Predicting Consumer Demand for Alternative Transportation Services Among Suburban Commuters

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A survey of suburban commuters revealed that their interest in ridesharing and related transportation system management (TSM) strategies, other than flextime, was minimal. The disincentive of high parking costs did not appear to be sufficient to attract riders to standard transit services. Enhanced service, however, provided an important incentive for transit use, even when disincentives were comparatively low. Improvements in service, including express buses, reduced access time, and guaranteed seating, can induce automobile commuters to use alternative transit or paratransit. Moreover, decentralization of service from its downtown focus could open up a sizeable market for alternative transit both among carpoolers and solo drivers. Interest in alternative transit with improved service characteristics is directly related to commute time. Thus, increases in traffic congestion may stimulate demand for alternative transit, even at higher fares. The balance between service and fare that will optimize ridership can be easily deduced for various markets. Demand-response transit services appear to provide a feasible and profitable transit alternative, particularly if they are linked to a computerized, real-time, booking and dispatching network.

Commuters from East Honolulu experience high levels of traffic congestion along the only direct route to the island's major employment centers. A survey conducted in an eastern suburb of the island of Oahu was designed to explore the potential of various transportation system management (TSM) strategies for easing this congestion.

Of particular interest was commuters' inclination to use alternative forms of transit. Fares, service characteristics, hour of travel (with respect to peak-hour congestion), ease of access, miles traveled, and commute time all have been shown to influence mode split and transit ridership (*1–3*). The purpose of the East Honolulu survey was to assess the relative contributions and interactions of these factors on choice of mode and potential demand for alternative transit modes.

METHODOLOGY

Under the aegis of the Hawaii Department of Transportation, all 8,900 or so households in the section of East Honolulu shown in Figure 1 were contacted by mail. Because virtually the entire study area is owned by a single developer, a commercial list of all mailing addresses in the specific area of interest was readily available.

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A total of 3,322 households in the target population completed and returned their questionnaires, a response rate of 37 percent.

Most of the households in the sample (79.2 percent) consisted of three or four people, and only 13.5 percent were larger. The majority of respondents (60 percent) were between 30 and 50 years of age; 6.7 percent were younger, and 33.4 percent were older. Roughly two-thirds of respondents (64.4 percent) were male, and more than 99 percent had a driver's license.

The questionnaire elicited data on the demographic characteristics of respondents, their present commuting habits, and their attitudes toward and interest in using different travel alternatives. Most of the questions, especially those dealing with travel alternatives, required participants to rate their opinions and judgments on a scale of 0 to 10 (*4,5*). This rating scale allows people to assign a specific, subjective value to their attitudes, and it is particularly valuable in asking people about their probable future behavior (*6*). The ratings can be assumed to reflect respondents' own subjective probability of choosing a given behavioral alternative under the conditions stated in the question (*4*). For example, a rating of 10 assigned to the likelihood of using an express bus at a $1.00 fare is assumed to indicate 100 percent certainty that the respondent would use an express bus at a $1.00 fare. A rating of 0 to the same item expresses certainty that the respondent will not take an express bus; that is, that the respondent's subjective probability of using an express bus is zero under given conditions.

To obtain demand estimates from these data, each rating was multiplied by 10. The average, or mean, likelihood score (the rating times 10) for any question provides an estimate of the percentage of people that are likely to use a given alternative. The standard deviation of the mean was used to calculate an error of estimate (the standard error of the mean). Although the relationship between respondents' likelihood scores and their actual behavior has yet to be validated, this method should prove to be more accurate than other commonly used scaling methods for determining consumer preferences.

Continuous variables, such as travel time and the attitudinal and behavioral ratings, were analyzed by parametric techniques, such as analysis of variance (ANOVA). Unweighted means ANOVA was used for most purposes to correct for disparities in sample sizes when participants were classified into subgroups such as carpool or solo driver. Wherever pos-

