TRANSPORTATION RESEARCH

RECORD

No. 1321

Planning and Administration

TRANSPORTATION RESEARCH
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Rideshare Programs: Evaluation of Effectiveness, Trip Reduction Programs, Demand Management, and Commuter Attitudes 1991

A peer-reviewed publication of the Transportation Research Board

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. 1991

Transportation Research Record 1321
Price: $26.00

Subscriber Category
IA planning and administration

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Printed in the United States of America

Library of Congress Cataloging-in-Publication Data
National Research Council. Transportation Research Board.

Rideshare programs : evaluation of effectiveness, trip reduction programs, demand management, and commuter attitudes.
p. cm.—(Transportation research record, ISSN 0361-1981 ; no. 1321)
ISBN 0-309-05159-2
1. Ridesharing—United States—Congresses. 2. Van pools—United States—Congresses. I. National Research Council (U.S.). Transportation Research Board. II. Series: Transportation research record ; 1321
TE7.H5 no. 1321
[HE5620.R53]
388 s—dc20
[388.4'1321] 92-697
CIP

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Transportation Research Record 1321

Contents

Foreword

This Record focuses on various aspects of ridesharing and vanpool operations. Discussed are developing techniques for site location and lot size for location of park-and-ride lots for rideshare programs. The characteristics and effectiveness of ridematching systems reported by a nationwide survey are described. Incentives to increase ridesharing such as raising the cost of driving alone are reviewed, and efficiency incentives to lower the costs of ridesharing, an innovation allowance program to increase ridesharing, the impacts of variable work hours, guaranteed ride home, and other market strategies are presented. Various aspects of employer-based programs to help develop rideshare programs are discussed. The effectiveness of various on-site parking management programs is discussed, along with transportation demand management promotional efforts, guidelines for developing transportation management associations, the effectiveness of trip-reduction ordinances, and an overview of evaluation methods with applications to transportation demand management.

Analysis of Park-and-Ride Lot Use in the Sacramento Region

JOAN AL-KAZILY

Rideshare programs and their associated park-and-ride lots in California are administered by the California Department of Transportation. In the Sacramento region, Sacramento Rideshare operates 38 park-and-ride lots with use ranging from zero to 100 percent. As a first step toward developing improved site location and lot size selection techniques, use and service areas of existing lots have been analyzed. Lot occupancy was counted on two days, in June 1988 and in May 1989. In May 1989, a survey of lot users was also conducted. Highly used lots were found to have the expected desirable characteristics of clearly identifiable commute corridors and relatively high-density service area populations. Many were served by vanpools, and two were used by commuters traveling from Sacramento to work in other cities. Underused lots lack these characteristics, are poorly located relative to other lots, or are located very close to or very far from Sacramento. In order to identify service area boundaries, respondents to the May 1989 survey were asked about their travel distance to the lot. Overall, 60 percent of respondents lived within 5 mi of the lot; 71 percent lived within 7.5 mi. Some service areas were found to be more compact with up to 79 percent of respondents coming from within 7.5 mi; others were very dispersed with as few as 32 percent of respondents coming from within 7.5 mi of the lot. Most of the highly used lots draw between 60 and 75 percent of their users from within 5 mi. Analysis of lot use for service areas in the Sacramento region is continuing with the objective of developing a service area index that can be used to predict use of new park-and-ride lots.

The California State Department of Transportation (Caltrans), District 3, operates a system of 38 park-and-ride lots in the Sacramento region (see Figure 1 and Table 1). These lots are used daily by approximately 670 vehicles and thus contribute significantly to the reduction of peak-hour traffic on the area's regional and urban highway networks.

In developing this park-and-ride lot system, important decisions regarding lot location and size had to be made without the benefit of past experience or local area research. Caltrans guidelines (*1*) were followed. These guidelines suggest that the lots should be located at natural staging areas that are evidenced by commuter parking on the street. The guidelines also stress the importance of local community support and of ensuring consistency with long-range plans. The Caltrans guidelines do not provide a method for estimating the required lot size.

Available parking spaces at lots in the existing system are used at an average of 48 percent, but use ranges from zero to 100 percent. Clearly, the use at some locations has reached expectations, whereas at other locations use is far below expectations. Caltrans District 3 park-and-ride lot system operators (Sacramento Rideshare) are now seeking ways to improve the site location and lot size selection techniques for future park-and-ride lots.

Although models have been developed to estimate park-and-ride demand (*2*) and to predict park-and-ride lot use by bus commuters (*3,4*), an attempt to produce a similar model for park-and-ride lots used by members of car- and vanpools was unsuccessful (*5*). Weak correlation was found between lot use and possible explanatory variables. The use of models for site selection and sizing of park-and-ride lots is not recommended in the Caltrans *Design Guidelines for Park-and-Ride Facilities* (*1*).

Although no quantitative models have been developed, the factors that contribute to high use of park-and-ride lots are well understood. The following factors have been identified in the literature (*3,5*):

1. Existence of a well-defined travel corridor,
2. Size of population within easy access of the site,
3. Availability of transit at the site,
4. Significance of savings over automobile commute cost,
5. Distance from the site to the employment centers,
6. Availability of high-occupancy vehicle lanes,
7. Quality of access to and from the site, and
8. Degree of security at the site.

As a first step toward understanding park-and-ride lot use and future needs in the Sacramento region, users of the existing park-and-ride lot system were surveyed in May 1989. Survey forms were placed on the windshields of the 689 users; 264 responses were returned. These responses came from 32 of the 38 park-and-ride lots in the Sacramento system. Results from this survey are presented later in this paper.

EXISTING PARK-AND-RIDE LOT SYSTEM

Figure 1 shows that most of the park-and-ride lots in the Sacramento region are located east of the city. Nine are on State Route (SR) 50 and 16 are on or adjacent to Interstate 80. One site is in Grass Valley and five are on SRs 49 and 20. Two lots are south of Sacramento on SR 99 and one is on SR 99 north of the city. There are two lots west of the city, one in West Sacramento and one in Winters. Finally, two lots are located a considerable distance from Sacramento, in Chico and Oroville.

The 38 lots have a total of 1,372 automobile parking spaces and 146 bicycle lockers. Lot capacities for automobiles vary

Department of Civil Engineering, California State University, 6000 J Street, Sacramento, Calif. 95819–6029.

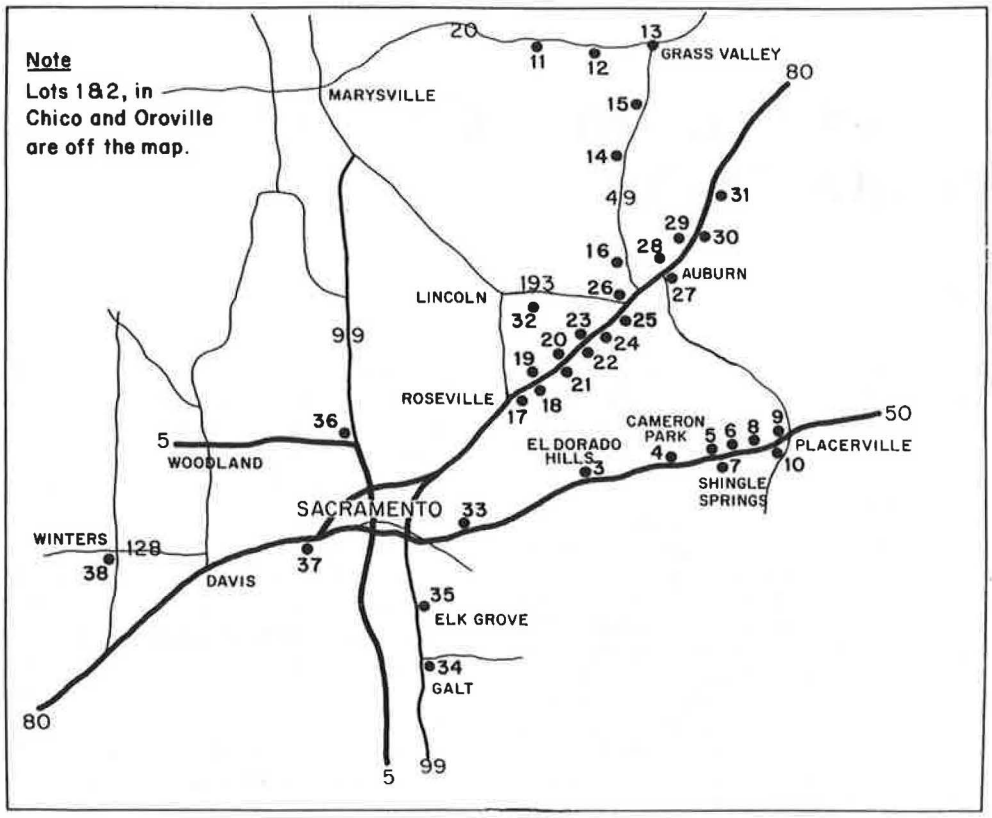

FIGURE 1 Park-and-ride locations, Sacramento region.

from 10 to 111 spaces. Two lots are exceptionally large (Lots 5 and 37), but most lots (22 of the 38) have between 20 and 40 parking spaces. For this study, the lots have been grouped into seven service areas, as presented in Table 2.

Park-and-ride lot occupancy was observed on June 15, 1988, and on May 20, 1989. The average numbers of automobiles using the park-and-ride lots on these two dates are presented by grouped service area in Table 3. (Use of bicycle lockers was also observed.)

Only one lot, Number 37 in Group 1, is fully used. This lot differs from the others in the region in that it serves long-distance commuters traveling to the San Francisco–Oakland area and other points west of Sacramento. Other highly used lots are Lots 34 and 35 in Group 7. These lots serve commuters traveling to Stockton as well as to Sacramento. Lots in Group 3, east of Auburn, and Group 5, west of Placerville, are highly used. Groups 1, 2, 4, and 7 have the lowest percentage of use. Group 1 lots serve commuters traveling between Chico and Oroville, whereas Groups 2, 3, 4, 5, and 7 all serve commuters traveling to Sacramento. A small percentage of users in Groups 2, 3, and 4 commute to Roseville.

Percentage use of park-and-ride lots provides a measure of the accuracy of the predictions or expectations of planners and designers of the existing park-and-ride lot system. As indicated by the data, the degree to which expectations have been met is variable. In order to understand the factors influencing use, the actual numbers of park-and-ride lot users are of more interest.

In Table 4, lots are listed in descending order of use. Lots that draw users for the same or overlapping service areas have been grouped in the table. Excepting Lot 37, which serves commuters traveling to points west of Sacramento, the highest concentration of users is found in lots west of Placerville. A group of four lots there draws 84 users, and a group of two lots draws 63 users. As indicated in Table 4, the lot in Chico draws 48 users; seven other lots, or lot pairs, attract between 21 and 40 users. Seven lots attract between 11 and 20 users and 13 lots attract between 0 and 10 users.

A preliminary review of these data confirms the expected influence of factors listed in the introduction. Lots with large numbers of users serve clearly identifiable population centers and are located to provide easy access to well-defined travel corridors. Lots with low use exhibit one or more of the following: (a) low population in the service area, (b) lack of a well-defined travel corridor, (c) poor location relative to other lots with the same service area, and (d) distance from employment centers is either very long or very short. The factors influencing park-and-ride lot use in this region are explored more fully in the following sections.

FACTORS INFLUENCING PARK-AND-RIDE LOT USE

Well-Defined Travel Corridors

In the Sacramento area, the predominant directions of inbound commute traffic are SR 50 and SR 80 from the east, and SR 5 and SR 99 from the south. Most of the highly used lots serving Sacramento are on three of these routes. SR 5

TABLE 1 PARK-AND-RIDE LOT LOCATIONS IN SACRAMENTO AREA

	County	Route	Location	Spaces	
				Autos	Bikes
1.	But	70	Grand Ave/3rd St Oroville	30	4
2.	But	99	Hwy 32/Fir St., Chico	73	8
3.	ED	50	Saratoga Way/El Dorado Hills	30	4
4.	ED	50	Cambridge Rd in Cameron Park	33	12
5.	ED	50	Ponderosa Rd./Wild Chapparal	111	4
6.	ED	50	Ponderosa Rd./North Shingle	28	0
7.	ED	50	Durock Rd./S. Shingle Springs	56	4
8.	ED	50	Shingle Springs Dr./NW	20	0
9.	ED	50	Greenstone Rd	22	4
10.	ED	50	Missouri Flat Rd./Mother Lode	70	0
11.	Nev	20	Pleasant Valley Rd	23	4
12.	Nev	20	Penn Valley Rd.	23	4
13.	Nev	49	Grass Valley/under freeway	53	8
14.	Nev	49	Streeter Rd.	34	4
15.	Nev	49	Lime Kiln Rd./Alta Sierra	47	4
16.	Pla	49	Atwood Rd, Nr Auburn	42	4
17.	Pla	80	Orlando and Cirby-Calvary	40	0
18.	Pla	80	Douglass Blvd in Roseville	36	12
19.	Pla	80	Taylor Rd/Hwy 65	51	0
20.	Pla	80	Sierra College Blvd N. of Fwy	23	0
21.	Pla	80	Sierra College Blvd S. of Fwy	24	4
22.	Pla	80	Horse Shoe Bar Rd/Loomis	24	4
23.	Pla	80	Penryn Rd/Penryn	39	8
24.	Pla	80	Newcastle Rd/Newcastle	39	4
25.	Pla	80	Newcastle/Indian Hills Rd.	27	0
26.	Pla	80	Lincoln/Ophir at Rte 193	37	8
27.	Pla	80	Lincoln Way/Bowman	21	4
28.	Pla	80	Bell Rd/Bowman Rd in Bowman	33	8
29.	Pla	80	Dry Creek Rd/Lake Arthur Rd	10	0
30.	Pla	80	Clipper Gap Rd near Applegate	15	4
31.	Pla	80	Weimar Cross Rd in Weimar	12	4
32.	Pla	193	Sierra College Blvd/ Lincoln	14	0
33.	Sac	50	Hazel Ave/Natoma	33	4
34.	Sac	99	Rte 99/Rte 104, nr Galt	38	4
35.	Sac	99	Sheldon Rd, nr Elk Grove	45	6
36.	Sac	99	Elkhorn Blvd.	12	0
38.	Yol	128	Main/Railroad Sts., Winters	25	4

TABLE 2 LOTS GROUPED BY SERVICE AREA

Group	Lots	Service Area
1	1, 2	Chico-Oroville.
2	11, 12, 13, 14, 15, 16	Route 49-Grass Valley-Route 20.
3	27, 28, 29, 30, 31	Interstate 80, east of Auburn.
4	17, 18, 19, 20, 21, 22, 23, 24, 25, 26, 32	Interstate 80, west of Auburn, and one lot near Lincoln.
5	3, 4, 5, 6, 7, 8, 9, 10	SR 50, west of Placerville.
6	37, 38	West of Sacramento.
7	34, 35	South of Sacramento.
8	33, 36	North and east of Sacramento, close to the city.

TABLE 3 SPACE AVAILABILITY AND USE BY SERVICE AREA

Group	Number of Lots	Total Number of Spaces	Number of Automobiles		Average Occupancy (percent)
			June 1988	May 1989	
1	2	103	?	56	27
2	6	222	88	59	33
3	5	91	17[a]	52	54
4	11	340	144	123	39
5	8	370	180	208	52
6	2	131	118	116	89
7	2	83	49	64	68
8	2	45	9	13	24
Totals	38	1,385	605	689	47

[a]For three out of the five lots in this group.

TABLE 4 PARK-AND-RIDE LOTS IN DESCENDING ORDER OF USE

Lot No.	Location	Average Number of Users
37	West Sacramento	108
5	Ponderosa Road	84
6	Ponderosa Road	
7	Ponderosa Road	63
8	Shingle Spring Road	
9	Greenstone	
10	Missouri Flat	48
2	Chico	
17	Roseville	39
18	Roseville	37
35	Elk Grove	
24	Newcastle	34
25	Newcastle	31
4	Cameron Park	
13	Grass Valley	28
28	Bowman	26
20	Sierra College	22
21	Sierra College	20
34	Galt	
3	El Dorado Hills	18
22	Horseshoe Bar	15
26	Lincoln/Ophir	13
16	Atwood Road	12
14	Streeter Road	12
15	Limekiln	11
11	Pleasant Valley	10
38	Winters	10
33	Hazel Avenue	10
1	Oroville	9
23	Penryn	9
27	Bowman	9
30	Clipper Gap	8
31	Weimar	8
19	Taylor Road	5
12	Penn Valley	2
29	Dry Creek	2
36	Elkhorn Boulevard	1
32	Lincoln	0

had no park-and-ride lots at the time of this study. A highly used lot in Grass Valley indicated that SR 49 also serves as a commute route.

Lack of a well-defined (or highly traveled) commute corridor contributes to the low use of a few park-and-ride lots in the Sacramento area. These include Lots 11, 12, 32, and 38, none of which are located on the corridors defined earlier.

There is potential for expanding the Sacramento park-and-ride lot system on well-defined routes where there are few or no lots at present (such as on SR 5 and SR 99 from the south). A moderately well-used commute route, SR 80 from the west, is also a candidate for expansion of the system.

Size of Population With Easy Access to the Site

Although some commuters are willing to travel a considerable distance to the park-and-ride lot, higher lot use will be achieved if population density in the vicinity of the lot is high. For long commutes, the high-density population may extend as far as 15 or 20 mi from the park-and-ride lot. This case holds for Lot 37, which serves car- and vanpools traveling 60 to 90 mi each way. However, most of the lots in the Sacramento area serve poolers traveling distances of 15 to 50 mi from the lot to work destinations. The residential service areas of these lots may be effectively limited to an area within 5 to 8 mi of the lot.

In order to define the service areas of park-and-ride lots in the Sacramento area, the May 1989 survey included questions about travel time and distance to the lot. The results, summarized by group number, are presented in Table 5.

Overall, 60 percent of park-and-ride lot users come from within 5 mi of the lot and 71 percent come from within 7.5 mi of the lot. However, these percentages vary considerably between the service groups. Groups 2, 4, and 5 have the most compact service areas; Groups 1 and 2 have compact service areas; and Groups 6 and 7 have dispersed service areas.

For Groups 2, 4, and 5, 77 to 79 percent of the survey respondents travel no more than 7.5 mi to their park-and-ride lot. However, Groups 2 and 4 exhibit a significant percentage (15 to 17 percent) of users traveling over 10 mi; whereas Group 5 exhibits only 9 percent traveling over 10 mi. Groups 2 and 4 serve areas with a mixture of high and low population density, whereas Group 5 lots serve more compact suburban and urban areas.

Group 1 and 3 lots also serve areas with a mixture of high and low population densities. They have a higher percentage (29 to 32 percent) of users traveling over 7.5 mi. These two groups are located the longest distance away from Sacramento. Group 3 serves commuters traveling to Sacramento, Roseville, and Auburn, whereas Group 1 serves commuters traveling between Chico and Oroville.

Lots in Groups 6 and 7 exhibit the most dispersed service areas. Survey respondents coming from within 7.5 mi make up only 32 and 58 percent, respectively, of the total respondents. The large percentages of users traveling more than 7.5 mi, and even more than 10 mi, reflect the fact that these lots serve commuters traveling away from Sacramento. Thus their service area is in effect the entire Sacramento metropolitan area. Lot 37, in Group 6, serves outward-bound commuters only, whereas the other lots in these two groups serve a combination of outward and inward bound commuters.

A more detailed analysis of distance to the lot (see Table 6) reveals that some lots exhibit very low or very high percentages of respondents living within 5 mi of the lot. Five lots have less than 25 percent of respondents within 5 mi, five lots have 26 to 50 percent within 5 mi, and six lots have more than 75 percent of respondents living within 5 mi. Most of these 21 lots have less than 15 daily users; because they produced fewer than six responses in the survey, the data could be biased. However, in some cases it is intuitively clear that

TABLE 5 DISTRIBUTION OF RESPONDENTS BY TRAVEL DISTANCE FROM HOME TO PARK-AND-RIDE LOT

Distance (mi)	Percent by Group							
	1	2	3	4	5	6	7	Total
≤5	65	68	54	63	68	18	53	60
>5 and ≤7.5	6	11	14	15	9	14	5	11
>7.5 and ≤10	24	4	9	6	14	25	11	11
>10	5	17	23	15	9	43	31	18

NOTE: No survey responses were received from Group 8.

TABLE 6 PERCENTAGES OF RESPONDENTS WITHIN 5 mi OF EACH LOT

≤25 Percent			26 to 50 Percent			51 to 75 Percent			76 to 100 Percent		
Lot No.	Responses	Percent	Lot No.	Responses	Percent	Lot No.	Responses	Percent	Lot No.	Responses	Percent
6	14	0	1	9	30	25	22	54	14	12	80
9	5	0	35	37	36	28	26	56	34	20	83
37	108	11	16	12	50	3	18	60	11	10	100
27	9	20	26	13	50	13	28	60	17	10	100
21	13	25	31	8	50	10	58	62	29	2	100
						5	30	65	38	10	100
						8	4	67			
						18	29	67			
						19	5	67			
						23	9	67			
						2	48	71			
						4	31	73			
						7	37	73			
						22	15	75			
						30	8	75			

NOTE: No responses were received from Lots 12, 20, 24, 32, 33, and 36.

the data are reasonable. The 21 lots include some with compact service areas. Lots 34 and 38, for example, serve the small towns of Galt and Winters. Conversely, park-and-ride lots with large service areas are also included in the 21 lots with very high or very low percentages of respondents living within 5 mi of the lot. Lots 35 and 37, for example, serve the larger Sacramento area for commuters traveling away from the city; thus only a small percentage of users come from within 5 mi of the lot.

All but two of the more highly used lots draw between 60 and 75 percent of their users from within 5 mi. It is likely that underused lots, with less than 51 percent of their users coming from within 5 mi, are underused because there is no concentration of population within 5 mi. Underused lots with more than 75 percent of their users from within 5 mi may be underused because they are too close to competing lots that are more convenient for users.

Availability of Transit at the Site

The May 1989 survey of park-and-ride lot users included a question about the commute mode; its responses are presented in Table 7. Only four of the park-and-ride lots administered by Sacramento Rideshare were served by transit and only 21 (8 percent) of the 273 survey respondents indicated that they used transit. Significant transit service was available from the south on SR 99 (Lot 35), from the east on SR 80 (Lot 18), and in Chico (Lot 2). In the lots where transit was available, 27 to 75 percent of the survey respondents rode transit.

Vanpools play a much higher role than transit in the Sacramento park-and-ride lot system. As indicated in Table 7, 44 to 53 percent of users in all groups, except Groups 1 and 7, ride in vanpools. Noticeably high vanpool use is found in Group 2 lots, which are those most distant from Sacramento. A more detailed analysis also revealed that a very high percentage of park-and-ride users of the lots just west of Placerville ride in vanpools. Seventy-five percent of the respondents from Lots 5, 6, 7, and 8 gave vanpool as their commute mode. The availability of a vanpool in this location contributes to the high park-and-ride lot use in these lots.

Significant Savings over Automobile Commute

Most respondents of the June 1988 survey indicated that their primary reason for vanpooling was to save money. Many added that pooling saved wear and tear on the automobile, indicating that costs other than gasoline are considered when the pooling decision is made.

Savings in travel time was not given as a reason for pooling; many respondents in fact indicated that their travel time was increased by pooling. This is a reflection of the fact that no high-occupancy vehicle lanes existed on the access freeways at the time of the survey. Reduced aggravation by not driving was the second most frequently given reason for pooling. Clearly the savings in cost and aggravation that accrue from pooling in the Sacramento area are a function of commute distance.

Distance to Employment Centers

Park-and-ride lots serving Sacramento are located between 12 and 60 mi from the central business district (CBD). A number of employment opportunities exist outside the CBD

TABLE 7 TRANSPORTATION MODE OF SURVEY RESPONDENTS

	Carpool		Vanpool		Transit	
Group	Number	Percent	Number	Percent	Number	Percent
1	10	59	3	18	4	23
2	10	31	22	69	0	0
3	11	48	12	52	0	0
4	24	41	26	44	9	15
5	40	44	48	53	3	3
6	14	48	15	52	0	0
7	11	50	5	23	6	27

NOTE: No survey responses were received for Group 8.

on SR 80, thus the commute distance for some users is less than the distance to the CBD. Significant lot use (25 or more automobiles) has been observed in lots between 16 and 55 mi of the CBD. However, no correlation was found between distance to the CBD and lot use. For example, a town with population of about 9,000, located 55 mi from the CBD, produced about the same number of users as a suburban community of the same size located 27 mi from the CBD.

West Placerville and Shingle Springs (Lots 5 through 10), which produce the highest concentration of users, are located between 35 and 40 mi from the CBD. Thus, this distance may be the optimum for park-and-ride lot uses. However, other factors such as density of population and availability of vanpools clearly play a role. There is no corresponding concentration of park-and-ride lot use on SR 80 west of Auburn (30 to 35 mi from the CBD). Another influencing factor on SR 80, moreover, is that commute destinations include Rocklin and Roseville as well as Sacramento, whereas commute destinations for park-and-ride lot users west of Placerville are confined to Sacramento.

Park-and-Ride Lot Access and Security

The park-and-ride lots in this study are located in rural and suburban areas or in small towns. Although 205 out of 264 survey respondents said that they feel comfortable leaving their vehicles in the lot, 40 respondents commented on the lack of security and occurrence of vandalism and theft in the lots. Seventeen respondents complained that the lots were not swept regularly and some requested telephone facilities at the lot.

Some of the lots in the Sacramento Rideshare system have been designed specifically as park-and-ride lots. These are located on residential collector roads and they generally provide good access to the freeway. Other lots are existing parking areas (such as church parking lots), which are leased by Sacramento Rideshare. These generally do not provide the same good access to the freeway.

Although survey respondents overwhelmingly stated that access to and from their park-and-ride lot was good, it seems likely that accessibility plays a major role in use of the park-and-ride lots in this study area. Accessibility is expected to play a particularly important role in locations where the service areas of two or more lots overlap. It is expected that relative accessibility explains the low use of Lot 6 in the group of Lots 5, 6, 7, and 8, as well as the low use of Lot 9 relative to Lot 10. The influence of accessibility is undergoing further investigation in a current follow-up study in which service areas of selected park-and-ride lots are being mapped.

SUMMARY OF INFLUENCING FACTORS IN THE SACRAMENTO AREA

Well-defined commute corridors have been used for the location of most park-and-ride lots in the Sacramento region. The lots operated by Sacramento Rideshare are generally outside the transit service area; thus car- and vanpooling are the predominant commute modes of lot users. The extent to which these modes are used on the commute corridors is influenced by the lack of HOV facilities. Time lost in freeway congestion, though not extensive, is not avoided by pooling. Nevertheless, a significant number of commuters make use of the park-and-ride lots.

Park-and-ride lot users choose to ride in car- or vanpools because of cost savings and reduction in wear and tear on their automobiles. The most highly used lots are located outside the metropolitan area, 35 to 40 mi from the Sacramento CBD, or they are located on the fringes of the metropolitan area. The former locations serve commuters heading toward the city and the latter locations serve commuters destined for other cities. A high level of vanpooling was found at these more highly used lots.

Accessibility of park-and-ride lots is likely to influence use, but this could not be deduced from the survey responses. Most respondents were satisfied with the accessibility of the lot that they were using.

FUTURE PLANS

Future demand for park-and-ride lots will be influenced by many factors. Enormous growth is taking place around Sacramento; furthermore, air pollution is a major problem in the area and people are becoming more aware of the automobile's role in creating this pollution. Thus, attitudes are changing. In addition, the first HOV lanes are now being introduced on some freeways. All of these factors will contribute to increased use of car- and vanpooling and hence to increased use of park-and-ride lots. In addition, Sacramento Rideshare is now working with local transit agencies to provide transit service at park-and-ride lots. There are opportunities for expanding the park-and-ride lot system to the areas not currently served; on the other hand, underused lots in the existing system could be considered for abandonment.

In order to accommodate this growth and change in the most cost-effective way, and to make informed decisions about lot abandonment, Sacramento Rideshare is seeking a model or procedure for site selection and sizing of future park-and-ride lots. Existing lots are being monitored on a continuing basis so that growth or decline in use can be detected. Service areas of selected existing lots are being mapped and characteristics such as population, distance to the lot, population distribution within the service area, lot accessibility, and the extent of vanpool and transit service are being examined. The objective of the current work is to develop a service area index that can be used as a measure of expected use.

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Publication of this paper sponsored by Committee on Ridesharing.

Ridematching System Effectiveness: A Coast-to-Coast Perspective

STEVE BEROLDO

Although ridematching is one of the most widely used transportation demand management strategies, little information has been gathered about the characteristics and effectiveness of the systems used to provide the service. A nationwide survey of 84 ridematching systems was conducted in spring 1990. The systems are described with respect to five components: information storage, matching techniques, information dissemination, data base maintenance, and evaluation. The components are compared with the effectiveness of the systems in an attempt to identify cause-and-effect relationships. Program effectiveness is measured by the percentage of commuters using the service who successfully find alternative commuting arrangements through the program. A surprisingly small number of organizations, 27 of 84, monitored placement. Seven program characteristics are compared with placement. Positive but weak relationships were identified between placement and data base size, level of automation, match-list delivery, and follow-up activities. Parking supply, commute distance, and other elements of the commute environment may have a stronger effect on placement than ridematching system characteristics.

Matching commuters to share rides (ridematching) is one of the oldest transportation demand management strategies used to mitigate congestion and air pollution on the nation's highways. However, little current information is available on the various systems being used around the country. This research provides some perspective on the state of ridematching. Its objective is to identify common ridematching system characteristics and relate them to system effectiveness. Ridematching system effectiveness could be defined in a number of ways (e.g., the number of commuters using the system, the vehicle-miles of travel reduced, etc.). Effectiveness is defined here as the percent of commuters using the system that actually find or continue to use alternatives to driving alone as a result of using the ridematching service.

The emphasis of this study is not on the details of software design. Ridematching is viewed as a system that includes a number of elements in addition to the software. Although the software is essential for storing and matching commuter records, the interaction between rideshare system operators and commuters, as well as follow-up activities, is essential to the operation of an effective system. A good example is the well-documented Silver Spring, Maryland, Share-A-Ride program, which uses an extensive array of follow-up procedures—including personalized match letters, rematch post cards, and follow-up calls—to improve the effectiveness of the system.

RIDES for Bay Area Commuters, Inc., 60 Spear Street, Suite 650, San Francisco, Calif. 94105–1512.

Most major cities in the United States have ridematching organizations. They are operated under various structures; some are part of local, regional, or state governments; some are operated by transit authorities; and others are operated as private companies. Most have a common goal of helping commuters to join, form, or expand carpools or vanpools or to make use of transit for their trip to work or school. Although most organizations share a common goal, few share a common vocabulary. For example, the commuters who use the ridematching service are called "applicants," "registrants," or "candidates," among other terms. Every effort is made here to use the most common terminology.

METHODOLOGY

Simply identifying organizations around the country that provide ridematching services was a more formidable task than first imagined. Fortunately, the Association for Commuter Transportation (ACT) recently completed a broad-based national survey of organizations involved in commuter transportation. Although the questionnaire did not ask directly if the responding organization provided ridematching services, several questions indicated that such a service was provided. On the basis of responses to five questions on the ACT survey, a list of approximately 110 organizations was compiled that were likely to provide ridematching services.

Mail-back questionnaires were sent to these 110 prospective ridematching service providers. Follow-up reminders were sent to everyone who had not responded by the original due date. Ninety-two of these were returned, for a response rate of 84 percent; all but eight provided ridematching services. Finally, a telephone interview was completed with those organizations that monitored program effectiveness; details that required probing were ascertained through the telephone interviews. The questionnaires and interviews were completed by the person in the organization who was most familiar with its ridematching system. The data and opinions reported here are from the country's most knowledgeable ridematching system administrators.

RIDEMATCHING SYSTEM CHARACTERISTICS

A potentially unlimited array of ridematching system characteristics exists. In order to focus on those elements that are likely to influence effectiveness, it is helpful to identify the key attributes of an effective system. Respondents were asked to identify these key elements (Table 1). An accurate data

TABLE 1 KEY ATTRIBUTES OF AN EFFECTIVE RIDEMATCHING SYSTEM

system attributes	number*	percent*
Accurate database	27	33
Promotion of service	23	28
Quick response	19	23
Follow-up procedures	17	21
Personal service	17	21
Large database	13	16
Incentives	11	13
Employer commitment	11	13
Other	5	4

* multiple responses permitted

base was the most frequently cited attribute. Quick response, personal service, and follow-up all ranked high on the list; together these attributes make a strong case for customer service. Promoting the service was considered more important than many of the system's actual attributes. Few respondents mentioned only one characteristic. Most cited a combination of two or three attributes necessary to operate an effective system.

The results of this research indicate that a comprehensive ridematching system includes the following components:

- Means for storing information about individual commute trips;
- Means for matching the information on commuters to determine which have the highest potential for sharing a ride;
- Means for disseminating the information to commuters;
- Means for validating and updating information to ensure accuracy, and
- Means for evaluating what is happening with users of the system in a timely way; this is the subject of the latter part of this study.

