.0
	$\bar{x}$[b]	3.1	4.8	5.8	6.8

[a] % = Percent of respondents saying they are likely to join a carpool with three or more people.

[b] $\bar{x}$ = Mean rating of "how likely" participants are to join a carpool of three or more people; means are based on those respondents giving ratings of 1 through 10.

Decreasing parking costs for carpools (Table 5) produced a similar increase in both the percentage of people (i.e., respondents who now pay for parking) who said they were likely to carpool, as well as their ratings ($F = 29.51$, $df = 3, 909$, $p < 0.001$). Again, no reliable differences between solo drivers and carpoolers were found for either measure. But when family and nonfamily carpoolers are compared, it was found that people in nonfamily carpools looked more favorably on expanding their carpool size in order to benefit from the incentives posed ($F = 3.94$, $df = 1, 163$, $p < 0.05$).

Work Schedules

The times that full-time state employees in the downtown area arrive at and depart from work are depicted in Figures 4 and 5, respectively. Since many downtown state offices permit workers to set their own schedules to some degree, a broad distribution of arrival and departure times is to be expected. Looking first at Figure 5, it can be seen that departure times are distributed over a period of almost 4 hr. Roughly 92 percent of departures occur within a 1½ hr period between 4:00 and 5:30 p.m. However, the greatest proportion (35.4 percent) of employees leaves for home at 4:30 p.m., the standard closing time for state offices. Since the work day is 8 hr and 45 min (including 45 min for lunch), the same distribution could be

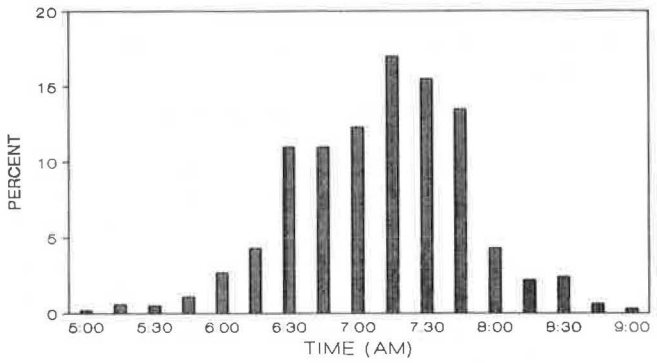

FIGURE 4 Distribution of times of arrival at work.

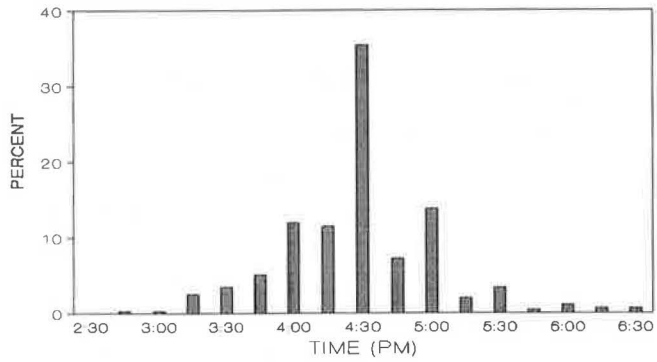

FIGURE 5 Distribution of times of departure from work.

expected for morning arrival at work, with a peak around 7:45 a.m. or so. Instead, as indicated in Figure 4, the distribution of arrivals is platykurtic, with a broad peak in arrivals shifted toward earlier times than would be expected. Although arrivals are distributed across the same time interval (4 hr), 92 percent of arrivals occur within a period of 2½ hr.

These data suggest that some workers, at least, may arrive at work earlier than they need to in order to avoid peak traffic congestion that occurs on all corridors into town (as measured 5 to 7 mi from downtown) between 6:15 and 7:15 a.m. The obvious implication of these data for proposals for shifting the work hours of state employees is that start times would have to be pushed back until after 8:00 a.m. if changes in work schedules were to have an effect on reducing congestion during the morning peak.