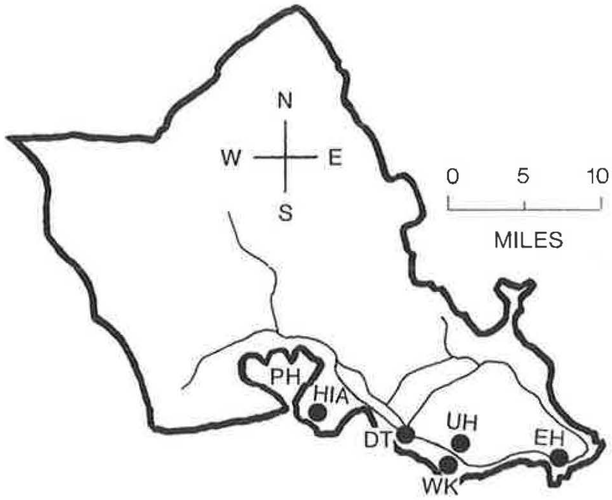

FIGURE 1 Primary highways on the island of Oahu and major work sites of commuters from the East Honolulu study area.

sible, the data were analyzed by factorial designs so that the effects of several independent variables could be examined simultaneously. Other parametric and nonparametric statistics were used as necessary.

RESULTS

Among those defined as commuters (that is, those living farther than 1 mi from work), 44.1 percent traveled roughly 10 mi from home to work in downtown, an area approximately 1 mi square that includes the capitol district, where most state and municipal offices are located. An additional 13.1 percent worked within 2 mi east or west of downtown (8 to 12 mi travel from East Honolulu), excluding Waikiki, part of which is within this 2-mi range. About 7.7 percent worked in Waikiki, a major tourist center southeast of downtown. Another 12.7 percent of commuters worked in the area east of Pearl Harbor that includes commercial and industrial establishments near the Honolulu International Airport. These work sites are 5 to 6 mi west of downtown, 15 mi or more from East Honolulu. Slightly more than 10 percent of the commuters traveled more than 20 mi each way to work.

Because of the topography of Oahu, all but 1.2 percent of the responding commuters made their daily commute along the same corridor into downtown, much of it on a single suburban arterial. Hence, in addition to the 44.1 percent working downtown, 29.1 percent of the commuters traveled the same route to get to jobs west of downtown, and another 19.2 percent traveled 7 mi or more with other inbound traffic each morning to reach job locations east of downtown. Given this situation, the geographical relationship of commuters' work sites with respect to downtown might be expected to have a more profound influence on commuter behavior than commute distance alone, although the two factors are closely related in this case (7).

Approximately 92.7 percent of commuters responding to the survey traveled to and from work by car, 6.4 percent took a bus, and fewer than 1 percent walked or rode a bicycle or motorcycle. Roughly 67.1 percent of all commuters said they drive alone, while 11.7 percent were in two-person carpools, 7.5 percent were in three-person carpools, and 6.4 percent were in carpools of more than three people. Nearly 80 percent (78.9 percent) of the people who carpool did so only with family members, another 12.9 percent were in carpools with people who are not family members, and the remaining carpoolers commuted with both family and nonfamily members.

Work Location and Mode Choice

No significant differences were found among modes with respect to commute distance. The average one-way travel distances of bus and car commuters were comparable (10.9 and 11.4 mi, respectively), and no differences in commute distance were found between carpools and solo drivers or among the different types of carpools (family, nonfamily, mixed). The location of work sites with respect to downtown, however, was found to exert a significant influence on choice of travel mode.

Generally, the closer people work to downtown, the greater their likelihood of riding the bus ($p < 0.001$). Only 4.4 percent of people that work 2 to 4 mi east of downtown commuted by bus, whereas 8.9 percent of people working within 2 mi of downtown were bus riders. Bus ridership was highest (12.0 percent) among those who work in downtown, but it was lowest (1.6 percent) among commuters working west of downtown.

A similar trend was found in carpooling. Among car commuters who worked more than 4 mi east of downtown, some 70.4 percent drove alone. This proportion decreased approaching downtown from the east, reaching a low of 67.9 percent solo drivers among car commuters who work downtown. Once past downtown, the percentage of solo drivers rose significantly again, to 77.7 percent ($p < 0.001$). No relationship was found between work location and types of carpools.

Transit Service

Clearly, for the commuters surveyed, mode choice was more a function of destination than of distance. The results further suggest that the decision to use transit is also a function of service. Among the commuters that rode the bus, 77.6 percent worked downtown and 9.4 percent worked at the University of Hawaii, the only two work sites having express bus service from East Honolulu. The sparsity of ridership among people working west of downtown may reflect the lack of express service to these work sites, the need to change buses to travel west of downtown on some bus routes, or both.