Information Storage

An accurate data base is viewed as the most important attribute of an effective ridematching system (Table 1). The storage and matching of commuter records are important components of data base accuracy. Ridematching information storage is an ideal job for the computer. Only six of the respondents indicated that their matching service was provided manually (Figure 1). Four of the six manual systems had data bases of less than 500. Although few were completely manual, 29 respondents indicated that their system was of a hybrid nature using both manual techniques and computer assistance.

Programs with customized software were the most common; 45 of the ridematching systems were customized. There does not appear to be a relationship between the use of a hybrid-type system and data base size.

Matching

The most common criteria used for matching were start and stop work time and geographic location. The types of ride-

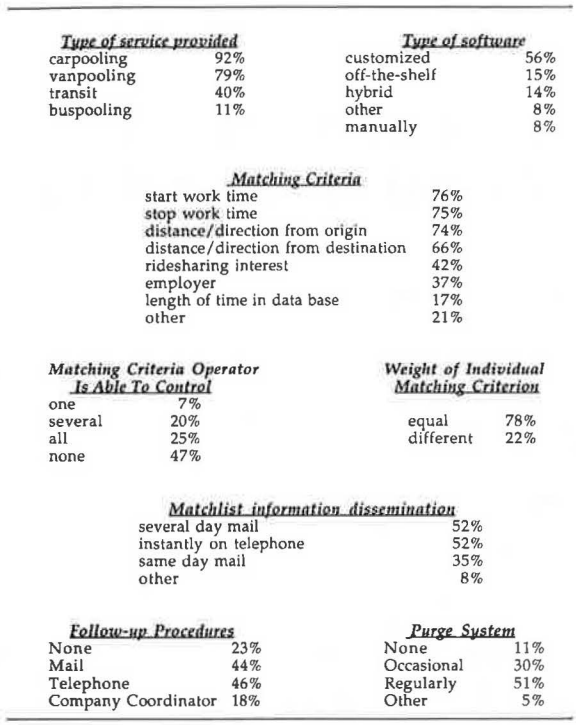

FIGURE 1 Summary of system characteristics.

sharing arrangement requested by the applicant (e.g., vanpool passenger and shared driving carpool) and the employer were also used by a large number of programs as matching criteria (Figure 1).

In addition to the criteria used, the operator's ability to control them (e.g., expanding the geographic area searched or searching additional areas along the route) and the relative weight or degree of importance assigned to each criterion can potentially influence the quality of matching. Matching is more than an automated function for many of the respondents' programs. About half indicated that the operators of their program were able to control several or all of the matching criteria (Figure 1). The other half were completely automated, offering the operator no control over the matching criteria. An equal number of customized and off-the-shelf programs used operator-controlled criteria. It is less common for the matching program to assign different levels of importance to specific matching criteria. Only about one-quarter of the programs assigned different weights to different criteria.

Information Dissemination

Two of the key attributes of a successful ridematching service mentioned earlier—personal service and a quick response—relate directly to information dissemination. Four primary methods of information dissemination were identified—instantly by phone, mailed the same day, mailed within a few days, and through a company coordinator (Figure 1). It is most common to provide information instantly over the phone and put a matchlist in the mail within a few days. About a quarter of the programs use company coordinators to disseminate matchlist information. Some of the less common meth-

ods (used by one or two programs) include same-day call back, in-person pick-up, and delivery by fax.

Data Base Maintenance

Maintenance is possibly the most important part of an accurate data base. There are two distinct components to data base maintenance. One is updating records that are to remain in the data base through follow-up procedures. The second is removing or purging of commuter records when requested or when their potential for matching is lower because of the length of time they have been inactive in the data base.

Three follow-up methods were identified by respondents: mail, telephone, and through company coordinators. Attesting to the importance of follow-up activities, three out of four programs initiated follow-up contacts. Purging is an important part of keeping a data base up-to-date. Most programs purge on a regular basis. It is difficult to identify an ideal purge frequency from the broad range that programs currently use. The purge frequency varies from 4 months to 2 years; the average is just over 10 months. Some programs (17 percent) select records for matching on the basis of how recently they were entered or updated. The newest records receive a higher priority in the matching process. This potentially reduces the negative impact of disseminating out-of-date information.

PROGRAM EFFECTIVENESS

There are two common indicators of a ridesharing organization's effectiveness: the number of commuters using the service and the percentage of those commuters who successfully find alternative commuting arrangements. The latter is referred to here as the "placement rate."

Placement Rate

Placement rate is the indicator that most closely reflects the effectiveness of the ridematching system. It is defined as the percentage of commuters who find alternative commuting arrangements through contacts made as a result of receiving a matchlist. It is subdivided in this study into carpool, vanpool, and transit placements.

Surprisingly few programs, 27 of 84 (32 percent), actually monitor placement rate. One might guess that it is simply the smaller programs that do not have the resources to track placement. However, results of this survey indicated only a weak relationship between size and monitoring placement (Table 2). Four indicators of average organization size are presented—total staff, number of staff working directly with the ridematching service, budget, and service area population. Although those organizations that do track placement are slightly larger, the difference is relatively small.

If placement rate is an important indicator of program effectiveness, why do so few programs actually monitor it? Because organization size does not seem to be directly related to monitoring placement, there are two other possibilities.

TABLE 2 COMPARISON OF PROGRAMS THAT DO AND THAT DO NOT TRACK PLACEMENT

indicator of program size (average)	*track placement*	*do not track placement*
Total Staff	14	12
Ridematching Staff	5	4
Budget	$587,000	$522,000
Population	1,748,000	1,472,000
	n=27	n=57

The first possibility is simply that not everyone considers it an important indicator. The second possibility is that although placement may be considered important, it may not be important enough to justify the resources needed to consistently monitor it.

Most organizations attempt to improve their ridematching system's effectiveness through marketing or promotional efforts designed to increase the size of the data base. This process works on the basis of the theory that a larger data base may increase the potential of finding a good match. Only 5 of the 27 programs that monitor placement rate indicated that they are involved in any special projects to increase the percentage of commuters placed. These projects include distinguishing between an applicant with limited interest and one who is more highly motivated, follow-up calls to specific segments of the data base, actually making calls for matchlist recipients, updating commute records in the data base through mail-back post cards, and generating matchlists at an employment site.

Placement Evaluation Methodologies

In order to compare the characteristics of programs monitoring placement, it was necessary to confirm that everyone was defining and measuring placement in the same way. Follow-up phone calls were made to organizations where the methodology was not clear. A few discrepancies were found; the most common difference was measuring the percent who received potential matches (i.e., valid names appear on the matchlist), rather than the percent who successfully made carpool or vanpool arrangements or began using transit as a result of having received a matchlist.

There are three methods commonly used to determine placement. One is a telephone survey of commuters who have used the service. The second is a mail-back survey of commuters who have used the service. It is common for these surveys to be done either annually or every other year. The third method uses follow-up calls done several weeks after a commuter enters the system. There are pluses and minuses to all three of these approaches. Surveys are a relatively efficient way to collect the data, but because they are done so infrequently it is difficult to relate changes in placement to the myriad of events that occur over a 1- or 2-year period. Follow-up calls provide information at regular intervals, but are labor-intensive and if made too soon they potentially miss placements that may take longer to successfully find alternative arrangements.

PLACEMENT RATE CORRELATIONS

Almost all of the 27 programs that monitor placement include carpool estimates (Table 3). Ten include separate vanpool placement estimates and eight include separate transit placement estimates. Placement rates vary considerably from program to program; carpool placement varies from a high of 60 percent to a low of 3 percent; vanpool placement varies from a high of 40 percent to a low of 1 percent.

In order to account for this significant variation in placement, a comparison was done of system characteristics discussed in the previous section and placement rates. Seven program characteristics were analyzed to look for cause and effect relationships:

- Staff to service area ratio,
- Level of automation,
- Matching criteria,
- Information delivery,
- Size of data base,
- Follow-up contact, and
- Purge system.

TABLE 3 REPORTED PLACEMENT RATES

Carpool *		
High	60%	
Low	3%	
Average	23%	n=26
Vanpool		
High	40%	
Low	1%	
Average	4%	n=10
Transit		
High	12%	
Low	1%	
Average	5%	n=8

* Some organizations do not distinguish between carpool, vanpool and transit placements. In this table, these combined placements are included with the carpool group.

TABLE 4 PLACEMENT RATES VERSUS RATIOS OF STAFF TO SERVICE AREA POPULATION AND STAFF TO DATA BASE SIZE

Staff To Service Area Population		
one staff person per population of:	*placement Rate*	
50,000 or less	22%	n=5
51,000 to 100,000	40%	n=5
101,000 to 250,000	25%	n=6
251,000 to 500,000	26%	n=6
501,000 or more	30%	n=5

Staff To Database Size		
one staff person per records in database:	*placement rate*	
500 or fewer	31%	n=7
501 to 1000	30%	n=5
1001 to 2500	25%	n=7
2500 or more	23%	n=7

Ratio of Ridematching Staff to Service Area

As staff size increases relative to the population of the service area, one would anticipate placement rate increasing (Table 4). However, the results do not support this assumption. Placement rate is highest at one of the higher staff-to-population ratios (1 to 51,000–100,000), but the second highest placement rate level is actually for the lowest staff-to-population ratio (1 to 501,000 or more). The relationship between staff size and service area (as defined by population) is weak.

Because staff-to-population ratio was such a dismal predictor, the ratio of staff to data base size was also examined (Table 4). A much more positive relationship was found. As the number of staff persons to the size of the data base decreased, so did placement. This more rational finding lends credibility to the data.

Level of Automation and Matching Criteria

Two measures of program automation were compared with placement rate. The first was a fully automated system versus a system that included manual techniques. One of the key attributes of an effective system described earlier (Table 1) was personalized service. A fully automated system may reduce the ability to provide personalized service. The results showed that fully automated systems actually had a higher average placement rate: 29 percent placement for the automated systems and 22 percent placement for the hybrid systems. Four of the five programs that had the lowest placement rates allowed the operator to control all matching criteria. The second comparison was between customized and off-the-shelf software. Placement rate was equal for these two; each averaged 28 percent.

There are two potential relationships between the selection of matching criteria and placement rate. One is that the more control given to the operator the better; the second is that the less control (or the more standardized) the better. The evidence supports the more standardized approach. The more criteria used, the lower the placement rate. Three or fewer matching criteria had an average placement rate of 30 percent; four or five matching criteria had an average placement rate of 27 percent, and six or seven had an average rate of 25 percent.

Matchlist Information Delivery

The most common distribution methods are by mail within a few days and instantly over the phone (Table 5). Surprisingly, placement rate varies little for the different distribution methods. The only noticeable difference is the increase in placement rate associated with putting the matchlist in the mail on the same day. The five programs with the highest placement rates all mailed matchlists on the same day that the commuter contacted them. This supports the hypothesis that a quick response is an important component of an effective system. However, if a quick response is important, one would also expect those programs offering instant service over the telephone to be significantly higher. There was no difference

TABLE 5 MATCHLIST INFORMATION DELIVERY

delivery method	*placement rate*	*% using method*
Instantly on phone	26%	50
Mailed same day	30%	35
Mailed within X days	26%	53
Via company coordinator	24%	24

between programs offering combined instant telephone and same-day mail and those offering instant telephone and several-day mail. Both had an average placement rate of 31 percent. This fact could be interpreted to mean that instant telephone service is the most important delivery method and that mailing the matchlist on the same day or within several days does not influence placement.

Data Base Size

An interesting relationship exists between data base size and placement (Figure 2). The smallest (less than 500) data bases do not do well, perhaps because they do not have the necessary entries to provide consistent matches. Somewhat larger data bases (500 to 1,000 and 1,001 to 5,000) have the best placement rates. At these levels, sufficient entries may exist to produce good matches, and their size is such that personal service and follow-up can be done effectively. At the 5,000 to 10,000 level, the placement drops. This size appears to be awkward—perhaps too large for personal service, but not large enough for the numbers to compensate for the lack of personal service. Another peak occurs in the 10,001 to 15,000 category for which entries are numerous and personal service possible, but not as effective as for the smaller categories. For the largest data bases, it may be difficult to provide personal service and effective follow-up, although they obviously have numerous entries. Examining the top and bottom five programs supports these findings. The average data base size for the programs with the five highest placement rates was within the 501 to 1,000 range; the five programs with the lowest placement rates had average data base sizes between 5,001 and 10,000.

Follow-Up Contacts

The opinions presented earlier (Table 1) indicated that follow-up activities are a key attribute of effective systems. Time series studies from one program also indicated a strong relationship (RIDES for Bay Area Commuters, Inc., unpublished data). In three consecutive surveys of ridematching system users conducted in 1986, 1988, and 1990, customers that received follow-up contact had a dramatically increased placement rate. The differences in placement rate were 45 versus 27 percent in 1986, 49 versus 29 percent in 1988, and 38 versus 16 percent in 1990. Despite opinions of respondents and this evidence that follow-up activities were an important ingredient in an effective program, Table 6 does not indicate a consistent increase in effectiveness with increased follow-up activity. Programs offering no follow-up contact had placement rates as high as those providing follow-up by telephone and through company coordinators. Follow-up contact through the mail appeared to increase placement.

Purge System

One might expect to find a relationship between purge frequency and placement rate. However, the scatter plot (Figure 3) of purge frequency and placement indicates an amazing lack of correlation between the two. Purge frequency is used here as a rough indicator of the accuracy of the data base. The more frequently a data base is purged, the more accurate the records in it should be. There are two potential explanations for this poor correlation. It is possible that the hypothesis is wrong and that a regular purge cycle does not significantly affect the accuracy of a data base. A second explanation is that an accurate data base may not mean a significantly better placement rate. The data do not indicate any sign of an inverse correlation. An inverse correlation would indicate that infrequent purging improves placement—perhaps by keeping the number of potential matches high.

TABLE 6 FOLLOW-UP CONTACT AND EFFECTIVENESS

type of follow-up activity	*% placed*	
No Follow-up Contact	25	n=4
Mail only	32	n=3
Telephone only	24	n=5
Mail and Telephone	32	n=11
Telephone & Company Coordinator	24	n=4

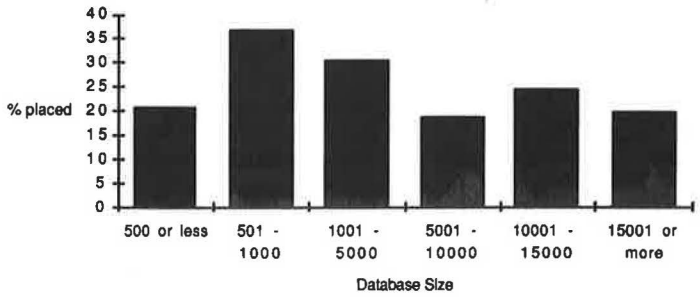

FIGURE 2 Data base size and placement.

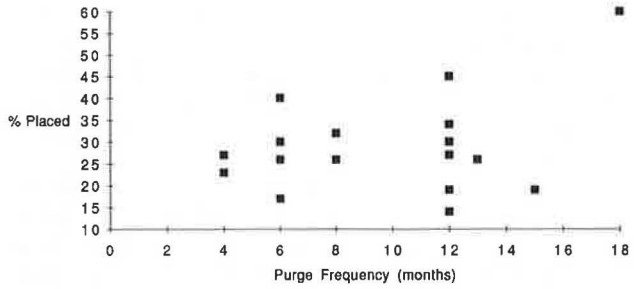

FIGURE 3 Purge frequency and placement.

CONCLUSIONS

The limited amount of current research on the subject of ridematching effectiveness is indicative of the limited resources organizations devote to this issue. Of the 84 responses to this questionnaire, only 27 monitor placement rate. Of the 27 that monitor placement, only 5 indicated that they were involved in special projects (other than promotional efforts) to improve placement. Thus most organizations did not know how many commuters actually started pooling or using transit as a result of their ridematching service. The supporters of these programs acted without this type of information. On the other hand, ridematching is viewed by many as a practical, hands-on service that produces immediate results at relatively low cost; it may not seem that important to devote additional resources to rigorously evaluate results.

Few programs monitored placement, and few correlations were found between ridematching system characteristics and placement rate. If more programs monitored placement, stronger relationships might be evident. The information analyzed here indicates that fully automated matching systems, mailing the matchlist on the same day, and follow-up contact through the mail all positively influence placement. An interesting relationship was found between data base size and placement. The highest placement rates were found among the small-to-medium size data bases (500 to 5,000 records) and the medium-to-large size data bases (10,000 to 15,000 records). The smallest data bases may not do well because they do not have the necessary entries to provide consistent matches. The largest data bases may not do well because of the difficulty in providing personal service to so many commuters. At the 500 to 5,000 and 10,000 to 15,000 levels, sufficient entries may exist to find good matches, yet their numbers are such that personal service and follow-up can be done effectively.

The relationship between data base size and placement is interesting but by no means conclusive. The lack of a strong relationship between other system characteristics and placement is probably more conclusive. There must be other factors that strongly influence placement. The two programs with the highest placement rates do not have any outstanding system design features. However, both have unique commute environments that appear to create strong incentives for ridesharing. They both cater to suburban markets with limited transit service. One area is dominated by long commutes and the other by a difficult parking situation at the work end.

Commute distance, lack of transit options, and difficult parking create commute environments that enhance the desirability of ridesharing. These environmental factors appear to more strongly influence placement rate than the ridematching system characteristics. This finding does not suggest system design is unimportant, but rather that creating a total environment that combines a good ridematching service with other incentives will produce the best results. In addition, each ridematching program looked at here is unique; attempting to reduce them to numbers and categories may not work. The individual parts may not provide a good representation of the sum. Perhaps what is required is a more detailed qualitative look that includes service philosophy and more emphasis on the commute environment to better understand the relationship between ridematching system design and system effectiveness.

Publication of this paper sponsored by Committee on Ridesharing.

Difficulties with the Easy Ride Project: Obstacles to Voluntary Ridesharing in the Suburbs

STEPHENIE J. FREDERICK AND KAY L. KENYON

The example of a recent ridesharing demonstration project in Bellevue, Washington, is used to explore how money, convenience, and time costs influence the commute mode decision in low-density office parks. Commuters perceived that driving alone was low cost and ridesharing was high cost. The Easy Ride project attempted to lower the perceived costs of ridesharing and transit. Key features of the Easy Ride project were area-wide transportation coordinators who offered personalized commuter assistance; an intensive marketing campaign; vanpool discounts; and taxi rides home for ridesharers who missed their ride. Despite Easy Ride attempts to lower the perceived cost of ridesharing, most project sites exhibited no measurable change in mode split over 2 years' time. But Easy Ride also found that imposing costs on solo drivers can have a dramatic effect on mode split. The report concludes that the most effective approach to increasing ridesharing and transit rates may be to raise the cost of driving alone while at the same time offering incentives that lower the costs of ridesharing. But regulating suburban employers in order to impose costs on suburban drivers is politically difficult. Until such costs can be imposed, public agencies have little choice but to pursue voluntary ridesharing programs to control traffic congestion. However, to increase ridesharing and transit use significantly, the incentives of voluntary programs may have to be substantial.

Easy Ride was a demonstration ridesharing project sponsored by the city of Bellevue, Washington, and implemented by the regional transit agency, the Municipality of Metropolitan Seattle (Metro). Intended to discover ways to boost ridesharing rates and transit use, the project offered a package of services and incentives to the employees of two low-density suburban business areas within the city limits of Bellevue. The project began in June 1987 and ended in June 1989.

Easy Ride was unusual among municipal and other government-sponsored ridesharing programs, which usually require employers to provide ridesharing and transit incentives to their workers. With Easy Ride, the city of Bellevue provided services, marketing, and ridesharing incentives directly to the workers of the two target areas with the cooperation of the employers. The program was thus voluntary for both employers and workers. It was hoped that if employers recognized the benefits of ridesharing, they would support it themselves after the demonstration project had ended.

As an experimental program, Easy Ride yielded valuable information for future public policy directions. However, final assessment of Easy Ride indicated that on average, across the companies in each target area, the ridesharing rate did not change over the 2 years of the project. With such an outcome, employers were not interested in continuing the program themselves. However, the average results did mask some variation in the ridesharing rates: two firms experienced increases by the end of the project. Their unique circumstances offer an instructive counterpoint to the overall Easy Ride experience. They also furnish significant policy implications for combining positive and negative incentives to induce commuters to carpool, vanpool, and ride the bus to work.

Easy Ride was part of the city of Bellevue's overall approach to managing traffic congestion. This context, in which Easy Ride was conceived, developed, and implemented, is described in the following sections. After presentation of the background and reasoning that led to the program, the actual outcome of the project is analyzed. In the concluding section, the policy implications of the Easy Ride experience are explored.

PROGRAM CONTEXT

Managing Change

Bellevue is a fast-growing city in the most populous county of Washington State. As early as 1980, the city recognized that it would have to manage the dramatic regional growth that loomed ahead, and that transit and ridesharing would be critical to this goal.

The city embarked on a sustained program of capital improvements that in 1989 culminated in a $187 million commitment to transportation facilities over the next 12 years. In addition to capital improvements, the city has over the last decade been developing a comprehensive program to increase the rate of transit use and ridesharing. The city's goal is a 40 percent rideshare-to-transit rate in the central business district (CBD), where in 1990 that rate was about 20 percent. Outside the CBD, the goal is a 25 percent rideshare-to-transit rate—in 1989 the rate was about 12 percent.

S. J. Frederick, Transportation Management Services, 959 East Walnut Street, Suite 200, Pasadena, Calif. 91106. K. L. Kenyon, Planning Department, City of Bellevue, 11511 Main Street, Bellevue, Wash. 98009–9012.

Downtown Strategies

Many of Bellevue's transportation demand management (TDM) strategies have centered on its CBD, which had a work force of 23,000 in 1989. Some of these strategies have included

- Establishing the Bellevue Transportation Management Association, of which the city was a partner;
- Imposing strict TDM requirements on developers of new office buildings;
- Limiting office parking;
- Negotiating a transit incentive agreement whereby Bellevue received additional downtown transit service. This service was furnished by the regional transit authority, Metro, in return for actions taken by the city to encourage transit use (e.g., increasing downtown employment densities, decreasing parking availability, raising parking fees, and providing of commuter bus pass subsidies by the private sector).
- Cooperating with Metro to build a downtown transit center (which was completed in 1985).

The city's long-range downtown transportation plan, adopted in 1990, called for a relocated and expanded transit center with exclusive freeway access, high-occupancy vehicle (HOV) lanes on two additional arterial streets (in addition to an existing HOV lane), and monitoring of parking prices to ensure higher user costs (with a goal of $75.00 per month, in 1989 dollars, by the year 2000).

Bellevue's Suburban Activity Centers

Although employment in downtown Bellevue is expected to double in the next 10 years, employment outside the downtown will also grow rapidly. By the year 2000, the non-CBD work force will increase by 35 percent, from 57,000 to more than 76,000, according to the city of Bellevue Department of Planning.

Bellevue's nondowntown employment is loosely clustered in four areas ranging in work force size from about 3,500 to nearly 15,000. The office parks in these areas tend to be occupied by many small employers. Employment density is low, and parking is provided in the range of 4.0 to 5.0 stalls per 1,000 ft^2 of office. Transit service is relatively poor, capturing about 1 to 2 percent of the work trips. Ridesharing is the choice of about 8 to 10 percent of the office workers, a background (or ambient) rate that is standard in the absence of TDM measures.

To Regulate or Not To Regulate

To help address the challenges of the low-density suburban market, some jurisdictions around the nation have turned to TDM ordinances and agreements with developers to increase transit and ridesharing use. Probably the best known of these is Southern California's Regulation XV, a program under which the regional air quality district requires employers of 100 or more workers to offer trip-reduction incentives to their workers. The goal is to achieve an average vehicle ridership of 1.50 among employees who report to work from 6:00 to 10:00 a.m., a figure that equates roughly to a 55 percent drive-alone rate.

This approach has limited applicability in some states, such as Washington, where state law does not authorize trip-reduction ordinances except as part of land-use regulations for new development. Because of this limitation, the Non-CBD Transportation Management Program ordinance that was adopted into Bellevue's zoning regulations in 1986 may be applied only to new development. The ordinance affects only a small minority of Bellevue employers, because most vacant land has already been developed.

Voluntary Alternatives

Judging that the road to changes in state law might be long and rocky, the city decided to explore voluntary TDM programs for existing firms in low-density suburban employment areas. Metro had long had an outreach program aimed at major employers; it was thought that this could be intensified in the suburban setting with additional resources.

Staff at first considered whether local firms might organize and fund TDM activities through a transportation management association (TMA). However, discussions with non-CBD Bellevue firms indicated a low likelihood of TMA formation (Bellevue's existing TMA has chosen to maintain its focus on the CBD). If Bellevue were to launch an intensive TDM program in suburban activity centers, some support from local firms could be expected, but it was clear that public-sector leadership and funding would be necessary at the outset.

Working with Metro, the city conceived of a publicly funded TDM marketing program aimed at Bellevue's suburban employment areas. The city decided to test the effectiveness of an intensive and personalized transportation coordinator approach on two areas as demonstrations. If the campaign proved effective, it could be applied city-wide at a later time.

From this preliminary concept, the Easy Ride program was developed, growing into a two-year exploration of a voluntary TDM program for suburban office parks.

PROGRAM SCOPE

A total of $110,000 per year for 2 years was budgeted by the Bellevue City Council for the Easy Ride transportation coordinators and promotional efforts, described later, and the incentives, which are addressed in detail in the section titled "Program Analysis." Actual annualized costs were $91,100, which did not include Metro or city administrative supervision or the cost of Metro's Early Start vanpool incentive, described with the Easy Ride incentives. Of the total cost, $26,000 per year was spent on evaluation.

Two activity centers were targeted. One was the Bellefield Office Park and Bellevue City Hall site, located south and east of the Bellevue downtown. It encompasses a large office park, several large multitenant buildings, and the City Hall. It has a work force of about 2,200. The other was the I-90 Corridor, located south and east of Bellefield–City Hall. It contains several large office parks and multitenant office buildings that house approximately 7,100 employees. It is named for Interstate 90, which traverses it (see Figure 1).

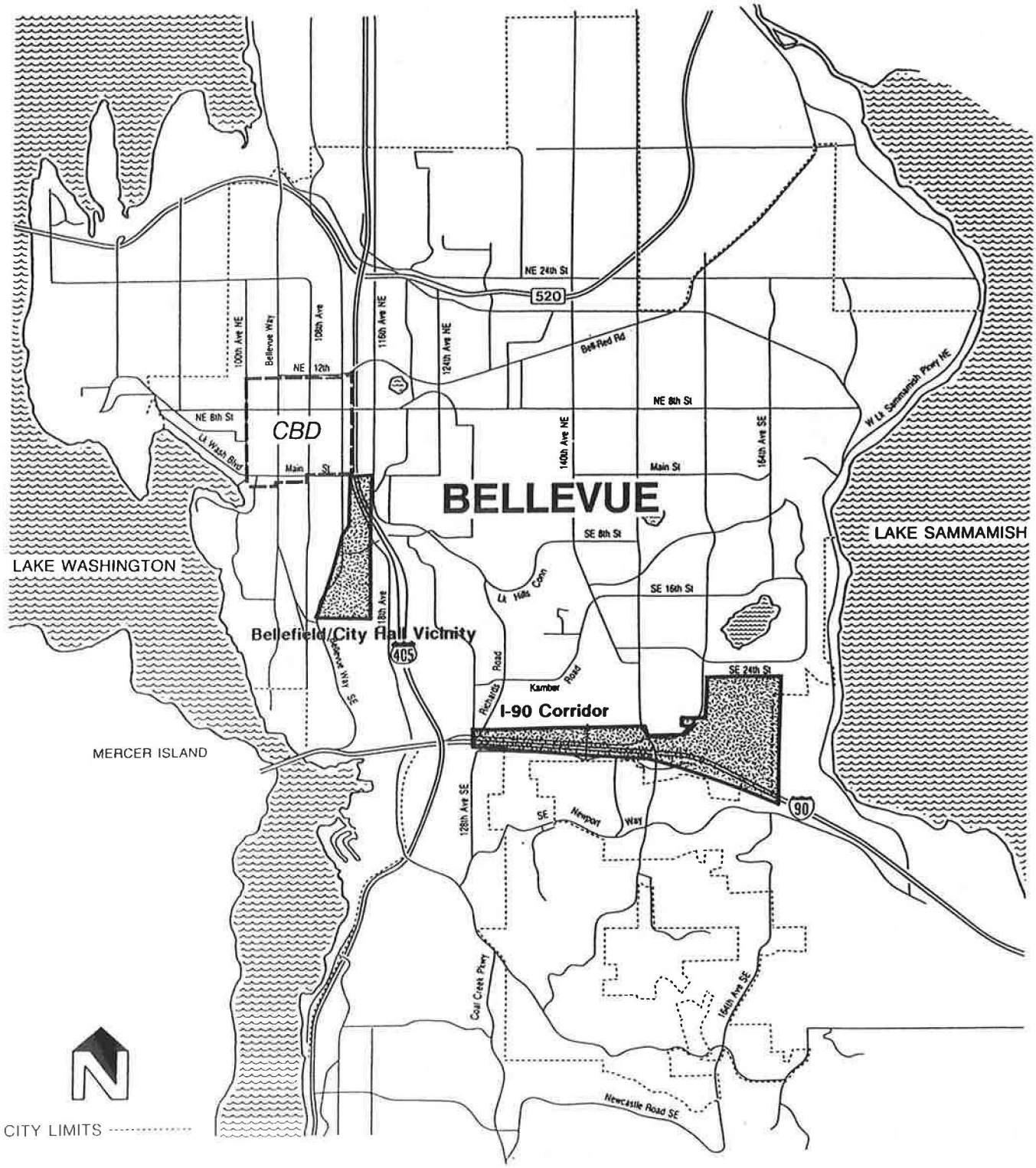

FIGURE 1 Easy Ride project areas.

Transportation Coordinators

A key feature of the Easy Ride project was personalized commuter assistance through Metro-trained transportation coordinators. The full-time (I-90 Corridor) and half-time (Bellefield–City Hall) transportation coordinators had three primary roles:

- To personalize HOV marketing by helping commuters to make carpool and vanpool arrangements and to find suitable transit routes. This personalization included making follow-up calls to individuals applying for Metro's computerized ridematch service, offering assistance in resolving problems, and helping to overcome resistance to forming rideshare arrangements.
- To assume the role of the normally on-site employee transportation coordinator (ETC) for employers of fewer than 100 employees.
- To market HOV programs to all employers in the targeted areas, encouraging them to implement TDM programs. These programs included parking management, flex time, provision of transit pass subsidies, appointment of a staff coordinator, and regular distribution of Easy Ride marketing materials.

Promotion techniques included regular distributions of ridematch applications, setting up information tables in lobbies, posting flyers and information materials, and conducting large and small transportation fairs both indoors and out. Research of existing employer characteristics and logging of contacts and results were also major activities.

The transportation coordinators used an array of HOV incentives as sales tools. These incentives included some incentives that Metro already had available, as well as a few developed especially for Easy Ride. The two sets of incentives—both Metro and Easy Ride—were primarily targeted at vanpoolers and are described in detail in the section titled "Program Analysis."

Project promotion was aided by a package of coordinated marketing materials. Eight brochures described services and incentives; these were grouped into a presentation folder. Firms were offered free wall-mounted plexiglass "commute options boards" that were regularly stocked by the transportation coordinators. A portable table-top display was developed for use at fairs and in building lobbies.

Advisory Committees

To help ensure private-sector participation, Easy Ride established two advisory committees (one for Bellefield, one for I-90) composed of employers, building managers, and developers. The advisory committees' roles were to review program operations from a private-sector perspective, to suggest new marketing tactics and employee incentives, and to facilitate the introduction of the transportation coordinators into reluctant firms.

Data

Easy Ride was conducted under good circumstances for assessing its effectiveness. To analyze the performance of the Easy Ride program, Metro conducted employee surveys in several buildings in each project area at three times during the program. These surveys determined mode split, attitudes toward and awareness of program services, and demographic information.

The first round of surveys was conducted before the program was offered, in June of 1987. This provided baseline data. A second survey was fielded 1 year later, and a final survey was conducted at the program's conclusion, in June of 1989. In each year, the same buildings were surveyed. The sample in each survey was determined by the number of employees who chose to return completed questionnaires. The samples were not random, but the methodology offered consistency and return rates were generally high enough to furnish a clear picture of employee commuting habits (return rates for Bellefield–City Hall's three surveys were 47 percent of 1,299 employees, 30 percent of 1,451 employees, and 43 percent of 1,093 employees; for I-90, they were 21 percent of 3,025 employees, 32 percent of 2,363 employees, and 43 percent of 2,053 employees).

As a back-up indicator, employee automobile occupancy counts were conducted. Other evaluation tools were logs of contacts made with clients and other reports of the transportation coordinators.

In addition, other sites were surveyed that could be used as bases of comparison with Easy Ride. Because these Eastside business areas received only the Metro incentives, they acted as quasi-controls on the project. (Eastside refers to King County east of, and across Lake Washington from, Seattle. It encompasses six incorporated cities, including Bellevue, and unincorporated county areas.) All incentives are explained in the following section.