CONCLUSIONS AND RECOMMENDATIONS

The present results are consistent with the 1980 census showing that Hawaii has one of the highest rates of carpooling (two or more persons per vehicle) in the nation. The analyses reveal, however, that the vast majority (78 to 87 percent depending on carpool size) of carpoolers in the sample commute with only members of their family. This proportion is substantially higher than that reported nationally (*4, 6*). In part, the high rate of family carpooling in Hawaii is probably a consequence of the high percentage of households in which both spouses work and, as the data show, travel together to work. This high rate of family carpooling has implications for several of the transportation management strategies to be considered.

While the average one-way commute distance of the sample (9.7 mi) is comparable to national figures on work trips into the central city, travel time is considerably higher than the national average (*1*). Several factors contribute to this situation, including the limited number of highways into the city and the nature of these highways. Only one is a limited access freeway and the other four are actually suburban arterials, having numerous traffic lights and driveway accesses.

Since the data indicate that travel time is substantially less for car commuters than bus riders at distances of over 10 mi, time savings would appear to be a prime motive for traveling to work by car. The finding that workers who commute by car travel significantly farther than those who take the bus is consistent with this premise. That time savings is an important factor in the selection of the automobile as the preferred mode is, of course, well recognized (*2–4*). But, according to the results, the real time savings is not nearly so great as those who commute by car believe it to be. Such misjudgments and overestimates of savings are very common in commuters' perceptions of the characteristics of different modes (*8, 9*).

Two alternatives were examined to reduce travel time, which also help to reduce congestion generally. The first is the expansion of express bus service—buses that pick up passengers at a few key stops in suburban areas and then travel nonstop into the downtown area. The second is the extension of existing HOV lanes and the expansion of the HOV lane system.

Interest in express bus service is quite high among regular bus riders, and carpoolers, especially when passengers are guaranteed a seat. The degree of interest in a guaranteed seat on an express bus, even at a considerable increase in fare, suggests that a market exists for such service among people who commute more than 5 mi each way. The growth of commercial vanpool operations throughout the country demonstrates the feasibility of such alternate transportation modes as subscription buses and vans, and it is recommended that such services be provided by existing private transportation suppliers (tour companies) on Oahu.

Not surprisingly, the present results show that people who now commute in carpools of three or more people are quite interested in using HOV lanes. The problem is getting other people to carpool so that they can use the HOV lanes. The limited length of the existing lanes and, therefore, their limited potential time-savings do not seem to be sufficient to make carpooling worthwhile. As suggested by the findings of Margolin and Misch (*2*), the time savings afforded by an HOV lane must be close to 50 percent to be a strong inducement for solo drivers to carpool. And this, of course, also depends upon the distance traveled.

Nevertheless, the extension of existing HOV lanes and the establishment of HOV lanes along other corridors should increase carpooling, especially among automobile commuters traveling 10 mi or more (*5*). A combination of parking incentives for carpoolers and disincentives for solo drivers should also help to encourage carpooling, and a proposal to adjust the rate structure of parking facilities in accordance with the findings has been submitted to the agency that controls the state's parking lots. The findings provide limited evidence, however, that people belonging to family carpools of only two persons may be resistant to expanding their carpools to take advantage of these incentives.

Finally, the results indicate that restructuring the work schedules of state workers by staggering hours or instituting a 4-day work week will have only a minimal effect on traffic congestion during the peak period, at least during the morning. Most workers already seem to be arriving at work in order to avoid the "rush hour," between 6:15 and 7:15 a.m., and the number of state workers that would be removed from the highways between these times, by delaying start times or going to a 4-day week, would be small in comparison with the total traffic volume during this period. Nor is it clear that removing state workers from the roads at a given time, or on a given day, will reduce the number of cars. Given the large number of family carpools, unless the work or school schedules of all family members who now commute together are also changed, the same numbers of cars may simply be driven into town with fewer passengers.

Since these problems are clearly not unique to Hawaii and the results have much in common with research conducted in other major U.S. cities, it is believed that this assessment of the various transportation system management strategies will be of value to transportation planners in other metropolitan areas.

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