The importance of express bus service in the decision to use mass transit is made more evident by comparing bus ridership to the university, which is about 2 mi due east of downtown, with that to Waikiki, which stretches from about 1.5 to 3 mi southeast of downtown and does not have express bus service. Only 2.1 percent of the commuters surveyed traveled by bus to work in Waikiki ($p < 0.001$), even though the price of parking in Waikiki was about 35 percent higher than at the university (see section on parking costs). To put these percentages in perspective, only 1 out of every 55 respondents who commuted to Waikiki traveled by bus compared to 1 out of 8 commuters to the university. Only downtown Honolulu, itself, had a higher ratio of bus riders to commuters (1 out of 7).

Travel Time

Analysis of covariance, used to control for distance, revealed that automobile travel was 25 percent faster than bus travel ($p < 0.001$), according to respondents' estimates of their typical commuting times. Even though the majority of bus riders in the sample used express bus service, on average, a bus commuter traveled 1 mi in 4.4 min (approximately 13.6 mph), whereas a car commuter covered the same distance in 3.5 min (17.1 mph). The data do not permit separation of in-vehicle and out-of-vehicle travel time.

No direct relationship was found between travel distance and travel speed, but travel speed of car commuters was found to vary with respect to job location. The morning commute is slowest for people working downtown, and speed increases in proportion to the distance of job sites from downtown, in either direction. People who drove through downtown in the morning to get to job sites west of it had higher average speeds (25 to 35 mph, depending on distance) than those who drove to downtown (18 mph) or to areas within 2 mi east of downtown (18.5 mph).

The faster speeds of workers commuting through downtown in the morning is explained in part by the difference in home departure times of commuters. An inverse linear relationship was found between departure time and commute distance ($r = -0.26$, $p < 0.001$), with car commuters leaving 4 to 5 min earlier for each mile they have to travel. This suggests that people who worked west of downtown left earlier than other commuters in order to avoid traffic congestion. Presumably because of the slower speed of bus travel, bus riders left for work an average of 20 min earlier than car commuters ($p < 0.002$).

The distribution of departure times among car commuters in relation to work location with respect to downtown is shown in Table 1. On average, carpoolers left for work 20.4 min earlier than did solo drivers ($p < 0.003$). Further analyses showed that almost 43 percent of morning commuters traveling toward downtown left home early enough to avoid the peak-hour traffic east of downtown between roughly 7:00 and 8:00 a.m. About 39 percent, mainly those working east of downtown, traveled during peak westbound (that is, inbound) traffic, and the remaining 18 percent traveled after the peak hour.

Parking Costs

Only 37 percent of automobile commuters paid to park at or near their places of work, and in most areas of the island, 70 to 97 percent of workers parked free. In the major commercial districts of Waikiki and downtown Honolulu, however, about half of the car commuters paid for parking. Both the percentage of people who paid for parking and their average monthly cost for parking (the monthly price) were significantly higher in these two areas compared to all other work sites ($p < 0.001$).

As seen in Table 2, parking was one-third less expensive in areas adjacent to downtown (within 2 mi east or west of downtown), excluding Waikiki, and the percentage of car commuters that actually paid for parking was less than half that for downtown. Islandwide, the proportion of car commuters that paid for parking at work was inversely related to the distance of their work sites from downtown (biserial $r = -0.30$, $p < 0.001$). This relationship also holds for the price of parking ($r = -0.40$, $p < 0.001$)

Attitudes Toward TSM Strategies

The time of day that commuters traveled to work and the location of their work sites with respect to downtown each had significant effects on the attitudes of respondents toward various TSM strategies. Both of these effects were far more pronounced than were effects of respondents' mode of travel.