PROGRAM ANALYSIS

Assumptions

Transportation costs are composed of money, time, and inconvenience costs. In the analysis that follows, the thesis is proposed that commuters perceive ridesharing or transit use as much more costly than driving alone in terms of these three costs. Driving alone actually costs little, especially when the special attributes of the automobile are taken into consideration (power, beauty, control, instant mobility, and so on). Ridesharing and transit cost more not only in out-of-pocket expenses but also in manifest inconvenience and lost time. If a cost disparity did not exist, just as many commuters would be seen riding in carpools, vanpools, and buses as driving alone in automobiles.

The Easy Ride strategy was to try to lower the three-faceted cost of ridesharing enough to divert commuters from their single-occupant automobiles into carpool, vanpool, and transit arrangements.

Lowering the Cost with Services and Incentives

Easy Ride lowered the cost of ridesharing in several respects. One, it reduced some of the costs of inconvenience, which we might call transaction costs. These are the costs of finding fellow passengers or bus lines, making arrangements and communicating with fellow passengers, finding a way home in emergencies, and so on.

Easy Ride reduced some transaction costs by providing computerized ridematching and personal follow-up services in both I-90 and Bellefield–City Hall. The transportation coordinators widely publicized and distributed ridematch registration forms and made follow-up calls to registrants to assist in resolving problems in carpool and vanpool formation.

The transportation coordinators also conducted carpool and vanpool formation meetings, thus absorbing the cost of bringing interested parties together. Coordinators also planned transit routes for interested individuals if transit options were available.

Finally, Easy Ride offered a solution to the problem of having to leave earlier or stay later than the rest of one's pool. This was done through a service guaranteeing a ride home by taxi, which was offered in the I-90 Corridor only. The program had a 60-mi limit per person per year and was free except for the $1.00 taxi drop charge.

Metro offered a 6-month subsidy, available throughout the Eastside, that covered the cost of empty vanpool seats. This was not part of Easy Ride but was still available to I-90 and Bellefield–City Hall employees. Called "Early Start," it enabled vanpools to begin operating before they had their full complement of riders. This process reduced search costs because once on the road, a vanpool was its own best advertisement for additional passengers. (Early Start applied only to vanpools using Metro vans. Under Metro's vanpool program, passenger vans—owned, insured, and serviced by Metro—are loaned to groups of 8 to 15 commuters.)

Carpoolers and vanpoolers generally share the cost of fuel, and vanpoolers and transit users buy vanpool or bus passes. These expenses make the out-of-pocket costs of ridesharing seem greater than the out-of-pocket costs of driving alone. The actual costs of driving to work alone are hidden in monthly gasoline credit-card payments, insurance premiums, and vehicle maintenance.

Easy Ride reduced out-of-pocket expenses by offering vanpoolers a savings on their fares. This savings varied by target area. In Bellefield–City Hall, "one month free" was offered over the first 8 months of Easy Ride and was renewed for a 5-month period in the second year. In the I-90 Corridor, vanpoolers could collect a subsidy of $10.00 per month if they rode in a Metro van. They could also participate in the "two months free" program that was offered during the last 4 months of Easy Ride.

An I-90 Corridor employee who vanpooled for the last 18 months of the Easy Ride project could have saved $180 (at $10 per month). Using a monthly vanpool fare of $60 as an example, the employee who vanpooled for the last 4 months of the project could have saved $160 (at $10 per month plus two months free). In contrast, a Bellefield vanpooler could have saved at most only $60 (one month free), and then only during certain portions of the project. Thus the financial inducements to vanpool were greater in the I-90 Corridor.

In addition to the monetary subsidies, the Easy Ride transportation coordinators attempted to educate their target work forces about the real costs of daily drive-alone commuting. The intent was to narrow the perceived chasm between ridesharing and drive-alone costs.

Ridesharing takes more time than driving alone to work because a commuter must collect passengers (or wait for a bus) before the actual commute begins. In time-conscious, high-pressured society, the time loss is one of the largest deterrents to ridesharing and transit use, surpassing transaction costs and out-of-pocket expenses. Therefore, time loss should be the element most urgently addressed in a ridesharing program. However, Easy Ride did not include an extensive time-savings element except that the transportation coordinators did try to persuade employers to reserve parking spaces close to building entrances to provide ridesharers with a time-savings fillip at the end of the drive to work.

Results

Two years of marketing Easy Ride's services and incentives yielded valuable information about how to approach the matter of ridesharing in the suburbs. However, final assessment of Easy Ride indicated that on average, across the companies in each target area, the ridesharing rate did not change over the 2 years of the project (*1*).

In the Bellefield–City Hall target area, survey data indicated that 6.9 percent of the total employee population had begun carpooling and vanpooling since the beginning of the Easy Ride program. The surveys also indicated that 6.0 percent reported abandoning ridesharing, for a statistically insignificant net gain (*1*).

In the I-90 Corridor, survey data indicated that 3.9 percent of the employee population began carpooling and vanpooling over the 2 years of the Easy Ride program, and 3.9 percent left these modes to begin driving alone (*1*). Hence, there was no net gain in the ridesharing rate.

The rates of ridesharing entry and exit in Bellefield–City Hall and I-90 Corridor were about the same as the control sites. The 1989 results indicated that in 1989, over all sites (Easy Ride included), 5.5 percent entered ridesharing or transit use, and 5.5 percent left it (*1*). Thus the Easy Ride rates of 6.0 and 3.9 percent, respectively, are probably background rates of turnover that occur whether ridesharing incentives exist or not.

Table 1 presents the means of travel over the course of the program for survey respondents in Bellefield–City Hall and I-90 Corridor. The responses indicate that the percentage of people commuting by HOV to Bellefield–City Hall or I-90 Corridor was no greater in 1989 than it had been in 1987. The drive-alone rate crept up somewhat in I-90 and declined in Bellefield–City Hall, but neither change was statistically significant (*1*). The apparent decline in Bellefield–City Hall was caused entirely by two firms whose experience is discussed later.

Counts of employee vehicle occupancy confirmed the results of the HOV–TSM surveys. Counts in Bellefield–City Hall and I-90 Corridor indicated that the average number of occupants per vehicle driven to either area did not increase over the 2-year period.

TABLE 1 MEANS OF TRAVEL, BELLEFIELD–CITY HALL AND I-90 CORRIDOR, 1987 TO 1989 (*1*)

	Bellefield/City Hall			I-90		
Mode	1987	1988	1989	1987	1988	1989
Drive Alone	84.3%	80.1%	79.6%	87.9%	90.7%	89.8%
Carpool	9.1	11.1	11.0	7.7	5.7	6.4
Vanpool	1.5	3.9	4.3	0.2	0.3	0.5
Bus	2.9	2.2	1.8	1.6	1.3	0.9
Other	2.3	2.7	3.4	2.7	2.0	2.4
Total	100.0	100.0	100.0	100.0	100.0	100.0

The effects of the fare discounts for vanpools and the Early Start vanpool program were difficult to document. According to Metro surveys of project area vanpoolers, employee awareness of the fare discounts was low, even among recipients of the discounts. The rate of vanpool formation was higher in Bellefield–City Hall than in I-90 Corridor, where the subsidies were larger. Discounts were not a major consideration in decisions to vanpool. Nor did employees respond to the transportation coordinators' efforts to educate them about the true costs of solo commuting.

Of the monetary subsidies, Metro's Early Start subsidy appeared to be the most popular in both target areas. This fact makes sense where few people choose to vanpool. If commuters were clamoring to vanpool, search costs would be low and fare discounts would then draw commuters' attention. But where vanpoolers are scarce, search costs can be reduced by permitting vanpools to operate only partly full.

The Guaranteed Ride Home (GRH) was offered only in the I-90 Corridor. Commuters to the test area who used an HOV mode at least three times per week were eligible to use the program. By the end of the Easy Ride program, only 28 percent of those eligible had signed up for it (*2*). The failure to register may have been because of lack of awareness of the program or because of lack of interest. There are few data to support either speculation. Roughly 40 percent of the I-90 Corridor employees could have been exposed to ETCs and commute option boards, the main sources of information about the existence of the GRH. But according to the last survey, no more than 17 percent of the I-90 Corridor employees were aware of it.

Thirteen percent of all GRH registrants had commuted alone to work shortly before registering for the GRH program (*2*). Whether GRH was the most compelling reason to abandon solo commuting is not clear. Focus groups on ridesharing conducted by Metro elicited comments from solo commuters who said that they needed more incentives than just GRH to get them out of their cars. In particular, they noted that if they were charged for parking or if there were more convenient transit service, they would consider abandoning solo commuting.

In the same focus groups, those who were already HOV users stated that they found the GRH program valuable. In addition, 70 percent of the respondents to a survey of GRH registrants reported that GRH was important to their decision to rideshare, and 50 percent said that GRH allowed them to continue ridesharing (*2*).

Actual usage of the GRH program was low. Over the 2 years of Easy Ride, 21 registrants took 24 trips, which accounted for 3.4 percent of the miles that could have been used under the program (*2*).

To trim time consumed by carpooling and vanpooling, the transportation coordinators in both target areas attempted to persuade employers to provide reserved parking close to building entrances. The response was minimal. Only 25 spaces were reserved in Bellefield, and 24 in the I-90 Corridor—enough for only 19 percent of the carpool and vanpool vehicles arriving in Bellefield–City Hall and 10 percent in the I-90 Corridor.

Employer interest was lukewarm at best. Unmotivated employers did not allow access to employees, failed to distribute promotional materials as promised, refused to provide transit or other subsidies, and declined to reserve rideshare parking or charge for parking. In addition, although many employers appointed on-site ETCs, it was made clear that the ETCs' primary allegiance was to their full-time jobs.

As a measure of employee interest, the number of employees who submitted ridematch registration forms was assessed. Relatively few employees completed and returned forms: 7 percent in the I-90 Corridor and 9 percent in Bellefield–City Hall. To put these figures in perspective, Southern California's Commuter Computer in the pre-Regulation XV days usually collected applications from 20 to 30 percent of a given employee population. Thus employee interest in ridesharing appeared to be low.

The Advisory Committees played fairly conservative roles. Management of the Easy Ride project was retained by Metro and the City of Bellevue, leaving the committee to assist with promotions and entry into firms. Interest in forming a TMA was low. When asked what would increase that interest, one committee member listed (a) severe local congestion; (b) complaints by employees that congestion impaired their mobility; (c) a requirement that employees pay for parking; and (d) improved Metro suburban transit service.

A surprising outcome in the Easy Ride effort was that unexpectedly large numbers of employees requested bus transit information. Bus patronage did not increase, however. Suburban bus service was not well matched to local commute patterns.

How Low Is Low Enough?

The final survey results indicate that Easy Ride did not lower the time, inconvenience, and monetary costs of ridesharing enough to stimulate demand for it. Easy Ride in fact offered fairly minimal reductions in the costs addressed here. How much of a reduction would have been enough?

With enough funding, Easy Ride could have reduced the cost of ridesharing much further than it did. Financial subsidies could have been extended to carpoolers (in the form of money, car washes, fuel, tune-ups, or the like). Firms could have been paid to reserve rideshare parking and grant ridesharers extra vacation time. Bus riders could have been given free or discounted passes. Vanpool discounts could have been enormously increased.

Even more expensive ways of lowering the costs to ridesharers might have been to install a coherent system of freeway HOV lanes, bring express (or luxury) bus service into Bellefield–City Hall and the I-90 Corridor, provide on-site fleet vehicles for midday trips, or furnish high-quality child care centers at outlying park-and-ride locations.

But to create significant, noticeable demand for ridesharing or transit, how high the financial subsidies should be, how many miles of HOV lanes are needed, where the bus service should be routed, or how many child-care centers should be built need not be known. How to make ridesharing competitive with the private automobile is not known although an enormous investment may be required. The results of Regulation XV in Southern California may eventually provide some idea of how low is low enough. Until then, trying to stimulate demand with positive incentives is experimental at best.

Raising the Price of Driving Alone

As documented elsewhere (*3,4*), the most effective way to increase ridesharing and transit rates is to attach a cost to single-occupant-vehicle (SOV) parking by either charging a fee or reducing the supply. Carpoolers park free or park near the building entrances. Solo commuters pay a fee or walk. The Easy Ride experience provided a few unexpected opportunities to measure the effects of parking shortages and parking fees.

In the descriptions of the Bellefield–City Hall and I-90 Corridor averages were used. In the case of Bellefield–City Hall, the average survey results masked two interesting variations at the building level. The drive-alone rate among City Hall's 400 employees decreased from 79 to 48 percent over the course of the Easy Ride program. The drive-alone rate for a company called Contel decreased from 80 to 70 percent over the same 2 years.

The story behind these figures is instructive. Before the Easy Ride program began, City Hall reported an alternative-mode travel rate of about 20 percent, which compares favorably with the 10 percent experienced by the rest of the Bellefield project area. City Hall had a long-standing rideshare program with an active ETC and a fleet ridesharing arrangement whereby carpooling employees could take city cars home free of charge.

Some parking problems had also begun to crop up at City Hall. As employee numbers grew, employees began to use visitor parking as well as employee slots. This practice forced visitors and employees into competition for the same parking spots, making parking more difficult for employees.

When the Easy Ride program began, City Hall began to offer additional subsidies to its work force: a $15-per-month subsidy to carpoolers, a $25-per-month subsidy to vanpoolers, and free passes to transit users. At the same time, City Hall began to monitor use of its desirable visitor parking close to the building. This practice forced drive-alone employees to park further away and thus exacted from them a time and distance cost. Carpoolers and vanpoolers, however, could park close to the building with the visitors.

Two months before the end of the Easy Ride program, City Hall began charging $30/month for parking, with free or discounted parking for carpools and vanpools. Although the fees were begun late in the program, they had been discussed for many months; employees believed for a year that they might be charged at any time.

The combination of ridesharing subsidies and services, monitored visitor parking, preferential parking, and parking fees (or the threat of fees) had a striking effect. By the end of the Easy Ride project, City Hall's drive-alone rate was 48 percent, in contrast to approximately 90 percent for the rest of Bellefield.

The Contel story is a less dramatic version of the City Hall story. Contel had just moved to Bellefield when Easy Ride was undertaken. The parking supply in its new quarters was inadequate. Unlike City Hall, Contel did not reserve parking for rideshare vehicles, charge for parking, or supplement the Easy Ride program with extra subsidies early in the program. It had only its parking shortage and a management committed to employee ridesharing as a solution to the parking problem. Contel exhibited a decline in solo commuting from 80 to 70 percent, which occurred during the first year of the Easy Ride program. During the second year of the program, the parking shortage eased because of company layoffs; at the same time, a $15/month vanpool and transit subsidy was introduced, and the rideshare held steady.

IMPLICATIONS OF EASY RIDE FOR POLICY MAKING

City Hall and Contel were the only institutions with parking problems, and they were the only ones to report an increase in ridesharing. The implication is straightforward. But what makes negative incentives work when positive incentives do not?

One reason, of course, is the cost. Requiring employees to hunt for parking spaces (or walk farther to the office or pay for parking) attached relatively large costs to a mode that in the past had little out-of-pocket cost. This change narrowed the gap between the cost of ridesharing and the cost of driving alone. In the City Hall case, the provision of substantial ridesharing and transit subsidies reduced the cost disparity even further.

To obtain some idea of the lower costs offered by City Hall's actions, consider the following: carpoolers to City Hall began receiving $180 year (and shared fuel costs). Vanpoolers received $300 (in turn they paid annual vanpool fares of approximately $720 but shared fuel costs). Solo commuters received nothing; instead, they had to pay $360/year for parking (and to bear the full cost of their vehicles' fuel). Carpoolers and vanpoolers could park near City Hall, realizing a time savings, whereas solo commuters were required to walk some distance to work. In addition, the on-site employee transportation coordinator provided ridematching, transit information, and assistance in forming carpools and vanpools, services that helped employees choose new travel modes by reducing transaction costs. From the results, it was clear that the cost gap was narrowed to the point that considerable numbers of employees were willing to make alternative transportation arrangements.

But costs alone may not be the only motivating factor. Research indicates that if it is possible to intrude on employ-

ees' habitual commute activities, the chances of diverting the employees into ridesharing are considerably increased (*5*). The intrusions can be permanent, as in applying parking charges, or temporary, as in relocating a firm. (But if the intrusion is temporary, its effect may need ongoing reinforcement.)

Mandatory disincentives or shocks like relocation intrude into commuters' lives and force them to make an unpleasant change—if their company has moved, they must pay out more money, walk a longer distance from the parking lot, lose privileges they once held, or commute farther. Once commuters have been forced to alter their behavior, many become willing to consider transportation options that they had previously ignored.

Contrasted with the overall Easy Ride results, the City Hall experience offers interesting implications for policy making. It suggests that a combination of substantial positive and negative incentives can be the most effective approach to trip reduction. This combination of approaches offers advantages in low-density office park settings, where exceptionally high parking charges or other major disincentives to driving alone are out of the question. In this environment, working the cost issue from both the incentive and disincentive sides seems most effective. In other words, policy makers should attempt to narrow the gap between the costs of ridesharing and the costs of driving alone by lowering the cost of one while raising the cost of the other.

FUTURE DIRECTIONS

The difficulty, of course, is to surmount the political and legal barriers so that the costs of solo commuting can be raised and imposed on commuters, either through employers or through direct government mandate. The suburbs are particularly difficult for imposition of strict regulation, because the private sector does not perceive a need for, and would oppose, mandatory measures. After all, parking is abundant, and buses do not provide good alternative transportation. Further, many employers chose suburban locations expressly for driving convenience. Imposing aggressive ridesharing regulations on suburban areas appears almost insurmountably difficult, absent an unusually strong public policy arising from air quality or growth management laws.

Even supposing that a municipality were successful in requiring suburban employers to charge employees for parking and to provide ridesharing incentives, successful enforcement is the question. For Bellevue and other cities, it may be difficult to monitor and enforce TDM regulations that apply to a large population of small employers.

However, it is not clear what other choices remain. Bellevue is exploring, along with Metro and other jurisdictions, the possibility of levying a tax on parking. Whatever the outcome of the parking tax research, it is clear that a do-nothing approach will not long be tolerated by the citizens of fast-growing communities like Bellevue. Programs of voluntary incentives appear to be expensive versions of the do-nothing approach—unless the incentives can be made far more substantial than those offered by the Easy Ride program. Even then, as noted earlier, the investment that must be made to increase ridesharing and transit use cannot be predicted. The required investment may be beyond the means of any municipality or public agency.

Although Bellevue has less enthusiasm now for publicly funded employer programs in TDM, for now there seem to be few other alternatives. Until progress is made on parking taxes or removal of legislative barriers to employer regulation, formidable obstacles will remain in the path of suburban ridesharing for jurisdictions like Bellevue. Meanwhile, the city of Bellevue and Metro are pursuing further research in voluntary programs, especially those focusing on expanding the involvement of employers.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the helpful comments of Tom Noguchi, Peter Valk, and Kenneth A. Small. Data presented in the report were supplied by the Municipality of Metropolitan Seattle (Metro).

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The opinions expressed in this report are those of the authors and are not intended to represent the official positions of the city of Bellevue or Metro.

Publication of this paper sponsored by Committee on Ridesharing.

Ventura Freeway Vanpool Support Program

MICHAEL R. KODAMA, JOHN J. PANKRATZ, AND MARGARET MOILOV

The Ventura Freeway Improvement Project Vanpool Support Program (VSP) discount strategy is examined. This program was used to introduce Ventura Freeway Corridor commuters to vanpooling. Results from the project indicate that changes in travel behavior were price sensitive in that 673 commuters were willing to make the trade-off between lower fares and the value placed on privacy and convenience in order to sample vanpooling.

In February 1988, the California Department of Transportation (Caltrans) began extensive reconstruction work on a 7.4-mi segment of the Ventura Freeway (U.S. Route 101) in the San Fernando Valley (see Figure 1). To accomplish the needed work on one of the nation's busiest freeways, Caltrans developed a comprehensive traffic management plan that included a high-profile public information campaign, a local access route to ease traffic in a portion of the construction area, a roving service patrol to assist motorists with disabled vehicles, a 24-hr project information telephone hot line, changeable freeway message signs, freeway advisory radio broadcasts, and a reduced-fare vanpool program.

COMMUTER TRANSPORTATION NEEDS

Caltrans analyzed the ridesharing potential for the Ventura Freeway corridor by looking at the following community characteristics:

1. The west San Fernando Valley has a significant population of affluent, middle-class professionals commuting to distant employment centers.
2. Significant employment sites within the study area included suburb-to-suburb long-distance commuters with limited alternatives to solo driving.
3. Available local bus service existed throughout the San Fernando Valley. Express bus service was available to downtown Los Angeles or Westwood–Los Angeles International Airport.
4. Over 100 vanpools used the corridor before construction. Demographic and commute patterns suggested that solo commuters were likely vanpool candidates.

Ridesharing, with an emphasis on vanpooling, was included as a component of the traffic management plan because of its capacity for reducing the number of drive-alone vehicles and low-occupancy carpools driving through the reconstruction corridor. The FHWA provided funding. Caltrans was responsible for program administration. Commuter Transportation Services, Inc. (CTS), the local rideshare agency, provided marketing support, and a public information contractor assisted with publicity and marketing collaterals.

Until the Vanpool Support Program (VSP), the rideshare industry's most popular promotional strategy to generate vanpool start-ups was the empty seat subsidy that stabilized fares while additional passengers were being recruited. The VSP fine-tuned this strategy and refocused it on the individual commuter, so that the incentive was to risk a temporary (at least 1 month) change in travel behavior. A 92 percent retention of ridership later confirmed the effectiveness of the VSP discount strategy. The VSP offered discounts that directly reduced each passenger's share of the monthly cost. Each qualified vanpooler received 6-month fare reductions on the basis of the following monthly schedule:

Month	*Percent Discount*
1	50
2	40
3	25
4	15
5	10
6	10

A qualified VSP candidate was a construction corridor commuter who had neither been a recipient of VSP funds nor vanpooled during the previous 6 months before making application for the program. A qualified (new or existing) vanpool had to have a minimum of eight paying passengers as of January 1, 1988, and thereafter. To further encourage vanpool formations, vanpools with seven paying passengers were permitted one empty seat for 1 month, counting it as a paying passenger for the purpose of fare calculations and program qualification. The program, tied to the construction schedule, concluded on October 31, 1989.

PROCEDURES

To form vanpools, employers, van-leasing companies, or individuals worked with Caltrans or CTS. Once Caltrans approved an applicant for a new or existing vanpool, that individual was eligible for 6 months of fare reductions. Depending on the van provider, two methods of fare collection were used. Under the first method, individual fares were reduced at the beginning of each month, with the van provider billing Cal-

M. R. Kodama and J. J. Pankratz, Metro Transportation Services, P.O. Box 5961–184, Sherman Oaks, Calif. 91413. M. Moilov, California Department of Transportation, 120 South Spring Street, Los Angeles, Calif. 90012.

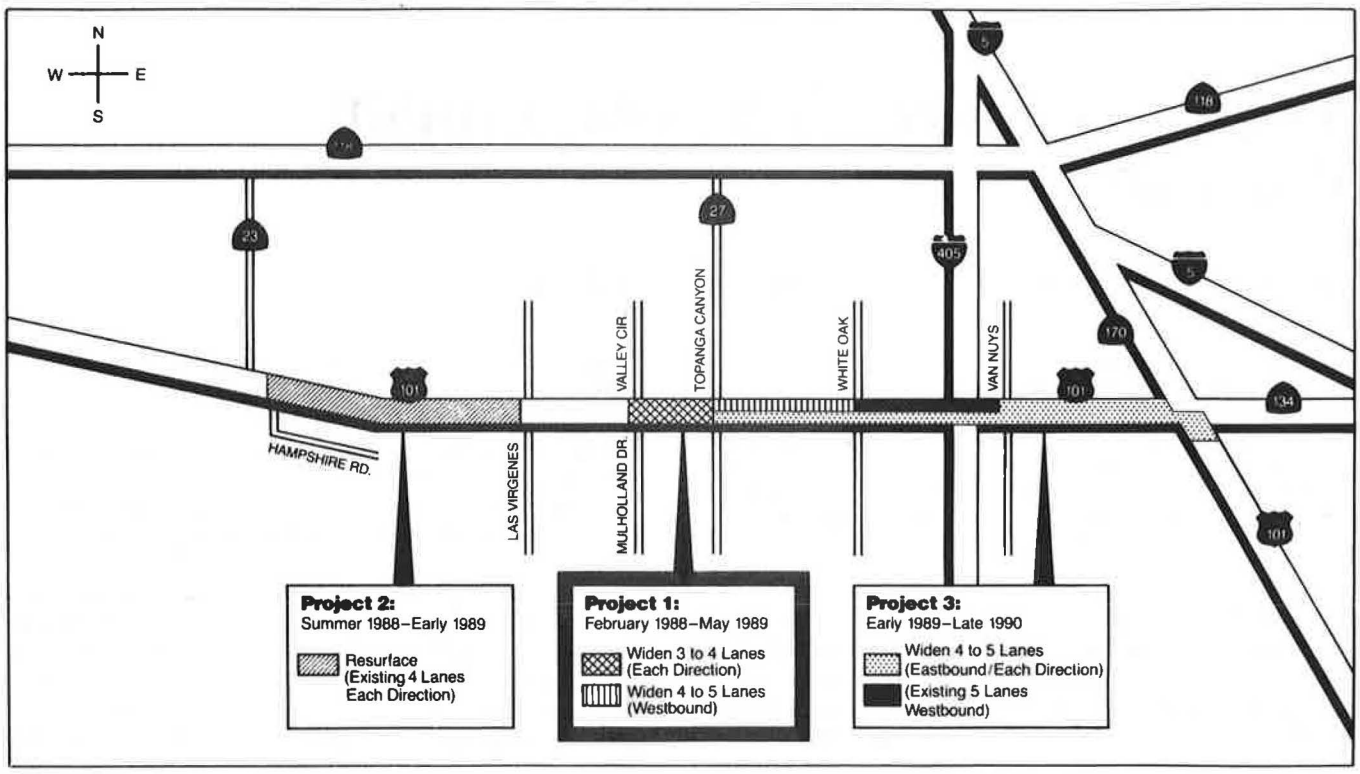

FIGURE 1 Overview of Ventura Freeway improvement projects from 1988 to 1990.

trans for the shortage. Under the second method, the van provider billed Caltrans for reimbursement of previously collected fares. Individuals then received their reimbursement.

The objective was to make the program flexible and consumer oriented. Vanpoolers could join at any time, permitting each qualified subscriber to have the benefit of the full 6-month fare reduction.

PARTICIPATION

During the 16-month campaign, 673 persons were converted to vanpooling, with 618 (92 percent) continuing to vanpool after the program concluded. The major reasons given for persons dropping out of vanpools were work schedule changes or changes in employment. Of 69 participating vans, more

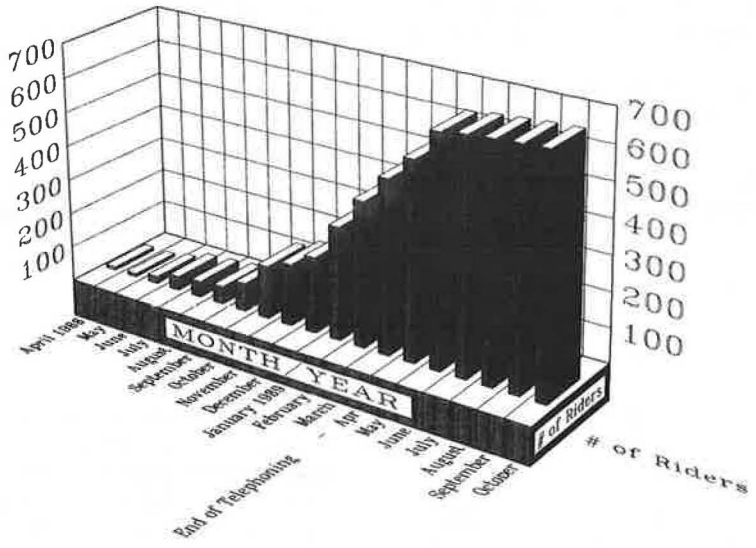

FIGURE 2 Ventura Freeway Vanpool Support Program (673 participating riders).

than 66 (95 percent) remained active after construction was completed. Among these vans, 23 (33 percent) were new vanpools that were organized as a result of the campaign. A total of 3,372 months of individual ridership was generated because of this promotional effort (see Figures 2 and 3).

ROUTE 101 PROJECT COST SUMMARY

The total program cost was $223,901.84. Of this amount, $65,261.94 was reduced fare payments. The Route 101 budget breakdown was as follows:

	Budgeted	*Expended*
Subsidy allotment	$250,000.00	$ 65,261.84
Baseline study	3,000.00	3,000.00
Printing	70,000.00	70,000.00
Marketing planning and collateral design	60,000.00	60,000.00
Program design	0.00	15,000.00
Administration	0.00	10,000.00
Total	$383,000.00	$223,261.84

The printing allocation was made to the regional rideshare agency. The marketing planning and collateral design allocation was made to the public relations contractor.

VANPOOL ORIGINS AND DESTINATIONS

The mean one-way commute trip for project vanpools was approximately 43 mi, with a mean commute time of about 64 min. The program experience suggests that the Ventura Freeway Corridor vanpool market tended to be middle class, low density, and 20 to 80 mi from employment centers.

The major vanpool work trip origins for the program were (a) Antelope Valley (Palmdale, Lancaster), in north Los Angeles County; (b) Conejo Valley (Thousand Oaks, Camarillo), in east Ventura County; and (c) West Los Angeles County (Santa Monica, Sawtelle, and Palms).

The major vanpool work trip destinations were (a) Conejo Valley (Thousand Oaks-Westlake Village), (b) Warner Center (Canoga Park-Warner Center-Woodland Hills), and (c) University of California at Los Angeles (UCLA) in Westwood (West Los Angeles).

ENVIRONMENTAL IMPACTS

Each new vanpool passenger trip represented a vehicle-miles traveled (VMT) reduction and a trip deleted from traffic. Air quality impacts were based on the standard vehicle average established for all vehicles in 1988 by the South Coast Air Quality Management District.

In order to determine the daily VMT reductions, the following formulas were used:

For existing vans,

$$\text{Daily VMT per month} = (2 \times \text{trip distance} \times \text{number of new vanpoolers in the month})$$

For new vans,

$$\text{Daily VMT per month} = [2 \times \text{trip distance} \times (\text{number of new vanpoolers in the month} - 1)]$$

VMT/day determines the mean air quality impact for each work day of the month.

Assuming that only solo drivers converted to vanpooling, the campaign produced a potential daily VMT savings of 45,156 (see Figure 3). Even if these vanpools did not eliminate cold starts, these VMT savings would result in desirable emission reductions.

In order to calculate the trip-reduction impact on the project corridor, the trip times were converted to average aggregate trip hours for the average morning peak load traffic period for each month of the project. All project vanpools traveled on the Ventura Freeway between Topanga Canyon Boulevard (Route 27) and Balboa Boulevard during the a.m.

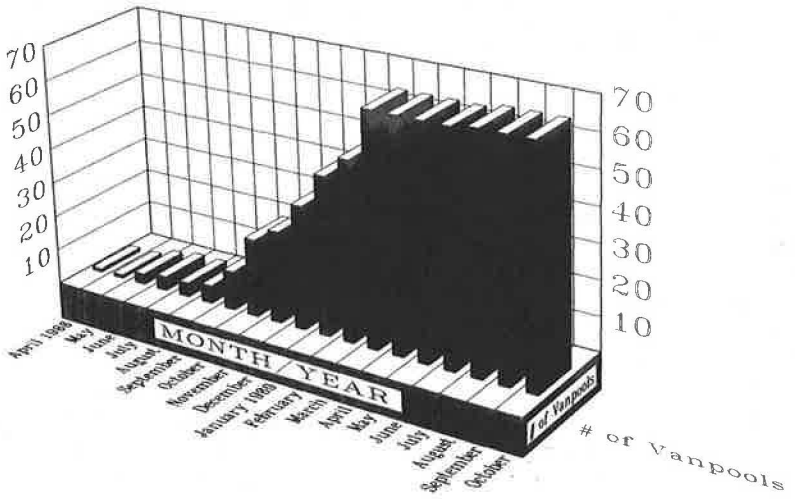

FIGURE 3 Cumulative numbers of vanpools participating in Ventura Freeway Vanpool Support Program.

and p.m. peak time periods. To calculate trips per hour saved, vanpool travel times were multiplied by the number of new passengers (as distinguished from drivers of new vanpools) for each month during the life of the project.

Caltrans identified the home-to-work trip direction for each vanpool. Twenty-eight vanpools traveled eastbound and 38 traveled westbound. Assuming solo drivers joined the vanpools, the program could have resulted in an eastbound trip reduction of 226 trip-hr and a westbound reduction of 288 trip-hr. The trip reduction had a westerly directional split of 56:44. This split excludes a westbound reduction of 33 trip-hr saved by two afternoon swing shift vanpools. The directional split of vanpool vehicles was 58:42 in a westerly direction.