A three-way ANOVA on morning time of travel (before, after, or during the peak traffic hour), work location (east of, west of, or in downtown), and travel mode (bus, carpool, or solo driver) found that time of travel and work location, but not mode, had major effects on the proportion of commuters interested in having flextime or staggered work hours and in using express bus service. The results for work location and time of travel are presented in Tables 3 and 4, respectively. From 35 to 42 percent of commuters were interested in having flextime or staggered work hours on their jobs, depending on where they worked ($p < 0.05$) and the time they usually left

TABLE 1 AVERAGE MORNING DEPARTURE TIMES FOR SOLO DRIVERS AND CARPOOLERS

Job-Site Location	Solo Driver	Carpooler
> 2 Miles East of Downtown	7:23	6:57
< 2 Miles East of Downtown	7:12	6:48
Downtown Proper	6:52	6:39
< 2 Miles West of Downtown	6:43	6:30
> 2 Miles West of Downtown	6:25	6:24

TABLE 2 PERCENT OF CAR COMMUTERS PAYING FOR PARKING AND AVERAGE MONTHLY COST

Location	Percent	Mean	S.E.M.
Downtown	51.7	$61.09	± 1.45
Downtown ± 2 Miles [a]	21.9	$41.18	± 3.30
Waikiki	46.0	$47.30	± 2.19
All Other Sites	24.5	$25.44	± 1.40

[a] Downtown ± 2 Miles = 2 Miles East or West of Downtown.

TABLE 3 PERCENT OF COMMUTERS LIKELY TO USE VARIOUS TSM STRATEGIES BY JOB LOCATION

	Work Location		
TSM Strategy	East of Downtown	In Downtown	West of Downtown
Flex-Time/Staggered Hours	36.2	39.1	41.2 [a]
Park & Ride for Express Bus	23.3	29.0	21.0 [a]
Park & Ride for Carpooling	16.1	15.3	16.6
Non-Family Carpooling	15.8	15.5	17.0

[a] Significant difference across categories.

TABLE 4 PERCENT OF COMMUTERS LIKELY TO USE VARIOUS TSM STRATEGIES BY TIME OF TRAVEL

	Time of Travel		
TSM Strategy	Before Peak	During Peak	After Peak
Flex-Time/Staggered Hours	39.1	42.1	34.7 [a]
Park & Ride for Express Bus	26.2	25.1	19.7 [a]
Park & Ride for Carpooling	16.3	16.4	12.9
Non-Family Carpooling	17.6	17.1	11.0 [a]

[a] Significant difference across categories.

for work ($p < 0.01$). Somewhat more car commuters (41.0 percent) than bus riders (32.3 percent) were interested in alternative work schedules, and solo drivers (40.4 percent) showed slightly higher interest than carpoolers (37.2 percent), but these differences are not statistically significant.

Both commuters' time of travel ($p < 0.005$) and their work location ($p < 0.001$) had statistically significant effects on the likelihood of using park-and-ride facilities for express bus service, with downtown commuters and those traveling before or during the peak hour showing the greatest interest. This level of interest was attributable, in part, to those who were already bus riders (mainly downtown bus riders), 40.1 percent of whom said they were likely to use the facilities ($p < 0.005$) compared to 24.6 percent of solo drivers and 25.7 percent of carpoolers. Yet, even among car commuters ($p < 0.001$), those who worked downtown showed more interest (28.3 percent) than those working elsewhere (21.9 percent).

Lack of interest in using park-and-ride lots for carpooling was virtually universal, reflecting commuters' general resistance to carpooling with people from outside the family. Postpeak commuters showed significantly less interest than other commuters ($p < 0.05$) in park-and-ride lots. Nevertheless, car commuters recognized the potential time savings of high-occupancy-vehicle (HOV) lanes, and respondents in carpools with four or more people rated the value of HOV lanes quite highly.

Alternative Transit

The major purpose of this study was to determine potential demand for alternate modes of transportation that differ in service characteristics from normal bus service. Based on previous research (*1,4,8*), the two service characteristics of interest were a guaranteed seat and the distance of pickup and drop-off points from a commuter's points of origin and destination (referred to hereafter as access). The survey asked people to rate their likelihood of using alternative public transit or paratransit service, based on access, whether or not they were guaranteed a seat, and three hypothetical fares.

Time of travel, work location, and mode had significant but sometimes marginal effects on interest in using alternative transit or paratransit services. Overall, prepeak commuters were most likely to favor using such service ($p < 0.01$). Differences in interest between commuters traveling during and after peak were not statistically significant. No differences were found between downtown workers and those working west of downtown, and both of these groups were significantly more likely to use paratransit than people working east of downtown ($p < 0.05$).

Solo drivers and carpoolers appeared to be equally likely to use paratransit under all conditions posed. The primary effect of mode was for bus riders, who revealed an interaction between mode and fare and service characteristics. The percent of bus riders interested in paratransit exceeded that of automobile commuters only at a one-way fare of $1.00. Some 52 to 67 percent of bus riders were likely to use such service for a $1.00 fare if they were guaranteed a seat and access was comparable to current conditions. Potential ridership among bus commuters would increase to 74 percent if door-to-door service were offered at a $1.00 fare.

At a one-way fare of $2.00, interest among bus riders dropped to 20 to 29 percent even with a guaranteed seat (depending on access).

A $2.00 fare would be substantially more than the prevailing cost of commuting by bus for commuters who purchased a $15 monthly bus pass, which allows unlimited travel on Oahu's bus system. Pass holders were estimated to make an average of 2.9 daily weekday trips, so a $2.00 one-way fare would be more than seven times the current average trip cost of bus commuters, almost all of whom used monthly passes.

Although these findings, like those of other researchers (*2*), indicate that work site affects mode choice, this could reflect the importance of existing service conditions and may not apply to transit having different service characteristics. Other variables, such as commute distance, might exert greater influence if geographical biases, such as centering service around downtown commuters, were eliminated. Because commute distance can exert a significant influence on transit ridership (*2*), independent of work location, analysis of covariance was used to partition out or statistically remove the variance attributable to commute distance. Bus commuters were excluded from these and subsequent analyses because of their small number.

This exercise substantially reduced the effects of time of travel and work location on commuters' professed likelihood of using alternative transit. Commute distance significantly ($p < 0.002$) affected potential transit ridership of both carpoolers and solo drivers in a positive but nonlinear fashion. The percentage of automobile commuters (no reliable differences between solo drivers and carpoolers were found) likely to use paratransit was lowest (13 to 14 percent) among those traveling less than 5 miles each way to work. Interest jumped to 20 percent with commutes longer than 5 mi but increased only another 2 percent between 5 and 20 mi. At commute distances of more than 20 mi each way, interest in paratransit rose sharply again.

The effects of service characteristics and fare were more profound ($p < 0.001$ for each factor). Regardless of commute distance, a guaranteed seat increased potential ridership by roughly 7 percent, but each 5-min increase in access time (beyond door-to-door service) decreased prospective ridership 5 to 6 percent on average. Fare had the most powerful influence on commuters' likelihood of using paratransit, in that each $1.00 increase in fare produced a 12 to 13 percent decrease in potential ridership, all other things being equal. Significant two-factor and three-factor interactions among service variables and fare were found, however, implying that the effects of other things are neither equal nor inconsequential.

Various combinations of distance, service factors, and fare can produce extremely high or extremely low ridership, as seen in Table 5. For simplicity, Table 5 shows only three of the five commute distances used in these analyses because scores were relatively stable for commutes between 6 and 20 mi long (includes groups 6–10, 11–15, and 16–20 mi). Significance levels are not noted in the table because all main effects are significant.

The table reveals that trade-offs among service characteristics and fare can yield similar levels of ridership at different commute distances. Increases in service can compensate for losses in ridership that would occur with increases in fare. For example, at commute distances longer than 20 mi, 32.9 per-

TABLE 5 PERCENT OF AUTOMOBILE COMMUTERS LIKELY TO USE PARATRANSIT ON THE BASIS OF SERVICE CHARACTERISTICS, FARE, AND COMMUTE DISTANCE

Commute Distance [a]	Seating [b]	Access	One-Way Fare $1.00	$2.00	$3.00
		Door/Door	33.2	18.3	8.4
< 5	Seat	5 Minutes	27.2	14.0	7.3
		10 Minutes	18.9	10.9	4.8
		Door/Door	24.6	13.0	5.0
< 5	No Seat	5 Minutes	20.5	10.5	4.7
		10 Minutes	13.3	7.8	4.3
		Door/Door	47.8	27.7	13.3
11-15	Seat	5 Minutes	41.1	22.0	9.3
		10 Minutes	30.8	15.7	6.4
		Door/Door	36.0	19.6	8.9
11-15	No Seat	5 Minutes	30.1	14.8	5.8
		10 Minutes	21.2	10.1	4.4
		Door/Door	50.0	33.3	20.3
> 20	Seat	5 Minutes	44.3	29.0	16.3
		10 Minutes	32.9	20.9	13.1
		Door/Door	39.7	25.9	14.3
> 20	No Seat	5 Minutes	34.8	21.5	11.1
		10 Minutes	24.5	14.0	7.7