The directional split reflects the fact that two of the employment centers were major trip destinations located at the west end of the construction project corridor. It also suggests that employers in major centers of the eastern end of the corridor and beyond (Encino, Sherman Oaks, Van Nuys, Studio City, Universal City, Burbank, Glendale, Pasadena, Westwood, Century City, Hollywood, Wilshire Center, and downtown Los Angeles) merited a heavier promotional effort. Time constraints and limited staff resources prevented this additional work.

PROGRAM MANAGEMENT AND PROMOTIONAL EFFORT

In 1988, the Caltrans Public Transportation and Ridesharing Branch and CTS signed a memorandum of understanding that outlined their respective roles for this project. Caltrans agreed to administer the program and CTS took the responsibility of promoting the program with its network of client employers. Communication with the mass market of commuters was the result of media exposure facilitated by the public information contractor. CTS concentrated its efforts on employer outreach using posters, brochures, and a program information manual.

From January 1988 until August 1988, CTS conducted workshops, telephoned employers, and generally promoted the vanpool discount program. Despite this effort, few program applications were generated. At first, it was concluded that other elements of the transportation management plan were so effective in eliminating construction area congestion that commuters had no incentive to try vanpooling. Although the conclusion seemed plausible, a shift in promotional tactics was made to test its validity.

From October 1988 until April 1989, two Caltrans staff members began telephoning employee transportation coordinators for 2 to 3 hr each day. This brought about an immediate and dramatic increase in the number of program applicants and vanpool placements (see Figures 2 and 3). The majority of program participants was directly attributable to the shift in promotional tactics. These findings were shared with CTS, but staffing demands did not permit them to participate in the telephone solicitation activity. After April 1989, Caltrans discontinued telephoning employers because of the impending completion of the construction project.

Despite efforts to create a user friendly program, some employee vanpool coordinators became confused and complained about the time-consuming paperwork and documentation requirements. Feedback indicated that invoicing and subsidy disbursements needed to be distributed in a more timely manner. Since completion of the project, the process has been simplified and extended to other corridors for further testing and refinement. Ease of use has become a priority in order to facilitate program usage by area employers.

Program accomplishment (673 vanpool placements with a 92 percent retention rate) and employer feedback suggest that the discount strategy was effective in attracting new vanpool riders. Unlike the subsidy of empty seats that targets commuters already committed to vanpooling, the discount strategy reaches out to a larger audience that includes the uncommitted as well. The uncommitted are the subject of much discussion among transportation demand management planners. They represent a large group of commuters whose travel behavior could be changed.

An unanticipated finding, after the conclusion of the campaign, was the potential of a vanpool-focused promotion to generate carpool placements. Not every vanpool candidate was placed. Perhaps vanpooling did not make economic sense because the work trip was less than 15 mi or sufficient ridership was not available. In those instances, carpooling may have been elected as an alternative. In addition, the heightened awareness created by the vanpool campaign may have stimulated carpool prospects to finally cross the decision threshold to start carpooling. This linkage was not recognized during the campaign, and hence carpool placements were not tracked. This phenomenon was subsequently discovered during a similar campaign for the 23–118 interchange construction project where numerous call-in inquiries were generated by a series of vanpool signs on both the freeway and on surface street locations.

Because of the potential for a larger number of vanpool and derivative carpool placements, the discount strategy, when compared with the empty-seat subsidy approach, is clearly the more cost-effective investment. Other programs such as the campaign on the 23–118 Freeway and the I-110 VSP have been patterned after the Ventura Freeway vanpool strategy.

In order to capitalize on this strategy, all promotional materials and advance work need to be prepared before executing the campaign. The cash disbursement accounting mechanism must be in place before going public, so that new participants receive payment in a timely and efficient manner. Caltrans observed that word-of-mouth informal communication of the discount offer was one of the important ways employers discovered and developed an interest in the program. In addition, if the participants did not receive their funds in a timely manner, they became disgruntled and voiced their complaints to others. In general, when paperwork was perceived to be too difficult, both individuals and employers began to lose their enthusiasm.

Staff efficiency and time management can be enhanced with the use of a project-specific computer program that tracks each van and produces a status and summary report on demand. Such a program can offer valuable support to program administrators and employee transportation coordinators in monitoring each van. In addition, the need to simplify forms and procedures (while meeting legal and contractual requirements) was recognized. The benefits to the project manager include reduced administration time, better quality control, and an improved ability to evaluate program effectiveness.

CONCLUSIONS

1. Changes in travel behavior were price sensitive in that 673 commuters were willing to make the trade-off between lower fares and the value placed on privacy and convenience in order to sample vanpooling. In addition, once the ridesharing habit was established, 618 (92 percent) of the new riders found that other vanpooling benefits improved their commute trip and continued vanpooling even though fares eventually doubled over a period of 6 months.
2. Reduced-fare vanpooling targets individuals, thus increasing placement opportunities. This occurs because this process not only stimulates new vanpool formations, but unlike empty-seat subsidy programs, it recruits passengers to fill empty seats on existing vans.
3. Direct telephone solicitation proved to be the most effective promotional activity whether or not an employee transportation coordinator or individual had previous knowledge of the discount offer. Most new vanpools and individual placements on existing vans were generated as a direct result of telephone interaction. As a consequence of this experience, it was concluded that even if all other promotional activities were abandoned, this single tactic could be relied on to deliver results.
4. The simpler and easier the application process, the more likely it is that people will apply for the program.

RECOMMENDATIONS

1. Reduce program duration from 6 to 4 months. This appears to be sufficient time to establish the vanpooling habit. Further, this would accomplish program objectives at a lower cost.
2. Simplify the application and administration process to maximize participation and minimize administrative time and expense.
3. Design a quick-response cash disbursement mechanism to reimburse qualified vanpoolers at the conclusion of the trial ridership period. Without streamlining the process, future VSP campaigns and participation would suffer.
4. Extend a comparable discount to buspoolers, because a buspool (charter bus) is essentially a large vanpool.
5. Monitor derivative carpool placements.
6. Continue the pretest-posttest method of determining continued program effectiveness in attracting riders.

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Publication of this paper sponsored by Committee on Ridesharing.

Effects of the 1989 Loma Prieta Earthquake on Commute Behavior in Santa Cruz County, California

PAMELA TSUCHIDA AND LINDA WILSHUSEN

The October 17, 1989, Loma Prieta earthquake in Northern California caused extensive damage to the region's transportation network and forced temporary commute modifications during the reconstruction period. Pre- and postearthquake commute characteristics on the major interregional highway connecting Santa Cruz County with the San Francisco Bay area are described and whether the enforced carpooling required during the highway reconstruction period caused any sustained changes in ridesharing behavior in this corridor is examined. On the basis of the two surveys conducted during and after the reconstruction period, it was concluded that 57 percent of survey respondents who were forced to carpool during the postearthquake reconstruction period chose to continue ridesharing after the highway returned to normal operations. Survey respondents indicated that the greatest incentives to continue carpooling were cost savings and ease of finding suitable carpool partners. Those who discontinued ridesharing most often cited irregular work hours as the reason. Implications for rideshare marketing are discussed.

On October 17, 1989, northern California was rocked by a 7.1 (Richter scale) earthquake. The epicenter of the Loma Prieta earthquake was located in the Santa Cruz Mountains 80 mi south of San Francisco. Damage to the region's transportation network forced temporary commute behavior modifications throughout the San Francisco Bay area.

The pre- and postearthquake commute characteristics on State Route 17, the major interregional highway connecting Santa Cruz County with the San Francisco Bay area, are described and whether the unique enforced carpool requirement during the postearthquake reconstruction period caused any sustained ridesharing behavior changes in this corridor is examined. Findings from two commuter surveys conducted in the reconstruction and postreconstruction period are presented and implications for rideshare marketing are discussed.

BACKGROUND

A coastal county located 50 mi south of San Francisco on the Monterey Bay, Santa Cruz County is separated from the San Francisco Bay area by the Santa Cruz Mountains. The primary access route into the county is State Route 17, a four-lane highway traversing 13 mi of mountainous terrain between Scotts Valley in Santa Cruz County and Los Gatos in Santa Clara County. Other routes into the county include State Route 1, a two-lane highway along the California coast, State Route 9, a two-lane road through the mountains into the San Lorenzo Valley, and State Routes 129 and 152, both two-lane roads in the southern end of the county (Figure 1). There are no high-occupancy-vehicle restrictions on any roads in the county.

Santa Cruz County Regional Transportation Commission, County Governmental Center, 701 Ocean Street, Room 406B, Santa Cruz, Calif. 95060.

Out-Commuting to Neighboring Santa Clara Valley

Out of a total Santa Cruz County workforce of 122,700 people (California Employment Development Department 1990), it is estimated that approximately 20 percent commute to work on Route 17—"over the hill"—into the Santa Clara Valley (also known as "Silicon Valley") or the San Francisco Bay area. This significant level of out-commuting can be attributed primarily to a major jobs-housing imbalance in the Santa Clara Valley, forcing Santa Clara Valley employees to seek housing in surrounding counties, and significantly higher-paying jobs in the Santa Clara Valley than in Santa Cruz County. In addition, Santa Cruz County is perceived as having a desirable suburban coastal environment in contrast to the more urban environment of the San Francisco Bay area.

State Route 17

Route 17 between Scotts Valley in Santa Cruz County and Los Gatos in Santa Clara County includes steep grades, sharp curves, few or nonstandard shoulders, and concrete median barriers. The posted speed limit is 50 mph. This segment ranks sixth statewide with 62 accidents/mile/year in 1989. Route 17 becomes Interstate 880 in San Jose.

Average daily traffic volumes on Route 17, the primary commute route over the hill, have increased significantly over the past 10 years, from 38,000 in 1980 to 59,000 in 1989. In addition to general population and traffic growth, much of this increase in traffic volumes is caused by increased commuting.

Route 17 handles most commodity movement to and from the county; there is a restriction on large trucks on Route 152 and on a portion of Route 9. With five major quarries operating in the county, large trucks loaded with sand and gravel slow to a crawl on the steep uphill grade. This has a significant effect on the capacity of the four-lane highway, especially when one sand truck tries to pass another.

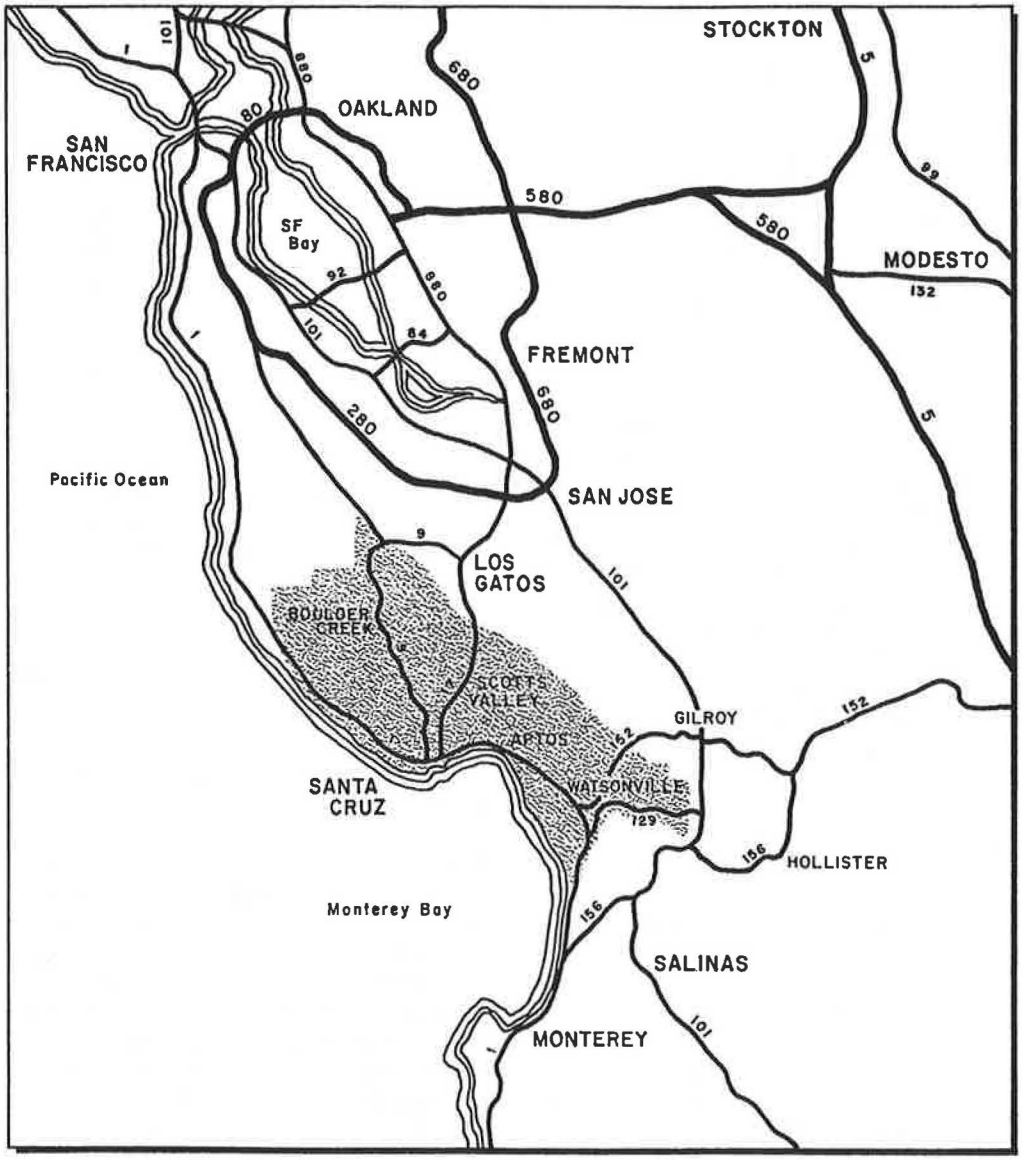

FIGURE 1 Regional location of Santa Cruz County.

Preearthquake Share-A-Ride Program

A Santa Cruz County share-a-ride program emphasizing ride-matching and marketing was instituted in 1979 with the objective of increasing vehicle occupancy countywide. It soon became clear that the primary local market for ridesharing was the Route 17 commuters; the longer commute distance and difficult highway conditions provide tangible incentives for commuters to consider ridesharing. Currently, 14 vanpools operate daily over Route 17. In 1989, vehicle occupancy on Route 17 during the a.m. peak was 1.23 persons/vehicle, compared with a ratio of 1.18 on Route 1, the major intracounty commute corridor.

In 1984, an annual rideshare open house was instituted at an inn conveniently located right off Route 17 in Santa Cruz. The annual event has attracted a high degree of media attention over the years and Route 17 commuters have become familiar with ridesharing options through this event as well as through informational highway signs, periodic media campaigns, special mailers, and other marketing programs.

OCTOBER 17 EARTHQUAKE

The October 17, 1989, Loma Prieta earthquake caused significant damage to the regional highway network. Route 17 was closed completely by four major landslides and other pavement damage; a bridge on Route 1 collapsed, forcing detours onto local arterials; three bridges on major local arterials were closed because of structural damage; and landslides and pavement damage closed many roads in the rural areas, including alternate routes over the hill. It was determined that restoring access to Route 17 was a high priority and efforts were concentrated on that issue in the following weeks.

Route 17 Operations During Reconstruction Period

In the days following the earthquake, local officials pressed California Department of Transportation (Caltrans) officials to provide limited access to Route 17 commuters during the repair period. An interim plan was drafted that attempted to balance Caltrans' need to clear hundreds of thousands of tons of dirt and rock off of the highway with local residents' need to get to work over the hill, as well as to the airport and other facilities in San Jose; mountain residents' need to access their homes, many of them damaged and without water or other services; and the need to maintain access for trucks, emergency vehicles, and construction equipment.

On the sixth day after the earthquake, Highway 17 was opened to carpools of three or more persons. Convoys of about 100 vehicles were led over the highway by California Highway Patrol (CHP) officers, using one lane in each direction to bypass the landslide-damaged areas; speed was limited to 35 mph. Trucks were allowed between 8 p.m. and 5 a.m. only and transit vehicles, mountain residents with a pass, and emergency or construction vehicles were allowed at any time. A checkpoint on each side of the mountain was manned by two different CHP divisions.

The first week of this operation was chaotic. Enforcement of the carpool restriction by the two CHP divisions was inconsistent; it was unclear to the public, the CHP, and Caltrans whether the carpool requirement was two or three persons; and the number of single-occupant drivers with mountain resident passes seemed to multiply a hundred-fold. Repair operations were being hampered by the volume of traffic on the highway and the few available alternate routes were jammed. Travel times over the hill increased from 40 min under normal operations to 2 to 4 hr.

By the end of the first week, local and state officials agreed to modify the requirements and to enforce them consistently throughout the repair period. The carpool requirement was reduced to two persons and carpools were allowed during the peak periods only, from 5 a.m. to 9 a.m. and from 3 p.m. to 7 p.m.; other restrictions remained the same.

Emergency Transit Services and Other Transportation Options

In addition to the reopening of Route 17 under restricted operation, Caltrain commuter rail service between San Francisco and San Jose was temporarily extended along the existing Southern Pacific Railroad (SPRR) line from San Jose to Salinas, with a stop in south Santa Cruz County. New public bus transit service was also instituted over Route 17 by Santa Clara County Transit, in cooperation with the local Santa Cruz Metropolitan Transit District, and new park-and-ride lots were designated.

When employers and commuters called the Regional Transportation Commission for information on rideshare matching, emergency transit services, or road restrictions, they often volunteered information on other options being used to cope with post-earthquake highway restrictions. Some Santa Clara County employers set up temporary vanpools for their Santa Cruz County residents; others subsidized hotel expenses to enable their employees to remain in the vicinity rather than drive over the hill every day. Some commuters stayed home and telecommuted 1 day or more per week; others stayed with friends or family over the hill.

Those who chose to use alternate routes, primarily Route 9, found extensive delays and long travel times; a temporary signal on Route 9 in Boulder Creek was installed to mitigate some of the problems caused by doubling traffic in that corridor. The public was kept informed about road closures and detours, highway restrictions, alternate routes, new transit services, and other options by daily press releases and media contacts.

Normal Operations Restored One Month Later

Route 17 was restored to normal operations 1 month after the earthquake. Caltrain service to Salinas was abruptly discontinued 1 week earlier because of liability insurance complications. The new public transit service over the hill, the Highway 17 Express Bus, is still in operation, although its long-term future is uncertain because of financial considerations. Approximate daily ridership on this route is currently 700; the service has attracted a vocal and active ridership and provides an economical and convenient alternative to automobile commuting over the hill.

Share-A-Ride Program Response After the Earthquake

In response to the need of commuters to establish carpools, the Share-A-Ride program went into high gear before and following the reopening of Route 17 under the enforced carpool requirement and other operational restrictions. All available Regional Transportation Commission staff, advisory committee members, temporary help, and friends who volunteered their services, were recruited and trained to provide instant ridematching services on an extended schedule.

In the first 2 weeks after the earthquake, the program enrolled approximately 900 applicants, which is equivalent to the number of applicants normally enrolled in 1 year. It is assumed that many other carpoolers found each other through their workplace or in their neighborhood.

Before the earthquake, share-a-ride callers had to wait 5 to 7 days to receive a computer matchlist of potential rideshare partners by mail. After the earthquake, share-a-ride set up a manual ridematching system that permitted callers to be instantly matched and given names and telephone numbers of possible carpool partners over the phone. Current information on the Highway 17 Express Bus and the South County Caltrain service was also provided. This approach proved to be one element in the success of the enforced carpool restriction on Route 17.

POSTEARTHQUAKE ROUTE 17 COMMUTER SURVEYS

Survey Objectives

The primary objective of the Route 17 Commuter Carpool Survey Project was to identify changes in the frequency of

ridesharing by commuters who were subjected to carpool restrictions on Route 17 during the postearthquake reconstruction period. The secondary objective was to identify Route 17 commuter attitudes and perceptions about ridesharing.

The survey results indicate the extent to which the temporary enforced carpooling was followed by changes in ridesharing behavior for survey respondents. In addition, the survey results suggest marketing strategies to increase ridesharing.

Methodology

Two surveys were conducted, the first while Route 17 carpool restrictions were in place, the second 6 months later. The questionnaires of both surveys had eight multiple-choice questions and ended with an open-ended question regarding the Route 17 commute. Survey results were compiled and analyzed using the statistical analysis and data management program, SPSS/PC+. Each survey was pretested on 10 individuals.

To encourage a large response for each survey, commuters who returned the forms and included the optional name and address were eligible for one of six prize drawings. In addition, an open-ended question asking how to improve the Route 17 commute also may have encouraged individuals to respond. Finally, the controversy surrounding enforced carpooling itself probably increased the willingness of commuters to complete and return the questionnaire.

The discussion of results only pertains to survey respondents. No attempt was made to conduct a random-sample survey.

First Survey

A total of 2,000 questionnaires was distributed over a 2-day period to each vehicle occupant on the Santa Cruz County side of the highway during the morning commute hours of 5 to 9 a.m. at the Route 17 CHP carpool convoy checkpoint a few days before Route 17 was restored to normal operations; 587 (29 percent) of the forms were completed and returned by prepaid return mail.

Second Survey

Six months later, in April 1990, the follow-up questionnaire was mailed to the 565 respondents of the first survey who had provided their names and addresses. Questionnaires were color coded on the basis of intent to continue ridesharing indicated from the first survey; 187 (33 percent) of the follow-up questionnaires were answered and returned.

DISCUSSION OF FINDINGS

Changes in Frequency of Ridesharing

The extensive damage caused by the Loma Prieta earthquake and the reconstruction that followed forced changes in daily commute habits. The question was whether enforced carpooling during Route 17 earthquake repair caused any changes in commuter attitudes towards ridesharing.

Intent to Continue Ridesharing

In the first survey, respondents were asked to indicate their frequency of ridesharing 1½ months before the earthquake. In September 1989, almost half of the survey respondents (47 percent) did not rideshare at all; 28 percent shared rides every day; 10 percent shared a ride 3 to 4 days per week; and 14 percent shared the ride 1 to 2 days per week.

When survey respondents were asked if they intended to continue ridesharing after Route 17 was repaired and reopened to normal conditions, the majority (62 percent) said yes, 23 percent said no, and 16 percent were uncertain.

Table 1 is a cross tabulation between preearthquake rideshare frequency of survey respondents and their intent to continue ridesharing after Route 17 resumed normal operations. As the table indicates, of the respondents who did not rideshare before the quake, 31 percent said that they intended to continue ridesharing after carpool restrictions were lifted, 41 percent said that they did not plan to continue ridesharing, and 28 percent were uncertain.

The reasons selected by survey respondents who indicated that they planned to return to driving alone were irregular work schedule (54 percent), need car for work (19 percent), carpooling is inconvenient (14 percent), other (7 percent), personal preference (4 percent), carpooling takes too long (2 percent) and incompatibility with carpool partners (1 percent).

Rideshare Frequency in January 1990

The second survey asked respondents whether they shared a ride in January 1990, 1½ months after Route 17 returned to normal operations and ridesharing mandates were lifted.

TABLE 1 RIDESHARE FREQUENCY BEFORE LOMA PRIETA EARTHQUAKE VERSUS INTENT TO CONTINUE RIDESHARING AFTER ROUTE 17 RESTRICTIONS ARE REMOVED

		HOW OFTEN DID YOU RIDESHARE PRIOR TO THE EARTHQUAKE?			
		Every day	3-4 days /wk	1-2 days /wk	Not at all
DO YOU INTEND TO CONTINUE RIDESHARING AFTER HWY. 17 IS REOPENED?	Yes	98%	93%	60%	31%
	No	1%	4%	23%	41%
	Don't Know	1%	4%	18%	28%
		n = 164	n = 83	n = 58	n = 273

Previous Carpoolers

Figure 2 shows the number of survey respondents who had been sharing rides before the earthquake, their intent to continue or discontinue ridesharing, and whether they actually shared a ride in January 1990.

Fifty-three percent of the first survey's respondents shared a ride before the earthquake. Of the total number of first survey's respondents who shared a ride before the earthquake, 87 percent intended to continue ridesharing after carpool restrictions were lifted, 8 percent intended to resume driving alone, and 5 percent were uncertain whether they would rideshare or resume driving alone.

A total of 187 of the second surveys were returned; 97 (52 percent) were from individuals who had shared a ride before the earthquake; 86 (89 percent) of these individuals continued to rideshare in January 1990, whereas 11 (11 percent) stopped ridesharing.

This latter group of 11 preearthquake carpoolers who were postearthquake noncarpoolers is of particular interest. Five of these individuals stopped carpooling over Route 17 because their commute had changed; they either moved closer to work, moved away to find another job, or found a new job closer to home.

Other survey responses by this particular group indicated that irregular work hours and the need for a car for work prevented them from continuing to carpool after the earthquake although they were ridesharing before the earthquake. When they were contacted by phone, these respondents elaborated that their change in attitude was in part influenced by the disaster; some were worried about being caught in the Route 17 congestion during another earthquake and asked that their hours be changed.

Others quit their regular carpool so that they could drive their own vehicles. By having their personal vehicles accessible to them at their workplace, these commuters felt that they could respond more quickly to their families' needs in an emergency without having to rely on their carpool drivers.

Carpool Converts

Figure 3 shows the numbers and percentages of survey respondents who did not rideshare before the earthquake, their intent to continue or discontinue ridesharing, and whether they actually shared a ride after the earthquake in January 1990.

Forty-seven percent of first survey respondents did not rideshare before the earthquake. Of the total number of first survey respondents who did not rideshare before the earthquake, 33 percent intended to continue after carpool restrictions were lifted, 38 percent intended to resume driving alone, and 29 percent were uncertain whether they would rideshare or drive solo.

Almost an equal number of preearthquake noncarpoolers (90) completed and returned the second survey as preearthquake carpoolers (97) discussed in the previous section.

Of the surveyed individuals who did not rideshare before the earthquake, more than half (51 individuals or 57 percent) continued to rideshare in January 1990, whereas 39 individuals (43 percent) stopped ridesharing over Route 17.

Of particular interest in the results of the second survey is the actual rideshare behavior of individuals who said in November that they did not intend to continue carpooling. Of the survey respondents who indicated that they did not rideshare before the earthquake and did not intend to continue ridesharing, 24 percent actually continued to rideshare in January 1990. Of this preearthquake noncarpooling group, those who were uncertain whether they would continue to carpool were split in their actual behavior, with 55 percent ridesharing in January and 45 percent driving alone. Eighty-six percent

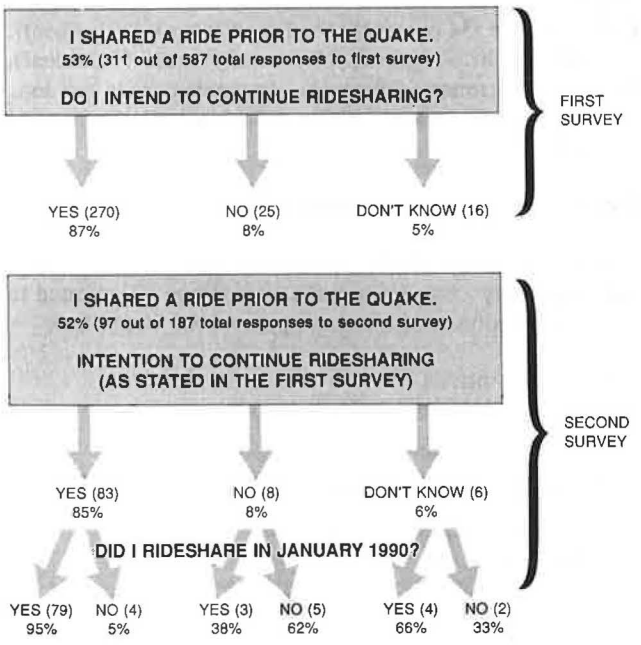

FIGURE 2 January ridesharing behavior of individuals who shared a ride before the earthquake.

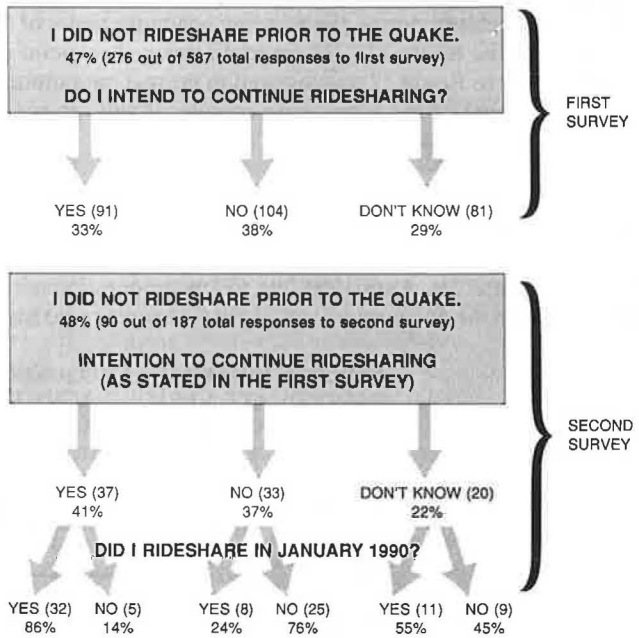

FIGURE 3 January ridesharing behavior of individuals who did not rideshare before the earthquake.

of those that intended to rideshare did actually rideshare in January.

Of these prior drive-alone respondents who indicated that they continued to rideshare after the earthquake, over half (52 percent) shared a ride every work or school day, 26 percent shared a ride 3 or 4 days per week, and 22 percent shared a ride 1 or 2 days per week.

What convinced them to continue to rideshare although the Route 17 ridesharing mandate was removed? Forty-two percent of this group of postearthquake carpool converts found the cost savings of ridesharing the best reason to continue. The second largest response was the people with whom they shared the ride (22 percent), followed by the enjoyment of ridesharing (12 percent), environmental preservation (12 percent), and finally, less stress (10 percent).

Some of these carpool converts indicated changes that made possible their switch from driving solo to doubling or tripling up. Several individuals noted on their surveys that their employer allowed them to adjust their hours to carpool successfully. Other respondents stated that they better coordinated their work schedules with carpool members.

Finding a compatible carpool and the camaraderie among rideshare partners was the second strongest reason to continue carpooling or vanpooling. It suggests that the Route 17 enforced carpool requirement prompted commuters to make the necessary changes and to find other commuters who shared or could easily share commute times and destinations. Once this relationship (and the carpool) was established, the carpool continued although the mandate to rideshare was lifted.

Persistent Solo Drivers

The survey provided information about the population of commuters who drove alone before the earthquake, shared a ride while Route 17 was being repaired, but were still persistent on resuming driving alone when the highway resumed normal operations. This group of persistent solo drivers is also shown in Figure 3; they composed 43 percent of survey respondents (39 individuals) who stopped ridesharing over Route 17 after it reopened.

The majority (60 percent) of these individuals indicated that they had irregular work schedules and terminated their rideshare arrangements. Twenty-two percent halted ridesharing because it was inconvenient, 8 percent because of personal preference, 5 percent for miscellaneous reasons, and 2 percent each for a change in work schedule and a change in ridesharing partners.

The other survey choices, change in residence or change in work location, were not chosen by survey respondents as factors in ending the ridesharing arrangement after the highway reopened.

Rideshare Marketing Implications

In addition to surveying the change of Route 17 ridesharing behavior after the earthquake repairs were completed, the questionnaires asked commuters about changes resulting from ridesharing, reasons for not sharing the ride, and incentives to increase ridesharing.

Changes Resulting from Ridesharing

Respondents to the second survey who continued to rideshare after the earthquake were asked to select the biggest changes experienced as a direct result of ridesharing. From a list of six options, respondents could choose as many as they wanted. The selected changes are shown in Figure 4 by the order of frequency. It should be noted that the over-the-hill commute is significant—at least 13 mi one way over the Santa Cruz Mountains.

Of the respondents to the second survey who continued to share the ride in January 1990, 22 percent cited saving money and 22 percent cited less wear and tear on their vehicle as direct changes produced by ridesharing. The cost of driving alone versus cost savings of ridesharing seems to be the major recurrent incentive towards ridesharing.

Twenty-one percent cited less stress as attributable to ridesharing. This might be especially true for Route 17, which is known for its steep grades, sharp curves, limited sight distances, and narrow shoulders.

Eighteen percent cited environmental preservation, 13 percent cited better use of time, and 4 percent cited meeting new people as changes ascribed to ridesharing.

Reasons for not Sharing Ride

Of the respondents who never shared a ride before the earthquake, an irregular work schedule was cited by 56 percent as the primary reason for driving alone. Other inhibitors to ridesharing included needing the car for work (16 percent), not knowing any potential pool partners (10 percent), the inconvenience of carpooling (9 percent), personal preference (5 percent), miscellaneous reasons (4 percent), and ridesharing takes too long (0.2 percent).

The inability to rideshare because of an irregular work schedule is a barrier to ridesharing echoed by many commuters in this survey as well as in other studies. However, work hours may not be as irregular or unmatchable as perceived.

One survey respondent commented, "I work 6 a.m. to 3 p.m. Who would share such odd hours?" Actually, in the

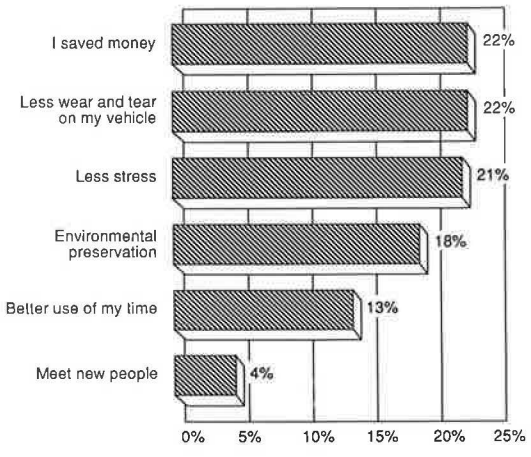

FIGURE 4 Changes resulting from ridesharing on the basis of 481 responses.

current Santa Cruz Share-A-Ride data base of 868 registrants, at least 10 percent stated that they actually worked or preferred the hours of 6 a.m. to 3 p.m. or had flexible enough schedules where they might be able to work that shift.

The second highest inhibitor to ridesharing indicated by survey respondents was the need for a car for work purposes. Specific respondents' comments implied that several of these individuals were involved in sales or service-oriented professions that required the use of their personal vehicle. However, needing a car for work does not exclude these individuals from ridesharing, because many current drivers of carpools can use their vehicle during the day while their passengers do not.

Several respondents indicated that they might be willing to leave a vehicle over the hill for workday purposes and then commute over Route 17 using alternative transportation, like train service, if that service were attractive and available.

Biggest Incentive to Resume Ridesharing

Several second-survey respondents who stopped ridesharing after Route 17 reopened to normal operations were asked to select the greatest incentives needed to renew their interest in ridesharing. From a list of 10 options, respondents could choose as many as they wanted. The selected changes are shown in Figure 5 by the order of frequency.

Several respondents did not answer this question and included handwritten notes beside this question indicating that no incentives would be large enough for them to rideshare again. The questionnaire should have included that response as an option.

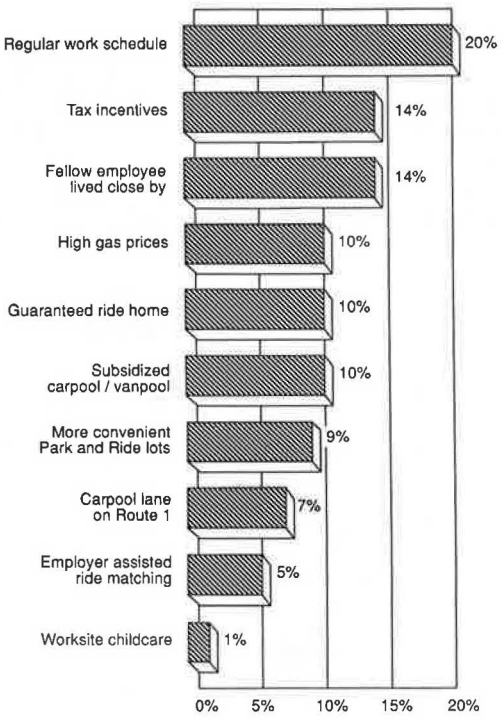

FIGURE 5 Incentives needed to resume ridesharing on the basis of 174 responses.

Of the second survey's respondents who stopped ridesharing after the carpool restrictions were lifted, 20 percent indicated regular work schedules, 14 percent cited tax incentives, 14 percent cited if a fellow employee lived close by, 10 percent cited high gas prices, 10 percent cited a guaranteed ride home, and 10 percent cited subsidized carpools or vanpools as incentives to resume ridesharing. Another 9 percent cited more park-and-ride lots, 7 percent a carpool lane on Route 1, 5 percent employer-assisted ride matching, and 1 percent worksite childcare as incentives to start ridesharing again.

According to these results, the broader implementation of flexible work hours to accommodate ridesharing, as was allowed by some employers temporarily after the earthquake, would assist in car- or vanpool formation. Bringing potential carpool partners together through small, focused home- or work-end match groups should also increase ridesharing.

To supplement more flexible work hours and improved information exchanges between potential carpool members, company vehicles should be made available for midday business and guaranteed transportation should be made available for individuals who must work late (or leave early) and miss their car- or vanpool.

NEED FOR ADDITIONAL RESEARCH

Despite the limitations in the methodology of the two surveys, the survey results indicate a potential promising hypothesis for further research: a high proportion of long-distance commuters will continue to rideshare given an adequate impetus to start sharing the ride in the first place. It would be necessary to conduct a statistically significant random sample survey of long-distance commuting population to test this hypothesis. Because of emergency conditions under which this study was conducted, such an effort was beyond the scope of this study.

CONCLUSIONS

Pre- and postearthquake rideshare frequency and Highway 17 commuters' attitudes about ridesharing have been examined through the analysis of surveys issued before and after enforced carpooling over Route 17 was in effect.

Although the number of the survey responses was small and there was no attempt to do a representative sample of Highway 17 commuters, some clear conclusions about the behavior of survey respondents can be made. The results of the two surveys indicate that mandated ridesharing over Route 17 did influence the ridesharing patterns of a number of survey respondents after the highway returned to normal operations. Of the second-survey respondents who did not rideshare before the earthquake, more than half (57 percent) continued to rideshare after carpool restrictions were lifted. Furthermore, more than half of these carpool converts shared a ride regularly every work or school day.

Several rideshare marketing implications can also be derived from the surveys' results. Increasing the awareness of the cost effectiveness of ridesharing versus driving solo remains a key factor in influencing commuters to leave their car at home. Cost savings was cited by survey respondents as

the strongest incentive to continue carpooling and as the largest change resulting from ridesharing. Additional cost savings was also a popular incentive for solo drivers to switch to ridesharing.

Increasing the cost savings of ridesharing can be accomplished through encouraging employer subsidization of carpools or vanpools, instituting rideshare tax credits or increasing the costs associated with driving alone.

This survey study suggests that commute alternative programs that focus on getting commuters to try ridesharing, transit, telecommuting, or other alternatives to driving alone have a potential for success in encouraging them to continue using these commute alternatives. This "try-it-you'll-like-it" approach can provide an incentive for commuters to rideshare on a trial basis similar to the postearthquake temporary enforcement of ridesharing over Route 17.

The information presented suggests that different approaches should be taken to address different groups of commuters. The Loma Prieta earthquake was the impetus for some individuals to modify their commute modes and patterns and start to rideshare. To persuade other commuters to use alternative transportation and leave their cars at home requires a collection of creative strategies to effectively counter their inclination to remain solo drivers.

Publication of this paper sponsored by Committee on Ridesharing.

Clean Air Force Campaign 1989–1990: Programs, Attitudes, and Commute Behavior Changes

RANDI ALCOTT AND MAUREEN MAGEAU DECINDIS

This was the fourth year of the Clean Air Force's "Don't Drive 1-in-5" campaign, a voluntary no-drive day program in Phoenix, Arizona. The campaign maintains a high level of awareness of 95 percent. Opinions are positive, with 89 percent indicating a favorable rating and 59 percent saying the campaign is likely to lower pollution levels. Half of the commuters indicated that it would be possible for them to rideshare at least once a week. Research also indicates a substantial increase in the number of people participating in alternative modes. This year, 36 percent of commuters used alternatives to driving alone (21 percent carpool; 15 percent bus, bike, and walk combined), up 80 percent from a year ago when only 20 percent of commuters used alternatives. The number of trips made by alternatives is also increasing, from about 18 percent of trips last year to this year's 22 percent. Commuter behavior changes are not expected to take place overnight, especially with the external factors working against them, including a decline in the price of gasoline from 1973 (inflation-adjusted), lack of density in residence and work locations, and lack of valley-wide bus service and bikeways systems. Over the past 2 years, an increase in bus ridership of 36.5 percent has been achieved, including a 13.3 percent increase this past year. The average number of riders has increased from 76,470 two years ago to 104,400 this year, an increase of 27,930 riders each weekday. Transit systems that enjoy ridership increases at all are achieving 2 to 5 percent boosts. All-day traffic counts did not exhibit statistically significant changes this year; however, an estimated reduction in peak period traffic of 2 to 3 percent occurred, equivalent to all-day reductions of 405,000 mi traveled and 5 tons of carbon monoxide emitted. Employers more than doubled their participation in the "challenges," the 1-week competition for the highest participation rates. Almost 100,000 employees from 81 employers participated. Community-wide events were aimed at getting people to try an alternative. Free bus day was a success with a 33 percent increase in ridership. Bike-to-work day and blue ribbon day, 1-day community-wide challenges, were also successful. The media task force played a major role in the success of the campaign and donated 1,803 radio and 1,935 TV public service announcements valued at over $750,000. Some 150 campaign volunteers helped expand the level of participation and in-kind services; donations totaled more than $202,000.

The year 1989–1990 marked the fourth year of the Clean Air Force Campaign. This campaign was designed to help solve the problem of carbon monoxide pollution in Phoenix, Arizona. The mission of the campaign was to decrease air pollution by asking drivers to reduce their vehicle-miles by not driving their car 1 day per week.

Regional Public Transportation Authority, 505 North Second Street, Suite 365, Phoenix, Ariz. 85005.

The goals of the campaign were to educate the public that automobile usage is the major contributor to carbon monoxide pollution, which causes certain harmful health effects; and to increase employer and employee participation in the program.

The specific objective was to reduce the average daily weekday trips by 4.0 percent, 2.1 of the 52.5 million miles driven daily, thereby reducing 40.5 tons of carbon monoxide.

The campaign consisted of sponsors, an advisory council, five task forces, a working group, and many community volunteers and professional staff. (See Figure 1 for the organization chart.) The sponsors, who are responsible for developing the overall policies, guidelines, and goals of the campaign, include the Arizona Department of Environmental Quality, the Arizona Energy Office, Maricopa County, the Phoenix Chamber of Commerce, and the Regional Public Transportation Authority (RPTA).

The campaign was organized into five task forces, each with a specific function, including media, government, business, health and education, and promotion. The task forces met frequently to help plan the campaign. They were responsible for planning and implementing the major elements of the campaign. The working group consisted of representatives from the major sponsors and staff members from each of the committees. This group met biweekly, thus providing the forum to discuss issues, exchange information, work out problems, keep the program on schedule, and provide overall direction.

GOVERNMENT TASK FORCE

Goal and Objectives

The goal of the government task force was to generate active involvement from the government sector.

The objectives included the following:

- Increase public employer participation in campaign from previous year,
- Increase participation levels in the challenge competition by exceeding last year's rate of 18.3 percent,
- Coordinate activities with the mandatory travel reduction program, and
- Integrate the high pollution advisory program into the public employer outreach program to maximize effectiveness.

FIGURE 1 Organization chart for the Clean Air Force Campaign.

Summary

Government jurisdictions throughout Maricopa County were active in the Clean Air Force campaign this year. During the course of the campaign, 23 jurisdictions and federal agencies were involved in promotion of the campaign effort.

Government jurisdictions sent representatives to all of the main campaign events including the campaign kick-off, free bus day, all challenge activities, blue ribbon day, and bike to work day. In particular, elected officials were active and visible participants in media activities.

Government jurisdictions have played an integral role in the success of the Clean Air Force Campaign and have contributed in a multitude of ways. Many of the larger jurisdictions are completing their fourth year in the campaign and these veteran participants have been an influential factor in the overall development of the entire program.

Government Challenge Week

During the week-long challenge event, 19 jurisdictions participated, an increase of 9 jurisdictions over last year. These jurisdictions represented over 43,000 employees; the overall rate of participation (percentage of employees using alternative modes) increased to 19.6 percent this year from 18.3 percent last year.

The challenge winners by flight (employee size) and participation rate were as follows:

Flight	*Participation Rate (%)*
City of Phoenix (over 10,000 employees):	25
City of Glendale (1,000 to 9,999 employees):	54.5
U.S. Housing and Urban Development (150 to 1,000 employees):	44.4
City of Avondale (50 to 149 employees):	32.3
Town of Cave Creek (under 50 employees):	100

Bike To Work Day Planning

Another major area in which the local governments had a great deal of input into the campaign was in the preparation of the bike to work day on February 28th.

Before this time, there had been no organized integration of bikeways between jurisdictions in Maricopa County. In the 7 months of planning this event, RPTA staff brought together bicycle and transportation planners from all the metro jurisdictions to develop a series of contiguous routes for the bike to work event. In addition to designing the map, the city of Phoenix coned off a route from Metro Center to downtown and many of the cities sponsored park and pedal events on February 28th. The long-term goal was to continue cooperation between the cities not only to incorporate bikeways into their transportation plans but also to emphasize the need for interconnecting bikeways.

Traffic Monitoring

Another area in which the government representatives were instrumental was providing assistance in traffic monitoring during the campaign. Under the direction of the Maricopa Association of Governments Transportation and Planning Office (MPO), the metro jurisdictions worked together to establish a comprehensive traffic monitoring program that was used throughout the course of the campaign. This work was all done on a voluntary basis and meant dozens of hours of time donated to the Clean Air Force Campaign by these traffic engineers from the cities of Phoenix, Mesa, Scottsdale, Tempe, and Glendale; and from Maricopa County and the Arizona Department of Transportation (ADOT).

BUSINESS TASK FORCE

Goal and Objectives

The goal of the business task force was to generate active involvement from the business community. The objectives were

- Increasing the number of employer commitments to participate in the overall campaign by more than 100 employers,
- Increasing participation rates and the number of firms in the 1-week business challenge competition by exceeding last year's rate of 8.2 percent and having over 25 employers participate,
- Coordinating the business outreach activities and promotions with the travel reduction program, and
- Integrating the high-pollution advisory program into the employer outreach program.

Summary

The business task force had a banner year in the recruitment and participation of the private sector. Under the chairmanship of Richard Hall, communications and public affairs manager at Bull Worldwide Information Systems, the committee has surpassed each of the previous 3 years, objectives in obtaining corporate support, commitment, and participation in the campaign.

General Workshops

The business task force was responsible for sponsoring four general campaign workshops that provided vital information on how to promote and participate in the campaign to over 88 valley organizations. The committee also held four challenge workshops to help explain the challenge week, promotional materials, and suggested and planned events.

Challenges

The overwhelming support of the clean air challenge was evidenced this year as 52 firms representing 56,000 employees formally participated in the challenge. This number was an increase from the 25 firms who participated the previous year and the 6 firms the first year. The committee also devised flights for different-sized companies so that each organization could compete against another of relatively the same size. These flights facilitated greater competition between firms and greater participation resulted. Law firms continued to have their own separate minichallenge as Meyer, Hendricks, et al. won the law firm minichallenge and Streich, Lang, et al. won the flighted minichallenge. AAA once again won in the micromini challenge. A complete listing of the challenge results is provided later. The overall participation rate of all 52 firms was 7.9 percent and a CEO bet for each firm was initiated as a motivating force to win in each challenge flight.

Events

The business task force was instrumental in ensuring the success of other campaign events. Free bus day realized a 33 percent increase in ridership even though there was much less publicity than last year because the San Francisco earthquake occurred the night before the event. More than 6,000 coupons were returned to the campaign for the blue ribbon day drawing and more than 1,500 coupons were returned for bike to work day. All these events illustrate the commitment and participation of private businesses in the campaign for both the benefit of their employees and as strategies to include in their travel reduction program plans.

Donations

Finally, the committee also secured donations to help defray many campaign costs. The following donated $2,700 for the final awards luncheon: Bull HN Information Systems; Streich, Lang, Weeks, and Cardon; U.S. West Communications; the Arizona Broadcasters Association; and Sundstrand. Valley National Bank sponsored a cocktail party for volunteers and the Phoenix and Scottsdale Chambers donated their time and support in soliciting the more than 300 prizes donated to the campaign. Allstate donated bus shelter advertising valued at more than $35,000 this year, the largest dollar donation of the campaign.

PROMOTIONS TASK FORCE REPORT

Goal

The primary goal of the promotions task force was to promote the campaign throughout the community and educate the public about the air pollution problem and its various solutions.

Objectives

- Creating widespread awareness and acceptance of the campaign throughout the community.
- Securing commitments to receive free advertising for the campaign through retailers, civic groups, and other organizations.
- Securing prizes for the clean air challenges.
- Conducting a poster contest for elementary school age children.
- Securing commitments to carry messages in organizational newsletters, promotional literature, grocery bags, marquees, cash register receipts, and other advertising media.

Summary

The promotions committee was busy this year under the leadership of Anne Wendell of the Scottsdale Chamber of Commerce. The primary objectives of the promotions task force were to secure in-kind gift donations for the challenges, to

coordinate the awards presentation, and to promote the campaign in a variety of different ways.

Prizes

More than 300 prizes were received this year for the participants in the clean air events. This number represented an increase of 237 percent from last year. The estimated value of the prizes was $15,000, an excellent response from valley retailers. The increase was caused by the special letters sent from the Phoenix and Scottsdale chambers of commerce.

Newsletters

A newsletter article with a schedule of events was sent to more than 1,000 community organizations with a request to run the article in their newsletters.

Marquee

The clean-air message ran on the coliseum message center for free bus day and blue ribbon day.

Library: Read a Book on the Bus Promotion

The Maricopa County Library District and Phoenix Transit created two posters for the read a book on the bus campaign. These posters were given to every library and put inside all buses. The county also produced a 30-sec public service announcement (PSA) with supervisor James Bruner.

Malls: Shop with a Friend Promotion

The shop with a friend reindeer crusade was kicked off with a press conference with Rudolf and scheduled visits with radio stations. Three key malls in the valley promoted the program by conducting drawings for prizes that they donated.

Driver Education Courses

Four informational fact sheets were sent to all the driver education teachers in the valley. Many teachers requested the clean air video.

Movie Slides

The only theaters in the Valley that ran clean-air PSAs were the Harkins Theaters. They ran clean air slides from October through February.

Bike-To-Work Day

There was cooperation from eight cities in developing the routes, which in some cases were especially set up just for this event. The event was publicized in all the Circle K stores, all 70 bicycle shops, 560 employers, all libraries, 1,500 Arizona Youth Hostel members, Multiple Sclerosis Society, Cystic Fibrosis Foundation, and the Tour de Tucson newsletter.

Arizona Hospital Association

The high-pollution advisory program and clean air campaign information was sent to all hospitals through the association.

Water Bills

Three clean-air articles were sent out to all valley residents through various water bill newsletters concerning the general campaign, blue ribbon day, and bike to work day. The city of Phoenix alone reached more than 200,000 households.

Emissions Testing

Hamilton Testing Systems incorporated an article into their booklet. This was handed out to 90,000 people per month.

Grocers Association

Posters were distributed to all grocery stores in October-November through the Association. In January, the major chains received logo artwork to print on the bags or in advertising. Fry's used the logo in its print advertising.

Unions

The Central Arizona Labor Council distributed 5,000 pieces of literature in conjunction with the flu shot program and printed articles in their newsletter.

Daycare and Senior Centers

Four major daycare centers including Children's World, Kindercare, Palo Alto Preschools, and Sunrise Preschools, with a total of 44 sites, received posters and brochures. All senior centers were sent a packet of information with ideas on how they could participate.

Poster Contest

The second annual clean-air poster contest was held. More than 5,000 grade school children participated representing 24 schools in 11 valley cities.

Bicycle Festival

The Clean Air Force Campaign sponsored a booth at the Ghoulzette Ride, which 3,000 people attended.

HEALTH AND EDUCATION TASK FORCE REPORT

Goal

The primary goal of the health and education task force was to educate the public on the health effects of air pollution.

Objectives

- Increase the level of understanding about the carbon monoxide problem;
- Increase the level of understanding of other harmful pollutants, their short- and long-term health effects, sources, and relationship to automobile emissions;
- Educate the elementary school age children about the pollution problem and transportation-related solutions; and
- Increase public awareness about the high-pollution advisory program.

Summary

The Health and Education Committee, as the newest committee of the Clean Air Force Campaign, has had two main goals this year. The two programs that the committee has been working on are (a) a high-pollution advisory media workshop, and (b) a curriculum on air quality for elementary age students.

Media Workshop

In September, the committee sponsored a high-pollution advisory media workshop for TV and radio personnel throughout the valley. More than 20 members of the media turned out for the workshop. A media briefing book was prepared that included information on the campaign, health effects, and pollution and provided a list of contracts. The workshop was videotaped for those who were unable to attend. The videotape was edited by the county down to 23 min and is available for any interested party to borrow and view.

Air Quality Bibliography

The committee has also produced a bibliography of resources on air quality for teachers that lists available curricula (both local and from other states), as well as field trips, videos, and a list of speakers.

Air Quality Curriculum

The committee has solicited and received two curricula from other states with air quality programs. It has received permission from both of these state agencies to edit and use any portion of the curricula without cost. The goal for the next year was to combine the best portions of these curriculums, add extension activities, and produce an accompanying teacher's guide, as well as provide in-service training for teachers who are using the curriculum. Private sponsors will be solicited to help defray promoting costs.

CLEAN-AIR MEDIA TASK FORCE

Goal

The primary goal is to help develop, implement, and monitor the public relations and advertising plans and strategies that result in increased participation in the campaign.

Objectives

- Increase the level of understanding about the problem and effects of air pollution,
- Increase the favorable attitude about the campaign,
- Increase the belief by the public that the campaign will have a positive impact on the problem,
- Inform the commuting and noncommuting public of the various alternatives, and
- Assist in helping to increase the level of participation.

Summary

This year, the media task force participation included solid representation from radio and television, but also outstanding print representation and special media including Skyview Traffic Watch and Gannett Outdoor Advertising. For the first time, advertisements for Spanish station KTVW TV 33 were produced and aired.

Broadcasting Reports for Radio and Television

Although the number of PSAs was down slightly from last year's campaign, live mentions on radio and TV were up significantly. In addition, special promotions and the overall level of participation from the broadcast media have increased. The total value was $750,635 (see Table 1).

Print Representation

The media task force was well represented by major newspapers and those in the valley communities. The larger newspapers were strongest in editorial coverage and the smaller dailies achieved a solid balance between editorial and PSA advertisement coverage.

Creative Contributions and Production

Evaluating the campaign's advertising and public relations elements were important functions of the media task force. The group recommended the advertisement concepts that were adopted by the campaign sponsors. The goal of the task force

TABLE 1 VALUES OF PSAs OVER RADIO AND TELEVISION

Radio

	PSA#	Value	Other Value	Sub Total
Oct.\Nov.	243	$13,376	$3,601	$16,977
Dec.	338	$15,370	$6,380	$21,750
Jan.	399	$29,450	$5,336	$34,786
Feb.	473	$41,047	$9,452	$60,499
Mar.	350	$25,041	$5,354	$30,395
	1803	$134,284	$30,123	$164,407

TV

	PSA#	Value	Other Value	Sub Total
Oct.\Nov.	552	$126,081	$12,000	$138,081
Dec.	582	$148,239	$12,000	$160,239
Jan.	412	$154,163	$26,523	$180,686
Feb.	230	$ 62,352	0	$ 62,352
Mar.	159	$ 44,870	0	$ 44,870
	1935	$422,224	$50,523	$586,228

Totals TV & Radio

	PSA\Mentions	Value
Oct.\Nov.	795	$155,066
Dec.	920	$188,981
Jan.	811	$215,472
Feb.	703	$122,851
Mar.	509	$ 75,265
GRAND TOTAL	3738+	$750,635

was to select effective advertisement concepts while achieving consistency in both sound and appearance.

Members of the Arizona broadcasters produced, edited, mixed, dubbed, distributed, and provided voice talent and video footage for the campaign's PSAs, as part of an agreement with the campaign, for $55,000.

High Pollution Advisories

In addition, the task force sponsored a design competition for the pollution advisory logo that the media used when alerting the public of a high-pollution advisory.

Clean-Air Buses

This year the campaign enjoyed a second year with KTSP TV–10 sponsoring the Challenge 10 clean-air bus. Channel 10 again subsidized one free trip, which they advertised 6 days per week on all four daily newscasts. Their news personalities also made weekly rides on the bus.

KOY FM (Y95) sponsored the Y95 clean-air bus this year for the first time and promoted bus ridership on the daily drive-time morning zoo.

PUBLIC RELATIONS AND ADVERTISING SUMMARY

The 1989–1990 Clean Air Force Campaign received an enviable amount of publicity and public service advertising as always. It was clearly one of the most successful public service campaigns in the valley, because in large part of the excellent constituency building that had been done over the previous 4 years. Changing the public's behavior is a slow process of education. It involves consciousness raising much like that for seat belt usage and fitness. Often, it is the news media that help raise awareness. This campaign has their continued support.

The public relations program began in late July 1989 by Phillips-Ramsey who was selected to conduct public relations and provide creative services for the campaign. The plan was designed to generate community awareness and involvement in the campaign through publicity and special events. The join the clean air team theme provided a good overall rallying cry. The events included the following:

- Clean air pep rally (kick-off), October 11;
- Free bus day, October 18;
- All-star challenge (1-week employer competition), November 9;

- Shop with a friend (mall promotion), December 5–9;
- Reindeer crusade (radio promotion), December 1–7;
- Blue ribbon day (1-day rideshare promotion), January 24; and
- Bike to work day (1-day bike promotion), February 28.

Publicity-Media Relations

Personal visits were made to news directors and key radio promotions directors, reports were made regularly to the media committee, and personal thank you messages were sent to media who had been especially helpful on an event. Media coverage of the events was excellent. Considerable prepublicity was generated for events requiring public participation like free bus day, blue ribbon day, and bike to work day. The media were both receptive and supportive.

Broadcast coverage was the primary goal because most people answering last year's postsurvey said they had heard about the campaign over television. Radio was emphasized because this medium was underutilized in the past. Radio remotes, on-air personalities, talk shows, traffic reporters, and weather reporters added substantially to the event coverage. Print coverage in the dailies was often skeptical or negative about the program as a whole. The reporters often focused on the lack of viable alternatives for commuters to use. Although this policy was short sighted, it was also probably a fair assessment of the valley's current transportation. Also, the information provided throughout the campaign did not offer enough hard news angles for the print media. More attention should have been given to developing sources and angles related to the environment, health, and so forth. This low-key information would have provided a serious counterpoint to the excessive publicity generated by the events.

Special Events

The special events were fun for everyone. They provided opportunities for companies and volunteers to get involved. The news media seemed to support them with coverage and personality involvement. Major public events like free bus day, blue ribbon day, and bike to work day should be expanded in the future.

The shop with a friend event never really got off the ground because of lack of support from area retailers. It might be better to create a winter event that is easier to lead from the staff side.

Using mayors, governor, and county supervisors is always a good media draw. Although getting commitments from them is difficult, they provide focal points for the media.

Advertising

Relying solely on public service advertising time and space is limiting, especially at the kick-off of the campaign. It would be better if the media could coordinate public service advertisements with the kick-off of the campaign or if some paid advertising were used. Because advertising lagged well behind the kick-off, the early impact of a coordinated advertising and public relations campaign was lost.

Even printed advertisements would be helpful if there were some guarantee they would run. This might be more certain if various sizes of the same advertisements were available. Perhaps one generic campaign advertisement and three event advertisements would be more useful. Because most radio stations do not use taped PSAs but provide considerable live announcer coverage, the cost of producing radio spots could go to more printed advertisements. Regular written PSAs could be sent to the radio stations. The total value of the broadcast media spots donated was over $750,000.00. The advertising produced for the campaign included three newspaper advertisements, billboards, seven television commercials, exterior bus posters, and nine radio commercials.

Collateral

The collateral materials were important to the campaign, especially those for the employees. The materials produced by the agency included employee brochure, four general posters, campaign coordinator books, video, three clip art pages, press kit folders, post-it notes, buttons, bags, water bottles, free bus day stickers, counter card holders, grocery bag logos, challenge poster and flyers, free bus day flyers, blue ribbon day posters and flyers, and bike to work posters and flyers.

Donated Services

The public relations support for this campaign is time consuming. With six major special events, many collateral pieces like brochures and flyers to write, public service announcements, news releases, media alerts, talk show bookings, radio station promotions, and committee and staff meetings, many more hours were spent on the project than were covered by the retainer fees. The current estimate is that Phillips-Ramsey donated approximately 750 hr in agency public relations time as community service.

Estimated donated time was 500 hr for creative services and 430 hr for accounting services. The resources donated by the media committee and production and talent companies were invaluable at keeping out-of-pocket costs within budget.

In-kind gifts supplemented the public relations and creative budgets as follows:

- Public relations, $100,000;
- Photography for events, $1,000;
- Talent for events (Sparky, etc.), $2,000;
- Refreshments (Kalil, etc.), $1,000;
- Flyers, ribbons (Circle K, etc.), $3,500;
- Hanging banner (Phx), $400;
- Video, radio, and TV talent, $42,000;
- Allstate-Transit shelters, $35,000; and
- Awards luncheon, $2,700.

The total for donated services was approximately $187,600.

TABLE 2 NUMBER OF PEOPLE BY MODE OF TRAVEL TO WORK FOR PERSONS EMPLOYED OUTSIDE THEIR HOMES

TRAVEL MODE	Pre'88-89 (%)	(Mean)	Post'88-89 (%)	(Mean)	Pre'88-90 (%)	(Mean)	Post '89-90 (%)	(Mean)
Single Occupant Vehicle								
Drive Alone	82%	4.9	89%	4.8	85%	4.7	87%	4.5
Motorcycle	2	4.7	*	1.0	3	3.2	2	2.4
Alternate Mode								
Car-pool	17	4.2	12	3.8	22	3.6	21	3.4
Ride a Bike	2	4.2	2	3.7	5	2.9	7	2.2
Take the Bus	1	4.0	3	2.9	3	2.6	4	2.7
Walk to Work	*	5.0	3	2.8	3	3.0	4	3.8
ALTERNATE MODE TOTALS	20%		20%		33%		36%	

Use caution when comparing time series data due to differences in sample size and the associated sampling error. Column totals exceed 100% due to multiple modes of transportation used in a typical week. * = Less than half of one percent.

CAMPAIGN RESULTS

Market Research

This report presents the results from a survey conducted for the RTPA by O'Neil Associates, Inc. The report is based on an analysis of 701 telephone interviews conducted with licensed drivers living in Maricopa County who own or lease at least one motor vehicle. The survey was conducted from February 24 to March 1 1990. This study represents a research plan analyzing drivers' attitudes and behavior before and after the campaign, and compared to the previous year's research.

Current Travel Behavior

Approximately 36 percent of commuters either carpooled, rode their bicycles, took the bus, or walked to work at least once a week in 1989–1990 compared with approximately 20 percent in 1988–1989. Driving alone, however, continues to be the predominant means of travel to and from work (see Table 2).

The percentage of total trips to and from work using one or more of the alternate modes of transportation has also increased, but by a smaller margin, from 18 to 22 percent. The reason for a greater increase in the number of persons using alternative modes for commuting and the proportion of trips made using alternative modes may indicate that more people are trying alternative modes on an infrequent basis (see Table 3).

The concept of carpooling continues to be appealing for shopping and recreational trips. Although driving alone remains the primary means of transportation on shopping trips, carpooling is much more popular for shopping than it is for work travel. Recreational travel is generally in the form of a carpool, though some drive alone in these instances as well.

Use of Alternate Modes of Transportation

When asked how they would get to work if they did not have a car, 26 percent of employed respondents indicated they would ride with someone else (carpool), 17 percent would take the bus, 6 percent would walk, and 14 percent would use some other means to get to work. Only 32 percent refused to respond, insisting that they absolutely needed to have a car to get to work. The primary reasons given for needing to drive alone were irregular work hours (23 percent), needing a car for business purposes (22 percent), and not knowing anyone with whom to carpool (20 percent). Half of these respondents, however, indicated it would be possible for them to get to work some other way than driving alone at least once a week. Younger respondents are more likely to indicate they could get to work by an alternate means.

When nonemployed respondents were asked how willing they would be to take specific steps to preserve air quality in Maricopa County, combining or reducing automobile trips appear to be the most acceptable alternatives followed by carpooling more often. Options that required leaving the au-

TABLE 3 PERCENTAGE OF TOTAL TRIPS TO AND FROM WORK

	TRAVEL MODE	Pre-88-89	Post-88-89	Pre-89-90	Post-89-90
Single Occupant Vehicle					
	Drive Alone	80%	86%	77%	77%
	Motorcycle	2	*	2	1
Alternate Mode					
	Carpool	15	9	15	14
	Take the Bus	1	2	1	2
	Ride a Bike	2	1	3	3
	Walk to Work	*	2	2	3
Alternate Mode Totals		18%	14%	21%	22%
	Total Trips:	1,340	1,342	2,948	2,218

Use caution when comparing time series data due to differences in sample size and the associated sampling error. Column totals exceed 100% due to multiple modes of transportation used in a typical week. * = Less than half of one percent.

tomobile (i.e., taking the bus, calling Dial-A-Ride, or riding a bicycle) were less acceptable.

Awareness and Perceptions

The Don't Drive 1 in 5 campaign continues to have high awareness among Maricopa County residents. More than 19 in 20 residents (95 percent) are aware of the campaign. This number is up slightly from the precampaign level of 93 percent, but is down slightly (yet nonsignificantly) from awareness levels experienced directly after last year's campaign concluded (97 percent).