[a] in Miles

[b] Seat = Guaranteed Seat; No Seat = No Guarantee of Seat.

cent of automobile commuters were willing to walk 10 min to board paratransit at a $1.00 fare, if they were guaranteed a seat. A similar percentage (34.8 percent) were willing to walk only 5 min at the same fare if they were not guaranteed a seat. At a $2.00 fare, both door-to-door service and a guaranteed seat would be required to attract roughly the same proportion (33.3 percent) of people commuting more than 20 mi. A comparable level of demand (33.2 percent) among people commuting less than 5 mi is achieved only with door-to-door service, a guaranteed seat, and a $1.00 fare.

Although commute time is related to commute distance, the correlation between the two was relatively low ($r = 0.29$) and the shared variance between these two factors varied from 3.6 to 13.6 percent, depending on mode. Because the time a commute takes to complete also encompasses some of the effects of the time of travel relative to the peak hour and mode, it would seem to be a potentially important variable affecting the likelihood of using alternative transit. Commute time produced a pattern of interest in paratransit quite similar to that found for commute distance: (a) low interest among those with commute times faster than 20 min, (b) a steep rise in interest among people whose commuting time was between 20 min and 30 to 40 min, (c) a gradual increase in interest up to 40 to 50 min, and (d) a second sharp increase among those commuting longer than 50 min. In part, the similar pattern of results produced by commute time and commute distance may reflect the correlation between them, although, as noted, the correlation was not high.

The relationships between commute time and the other variables tested (fare, access, and seating) also mirror those found for commute distance, and significant main effects of all variables and interactions among all variables were found. Despite these commonalities, interest in paratransit was greater at the highest levels of commute time than it was for commute distance, suggesting that travel time is more important than distance alone in attracting ridership. A more important difference between time and distance effects is that commute time has a significant interaction with seating that commute distance does not. Commute time is particularly sensitive to the value of a seat, and the value of a guaranteed seat increases systematically with commute time. Table 6 reveals how trade-offs among fare and service characteristics result in comparable levels of ridership at different commute times.

CONCLUSIONS

The results of the survey indicate a low rate of vehicle occupancy among commuters from the far eastern suburbs of Oahu. The vast majority of the people surveyed commuted by car, and the great bulk of these drove alone. Given these data, any efforts to increase vehicle occupancy seem worthwhile.

Only a small percentage of commuters were willing to carpool with people outside their own families, however (*4,7*). The existence of a parking facility that provides a central meeting place for carpoolers appears to offer virtually no incentive to carpool. Solo drivers were not interested in using these facilities, nor were current carpoolers, most of whom commute with family members. Even though people see the advantage of HOV lanes, the existing HOV/contraflow lane in Honolulu covers only a short distance (*9*). Apparently for most people, the time savings these lanes provide are outweighed by the burden of commuting with nonfamily members.

TABLE 6 PERCENT OF AUTOMOBILE COMMUTERS LIKELY TO USE PARATRANSIT ON THE BASIS OF SERVICE CHARACTERISTICS, FARE, AND COMMUTE TIME

Commute			One-Way Fare		
Time [a]	Seating [b]	Access	$1.00	$2.00	$3.00
		Door/Door	25.5	17.0	12.1
< 20	Seat	5 Minutes	21.0	14.2	9.1
		10 Minutes	17.4	11.0	6.9
		Door/Door	21.4	13.7	8.3
< 20	No Seat	5 Minutes	18.7	11.4	5.2
		10 Minutes	12.8	7.9	3.9
		Door/Door	49.0	28.7	14.2
30-40	Seat	5 Minutes	41.9	23.1	11.0
		10 Minutes	31.1	17.0	8.0
		Door/Door	37.9	20.4	9.4
30-40	No Seat	5 Minutes	31.4	15.5	6.5
		10 Minutes	22.6	10.9	4.9
		Door/Door	49.7	31.6	17.6
> 50	Seat	5 Minutes	43.1	26.2	13.4
		10 Minutes	34.5	21.6	11.4
		Door/Door	38.1	22.8	12.5
> 50	No Seat	5 Minutes	32.3	18.9	8.8
		10 Minutes	24.0	13.2	6.7

[a] in Minutes

[b] Seat = Guaranteed Seat; No Seat = No Guarantee of Seat.