Television and radio are the sources of information cited most frequently by respondents aware of the Clean Air Force campaign. Awareness based on information from all sources either remained the same or increased in comparison to percentages recorded postcampaign 1988–1989. The sources exhibiting the most noticeable increases in effectiveness this year are radio commercials, billboards, and the clean-air bus.

Overall, attitudes toward the Don't Drive 1 in 5 campaign are positive, with 89 percent indicating a favorable attitude toward the campaign. This figure is down insignificantly from last year's postcampaign level of 90 percent and up from this year's precampaign level of 84 percent. There has, however, been a drop in the proportion rating the campaign very favorable, from 55 percent in each of last year's surveys to 35 percent in this year's precampaign survey to 44 percent in the current survey. The reason may be found in continuing recognition of the severity of the problem (hence, overall favorability) coupled with concern over the absence of dramatic measurable effects (hence a diminished enthusiasm). If this interpretation proves correct, it indicates the potential for diminished support for the program in future years if demonstrable results cannot be communicated to the public.

Approximately three-fifths of respondents believe the campaign will lower pollution levels, a figure that has been fairly constant for the last 2 years. However, there has been a slight increase in the proportion who do not feel the campaign will lower pollution levels, from 29 percent in last year's postcampaign survey to 38 percent in the current survey. Most of the increase came from a decrease in don't knows. Although the feelings are still positive, this trend means attention should be paid to the need to maintain a high level of public support in future campaigns. This support may be more difficult to maintain in the future than it has been in the past.

High-Pollution Advisory Program

Three-fourths of the respondents are aware of the high-pollution advisory program, representing a slight increase in awareness from the precampaign survey and from the level of awareness a year ago. The percentage of respondents willing to alter their behavior on a high-pollution day by driving less or consolidating their trips continues to be up from postcampaign levels found in 1988–1989. Thirty-one percent of respondents indicated they would be very likely to make an extra effort not to drive their car on high-pollution days. This compares with only 17 percent in the postcampaign survey in 1988–1989 and 26 percent in the 1989–1990 precampaign survey. The percentage of those who claim they would not be likely to make an extra effort (37 percent) decreased substantially from the 52 percent reported in the 1988–1989 postcampaign survey.

Assessment of the Air Quality Program

The public's concern about air quality has not changed since the 1989–1990 clean-air precampaign survey. Air quality in Maricopa County remains a serious problem in the minds of most residents and two-thirds perceive the current level of air quality to be a major problem. Most residents also foresee air quality worsening in the future just as they did in the 1989–1990 precampaign survey. Air quality in Maricopa County also is considered to be a year-round problem not just a part-year problem.

The belief that oxygenated fuel is not enough to improve air quality and that automobile use must be limited as well has grown by more than 10 percent since the 1989–1990 precampaign survey, from 61 percent precampaign to 73 percent postcampaign.

Payment for Mass Transit Alternatives

Nearly two out of every three respondents (63 percent) would be willing to pay increased taxes for increased bus service. Approximately half would pay more taxes for more bicycle lanes or rail-based mass transit and two-fifths would support increased taxes for more carpool or bus lanes. When asked if they would take the bus if its service were made more convenient (i.e., stops within ½ mi of home and frequent routes), almost two-thirds report a likelihood of using the bus.

Employer Incentives

The majority of respondents (70 percent) agree that the government should provide tax incentives for employers who subsidize employees who carpool or ride the bus. More than two-thirds (69 percent) of respondents indicate that their employers have encouraged them to use some other means than driving alone to work.

Methods that provide the employee a means of meeting emergency or business needs or which subsidize desired activities have the greatest potential for changing travel behavior. The strongest incentive for carpooling among employed respondents is providing transportation home in the event of an emergency followed by subsidizing bus tickets or gas for carpools and providing a company car for business. Less effective were mandatory fees for parking at work, providing information about bus routes and service to employees, and the sale of bus tickets at work.

Traffic Count Analysis

An extensive program of traffic counting was designed and conducted to provide an indication of the effectiveness of the

1989–1990 voluntary no drive days program. Traffic counts taken during the campaign were compared with counts taken just before the campaign to determine whether or not any change was evident. All counts were adjusted to remove bias caused by seasonal variation and population growth. The results indicate that morning commuter traffic was down by approximately 2 percent during the 1989–1990 campaign, whereas all-day traffic counts were virtually unchanged (see Table 4).

An important limitation of traffic counting results is that they do not necessarily demonstrate cause and effect. The voluntary no drive days program was just one of many factors that may have affected daily traffic variation on any given street. Weather conditions, gasoline prices, traffic accidents, fluctuations in tourism, and numerous other socioeconomic factors may have influenced the outcome. Additional uncertainty in the final result may be caused by the limited precision of the seasonal adjustment factors, as well as to accuracy limitation of the mechanical counting equipment.

Jurisdictional Responsibilities

The actual collection of traffic counts was conducted (gratis) by five area cities, the county, and the ADOT. Analysis of the traffic counts was conducted by the local MPO.

Selection of Sites

To minimize the influence of random variability, traffic counts were taken at 43 sites around the metropolitan area. Thirty-four arterial sites were selected using random selection procedures. Nine freeway sites were selected in a nonrandom manner, because site availability was limited by construction. Data collection was attempted at the same set of sites for each of six traffic counting periods during the 1989–1990 campaign.

Schedule

In order to assess traffic levels before the program began, counts were taken during September 12–14 and October 3–6. During each counting period, 24-hr counts were taken on Tuesday, Wednesday, and Thursday to reflect average weekday traffic.

The same approach was used to measure traffic during the campaign. Care was taken to avoid scheduling counts for any week that would include a legal holiday. The first set of counts during the campaign was taken October 17–19. Further counts were taken at least one time each month from November through February.

Adjustment for Seasonal Variation and Population Growth

Some of the observed fluctuation in traffic counts from month to month would have occurred even in the absence of the voluntary no drive days program, because of other factors. One of these factors is seasonal variation, reflecting annual patterns such as winter tourism and school activities. Another important factor is population growth. In the absence of seasonal variation, regional traffic would be expected to increase every month because of population growth.

Weekday traffic counts taken over a 4-year period were used to derive monthly factors reflecting seasonal variations in traffic. The factors were calculated on a fiscal year basis, using ADOT data from July 1983 through June 1987. Regional population estimates from Mountain West Research provided a basis for adjusting factors to isolate normal seasonal variation. The adjustment factors finally applied to the results for the voluntary no drive days program are the multiplicative combination of the seasonal variation factors, and the estimated regional population increases.

Analytical Approach

The traffic counting results for September and October were seasonally adjusted and then averaged together to represent a preprogram base level of traffic. Traffic changes were calculated using both 24-hr counts and 3-hr counts from the morning commuter period (6:00 to 9:00 a.m.). All subsequent monthly counts were also adjusted for seasonal variation and population growth, for comparison to the preprogram base.

Traffic counts were not successfully retrieved each month at all of the sites, so the actual sample size varied from month to month. For each site where a matched pair of observations

TABLE 4 PERCENT TRAFFIC CHANGE FROM PREPROGRAM BASE (NEGATIVE NUMBERS INDICATE REDUCTION COMPARED WITH EXPECTED TRAFFIC LEVELS)

MONTH	MORNING PEAK PERIOD TRAFFIC COUNTS	ALL DAY TRAFFIC COUNTS
October	-1.11	+1.86
November	-2.42	-1.54
December	-0.63	+2.51
January	-2.55	+0.44
February	-6.82	-2.46
OVERALL RESULT	-2.88	-0.03
OVERALL EXCLUDING FEB.	-1.76	+0.67

TABLE 5 AVERAGE WEEKDAY BUS RIDERSHIP

	1987-88	1988-89	'87/88-'88/89 change	1989-90	'88/89-'89/90 change	'87/88-'89-90 change
OCT.	81,061	90,411	11.5%	107,008	18.4%	32.0%
NOV.	75,567	92,291	22.1%	105,197	14.0%	39.2%
DEC.	67,225	88,422	31.5%	98,474	11.4%	46.5%
JAN.	78,785	91,944	16.7%	103,114	12.1%	30.9%
FEB.	79,711	97,635	22.5%	108,206	10.8%	35.7%
TOTALS	382,349	460,703	N/A	521,999	N/A	N/A
AVERAGES	76,470	92,141	20.5%	104,400	13.3%	36.5%
Post campaign statistics:						
MAR.	85,039	96,747	13.8%	108,196	11.8%	27.2%
APR.	90,239	100,613	11.5%	109,701	9.0%	21.6%

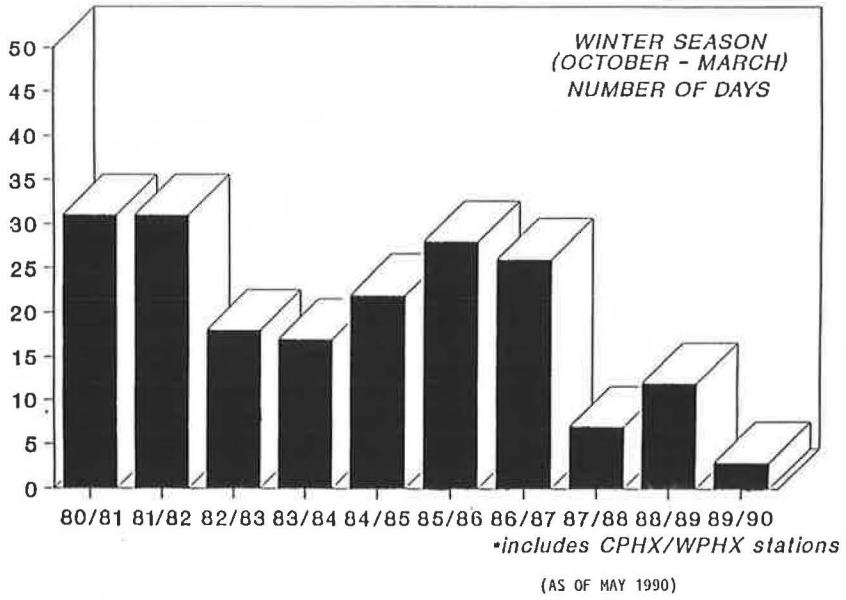

FIGURE 2 Days federal carbon monoxide standard was exceeded.

was available, the traffic change was calculated. The sum of these individual changes was divided by the sum of the corresponding counts in the preprogram base to yield the percentage change for the sample. This calculation was done separately for arterial streets and freeways to facilitate the computation of a weighted average.

The computation of a weighted average was necessary because freeway traffic was proportionally overrepresented in the sample. If all of the arterial streets and freeways in the region were included in the sample, freeway traffic would account for only 17 percent of the total, based on simulation results from regional traffic modeling. Therefore, the weighted average results assign the freeway counts a weight of 17 percent, and arterial counts are assigned a weight of 83 percent.

Statistical Significance

The traffic counting program described earlier involves the use of a sample to estimate overall regional behavior. Principles of statistical inference can be used to quantify the amount of uncertainty surrounding the use of such a sample. The key elements in the statistical calculations are the sample size (i.e., the number of sites used) and the amount of variance observed in the sample data. Based on the size and variance of the sample, the traffic count results are subject to a margin of uncertainty of ± 3 percent.

Bus Ridership Analysis

Bus ridership throughout the campaign was high. The increase in average weekday ridership during campaign months increased 36.5 percent from 2 years ago, including a 13.3 percent increase over the past year. (Table 5 presents statistics from 1987 through 1989–1990.) These ridership increases were also noteworthy in that bus service was not increased significantly during this 2-year period.

Since the campaign, average weekday ridership continued to increase. The average for April for 1990 of 109,701 riders increased over 5,000 riders from the average during the 1989 campaign.

On free bus day, there were 142,182 riders, an increase of 35,174 riders (33 percent) over the daily average for the month of 107,008. This increase is especially significant when the preevent television publicity was overshadowed by the San Francisco earthquake the evening before. This increase in ridership represents a decrease of 3.5 tons of total pollutants and 2.7 tons of carbon monoxide.

HIGH–POLLUTION ADVISORY

The goal of the high-pollution advisory program was to prevent potential exceedances of carbon monoxide levels by encouraging citizens to limit their driving on the day following the announcement. High-pollution advisories are issued by the county when the next-day forecast is for unhealthful concentrations of carbon monoxide. These advisories are issued between 9:00 a.m. and 3:00 p.m. by contacting Associated Press and UPI, which in turn issue a standardized HIGH POLLUTION ADVISORY statement provided by the Clean Air Force Campaign to the media. Figure 2 shows the number of days carbon monoxide standards were exceeded during winter seasons from 1980–1981 to 1989–1990.

Since the Clean Air Force Campaign began in 1986, the numbers of days exceeding the clean air standard have been as follows:

Year	*Number of Exceedance Days*
1986–1987	26
1987–1988	7
1988–1989	12
1989–1990	3

Publication of this paper sponsored by Committee on Ridesharing.

Review of Transportation Allowance Programs

KIRAN BHATT

Innovative transportation allowance programs that are increasingly being considered and adopted by localities to increase ridesharing among commuters are reviewed. The focus is on programs that go beyond traditional and straightforward transit and parking subsidy programs for employees by incorporating innovative elements aimed at enhancing high-occupancy vehicle use or developing innovative administrative procedures. The review addresses transit and vanpool scrip allowances, carpool parking allowances, parking allowances varying with automobile occupancies, and general travel allowances that commuters can use as desired. The review suggests that while some, but not all, of these innovative programs generate additional costs, they hold the promise to bring about significant shifts from solo driving to ridesharing among commuters. The acceptance by employers and employees affected by many of these innovative programs has been slow but positive in particular situations. When the desire and need to reduce solo driving among employees are strong, many of these transportation allowance programs offer potential solutions.

Transportation allowance programs can be found at numerous employment sites around the country, although experience with programs other than transit fare allowances is limited and recent. The intent in this summary is not to be exhaustive, but rather to synthesize key information describing the variation in the programs and the administrative and implementation experience. For this purpose, examples have been selected that provide lessons that could provide guidance to ridesharing agencies for developing such programs across the country.

Travel allowance programs provide subsidies to employees in one form or another and include transit fare allowances or subsidies, vanpool fare allowances, parking allowances or free parking, and general travel allowances that can be used by the employees toward any mode they choose or for any nontransportation purposes (including salary boost substitutes for parking or transit subsidies).

Transit fare subsidies (typically by subsidized passes, but sometimes by direct employer payments to employees) have been around for some time. Vanpool fare or cost subsidies have become more common over the past decade.

Parking subsidies have been around for decades, although differential subsidy programs that increase subsidy amounts as the carpool occupancy increases are much more recent. General travel allowances are relatively more recent and the experience with them is limited.

The focus of this review is on transportation allowance programs that go beyond traditional and straightforward transit and parking subsidy programs—programs that incorporate certain innovative elements aimed at enhancing high-occupancy vehicle use or develop and implement innovative administrative procedures.

K. T. Analytics, Inc., 103 Baughman's Lane, Suite 176, Frederick, Md. 21701.

TRANSIT AND VANPOOL ALLOWANCES

These programs are relatively well understood and accepted around the country. The administrative procedures and costs are reasonably well recognized. Two of the relatively more comprehensive regional programs are described in the following paragraphs.

Transitcheck

Transitcheck is a regional transit fare allowance program in the New York City area (*1*). This program is run by a quasi-public transportation organization called Transit Center. It administers a transit voucher program in which employers can purchase regional transit vouchers for $15. The vouchers can be given to employees who can use them to purchase tokens, tickets, and passes from any of the region's public and private transit operators. This program is a simple way for employers to provide transit fare subsidies to employees. All the administrative and accounting requirements are handled by the Transit Center and its contractors.

Commuterbucks

This vanpool voucher program is run by VPSI, a national private vanpool operating company (*2*). Vouchers are available to employers in various denominations and can be redeemed towards VPSI-operated vanpool fares. Like Transitcheck vouchers, these vouchers provide a convenient means to the employers to provide vanpool subsidies to employees. VPSI handles the major administrative and accounting chores.

PARKING ALLOWANCES FOR CARPOOLS

Pacific Northwest Bell Company

This firm achieved a low solo-driving mode share of 19 percent among its employees (when solo shares at comparable sites nearby were around 55 percent) by providing free parking to carpools with three or more persons and reduced-cost parking

to carpools with two persons and charging solo drivers full parking rates in excess of $50 per month in downtown Bellevue, Washington, a suburb of Seattle (*3,4*). No administrative or cost details are available.

State Farm

This firm's office with nearly 1,000 employees at South Coast Metro (a mixed-use activity center) in Orange County, California, has recently increased vehicle occupancy among its employees from 1.21 to 1.55 (implying a reduction in solo driving share from 70 to 40 percent) by an innovative carpool subsidy program in which an allowance is offered to carpoolers in lieu of parking charges (*4*).

DIFFERENTIAL ALLOWANCES FOR TRANSIT, RIDESHARING, AND PARKING

Atlantic Richfield Company (ARCO)

ARCO, Los Angeles, at its downtown location has an elaborate allowance program that includes reduced fare transit and commuter rail passes and parking allowances that increase with vehicle occupancy (*5,6*). The program covers over 2,000 employees. Transit allowance for various bus services and vanpool allowance is $15 per participating employee per month. Rail allowance is one-third of the monthly cost, not to exceed $25. Solo drivers have one-third of their parking costs (rates are approximately $120 per month) subsidized. Carpools with two persons have two-thirds of the cost subsidized whereas carpools with three persons or more have their parking costs fully covered. ARCO has a transportation office whose staff spends considerable time to coordinate and administer the program, determine eligibility, process requests for changes and monitor legitimate uses. Because the transit and vanpool allowance is limited to $15 per employee per month, it is treated as a tax-free reimbursement to the employee. Solo driver and carpool allowances are tax free to employees because they are parking subsidies.

ARCO Transportation Company

Located in Long Beach, this company charges solo drivers full parking rates. Two-person carpools receive free parking. Carpools with three or more persons get free parking plus each member gets additional allowance of $15 per month. The company pays fully for transit passes. Those who walk or bicycle receive an allowance of $15 per month (*7*).

Nuclear Regulatory Commission (NRC)

NRC (1,400 employees) in suburban Maryland in the Washington, D.C., area has high parking charges for solo drivers but provides some subsidies for carpool parking and for transit users. Solo share was reduced from 54 to 42 percent as a result of these allowances (*3,4*).

Twentieth-Century Insurance Company

This company in the Los Angeles area used to provide full parking subsidy of $45 per month to all its employees who drove to work. Several years ago, they implemented a comprehensive allowance program. The parking allowance for solo drivers was reduced and set at $30 per month. Carpool parking allowance was kept at $45 per month (full subsidy). Transit and vanpool allowances also were introduced. The allowance program increased the average vehicle occupancy from 1.10 to 1.46 (solo share dropped from 90 to 55 percent) (*3,7*).

San Diego Trust and Savings Bank (SDTSB)

SDTSB with 550 employees provides parking allowance of $55 per month to solo drivers (monthly rates are in the range of $80 to $120), $70 per month to two-person carpools and $100 to carpools with three persons or more. Transit-riding employees receive full reimbursement of transit fares plus 25 percent to cover the income tax bite. The solo shares for SDTSB employees is 55 percent, whereas it averages 80 percent at nearby sites. The bank management believes that the allowance program costs much less than subsidizing parking fully for all employees (Commuter Computer of San Diego. *Nomination for 1989 Governor's Award*. Internal memorandum, San Diego, Calif., Aug. 29, 1989).

Bank of America (BA)

BA in the Los Angeles area offers its employees a transit or carpool allowance of $15 per month. The company is planning to increase the allowance so that the after-tax subsidy would amount to at least $15 for the employee.

South Coast Air Quality Management District (SCAQMD)

SCAQMD in the Los Angeles region provides a carpool allowance of $55 per month to each carpooling employee. The carpool driver also gets free parking worth about $25 per month (*8*).

Bellevue City Hall, Washington

This agency started charging solo drivers full cost ($30 per month). Carpool vehicles received free parking (an allowance equal to $30 per month). Transit riders also received full subsidy. Solo driving declined from 75 to 58 percent (*3*).

GENERAL TRAVEL ALLOWANCES

These allowances can be used as desired with few restrictions.

City of West Hollywood, California

The city, in 1986, incorporated a travel allowance program for its employees. Employees who use modes other than solo

driving and relinquish their parking space can receive in-lieu travel allowance of $45 per month (the cost of leasing a parking space). The parking use declined 15 percent as a result of the program (*7*).

Commuter Computer

In order to encourage alternative mode use among its 100 employees, Commuter Transportation Services (CTS, commonly known as Commuter Computer) provides monthly travel allowances to cover employee transportation costs. A monthly allowance of $55 is added to employees' gross pay on the first paycheck each month. It is taxed as ordinary income, except in the case of employees parking at employer-provided paid parking. For these, the allowance is free of taxes. Each employee can use the allowance as they choose (except that those who want to use it as a tax-free allowance must use it to park at the company-provided spaces—if they are given a place). Each employee fills out a form by the twentieth of each month designating the use of the allowance for the next month for accounting and payroll purposes. Vanpoolers can use all for the vanpool or pocket a part. For transit users, the company will buy the pass and reduce the amount to be paid. The rest is pocketed by the employee. For the designated parking facility, there is a waiting list, but for those who are on it, the company will buy the monthly cards and treats the amount as nontaxable. Employees choosing to park elsewhere receive allowance as taxable income. Employees walking or bicycling pocket the allowance. When the allowance program was first introduced, the solo share fell from 48 to 8 percent (*9,10*).

CH2M Hill

When this engineering company with about 400 employees moved to downtown Bellevue, Washington, it introduced a general travel allowance program for its employees. All employees started receiving an unrestricted allowance of $40 per month by check to be used as they chose. The company leased parking spaces for $25 per month in the building. Previously, parking had been free. Now, the solo drivers were charged $40 per month to park. Carpools could park for free. Transit users get the $40 allowance plus four 15-transit passes every month. The program reduced solo share from 96 to 67 percent. An employee committee monitors the program, which is simple and low cost to operate (*3,4*).

American Hospital Supply Corporation

The firm in Evanston, Illinois, moved its headquarters to a new building in Evanston. Instead of free parking, it established a parking fee of $30 per month. Employee paychecks were increased by $30 per month. There were no restrictions to the use of the allowance (the company also provided transit passes to employees at 26.5% discount) (*5*).

Latham and Watkins

According to Melinda Sue Noran, a transportation coordinator at the firm (213–485–1234), all employees (300 to 400) at this law firm in downtown Los Angeles receive a general travel allowance of $102 per month (scheduled to go up to $122 this year). The amount is simply added to the salary. There are no other allowances, subsidies, or incentives provided. The average parking rates nearby are $135 per month. It is a simple and virtually no-cost program to administer. The impact on mode shares is not available.

Linowes and Blocher

This legal firm in Silver Spring, Maryland, with 100 employees last year eliminated all free parking and other travel incentives and introduced a general travel allowance. Each employee now receives $75 per month in travel allowance, which can be used as desired. This program was introduced in response to the employer travel demand management requirement introduced by the Silver Spring Transportation Demand Management District (*11*).

HOW DO THE TRANSPORTATION ALLOWANCE PROGRAMS WORK?

Rationales For Setting Up The Programs

These programs have been pursued under a variety of rationales. In some cases, such as Pacific Northwest Bell and CH2M Hill, employers have implemented them at least partly as a measure to control parking costs. In others, such programs have been viewed as making feasible additional economic development because of the freed-up parking or road space. Although some employers who have instituted the programs have pointed out intangible benefits of these programs such as improved employee morale, reduced tardiness, and help in attracting and retaining employees by enhancing employer image, these seldom appear to have been enough to pursue these programs by themselves.

In some cases, such as at Commuter Computer, the programs have resulted from pressures from employees interested in using transit or ridesharing and recognizing the inequity of the traditional employer role that was limited to parking subsidies. In numerous locations, the allowance programs have been realized as a direct result of pressures of meeting the requirements of recently enacted TSM or other growth management ordinances or regulations such as SCAQMD Reg. XV (e.g., several programs in the Los Angeles area). Lastly, in a few cases, more proactive companies have agreed to become "good citizens" by participating in socially and environmentally sound transportation policies (e.g., ARCO and Linowes and Blocher).

Eligibility Requirements

There is considerable variation in how the eligibility requirements are set and enforced. Requirements are generally set to meet certain trip reduction goals—whether explicit or implicit. Local situations regarding parking, road congestion and

the environment, and the nature and intensity of pressures from employees and their unions also have sometimes played a role.

The requirements pertain to which modes to include in the allowance program; how to treat equity (the amount of subsidy and tax consequences) across employees using different modes; and how to treat existing versus new employees. Some companies like Latham and Watkins law firm in the Los Angeles area have pursued general travel allowance programs largely to overcome the difficulties of setting most equitable requirements. Such programs are inherently more equitable and fair according to many observers.

Monitoring Procedures and Administration

Monitoring requirements surrounding these programs include ensuring that designated carpools are legitimate and remain so, preventing misuse and transfer of subsidized transit passes, and ensuring that the allowances are accounted properly from the standpoint of taxes. Again, general travel allowances that carry few restrictions with them are the easiest to monitor.

Typically, many organizations play an administrative role in setting up and running such programs. Employers are ultimately responsible for setting up the programs, developing eligibility requirements for their employees and checking proper use periodically, monitoring, and proper accounting. Often, regional public or quasi-public agencies also play a role in administration—particularly in planning and implementation. However, their continued participation is unusual except in case of complex programs such as Transitcheck, which coordinates numerous different passes and services.

In general, the private sector left to itself probably might have a greater incentive to pursue a program, such as a general travel allowance program, with the simplest administrative and monitoring requirements. In fact, among existing programs, where employers have taken full initiative to develop programs, they have largely set up general travel allowance programs.

Tax Consequences

A principal concern with travel allowances pertains to their tax consequences. From the standpoint of employers, the tax consequences are uncomplicated. Costs of travel allowance programs including the amounts of allowances and administrative expenses are fully deductible as business expenses for the employers.

The tax consequences for employees are much more complex and significant. Parking allowances or subsidies are treated as nontaxable income to the employees by the Internal Revenue Service (IRS), regardless of the amount, so long as they are specifically provided by the employer to cover parking at or near the employment site and identified as such. The specificity is established by the way in which the employer provides the subsidy. So long as the employer provides or arranges for free (or reduced-price) spaces, or purchases spaces directly from an operator and gives out cards or passes to the employees, the value of these parking privileges (subsidies) is treated as tax free from the employees' incomes.

In contrast, transit or ridesharing allowances or subsidies are treated differently by the IRS. Employer-provided transit or ridesharing subsidies are tax free to employees only if the amount is $15 or less per month per employee. Further, if the subsidy is greater than $15 per month, the entire amount (not the portion above $15) is considered by the IRS as taxable income to the employee.

In consequence, a parking allowance or subsidy of more than $15 per month is much more attractive from an employee's perspective compared with an equal transit or ridesharing allowance.

An unrestricted general travel allowance that an employee can use for any purpose (for transit, ridesharing, parking, or other use) is considered fully taxable income to the employee—regardless of the amount. Thus, such allowances might seem less attractive to employees compared to equal amounts of more specific allowances. However, the plus side is the complete freedom to use it as desired.

There are examples of employers replacing existing parking subsidies with transit or ridesharing allowances and paying a premium to the employees to account for the increased tax burden (see, for example, the Bank of America and San Diego Trust and Savings Bank examples cited earlier). There also are some incidences of employers paying the travel allowance to employees against fictitious but formal requests for miscellaneous expense reimbursement by employees—thus making the allowance tax free. This practice appears to be in violation of IRS regulations.

Many employers feel that the taxability and unattractiveness of general travel allowances is an issue only for existing employees who already enjoy tax-free parking allowances. For new employees this might not be a major issue and it might be more feasible to bring such a program on gradually as new employees are hired.

LESSONS FROM THE NATIONAL EXPERIENCE

Modal Shares

Evidence suggests transit and ridesharing allowances have a modest impact on modal shares at employment sites. When packaged with other TSM measures like information dissemination, preferential parking for carpools, on-site transportation coordinator, etc., such programs have reduced solo driver shares up to 5 or 10 percent (*3*).

Much greater reductions in solo driving shares (up to 30 percent) have been achieved at employment sites where transit and ridesharing incentives are packaged with parking charges for solo drivers or subsidy reductions for employee parking (*3*). At some of these locations, the reductions in parking subsidies or implementation of parking charges for solo drivers have been made feasible by making general travel allowances available to the employees.

In other words, if an employer wishes to reduce solo driving significantly (whether to save on parking spaces and costs, or to comply with local regulatory requirements), parking subsidy reductions or additional parking charges for solo drivers would have to be made a part of any employer-based trip reduction program. Then, transit and ridesharing allowances

and carpool allowances or parking discounts could be considered to achieve the trip reduction goals. In some of these situations, general travel allowances in lieu of parking subsidies might become necessary to enroll solo drivers' support for such programs.

Cost Implications

Significant variability has been observed in the costs of transportation allowance programs depending on the nature and complexity of the components and the amount of allowance offered.

Although general travel allowance programs have required considerable planning and promotional efforts during the preimplementation phase, the ongoing administrative costs have been relatively small. For instance, at Latham and Watkins in Los Angeles, Linowes and Blocher in Maryland, and CH2M Hill in Bellevue, Washington, the on-going administrative costs of the general travel allowance programs are virtually zero. Once well established, these are simple programs conceptually and require virtually no eligibility checks or monitoring, because there are no restrictions on use of the money received. The accounting costs are also negligible once the program is set because the allowance is given out to all employees as a bonus. The only significant cost to the employer is the cost of the allowance itself, although in most cases this has been partially offset by the new parking revenues from solo drivers or from the reduction in parking subsidies to solo drivers. Additionally, the reductions in parking needs have sometimes generated savings in maintenance costs and possibly in some future capital requirements.

More targeted and mode specific allowance programs such as transit and vanpool allowances require some on-going administrative effort to monitor eligibility requirements and accounting as the employee base changes. For example, staff at Commuter Computer in Los Angeles, who have considerable experience with assisting local employers set up allowance programs, suggest that once the program is well established, the on-going administrative costs might run in the range of $5,000 to $10,000 per year. The allowance itself would be extra.

More complex programs such as those allowing flexible use of allowance for services provided by many different operators (e.g., Transitcheck in New York) would cost more because of greater administrative, monitoring, and accounting needs and printing of multiple coupons. Other complex programs include different subsidies for different modes (e.g., ARCO in Los Angeles) requiring more effort for monitoring and periodic eligibility checks. Again Commuter Computer, which has considerable experience in this area, suggests on-going annual program costs in the range of $10,000 to $20,000 for staff support. In addition, there would be the cost of the allowance itself. The cost of a mode-specific allowance probably would be lower than for a general travel allowance if only a fraction of employees are eligible to receive them.

Reactions of Managers and Employees

The acceptance by employers of the more innovative allowance programs has been slow. Typically, considerable time has been taken up assessing the potential benefits from such programs. In many cases, what finally brought the management around to implement allowance programs was not the benefit cost assessment, but the requirements for trip reductions imposed by local ordinances.

On the benefit side, although the employers have exhibited some appreciation for potential intangible benefits of allowance programs such as increased employee morale, less tardiness, recruitment and retention value, and employer image, the real concern has been with more tangible benefits from these programs such as savings in parking costs and possibilities of expansion at freed-up spaces. Often, the perceived cost of the program has been much greater than actual experience and the value of benefits has been underestimated. In general, the employers also are reluctant to get tied down to another new employee benefit. Employers typically do not like to give away, or even talk about, new benefits outside of union negotiations.

The employers also do not like to take away a benefit that has been given to employees (nor do the employees like to give up). Thus, some employers have excluded existing (or long-tenured) employees from subsidy reductions that typically accompany allowance programs.

Response of employees to transportation allowance programs has been mixed depending on the eligibility requirements and the nature of the program. Transit users and potential transit users have supported transit allowances. Car- and vanpoolers have supported ridesharing and parking allowances. In fact, in many instances, these commuters were instrumental in pushing the employers to adopt these programs. Generally, the existing situation in which solo drivers were receiving the subsidies was viewed as unfair.

General travel allowances are perceived as a mixed bag by employees. Where the allowance has dollar-for-dollar replaced reduction or elimination of parking subsidy, the response has been generally positive, although some solo drivers have exhibited resentment when carpoolers have received the allowance as well as reduced-rate or free parking. For cases in which general travel allowance has only partially replaced the reductions in parking subsidies, the solo driver resistance has been much stronger. This has been the more typical situation with travel allowance programs, because these programs have, at best, set the allowances equal to the solo parking rates, but they have failed to cover the value of subsidized parking lost by the solo drivers who enjoyed a tax-free income earlier. All in all, the implementation process has required delicate negotiations and careful handling of employees by the employers.