Although interest in flextime or staggered working hours was high among various categories of commuters, morning departure times are distributed so widely already that any rigid institutional regimen of staggered hours is likely to cause considerable conflict with the usual travel arrangements of many commuters, as was found during the staggered working hours demonstration project with municipal, state, and other employees working in downtown Honolulu (*10*). Any such approach must be truly flexible, allowing commuters to adjust their departure times as they see fit.

Mode of travel had a significant effect on departure times, and departure times (presumably reflecting work schedules, with adjustments for other external influences) had significant effects on interest in using different modes of travel. Acting concurrently with these influences, and presumably interacting with them to some degree, work location with respect to downtown also affected departure time, mode choice, and the likelihood of using available and potential transportation alternatives. These relationships probably reflect the fact that work location itself is related to a number of factors, including parking costs, commute distance, traffic congestion, and job density, that themselves provide incentives and disincentives for using various modes and that may limit potential carpool mates (*2*). Offered a transit alternative free of existing operating conditions and constraints, such as transit's focus on downtown travelers, commuter interest was strongly influenced by basic factors such as commute time, service, and fare. Correspondingly, the effects of mode, time of travel (with respect to the peak), and work location appear to have less influence on interest in transit.

Potential ridership appears to grow with increases in commute time and distance. The influence of commute time in determining potential ridership would seem to be particularly important for providers of paratransit services because it implies that interest in transit that offers improved levels of service will rise as traffic congestion worsens. Improved service characteristics, such as guaranteed seating, significantly enhance ridership (*4,7*). Guaranteed seating augmented potential ridership at all access times and could compensate for increased access times, at least up to 5 min. Beyond this distance, the time spent walking to pickup and drop-off points partially outweighed the value of a seat, but this trade-off depended upon commute time. For commuters traveling more than 50 min, for example, walking 10 min to boarding points to get a guaranteed seat was valued about as highly as having door-to-door service without guaranteed seating.

Of course, fare had a major effect on the likelihood that the commuters in this sample would use paratransit. All things being equal, potential ridership was affected more by fare than it was by either service variable studied, although this finding may not hold generally (*1*). Tables 5 and 6 make apparent the ability of the combined, positive effects of door-to-door service and guaranteed seating to overcome the negative effects of fare on potential ridership. Furthermore, the combined effects of these service variables become more marked as commute time increases.

Can the type of service needed to attract alternative transit or paratransit ridership be profitable? The market appears to be strong enough to support a profit-making enterprise that can avoid the limitations and pitfalls of traditional transit operations (*11–13*). Existing computer technology seems to offer the solution to providing such service at low cost.

The innovative but inefficient dial-a-ride concept, which was first introduced in the 1960s (*14,15*), should be combined with current computer technology to provide a real-time, demand-response transit alternative (*16–18*). A computer network, enabling communication between consumer and transit operators through a centralized system, could improve service at low cost. This network could not only offer immediate access to information about alternative transportation services but also would enable users to book a ride for any time, at any time, from the services available, on a trip-by-trip basis. Fares could be billed monthly by the central computer, saving on accounting costs (*16,17*).

Access to the system need not be limited to consumers and operators of present day alternative transit or paratransit systems. Because the network would connect homes to a central computer, people seeking a ride could match their travel plans with those of people offering a ride, by posting appropriate information on an electronic bulletin board. This system would permit single-trip carpooling in its most convenient form—dynamic ridesharing, without the time and information costs or personal commitment that often deter people from joining permanent carpools (*5,19,20*).

State and municipal governments should take measures to encourage varied forms of paratransit and make efforts to integrate information and transportation services.