IMPLICATIONS FOR OTHER LOCALITIES

Complex travel allowance programs with different subsidies for different modes and specific eligibility requirements will be more expensive to design, implement, and monitor. Both participating employers and the regional ridesharing agencies would incur greater on-going effort. For instance, a ridesharing allowance that targets specific amounts of subsidies directly at different modes (bus, carpool, and vanpool) would be more difficult and expensive to administer than a simple transit fare allowance or a vanpool subsidy. In particular, a

program that allows the use of subsidy for many local services in a flexible manner (e.g., a regional voucher valid for bus, rail, light rail, or vanpools—much like the Transitcheck in New York), would probably be much more expensive to monitor and administer than a transit pass program, a program like Commuterbucks, or a general travel allowance such as at Latham and Watkins.

In principle, a general travel allowance program would be the simplest to administer and monitor, although it would probably require more preimplementation planning. Such programs do not require targeting and eligibility checks or significant administrative burdens because generally all employees at a work site are given a flat monthly or yearly allowance (or simply a commensurate salary increase) that they can use as they please.

General travel allowance probably would be linked to implementation of parking charges (at least for solo drivers) to enhance the trip reductions as well as to generate revenues to partially offset the allowance expenses. Because of these features, such programs are likely to encounter opposition from some of the employees, at least at start. The employer also might be apprehensive if the parking rates and supply in the vicinity will threaten the possibility of raising parking revenues from solo drivers to partly offset the allowance costs. Careful assessment of the site would be needed to ensure the financial integrity of the proposed program. In other words, such a program would make financial sense for the employer only if the parking market allowed rates comparable in magnitude to the allowance to be charged at least some of the employees. All in all, such a general travel allowance program might be feasible at employment sites where parking is at a premium (in availability or rates); the existing parking subsidies are high; and where there is considerable pressures to reduce solo driving significantly. Clearly, in order to ensure acceptance and success, the employer also would have to encourage transit and ridesharing by more traditional measures.

Where the goals of shifting employees to ridesharing are more modest and where parking is neither in short supply nor expensive, other transportation allowances (e.g., transit or ridesharing allowances) might make more sense, although they would probably require greater on-going administrative effort than a general travel allowance program.

ACKNOWLEDGMENT

The author wishes to thank all the persons contacted at the program sites included in this synthesis and who provided invaluable information about their programs. The author is also grateful to Philip Winters of Ridefinders and Cathy Gerwig of Commuter Transportation Services in Los Angeles for review and comments. Much of the information for this paper was collected as part of a contract with Ridefinders, Richmond, Virginia.

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The author alone is responsible for the accuracy of data and opinions expressed herein.

Publication of this paper sponsored by Committee on Ridesharing.

Effects of Variable Work Hour Programs on Ridesharing and Organizational Effectiveness: A Case Study, Ventura County

ALYSSA M. FREAS AND STUART M. ANDERSON

Commuter Transportation Services, Inc., conducted a 6-month pilot project to determine the impact of variable work hour schedules on ridesharing and organizational effectiveness in Ventura County. The results of the study revealed a significant relationship between ridesharing and the implementation of the variable work hour programs. At the 6-month juncture, ridesharing rates had increased from 8 to 113 percent and the cost of driving alone had decreased from 82 to 77 percent. Chi-square results indicated a significant decrease in commute time for participants. When considering the results of the variable work hour program on the individual and the organization, the results of the study reveal positive relationships between participation and self-reported increases in productivity, job satisfaction, satisfaction with schedule, morale, and ability to facilitate child care. Supervisor responses indicated similar, positive changes with respect to productivity and job satisfaction. Chi-square analysis revealed that participants on the 4/40 schedule had the largest increases in productivity, job satisfaction, and satisfaction with schedule; participants on the flex-time schedule reported more convenience facilitating child care. The results of this study have positive implications for the use of variable work hour schedules, which can be an effective strategy for increasing ridesharing and for improving organizational effectiveness.

As policymakers, business leaders, and the public become more committed to nontraditional approaches to reducing or shifting vehicle trips, increasing attention has focused on the use of variable work hour (VWH) programs as an effective transportation demand management (TDM) strategy. In Southern California, numerous ordinances advocate that employers consider VWH programs as one strategy to affect commute trips and subsequently, air quality. In Ventura County, as part of its effort to meet the requirements of the Air Pollution Control District's proposed Rule 210, its trip reduction rule, a VWH pilot program was initiated.

The VWH schedules being considered by the county were flex-time and the compressed work weeks: the 9/80 and the 4/40. The central feature of these programs is that they depart from a rigidly fixed, 5-day work week. The basic model of flex-time consists of five interrelated components: (a) a bandwidth, or total number of operating hours in a given work day; (b) a core time, or designated period of time during which all employees are required to be at work; (c) a flexible band of hours both before and after the core time that allows employees to vary their arrival and departing times; (d) banking of hours, which allows employees to carry-over surplus or deficient hours worked; and (e) variability of schedule allowing the employee the freedom to vary working hours from one period to another without prior approval from a supervisor.

A compressed work week schedule permits employees to finish their usual number of working hours in fewer days per week or per pay period. On the 4/40 compressed work week, employees work their usual number of weekly hours in 4 days. The fifth day is off. On the 9/80 schedule, employees work their usual number of hours in a 2-week period in 9 days. The 10th day is off.

Although VWH programs are gaining acceptance as a TDM strategy, the effect of these programs on ridesharing, the individual, and the organization is not fully understood. A review of the ridesharing literature suggests that the impact of flex-time on a variety of ridesharing factors can vary depending on a variety of site-specific characteristics including location, size, and accessibility (*1*). In their 1980 study, for instance, Ott et al. (*2*) found an increase in ridesharing and a decrease in driving alone after the implementation of a flex-time schedule. Another study (*3*) found increases in drive alone rates after the implementation of a flex-time schedule.

Similarly, studies focusing on the impact of VWH schedules on employee performance have produced differing results depending on implementation characteristics and criterion measures. Some authors, e.g., Hartman and Weaver (*4*), have reported increased productivity for employees on a compressed work week. Calvasina and Boxx (*5*) found no significant changes when a group of workers moved from a regular work week to a compressed work week. Similar results are found in the flex-time research (*6*).

As the demographics of the workforce change, so do the priorities of the workforce. These demographic changes make the implementation of VWH schedules even more complex. Today, there is a greater push for a balance between work and family life (*7*). In some cases, VWH schedules can be an alternative that allows for more time with the children; in others it can be an alternative that alleviates the difficulty of managing child care arrangements. Additional research is needed to determine which schedule is most beneficial.

Surprisingly, little research has been done to assess the impact of different levels of flexibility of VWH schedules on

Commuter Transportation Services, Inc., 3550 Wilshire Boulevard, Suite 300, Los Angeles, Calif. 90010.

ridesharing, employee performance, organizational effectiveness, and workforce priorities. The results of a 6-month pilot program assessing the impact of three VWH schedules are reported. The purpose of the pilot program was to determine the effect of the three different VWH schedules on ridesharing, traffic congestion, and organizational effectiveness. It is anticipated that the results of the study will serve to identify the most optimal VWH schedule.

METHODOLOGY

In October 1988, Commuter Transportation Services Inc. (CTS) conducted a survey for the County of Ventura Transportation Management Task Force. The survey was designed to determine which types of VWH schedules management would consider and which departments would be most suitable for the study. On the basis of the results of this survey, three pilot departments or agencies were selected.

As a program policy, employees on flex-time are allowed to determine their arrival and departure time within the band width offered to them by their supervisor. Employees are expected to be present during core time and supervisors may or may not permit employees to vary their schedules on a day-to-day basis. Employees on the 9/80 schedule are only allowed to change their off days twice per year. Employees on the 4/40 schedule are allowed to change their off days, usually Monday or Friday, with a supervisor's consent.

The 6-month monitoring report was distributed during the last week of April 1990 by county staff to all participants. Each department was responsible for the collection and distribution of the survey. A total of 376 surveys were distributed and returned. The survey was analyzed by CTS.

Survey Design

The stated purpose of the VWH program is to reduce traffic congestion and decrease vehicle trips. However, implementation will also impact the organization, the supervisor, and the employee in a number of ways. Therefore, the survey was designed to measure the effect of the VWH program on the following:

- Traffic congestion,
- Ridesharing,
- Organization operations,
- The employee,
- Child care arrangements, and
- The supervisor.

In addition, the pretest analysis survey conducted by the County of Ventura Transportation Management Task Force revealed several issues of concern, as indicated by survey respondents. These issues of concern, listed in priority order, were as follows:

- Difficulty scheduling meetings,
- Difficulty locating people,
- Decreased productivity,
- Decreased customer service, and
- Increased absenteeism.

All survey responses were self-reported.

Participant Demographics

Of the 376 employees participating in the study, 161 (43 percent) are women and 212 (57 percent) are men. There are 11 females and 22 males on the 4/40 schedule; 85 females and 86 males on the 9/80 schedule; 25 females and 50 males on flex-time; and 35 females and 40 males not in the VWH program. Before the end of the pilot, 5 females and 5 males discontinued the VWH program.

Of the 376 employees who participated in the program, 172 employees (47 percent) currently are on a 9/80 schedule, 76 employees (21 percent) are on a flex-time schedule, and 33 (9 percent) are on a 4/40 schedule, 76 (20 percent) do not participate, and 10 (3 percent) have discontinued. The employees who discontinued the program were treated as missing data.

Reasons for discontinuing the VWH program were described as follows: one respondent reported schedule conflicts with child care; three respondents reported health problems; three indicated their supervisor preferred that they work a regular schedule; and two respondents indicated fatigue.

Reasons for not starting the VWH program were described as follows: 2 respondents reported schedule conflicts with school; 9 respondents indicated schedule conflicts with child care; 39 indicated their supervisor preferred that they work a regular schedule; 10 respondents said they work a shift schedule; 3 respondents indicated fatigue; 5 respondents indicated the VWH program conflicted with carpool arrangements; and 10 respondents indicated they had other reasons for not participating.

IMPACT OF VWH ON COMMUTE

In order to investigate the impact of VWH schedules on ridesharing, participants were asked if they had changed their mode of travel after the implementation of the VWH program. A chi-square analysis was used to test the relationship between the VWH schedules and ridesharing. The results indicate a significant relationship between the implementation of the VWH program and increases in ridesharing chi-square $= 412.22$ (df $= 4$, $N = 376$), $p < .000$. Driving alone decreased from 82 to 77 percent, and ridesharing increased from 8 to 13 percent (see Table 1).

These findings agree with the rideshare research conducted by Ott et al. (*2*).

Although there is a relationship between the implementation of the VWH program and ability to rideshare, results of this study indicate no significant relationship between the flexibility of a particular VWH program and ability to rideshare chi-square $= 0.50370$ (df $= 4$, $N = 278$), $p > .05$. Although an unexpected result, this finding suggests that ability to rideshare is enhanced regardless of the type of VWH schedule implemented. These results may serve to alleviate

TABLE 1 RIDESHARING BEFORE VERSUS AFTER THE IMPLEMENTATION OF VWH

	After VWH, Percent			
Before VWH	Drive Alone	Ride-share	Other	Total
Drive alone	74.7	5.6	1.9	82.2
Rideshare	1.3	6.6	0.0	8.0
Other	0.5	0.5	8.8	9.8
Total	76.6	12.8	10.6	100.0

concerns among some employers that too much flexibility in schedule will obstruct the employee's ability to rideshare.

In addition to increases in ridesharing rates, participants reported significant decreases in commute time compared to those on a traditional schedule (the amount of time was not asked; the question determined only whether an increase, decrease, or no change occurred). Chi-square results indicate significant differences in commute time for those on the VWH program compared to those not on the program chi-square = 78.3 (df = 2, N = 331), $p < .0000$. For individuals on the VWH program, 171 (64 percent) indicated a decrease in commute time; 92 (35 percent) indicated no change in commute time; and 2 (1 percent) indicated an increase in commute time. Conversely, only 3 (5 percent) of the individuals not on the VWH program indicated decreases in commute time; 63 (95 percent) indicated no change and no respondent indicated an increase in commute time (see Table 2).

These findings may be the result of participants on the VWH schedule adjusting their commute time to avoid peak-congestion periods, reductions in commute trips, and increases in ridesharing that enable individuals to make use of carpool lanes. Additional research is needed to determine which, if any, of these factors influence decreases in reported commute time.

In summary, the results of this study indicate that VWH schedules do increase overall ridesharing rates. There was no significant relationship found between type of VWH schedule and effect on ability to rideshare. Taken together, these findings suggest that ridesharing will increase regardless of which type of schedule is implemented. They also suggest that commute time will decrease significantly for participants on VWH schedules. The following pages report and discuss the results of the relationship between implementation of the VWH pilot program and the work unit.

WORK UNIT OPERATIONS

Difficulty scheduling meetings and locating people were reported in pretest analysis as issues of most concern. Of the 371 participants, 64 (17 percent) said that ability to schedule meetings has worsened; 245 (66 percent) said that it had stayed the same, 25 (7 percent) said it improved, and 37 (11 percent) did not know. Results indicate that those not on a VWH schedule have more difficulty scheduling meetings with those on the program. The results also indicate that ability to locate people has worsened between participants and nonparticipants. That is, the employees who did not participate on a VWH schedule have difficulty locating the employees who did participate. Other work unit issues addressed in the survey included customer relations, coverage of daily tasks, and phone coverage. On a 1 to 4 scale (1 = improved, 2 = stayed the same, 3 = worsened, and 4 = didn't know), the mean for all questions was 2.0. These findings suggest that VWH schedules do not negatively impact these work unit operations. However, scheduling meetings and ability to locate people have become more difficult between those not on VWH schedules and those on VWH schedules.

TABLE 2 COMMUTE TIME CHANGES

	Commute Time, Percent			
In VWH?	Increase	No Change	Decrease	Total
Yes	0.8	34.7	64.5	100.0
No	0.0	95.5	4.5	100.0

EMPLOYEE PERFORMANCE

The results of the present study indicate a positive relationship between participation on VWH schedules and increases in productivity. Individuals on VWH schedules reported a significantly greater increase in productivity (M = 1.50) than did those not on VWH schedules (M = 2.03). The analysis of variance (ANOVA) results indicate a significant difference between the change in productivity between participants and nonparticipants $F(1; 331) = 61.121$, $p < .000$.

In addition to increases in productivity for individuals on VWH schedule, ANOVA tests indicate a significant positive relationship between satisfaction with schedule for individuals on VWH schedules (M = 1.42) compared with those who are not (M = 2.48). ANOVA $F(1; 352) = 106.472$, $p < .000$. Participants on VWH schedules report greater increases in job satisfaction and morale. In fact, 232 (83 percent) report increases in morale; 36 (12 percent) stayed the same and 1 (1 percent) report worsened morale. Correlation analysis revealed a significant positive relationship between work schedule satisfaction and overall job satisfaction r (352) = 0.39, $p < .001$.

In many ways, the most unique results of the study are the significant relationships found between flexibility of schedule and productivity, work schedule satisfaction, and job satisfactions. For instance, chi-square results indicate a significant relationship between flexibility of VWH schedule and productivity chi-square = 20.96353 (df = 4, N = 268), $p <$ .0003. Of the participants on the flex-time schedule, 30 percent indicated improved productivity, whereas 70 percent indicated their productivity level had stayed the same. Participants on the 4/40 schedule indicated the highest level of overall productivity. Sixty-seven percent indicated improved productivity; 30 percent indicated no change in productivity; and 3 percent indicated their productivity had worsened. Finally, 57 percent of participants on the 9/80 schedule indicated increases in productivity; 42 indicated productivity stayed the same; and 1 percent indicated their productivity had worsened (see Table 3).

Similar to productivity, chi-square results indicate a significant relationship between flexibility of VWH schedule and satisfaction with current schedule chi-square = 16.56501 (df = 4, N = 269), $p < .0023$. Of the participants on the flex-

TABLE 3 WORK SCHEDULE FLEXIBILITY VERSUS LEVEL OF PRODUCTIVITY

	Productivity Level, Percent			
Schedule	Improved	Same	Worsened	Total
Flex-time	29.9	70.1	0.0	100.0
4/40	66.7	30.3	3.0	100.0
9/80	57.1	41.7	1.2	100.0

TABLE 5 FLEXIBILITY OF SCHEDULE VERSUS JOB SATISFACTION

	Level of Job Satisfaction, Percent			
Schedule	Improved	Same	Worsened	Total
Flex-time	45.1	54.9	0.0	100.0
4/40	97.0	3.0	0.0	100.0
9/80	84.0	15.4	0.6	100.0

time schedule, 54 percent indicated improved satisfaction with schedule; 41 percent indicated their satisfaction had stayed the same; and 6 percent indicated their satisfaction had worsened. Participants on the 4/40 schedule indicated the highest level of satisfaction: 88 percent indicated improved satisfaction with schedule; 12 percent indicated no change; and none indicated their satisfaction with schedule had worsened. Last, 74 percent of participants on the 9/80 schedule indicated increased satisfaction with schedule; 24 percent indicated satisfaction stayed the same; and 2 percent indicated their satisfaction with their schedule had worsened (see Table 4).

Furthermore, results indicate a significant relationship between flexibility of VWH schedule and job satisfaction chi-square = 52.25312 (df = 4, N = 273), $p < .0000$. Of the participants on the flex-time schedule, 45 percent indicated improved job satisfaction; 55 percent indicated their job satisfaction had stayed the same; and none indicated job satisfaction had worsened. Participants on the 4/40 schedule indicated the highest job satisfaction: 97 percent indicated improved job satisfaction; 3 percent indicated their job satisfaction had stayed the same; and none indicated their job satisfaction had worsened. Eighty-four percent of participants on the 9/80 schedule indicated increases in job satisfaction; 15 percent indicated job satisfaction had stayed the same; and less than 1 percent indicated their job satisfaction had worsened (see Table 5).

The pilot test reviewed the impact of a variety of other work-related factors following the implementation of the VWH program. Quality and quantity of work, ability to work with fewer interruptions, ability to concentrate on work tasks, and ability to complete work on time were investigated. The majority of respondents reported that these areas stayed the same or improved.

IMPACT OF VWH PROGRAM ON EMPLOYEES WITH CHILDREN

In order to assess the impacts of VWH schedules, respondents were asked how participation in the VWH program affected their child care arrangement. Of the 376 who participated in this study, 137 (20 percent) of employees on a VWH schedule have children and 36 (21 percent) employees do not. As Table 6 indicates, the VWH program had a positive impact on child care arrangements.

Although it is not possible to draw many conclusions on the basis of such a small number of individuals, these results suggest that Ventura County's VWH program does not negatively impact employees with children. On the basis of work force projections, there will be more women with children in the work force, a positive result.

Chi-square analysis indicated a significant relationship between type of VWH schedule and ability to facilitate child care chi-square = 10.87463 (df = 4, N = 128), $p < .0280$. Forty-three percent of participants on the flex-time schedule indicated increased ability to facilitate child care arrangements; 57 percent indicated no change; and none indicated that ability to facilitate child care had worsened. Of the participants on the 4/40 schedule, 17 percent indicated increased ability to facilitate child care arrangements; 83 indicated no change; and none indicated worsened ability. Last, 19 percent of participants on the 9/80 schedule indicated increased ability to facilitate child care; 74 percent indicated no change; and 7 percent indicated worsened ability to facilitate child care (see Table 7).

TABLE 4 FLEXIBILITY OF SCHEDULE VERSUS WORK SCHEDULE SATISFACTION

	Level of Satisfaction with Schedule, Percent			
Schedule	Satisfied	Neither	Dissatisfied	Total
Flex-time	53.6	40.6	5.8	100.0
4/40	87.9	12.1	0.0	100.0
9/80	74.3	24.0	1.8	100.1[a]

[a]Failure to add to 100.0 percent is due to round-off error.

SUPERVISOR PERSPECTIVES

The supervisor survey was administered to all employees who manage staff on the VWH program. A total of 77 supervisors have employees who participated in the VWH program and 10 do not. When a supervisor had more than one employee in the program, they were asked to generalize their responses to describe the attitudes and performance trends of their group as a whole. Supervisors were asked if a variety of factors had changed in their department as a result of the variable work hour program. The results of the study indicate advantages and disadvantages from a supervisor's perspective.

As previously mentioned, the respondents participating in the VWH program reported an increase in productivity. Su-

TABLE 6 EFFECT OF VWH PROGRAM ON CHILD CARE

EFFECT OF VWH PROGRAM ON CHILD CARE	COUNT IN VWH PROGRAM	COUNT NOT IN PROGRAM	PERCENT IN VWH PROGRAM	PERCENT NOT IN PROGRAM
More convenient	31	0	24%	0%
Less convenient	6	1	5	3
No change	91	34	71	97
No Response	153	41	--	--
TOTAL	281	76	100%	100%

TABLE 7 FLEXIBILITY OF SCHEDULE VERSUS ABILITY TO FACILITATE CHILD CARE

	Level of Child Arrangement Convenience, Percent			
Schedule	Increase	Same	Decrease	Total
Flex-time	43.3	56.7	0.0	100.0
4/40	16.7	83.3	0.0	100.0
9/80	18.8	73.8	7.5	100.1[a]

[a]Failure to add to 100.0 percent is due to round-off error.

pervisors report similar increases: 23 (30 percent) reported an increase in the productivity of their employees and 54 (70 percent) reported that it stayed the same. Increases in the quality of work were also reported. This finding is important because some authors (e.g., *8*) claim that supervisors are less likely to regard flex-time as effective. This increase in productivity may be, in part, caused by the increase in job satisfaction noted earlier.

The results of the survey indicate that supervisors perceive a large increase in employee job satisfaction as a result of their participation in the VWH program. Sixty (80 percent) of all supervisors noted an increase in employee job satisfaction and 17 (20 percent) noted no change. The 80 percent of supervisors that indicated an increase in job satisfaction for employees who participated in the VWH program also reported the statistically significant increases in job satisfaction noted earlier. The increases in job satisfaction have led to decreases in absenteeism. As previously stated, one of the major concerns before the implementation of the VWH program was that it would increase absenteeism. Results of the pilot program indicate that the rate of absenteeism has improved as a result of employee participation in the VWH program. That is, 28 (36 percent) supervisors noted a decrease in absenteeism; 45 (59 percent) indicated absenteeism stayed the same; and 4 (5 percent) didn't know.

Although fatigue, coverage of daily tasks, and ability to locate employees are often reported as disadvantages for organizations after implementation of VWH programs, the results of this study indicate more positive results. Sixty-two of the supervisors (82 percent) reported that they were able to cover all daily tasks; 11 (14 percent) said they were not. The remaining 4 percent did not respond. Only 2 (3 percent) of the supervisors reported an improved ability to locate employees; 65 (84 percent) stated it had stayed the same; and 10 (13 percent) said it had worsened. Sixty-three (82 percent) of the supervisors felt that fatigue was not a problem, 5 (6 percent) felt that it was. There were 9 (12 percent) supervisors who did not know.

IMPACT ON SUPERVISORS

The pretest indicated that some supervisors were concerned about a loss of employee control or coordination. This concern was addressed by asking managers if they had to make changes in their management style as a result of their employees' involvement in the VWH program. Of the 76 supervisors participating in the VWH program, 15 (20 percent) indicated that they made changes in management style and 61 (80 percent) indicated that they did not. Of the 10 supervisors who do not supervise employees on the VWH program, 6 said they did not have to make changes in their style and 4 did not respond.

A chi-square analysis was used to test the relationship between flexibility of VWH schedules and supervisor's perceived need to make changes in management style. The results indicate no significant relationship between the flexibility of VWH schedules and perceived need to make changes in style chi-square = 3.297 (df = 2, N = 59), $p > .05$. This interesting yet unexpected result warrants further investigation.

Finally, supervisors were asked to indicate how satisfied they were with the VWH program. Seventy-two (94 percent) of the supervisors would like the VWH program to continue past the pilot; 4 supervisors (5 percent) did not want the program continued and 1 supervisor did not know.

SUMMARY AND CONCLUSIONS

The VWH program is an effective strategy for decreasing vehicle trips at minimal cost while enhancing organizational and employee effectiveness. The results of this study indicate that VWH programs have positive effects on ridesharing, commute time, employee and supervisor job satisfaction, as well as organizational effectiveness.

Overall ridesharing rates increased significantly after the implementation of the VWH program and the flexibility of VWH schedule did not obstruct the ability to rideshare. In addition to increases in ridesharing, individuals on VWH schedule reported significant decreases in commute time.

The impact of VWH schedules on the work unit was also positive. For instance, most respondents indicated that their ability to schedule meetings was not hindered by the implementation of VWH schedules. The majority of respondents indicated no change in ability to locate people; the reported difficulty in locating people and scheduling meetings was concentrated both in participants and nonparticipants. Participants in the VWH program reported experiencing significant increases in their productivity, morale, and job satisfaction, as well as more satisfaction with their schedule when compared to nonparticipants. The majority of employees would like to continue to participate, or begin to participate, in the VWH program.

Overall, the VWH program had a positive impact on child care arrangements. This finding has both important and positive implications for the recruitment and retention of employees with children. The flexibility of the VWH program affects the ease and convenience of child care arrangements. Yet another benefit of the program is a decrease in absenteeism. Supervisors indicate that VWH participation has decreased absenteeism, while job satisfaction and productivity have increased. The majority of supervisors indicate that they did not make changes in their management style. This finding was evident regardless of the flexibility of the VWH schedule. The majority of supervisors are satisfied with the VWH program and would like it to continue.

Three methodological limitations of this study should be considered. First, all participants knew that they were participating in a VWH pilot program and that the results of the pilot might influence policy decisions or county-wide implementation. The policy of Ventura County was to keep em-

ployees and supervisors informed. Therefore, the possibility of the Hawthorne effect (i.e., increases in production due to researchers' attention to the workers) or Rosenthal effect (the transmittal of the experimenter's expectations to his or her subjects) should be considered when interpreting the results. The Hawthorne effect should be minimal because the results were maintained over a 6-month period. Moreover, the employees and supervisors were not aware of the type of criteria used to measure the program. Because the criterion measures were compiled by CTS, the expectations on the experimental group were minimal.

Second, participation in the program was voluntary and Ventura County determined the range of flexibility allowed. Therefore, neither randomization nor manipulation of the independent variable was possible. Problems with internal validity, most significantly selection, are plausible (*9*).

Third, all survey responses were self-reported. There were no hard measures of productivity, job satisfaction, or changes in management style. The study may have been affected by response bias because, for instance, it did not include concealed questions about productivity increases. The criterion measure for permanent implementation was not disclosed to the respondents and the responses were anonymous and confidential. More important, the differences noted in all chi-square measures would not be influenced by response biases because the VWH programs were being measured against themselves.

Although there are some limitations to this research, the results do suggest that VWH schedules are an effective strategy for increasing ridesharing and decreasing commute time. The results of this study have also revealed several benefits such as increasing organizational effectiveness and employee satisfaction. On the basis of the results, the following recommendations were presented to Ventura County.

RECOMMENDATIONS

- Implement variable work hours county-wide. In doing so, emphasize the fact that the purpose of the VWH program is to decrease vehicle trips. Also, offer incentives to those who choose not to drive alone. For instance, allow employees who participate in ridesharing, take transit, walk, jog, bike, or telecommute, priority choice in scheduling off-days or flextime bandwidths.
- Appoint a VWH internal project director. Because there is a large overlap between implementation of the VWH program and the ridesharing program, consideration should be given to assigning these projects to the same department. The project director should be involved in all phases of implementation and work closely with each department to determine the type of VWH schedule most beneficial on a department-by-department basis. Furthermore, the project director should work closely with the labor union in all phases of implementation.
- Maintain similar off days and core periods within and between departments. Make use of core time and core days for scheduling meetings. Holding these departments constant within and between departments will facilitate the logistics of arranging meeting times. It will also make it more convenient to locate people, for participants and nonparticipants, within and between departments.

Notwithstanding the fact that the aforementioned recommendations are based on the results of the Ventura County pilot study, they have applicability to other employers considering the adoption of a VWH program. It is hoped that they will enhance the overall efficiency and effectiveness of the VWH program implementation process.

ACKNOWLEDGMENTS

This study was conducted by Commuter Transportation Services, Inc. The survey and report were prepared with guidance from Gail Matz, Transportation Coordinator, County of Ventura. The authors wish to express their thanks for her assistance. They also wish to thank Carol Walb, Patricia Price, Tanya Husick, and Jaime Amsel for their assistance.

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Publication of this paper sponsored by Committee on Ridesharing.

Examination of 11 Guaranteed Ride Home Programs Nationwide

COSETTE POLENA AND LAWRENCE JESSE GLAZER

Research on 11 guaranteed ride home (GRH) programs nationwide is documented. A GRH program provides a way home for ridesharers who miss their regular ride home as a result of a daytime emergency or working overtime. These programs may increase participation in ridesharing programs by reducing a common fear of being stranded without transportation. The research canvassed all GRH programs in operation in 1988; a series of case studies is followed by a comparative analysis of key program elements. The 10 GRH programs described are those of Hughes Aircraft, Golden Gate Bridge Highway and Transportation District's Flex-Pool program, Montgomery County Government's subsidized taxi service, Reston commuter bus, 3M's back-up vanpool service, Palo Verde Nuclear Power Plant's back-up vanpool program, Xerox's company fleet car program, Northern Telecom's back-up carpool service, Prudential's escort service, and the Seattle Metro's and City of Bellevue's subsidized taxi service. A description of UCLA's GRH service is included as an example of the planning and development of such a program. The experiences of these early pioneers can shed light on current GRH planning efforts. Although no program was able to statistically support or reject the contention that GRH services encouraged ridesharing (because of lack of data on commuting trends before introduction of the program), all program administrators felt that the GRH services were successful in reaching their basic goals.

A guaranteed ride home (GRH) service is an increasingly common element in employer transportation demand management (TDM) programs. This service provides a way home for ridesharers in cases where they miss their regular ride home as a result of a daytime emergency or working overtime. It is hoped that such services will increase participation in rideshare programs by reducing a common fear of being stranded without transportation.

Research conducted by Crain & Associates on 11 GRH programs nationwide is summarized. The research consisted of a telephone survey completed during the summer months of 1988 and updated in 1989. At that time, the GRH programs described were the only such programs operating in the country. Today, particularly because of AQMD Regulation XV in Southern California, GRH programs are much more commonplace. (Regulation XV requires large employers to implement a TDM program at each site with over 100 employees.) The experiences of these early pioneers can shed light on current GRH planning efforts.

There are six ways to provide a GRH service for stragglers and other off-hour commuters:

Crain & Associates, 2007 Sawtelle Boulevard, Suite 4, Los Angeles, Calif. 90025.

- Back-Up Vanpool. Vans are made available for taking commuters-employees home in cases of emergency or working overtime (after 6 p.m.). In most cases, the vans are used during the day for a vanpool service. Straggler vans follow a fixed route and the passengers are picked up from and dropped off at set locations. Back-up vanpools pick up all prospective riders at the same starting point. Passengers are dropped off at different locations of their choice, being served as though by a supershuttle.
- Back-Up Carpool. For persons needing a ride, carpool matches are arranged to get them home.
- Subsidized Taxi Service. A person in need of a ride calls a taxi, pays for the ride out of his or her own pocket, and later is reimbursed by the employer.
- Company Fleet Car. In cases of emergency or working overtime, the employee may use a company car to get home and bring it back the same or next day.
- Escort Service. The employee makes arrangements with the security office to have a security guard escort him or her to nearby public transit.
- Subsidized Public Transit. A person in need of a ride uses public transit to get home, pays for the ride out of his or her own pocket, and is later reimbursed.

The first 10 GRH case studies were located by canvassing ridesharing agencies, local, state, and federal transportation officials, and known ridesharing experts nationwide. The canvassing effort consisted of approximately 50 telephone calls. In-depth telephone interviews were conducted with the administrators of each GRH program located. Six of the programs were located in private companies. The remaining four programs were operated by public entities, including one ridesharing agency and three city or county planning departments. The 11th case study, the development of UCLA's GRH program, was compiled from information in Crain & Associates' files.

Case studies are included on each program, followed by a comparative analysis that reviews key elements of GRH programs, such as types of services offered, eligibility criteria, limits on usage of the service, usage of the service, staffing levels, program costs, promotion techniques, and length of program.

The 10 GRH programs located in the canvassing effort in spring 1988 were

1. Hughes Aircraft's back-up vanpool program, Tucson, Arizona;
2. Golden Gate Bridge Highway and Transportation Dis-

trict's (GGBHTD) Flex-Pool program, San Francisco, California;

3. Montgomery County Government's subsidized taxi service, Montgomery, Maryland;
4. Reston commuter bus, Reston, Virginia;
5. 3M's back-up vanpool service, St. Paul, Minnesota;
6. Palo Verde Nuclear Power Plant's back-up vanpool program, Phoenix, Arizona;
7. Xerox's company fleet car program, Palo Alto, California;
8. Northern Telecom's back-up carpool service, Santa Clara, California;
9. Prudential's escort service, Newark, New Jersey; and
10. The Seattle Metro–City of Bellevue's subsidized taxi service, Bellevue, Washington.

CASE STUDIES

Case Study 1: Hughes Aircraft's Back-Up Vanpool

Description

Hughes Aircraft Co. is located in Tucson, Arizona. The company has a work force of approximately 6,300 employees, one-third of whom use some type of ridesharing travel mode. The average commute is about 45 min round trip.