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REFERENCES

1. M. A. Kemp. Some Evidence of Transit Demand Elasticities. *Transportation*, Vol. 2, 1973, pp. 25–52.
2. C. B. Hamberger and A. Chatterjee. Effects of Fare and Other Factors on Express Bus Ridership in a Medium-Sized Urban Area. In *Transportation Research Record 1108*, TRB, National Research Council, Washington, D.C., 1987, pp. 53–59.
3. K. Neels and J. Mather. Modeling Mode Choice in New Jersey. In *Transportation Research Record 1139*, TRB, National Research Council, Washington, D.C., 1987, pp. 20–27.
4. M. S. McLeod Jr., K. J. Flannelly, and B. H. K. Henderson. Commuting Behavior of Hawaii State Workers in Honolulu: Implications for Transportation System Management Strategies. In *Transportation Research Record 1170*, TRB, National Research Council, Washington, D.C., 1988, pp. 53–59.
5. K. J. Flannelly and M. S. McLeod, Jr. A Multivariate Analysis of Socioeconomic and Attitudinal Factors Predicting Commuters' Mode of Travel. *Bulletin of the Psychonomic Society*, Vol. 27, No. 1, 1989, pp. 64–66.
6. R. L. Winkler. *An Introduction to Bayesian Inference and Decision*. Holt, Rinehart & Winston, New York, 1972.
7. K. J. Flannelly, M. S. McLeod, Jr., R. W. Behnke, and L. Flannelly. Attitudinal and Behavioral Inclinations of Automobile Commuters Towards Alternative Modes of Commuting to Work. *Psychological Reports* (in press).
8. G. J. Nicolaidis. Quantification of the Comfort Variable. *Transportation Research*, Vol. 9, 1975, pp. 55–66.

9. J. B. Margolin, M. R. Misch, and M. Stahe. Incentives and Disincentives of Ridesharing. In *Transportation Research Record 673*, TRB, National Research Council, Washington, D.C., 1978, pp. 7–15.
10. G. Giuliano and T. F. Golob. *Evaluation of the 1988 Staggered Work Hours Demonstration Project in Honolulu: Final Report.* Institute of Transportation Studies, University of California, Irvine, 1989.
11. R. Cervero. Intrametropolitan Trends in Sunbelt and Western Cities: Transportation Implications. In *Transportation Research Record 1067*, TRB, National Research Council, Washington, D.C., 1986, pp. 20–27.
12. D. T. Silcock. Bus or Paratransit?: The Issues Involved. *Transportation Planning and Technology*, Vol. 10, 1986, pp. 305–322.
13. M. Wachs. U.S. Transit Subsidy Policy: In Need of Reform. *Science*, Vol. 244, 1989, pp. 1545–1549.
14. W. F. Hoey. Dial-A-Ride in the Context of Demand-Responsive Transportation: A Critical Appraisal. In *Transportation Research Record 608*, TRB, National Research Council, Washington, D.C., 1976, pp. 26–29.
15. E. Kadesh. Evaluation of DRT Systems in Richmond and Santa Barbara. In *Transportation Research Record 608*, TRB, National Research Council, Washington, D.C., 1976, pp. 42–47.
16. R. W. Behnke. *A New Concept in Ridesharing for Honolulu.* Report prepared for the State of Hawaii Department of Transportation. Aegis Systems Corporation, Portland, Oregon, Sept. 1982.
17. R. W. Behnke and M. S. McLeod, Jr. Videotex, Transportation and Energy Conservation. Presented at the Pacific Telecommunications Conference, Honolulu, Jan. 1984.
18. J. Collura, R. Bonsignore, and P. McOwen. Computerized Management Information Systems for Transit Services in Small Urban and Rural Areas. In *Transportation Research Record 936*, TRB, National Research Council, Washington, D.C., 1983, pp. 60–68.
19. J. Glazer, A. Koval, and C. Gerard. Part-Time Carpooling: A New Marketing Concept for Ridesharing. In *Transportation Research Record 1082*, TRB, National Research Council, Washington, D.C., 1986, pp. 6–15.
20. A. L. Kornhauser, P. Mottola, and B. Stephenson. Transportation Efficiency and the Feasibility of Dynamic Ride Sharing. In *Transportation Research Record 650*, TRB, National Research Council, Washington, D.C., 1977, pp. 43–48.

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