Background

On April 1, 1988, Hughes started a vanpooling service contracted by People Ridesharing Systems (PRS). The cost of the service is approximately $39 per month per van rider. The cost to the vanpooler is low because of government air quality improvement subsidy. The program began with a 6-van fleet, which recently has increased to 35 vans. The vans are leased on a month-to-month basis. Hughes shares the vanpool program with a neighboring utility company; however, the majority of vanpool riders are Hughes employees. Each van carries an average of 11 riders and is driven by employees. Between the two work sites, there are approximately 400 vanpool riders.

GRH Service

The GRH program is limited to vanpoolers. Hughes has an emergency van for problems during the day and two late-schedule vans, one traveling to the east side of Tucson and the other traveling to the west side. The emergency van is usually driven by one of the ridesharing staff members; the two late vans are driven by employees who work later shifts on a daily basis. In this case, employees working overtime must call Hughes' ridesharing office before 4:00 p.m. to request a late ride.

Staffing and Budget

The cost of the GRH is included in the monthly vanpool charge. There are two PRS staff members on site at Hughes who coordinate the vanpool program and approximately 1 hr (12 percent) of each employee's workday is spent working on the GRH service.

Results

The late vans have an average of three riders per day and the emergency van has approximately five riders per week. These ridership levels amount to 195 rides per year per 100 eligible employees for the late van service, 65 rides per year per 100 eligible employees for the emergency service, and 260 rides per year per 100 eligible employees for both GRH services. Hughes' commuter services coordinator states that the GRH successfully attracts riders to the vanpool program, but there is no point of comparison because the GRH service was part of the initial vanpool service.

Case Study 2: Flex-Pool GGBHTD's Back-Up Vanpool

Description

In 1981, the GGBHTD received a National Demonstration Project grant from FHWA and UMTA to support several of the district's ridesharing programs. Golden Gate Ridesharing was the ridesharing division of GGBHTD, which administered these services for the counties of Marin, Sonoma, and San Francisco from 1977 to 1987. Since 1987, the GGBHTD has contracted with RIDES for Bay Area Commuters, Inc., for ridesharing services.

Background

Flex-Pool was created to address the concern that potential ridesharers and transit users might have about being stranded if they missed their regular connections. The Flex-Pool service was developed to enhance the existing services (vanpools, carpools, subscription club buses, and Golden Gate Transit Express buses) and to provide a convenient back-up vanpool transportation system. The service was available to all commuters in the financial district who registered with the program; 7,000 persons registered for the service and received mail-back identification cards that stated their usual commute mode and other information used in data collection. District-owned vans traveled in loops through the financial or civic center district. Up to four vans at one time were used. The drivers were commuters who volunteered to drive the Flex-Pool van and to maintain simple records in exchange for a free commute and unlimited personal use of the van. As part of the demonstration project, Flex-Pool began in September 1982, and ended in early 1984.

GRH Service

For commuters who worked late, a van would leave from San Francisco between 5:30 and 6:30 p.m., traveling along U.S.-101 to designated stops in Marin and Sonoma counties. A

commuter needing a Flex-Pool ride made a telephone reservation by 3:30 p.m. to be picked up at a designated location in the city. Commuters who made a reservation were guaranteed a seat. Registrants who did not reserve a ride could flag down a Flex-Pool van at a pick-up stop, but were not guaranteed a seat. Golden Gate Ridesharing would notify the Flex-Pool driver of the reservations and the locations where the persons were to be picked up. The passengers paid for their ride at the pick-up time and the $1.50 to $3.00 fare varied according to destination. The average fare was $1.95. The fare was kept low enough to attract riders, but high enough to prevent commuters from using the service as a daily commute mode.

Staffing and Budget

The project was staffed by three professional positions and one clerical position, one project supervisor, one project coordinator, one part-time information-dissemination coordinator, and one part-time clerical assistant. Coordinating rides, data collection, recruiting drivers, designing marketing techniques, and tracking ridership information and program cost proved to be labor-intensive. The GGBHTD Ridesharing Division administered the Flex-Pool demonstration project through FHWA–UMTA funding. Service was discontinued when project funds were exhausted.

Results

The most effective vans were those that operated right after the evening peak by leaving the financial district between 5:30 and 6:00 p.m. This fact suggests that vans that cater to the slightly delayed worker may be the most useful. Unlike transit, Flex-Pool's occasional ridership was low. The Flex-Pool experience indicates that ridership is highly dependent on external events (e.g., holiday shopping and unusual weather conditions) and that occasional ridership varies depending on the needs of commuters. Over 4,300 commuters used Flex-Pool; therefore, from the standpoint of being a back-up transportation system, the service was a success. In fact, 90 percent of those who rated the service gave it an overall rating of good to excellent. Survey results indicated that the principal reasons cited for using Flex-Pool were that the vans were convenient, eliminated the need to drive, and saved money.

Case Study 3: Montgomery County, Maryland, Subsidized Taxi Public Transit

Description

The Montgomery County government employs 6,000 employees.

Background

Montgomery County's ridesharing policy includes subsidizing a portion of employees' cost to ride a bus, subway, or vanpool in exchange for the employees' relinquishing their parking permits. The county has named this their GET-IN program; it was initiated in October 1986. Presently, of 6,000 employees, 155 are using transit or vanpool and are members of the GET-IN program. An additional 116 employees carpool, but are not eligible for GET-IN. Both these commuter groups are eligible for the emergency taxi fare reimbursement program.

GRH Service

In case of an emergency, the employee calls a taxi or uses public transit, pays for the ride, and later is reimbursed from the petty cash allotted each county department. Usage of the program is not limited because of the expected low ridership.

Staffing

No special staff is required.

Budget

No extra budget is allocated for the taxi fare reimbursement program. The total cost for the first year of operation was less than $50, which included only the amount spent on taxi rides.

Results

The emergency taxi public transit program is rarely used and has produced a relatively low cost to the county. Within the first year of operation, the GRH service provided 2.2 taxi rides per year per 100 eligible employees.

Case Study 4: Reston Commuter Bus Back-Up Vanpool

Description

Reston, Virginia, is concentrated in about 10 mi^2 and is located about 25 mi west of Washington, D.C. The city grew rapidly from a population of 3,000 in 1968 to a population of 35,000 in 1980.

Background

The Reston bus service began in 1968 as a private service. In the late 1970s, the county began to subsidize the service with regional funds. Presently, the Reston commuter buses feed into Washington, D.C.'s, extensive Metrorail system, but previously traveled the complete commute to Washington, D.C. There are two fixed routes, one that services the north side of Reston and the other that runs through the south side of Reston. Bus fare is paid at the time of the ride and set according to trip mileage and time of day.

GRH Service

After 7:00 p.m., the two routes are combined into one 12-mi straggler bus route, which is run three times to pick up late workers from Metrorail stations and other stops. This single line is slower and longer than the earlier routes. The rider pays the regular bus fare for the late runs.

Staffing and Budget

The straggler route is figured into the total cost of running the busy system; therefore, no special budget or staffing is set aside for the GRH service. The buses used for the late services are vehicles kept on longer from the earlier routes; therefore, no additional buses are needed. The labor and mileage costs are not significant in comparison to the overall service cost.

Results

The late-hour buses are approximately ¼ to ⅓ full, depending on the day.

Case Study 5: The 3M Company's Back-Up Vanpool

Description

The 3M Company, located in St. Paul, Minnesota, employs 12,700 persons.

Background

Of the 12,700 employees, 4,000 rideshare at this time. 3M began its ridesharing program in 1973 and has included a GRH service from its onset. The average commute is approximately 7½ mi one way. The vanpool program uses 100 vans, driven by 3M employees.

GRH Service

In the event of an emergency or work schedule change, the person needing a ride home will usually ask his or her supervisor, carpool mate, or vanpool mate for a ride. 3M allows employees the flexibility to take coworkers home if needed during the day. Commute times are low enough that a driver would not miss much work.

Staffing and Budget

The amount of work generated from the GRH equals less than 1 percent of a staff member's workday. The cost of the service is not separated from the overall vanpool program budget; however, the cost is low because the service is rarely used.

Results

For the vanpooler group, the GRH is used approximately 12 times per year. This usage amounts to 0.3 ride per year per 100 eligible employees. A count for other modes of ridesharing is not kept. One reason why the GRH is not used often may be caused by employees' apprehensions toward asking coworkers for rides.

Case Study 6: Palo Verde Nuclear Power Plant Back-Up Vanpool

Description

The Palo Verde Nuclear Power Plant is located in Wintersberg, Arizona, approximately 50 mi outside of Phoenix.

Background

The plant has a vanpool program coordinated and implemented by PRS. The program has 200 vans. The total number of persons ridesharing is 2,000 and the average commute is approximately 40 mi one way. Vans leave the plant at various times of the day serving employees who have more erratic work schedules. The last three vans are normally scheduled to leave the plant at 4:30, 5:30, and 7:30 p.m. These vans are usually not filled to capacity, allowing other riders on if needed in case of a schedule change.

GRH Service

In case an employee has a schedule change or home emergency, he or she calls the ridesharing office and a coordinator sets up a ride home for the person. The coordinator puts that person in another van, forms an ad hoc vanpool, or has a PRS employee take the person home. The emergency vans are usually driven by a PRS staff person or a plant security guard, unless the rider is put in a vanpool that is scheduled to leave earlier. The late vans are usually driven by vanpool drivers, back-up vanpool drivers, or PRS staff members. The GRH vans, acting as super shuttles, take people anywhere they need to be dropped off.

Staffing and Budget

PRS has 12 employees on site maintaining the van fleet. This number includes mechanics, drivers, and staff. The GRH is coordinated by one staff member who spends approximately 20 percent of his or her workday on this service.

Results

The GRH is used by 30 to 40 persons per day. The annual ridership level for this service is 637 riders per 100 eligible employees. The GRH is used often as a result of the erratic

schedules required by the plant workers and this frequent usage has made the program expensive to run.

Case Study 7: Xerox's Company Fleet Car

Description

Xerox employs approximately 375 persons at the Palo Alto site. These employees commute on average 10 to 20 mi one way from their homes. Some employees travel as far as San Francisco, which is located about 35 mi north of Palo Alto.

Background

Of the 375 Xerox employees, 25 rideshare. The company subsidizes 25 percent of the commuting costs for those employees who rideshare. This subsidy serves to encourage the employees not to commute alone by car. Types of HOV modes that are subsidized are vanpools, bus, and train. In addition, Xerox owns five cars that are used for business purposes, of which only three are let out at one time. These fleet cars have been available since 1978.

GRH Service

In cases of emergency, an employee may use one of the company cars to get home, if a car is available. The fleet car use is limited to 2 hr, but in desperate situations, can be taken home and brought back the next day.

Staffing and Budget

No special budget or staff is set for emergency situations as it is rarely used.

Results

The fleet cars are used approximately two times per week, which amounts to 27.7 rides per year per 100 eligible employees.

Case Study 8: Northern Telecom Back-Up Carpool

Description

Northern Telecom, located in Santa Clara, has 1,200 employees.

Background

Northern Telecom has a carpool match-up program, and subsidizes bus tickets for employees. The average employee commutes 10 mi one way to work. There are 111 carpoolers, 15 bike riders, and 10 motorcycle riders.

GRH Service

Northern Telecom has no written GRH program; however, if an employee cannot find a ride home, the ridesharing office will attempt to find him or her someone with whom to carpool. The company has provided this service since the beginning of the Carpool Matching Program in 1980.

Staffing and Budget

No special budget or staffing is set because it is not a written program. The time it takes to coordinate back-up carpool rides is small, which keeps down the associated costs for staffing.

Results

This ad hoc GRH is used approximately one time per month. The annual ridership level is one ride per 100 eligible employees. The low usage is because the assistance is used mostly as a last resort. In addition, there is no promotion of a GRH; therefore, employees may not be aware of this option in cases of emergency.

Case Study 9: Prudential's Escort Service

Description

Prudential, located in Newark, New Jersey, employs approximately 3,500 employees, who are located within four buildings in the downtown area.

Background

The company offers free parking; therefore most employees drive to work. The company also owns vans that are used as a shuttle service to the local train station and parking lots. The shuttle runs in the morning from 7:00 to 8:50 a.m., and in the afternoon and evening from 3:20 to 8:00 p.m. The shuttle vans are owned by Prudential. In addition, Prudential also has a vanpool program for its employees through a third-party service called Rideshare.

GRH Service

In the event an employee needs to work late, he or she must make an appointment with the security office before 8:00 p.m. that day for a security guard to take the employee to a train station or a parking lot. The security supervisor notifies the night shift of the appointment, and a security guard takes the employee to his or her destination with one of the shuttle vans. The service has been available since 1973 with the initiation of the shuttle service.

Staffing and Budget

No special staffing or budget is set aside from the total security budget. However, cost is low because of the short commute to and from the parking lots and train stations.

Results

Approximately 20 to 25 riders use the escort service per week. This calculates to 33.4 rides per year per 100 eligible employees.

Case Study 10: Seattle Metro–City of Bellevue's Subsidized Taxi

Description

The subsidized taxi concept was tested by the city of Bellevue and by Metro, the county transit and ridesharing agency, in two target areas in Bellevue: the central business district (CBD), and the suburban area along I-90. In 1987, the CBD target group was made up of 20,000 CBD employees, and along the I-90 corridor 7,000 employees were targeted. In addition, the city of Bellevue requires new developments of over 100,000 gsf to provide a guaranteed ride home program.

Background

Bellevue's TDM program began in 1979 to encourage ridesharing with reduced parking requirements in the central business district. In 1987, the city began a 2-year demonstration of various subsidy and marketing strategies, one of which was subsidized taxi. The Bellevue TDM demonstration program was called Easy Ride, and was targeted at suburban employment sites. Easy Ride was administered by the Bellevue Department of Planning, which contracted with Metro to provide specific services. Metro developed the subsidized taxi GRH program in conjunction with its contract to provide TDM services for the city. Metro has continued to study the subsidized taxi concept; however, this case study presents only the agency's initial efforts in Bellevue.

GRH Service

The GRH service began in August 1987. Carpoolers, vanpoolers, and bus riders were eligible for the program. Commuters interested in participating in the GRH service registered with the program by filling out a form detailing their commute information. The applicants were then given limited-mile taxi vouchers that were good for 1 year. The I-90 vouchers were worth up to 60 mi and the CBD vouchers were worth up to 40 mi. Metro negotiated an exclusive contract with the Yellow Cab Company and in return Metro received a 10 percent rebate for more than 25 taxi rides per month. The employee using the taxi service called and requested a Yellow Cab, paid for the ride out of his or her own pocket, and sent the voucher to Metro with the taxi ride information for reimbursement. Metro refunded the full cost of the taxi fare less a $1.00 copayment.

Staffing and Budget

Two staff positions entitled "transportation coordinators" were created to market the Easy Ride program including the GRH service, as well as other special commuter transportation programs. Metro's accounting staff processed the taxi vouchers that had been submitted within the first 6 months. Because of the low volume of vouchers submitted, Metro did not anticipate needing additional voucher processing staff at that time. At the program's onset in 1987, Metro agreed to subsidize the first 100 vouchers for the CBD target group, and the city of Bellevue agreed to subsidize the first 100 vouchers for the I-90 target area. Metro's GRH program budget was $6,000 per year for the first 2 years, which was taken from its Federal Aid to Urban Systems (FAUS) fund (gas tax), and sustained the program until spring of 1989. The city of Bellevue budget was $8,000 per year for 2 years, taken from the city budget, which carried the I-90 program into spring of 1989.

Results

Metro evaluated the GRH program's first 6 months of operation. The study found that 142 persons registered for the program within the CBD and I-90 corridor target areas. Metro's analysis also found that only nine employees who took 11 rides had used the service. This usage amounts to a ridership level of 15.5 rides per year per 100 eligible registered employees. The analysis concluded that the low usage may be because of the limit on travel miles, influencing riders to save their vouchers for emergency situations. In addition, several participants had stated that they disliked riding in taxis—yet, not enough to make them turn away from the program. Moreover, this factor may also encourage participants to use their taxi rides only as a last resort.

Metro found that 10 percent of the participants switched from driving alone to an HOV mode as a result of the GRH program. However, the promotional campaign targeted HOV users, thus making this analysis inconclusive. Furthermore, the majority of single-occupancy vehicle switching was into vanpools, which may be a result of a $10 per month vanpool subsidy offered through Easy Ride rather than of the GRH service.

Case Study 11: Development of UCLA's GRH Program

This case study serves as an example of the development of a new GRH program. It describes the policy-making process of developing the UCLA GRH program in 1988. Crain and Associates assisted UCLA's Commuter Assistance-Ridesharing (CAR) Office in implementing its TDM plan since 1985. In 1988, UCLA decided to develop a GRH program for UCLA vanpoolers. Such a service would provide a way home for CAR's 684 vanpoolers in cases when the van-

pool rider missed his or her usual ride home. The following sections contain the steps UCLA took in formulating its initial GRH service.

The CAR office reviewed background material and constructed a preliminary proposal. The proposed service had two programs: one for overtime workers and a second for daytime emergencies. The late service would consist of an evening straggler van service that would be driven by a UCLA employee who had a later work schedule (for example, 10 a.m. to 7 p.m. rather than 9 a.m. to 5 p.m.). The routes would follow existing vanpool routes. The emergency-day service would use subsidized taxies for those vanpool riders living within 20 mi of UCLA. Vanpoolers living more than 20 mi from UCLA would have a fleet service rental car available to them.

Focus Groups

Several questions regarding the GRH program surfaced repeatedly during meetings with the CAR staff, and it became evident that they needed clarification. Examples of the types of questions that needed to be addressed were the following. Where would riders like to be dropped off? Which travel options appealed most to vanpool riders and would be most useful for getting home in cases of emergency or working late? How would riders prefer to pay for the service? Would vanpoolers rather pay for the service through a monthly registration fee or by the ride? (The university was able to subsidize only a portion of the cost.)

In order to look more closely at these questions, Crain & Associates recommended that focus groups be conducted. Focus groups are a widely used marketing technique to gather in-depth qualitative information. Groups of subjects who possess a common characteristic related to a topic are gathered together. A structured discussion evolves on the basis of their responses to various questions posed by the researcher. This technique is most often used by marketing firms to examine personal opinions regarding a service or product. Focus groups are conducted in an informal atmosphere (by providing a lunch, for example) to ensure that the participants feel comfortable in voicing their opinions. The researcher prepares a question outline that he follows strictly to ensure that all issues are covered and that all focus groups receive equal treatment. However, questions are asked in an open-ended format to initiate discussion. Questions are broad at the beginning of each new topic and then move to specific issues within those topics.

Two GRH focus groups were conducted with CAR vanpool riders in January 1989. The focus groups were jointly organized by Crain & Associates and the CAR office. The CAR staff reserved space on campus and arranged for a light lunch to be served. The CAR staff also contacted vanpool riders who had been randomly selected from a current vanpool list to participate in the focus group meetings. About 20 people were scheduled to attend each session. Crain & Associates was responsible for the GRH focus group design and analysis. A discussion guide was constructed and the basic structure of the focus groups, including visuals, was organized. Each focus group session spanned 1½ hr and was audiotaped for later analysis.

Analysis of the focus group discussions produced the following key findings:

- Participants felt that the straggler van would best serve late departures. Carpools would be the second choice after the straggler van.
- Fleet service rental car would best serve the daytime emergency departures.
- Taxi rides would not be a viable option because of high fares unless trip distances were less than 15 mi.
- The UCLA Buspool would be a viable option for a small portion of vanpool riders that lived in the direction of the UCLA Buspool routes.
- The straggler van, taxi, and rental car services were the three most popular options with the focus group participants.
- Focus group attendees prefer a pay-per-ride system to a pay-per-month system.
- Participants from both focus groups commented that the straggler van name had a negative image. Thus, the name of the service was changed from straggler van to night rider van.

These focus group findings were used as a key reference in determining the final GRH program design. For instance, the travel options considered for the initial service, the night rider van, fleet car rental, and the taxi, were greatly influenced by the outcome of the focus groups.

Sensitivity Analysis of GRH Service Cost

Before the initial service was finalized, a sensitivity analysis of probable program cost and an estimation for a budget would need to be conducted. The sensitivity analysis examined the cost of providing a night rider van service, subsidized taxi service, and a fleet rental service, the three most popular options according to the focus groups.

Cost estimates for the three travel modes were gathered through phone interviews with local taxi services and information provided by the CAR office on fleet car rental rates and vanpool costs. The CAR staff also provided the data on the average vanpool commute and vanpool fare. These data were used to calculate the effects on cost if the night rider vans carried regular vanpool riders who would pay a monthly vanpool fare. If the van carried a few regular van riders, it would help recover a portion of the van's operating costs. Three cost scenarios were used to examine the effects of differing GRH ridership.

As expected, the analysis found that the per-ride cost of each travel mode differed. The night rider van is the least expensive per ride, because the service is operating regardless of GRH ridership. The fleet rental and the taxi are more expensive per ride because the total cost increases for each additional GRH ride taken.

GRH program costs vary depending on the specific characteristics of the employment site. However, UCLA's experience illustrates the importance of investigating the factors that may or may not affect the service costs.

GRH Policies and Procedures

The final step before implementation was to design GRH policy guidelines and operating procedures. The policies covered program purpose, subsidies, eligibility, GRH travel options, GRH day service, GRH evening service, pricing, generating workload, and staffing needs. For instance, the initial GRH program would only be available to vanpool riders and would be used primarily to supplement the vanpool program. It was also agreed that to best serve vanpool rider needs, the GRH program must be varied and not dependent on one service type. For instance, if a GRH participant must work past the time of the night rider van departure, he or she should be covered by a subsidized taxi program or fleet service rental car. Therefore, it was decided that the evening GRH service would consist of the night rider van, supplemented by the taxi and fleet service rental as back-up. The day GRH service would include the taxi service and a fleet car rental service. It was also established that the GRH user would pay a copayment for the service; it was not to be a fully subsidized program.

The GRH procedures set the guidelines for day-to-day operations such as program registration, notification, dispatch selection, travel option preference, and promotion. If a GRH user called and requested a ride, a certain chain of events would occur. First, the caller is transferred to the appropriate GRH staff specialist and is verified to be a registered vanpool rider. Then the staff person would ask the GRH participant for his or her destination, probable trip mileage, and desired trip time. On the basis of this information plus what time the request is made (certain options are not available after certain times in the day) the staff specialist can determine the most appropriate travel mode to be given.

If the night rider van is appropriate, the GRH user meets the van at an appointed place on campus. He or she must purchase a night rider ticket ahead of time to be admitted on the van. The GRH rider is then taken to his or her car located at one of the vanpool parking lots along the night rider route.

If instead, a rental car is preferred, the GRH user must come to the CAR office and fill out the appropriate forms. He or she is then given the keys to a fleet service's car and returns the vehicle the next day. On return of the rental vehicle, the GRH participant pays a portion of the rental car rate. The taxi service would be used as back-up because the fare would be high for the average vanpool rider (average commute is approximately 40 mi one way). The taxi company would bill the CAR office for the ride. The GRH staff specialist would then notify the user to pay the required copayment.

The UCLA GRH program began on July 1, 1989. The service is currently available to approximately 800 vanpool riders. The CAR office plans to expand the GRH program to include all registered carpoolers in the near future.

COMPARATIVE ANALYSIS OF GRH PROGRAMS

This section provides a summary and comparative analysis of 10 case studies that were in existence in 1988. Of the 10 programs, there were 5 back-up vanpool services, two subsidized taxi services, one back-up carpool program, one company fleet car use, and one escort service. The majority of the programs had formal GRH policies, whereas three, Prudential's escort service, Xerox's company car program, and Northern Telecom's back-up carpool matching, were essentially ad hoc programs.

Eligibility requirements for use of the program varied ac-

TABLE 1 SUMMARY OF SERVICE TYPES, ELIGIBILITY, USAGE LIMITS, AND ACTUAL USAGE

PROGRAM NAME	GRH TYPES	ELIGIBILITY*	LIMITS	USAGE**
FLEX-POOL	Strag/Van	All Commuters	request by 4pm	***
HUGHES	Strag/Van	VP	request	260.0
PALO VERDE	Strag/Van	VP	none	637.0
RESTON	Strag/Van	All Commuters	***	***
3M	Strag/Van	VP	none	0.3
N. TELECOM	Carpool	All Commuters	none	1.0
BELLEVUE	Taxi	CP, VP, T	mileage	15.5
MONTGOMERY	Taxi, Bus	CP, VP, T	none	2.2
XEROX	Fleet Car	All Commuters	time	27.7
Prudential	Escort	All Commuters	request	33.4

* CP - carpoolers; VP - vanpoolers; T - transit riders.
** Number of rides per 100 eligible employees per year.
*** Insufficient information.

TABLE 2 SUMMARY OF STAFFING, COST BUDGET, PROMOTION, AND LENGTH OF PROGRAM

PROGRAM NAME	STAFFING*	COST/BUDGET	PROMOTION**	LENGTH
FLEX-POOL	300%	$1.95/ride	High	9/82-84
HUGHES	40%	$40 VP fare	Medium	4/88-
PALO VERDE	20%	High	***	***
RESTON	0%	***	***	1969-
3M	1%	$0	None	1973-
N. TELECOM	0%	$0	None	1980-
BELLEVUE	10%	$14,800/yr	High	8/87-
MONTGOMERY	0%	$10/ride	Medium	10/86-
XEROX	0%	$0	None	1978-
PRUDENTIAL	0%	$0	Low	1973-

* Percentages assume that 100% equals one full-time staff person.
** "High" assumes 4+ promotional items; "Medium" assumes 2 - 3 items; "Low" assumes 1 promotional item.
*** Insufficient information.

cording to the type of service, how much of the costs were subsidized, and whether the program had formal policies. The ad hoc GRH services were generally available to all employees. The two taxi service cases were available to all commuters who rideshare, to avoid favoring one rideshare mode over another. The back-up vanpool most often had the strictest eligibility requirements, restricting service to vanpool riders. This circumstance was found for Hughes Aircraft, Palo Verde Nuclear Power Plant, and 3M. No other strong patterns for eligibility were found.

Staff size ranged from zero to four and workloads were low. When information was available, the daily work ranged from 1 to 20 percent of the staff persons' daily workload. The ad hoc GRH services took the least amount of coordination time because of low usage and lack of marketing tasks. This was the situation for 3M's back-up vanpool, Xerox's company car service and Northern Telecom's escort service. The taxi services of the Montgomery County government and Seattle Metro–City of Bellevue did not require much staffing because rides were arranged by the GRH participants themselves. The program that had the largest staff size, GGBHTD's Flex-Pool service, was a demonstration project that required large amounts of paperwork for UMTA documentation.

Budget estimates were higher for the back-up vanpools, which operated regardless of ridership. The services that operated only when in need (e.g., subsidized taxies, back-up carpools, company car rentals, escort service, and public transit) had lower usage and lower costs. All three of the ad hoc programs did not have GRH budgets set aside because the associated costs were too low to require it. Usage varies greatly by type of service and appears to be higher for services that operate regularly.

Nine out of the 10 cases were in operation during the survey. One program, GGBHTD's Flex-Pool, was discontinued because it was a demonstration project and had depleted its funds. One other program, the Seattle Metro–Bellevue subsidized taxi service, was an experimental 2-year project that was scheduled to end in Spring 1989. However, the service had low usage allowing the budget to fund an additional 6 months of operation. There is no real pattern with regard to lifespan of services; however, the ad hoc services tend to have long life spans ranging from 8 to 15 years.

Promotional techniques varied widely. Some of the formal GRH programs were heavily marketed, whereas the ad hoc services had no promotion whatsoever. No strong correlation between promotion techniques and usage patterns was found.

Five out of the 10 had no restrictions on usage. The limits associated with the other five programs were not extensive and mainly were related to ride requests being made within a time limit. The one service that had the most restrictions, Seattle Metro–Bellevue's taxi service, limited the mileage that would be subsidized.

PROGRAM RESULTS

No program was able to statistically support or reject the contention that GRH services encourage ridesharing. This was mainly caused by inadequate ridesharing data before and after GRH programs were implemented. In cases where adequate ridesharing data were collected, GRH was usually implemented concurrently with other incentive programs. This procedure made it difficult to attribute increases in high-occupancy vehicle ridership exclusively to the GRH service. However, all 10 programs felt they were successful in reaching their basic goals. The individual goals differed from service to service but they all were formed to assist ridesharers to get home in situations of daytime emergency and overtime work. Tables 1 and 2 present the 10 GRH programs and indicate how they relate to the nine characteristics described earlier.

Publication of this paper sponsored by Committee on Ridesharing.

Southwestern Connecticut Commuter Transportation Study: An Analysis of Commuter Attitudes and Practices on Connecticut's Gold Coast

CAROL DEE ANGELL AND JOSEPH M. ERCOLANO

Southwestern Connecticut commuters expend more than a minimum of time and effort to get to work each day. Increasing traffic congestion along the state's "Gold Coast" (so termed because of its cluster of high-income towns and corporate headquarters) and its accompanying strain on air quality and lifestyle have mobilized the public and private sectors to begin to seek effective solutions to the problem. The Southwestern Connecticut Commuter Transportation Study was conducted to better understand the Connecticut commuter and to develop effective programs to move commuters out of their single-occupant vehicles and into alternative forms of commuting. At the time of this survey, Connecticut had no trip reduction ordinances or other catalyst in place to move employers toward implementing comprehensive transportation demand management programs at the worksite. With the 1990 Clean Air Act Amendments, Southwestern Connecticut, as a severe nonattainment area for ozone, will require employers to implement trip reduction programs and to increase the average passenger occupancy of vehicles arriving at their worksite by 1996. Basic information on commuter attitudes and practices is necessary to develop programs that will attain this significant shift in commuter behavior.

Over the past decade, southwestern Connecticut has earned a position as a key employment center of the New York metropolitan area. Termed the state's "Gold Coast" because of its cluster of high-income towns and corporate headquarters, the region provides over 200,000 jobs for workers who live both within and outside its borders. The area grew quite rapidly through the 1980s; between 1980 and 1987, total employment in the region increased more than 20 percent.

The result of this rapid growth was traffic congestion on the area's roadways. This traffic congestion is expected to worsen. Despite current and future highway construction, traffic volume will continue to outpace highway capacity. By the year 2010, traffic volume in southwestern Connecticut is expected to increase more than 35 percent over 1989 levels.

For many employees, the commute to work on the region's congested highways can be troublesome. High housing costs have contributed to congestion by requiring longer distance—and more tedious—commutes. There is a demonstrated need for organizations to explore possibilities for promoting alternatives to single-passenger automobile travel.

C. D. Angell, MetroPool Inc., One Landmark Square, Stamford, Conn. 06901. J. M. Ercolano, Southwest Area Commerce and Industry Association, One Landmark Square, Stamford, Conn. 06901.

There is a unique challenge in convincing southwestern Connecticut commuters to switch from driving alone to an alternative mode of commuting. Despite a relative wealth of other options, including train, bus, express bus, carpool, and vanpool programs, commuters to and within southwestern Connecticut have developed an attachment to their automobiles that transcends convenient transportation and has become almost an obsession. This prevailing attitude, plus land use practices that have placed many new corporate centers far beyond the limits of the region's rich transit resources, makes an accurate portrayal of commuter attitudes and practices an essential first step to managing demand on the region's highways.

The Southwestern Area Commerce and Industry Association (SACIA), and MetroPool, Inc., the regional commuter mobility company serving southwestern Connecticut and the lower Hudson Valley region of New York, joined in partnership to sponsor this study.

Both planning and promotional goals were considered in formulating this study. By providing statistically valid descriptive information about commuting behavior as well as marketing-oriented information relevant to commuting alternatives, the study would help SACIA and MetroPool to plan transportation management programs and would provide guidance for positioning and developing campaigns that would promote alternatives to driving alone.

The procedures used in carrying out the research and the findings that emerged are documented. Three other studies (one east of the survey area in the next employment center, one statewide, and one in southern California) and the manner in which these findings compare with selected findings of the SACIA/MetroPool study are reviewed.

STUDY METHODOLOGY

The data collection instrument for the study was a highly structured questionnaire designed for easy self-completion. Respondents were asked about the characteristics of their commute to and from work (e.g., mode of travel and duration); their feelings about their commute; their willingness to switch to alternative travel modes; their reactions to possible incentives for switching travel modes; the reasons they prefer driving alone; and various demographic data.

The respondents were employees of companies chosen from a list of companies within the southwestern Connecticut region. Out of a possible 150 major firms, 135 firms were contacted to participate. A cover letter explaining the purpose of the study and asking for company participation was developed and mailed by SACIA to each company's chief executive. The high response rate was a direct result of a business organization asking for company participation—businesses networking to look at their region's transportation problems.

Cooperating companies were asked to distribute the questionnaire to all employees, regardless of mode of travel and region of residence. The questionnaires were distributed in May, June, and July 1989. By July, a total of 40 companies had cooperated with the study, distributing questionnaires to their employees and securing their return. This process yielded a return of 4,769 questionnaires completed by individual employees of these companies.

For data processing purposes, it was decided to include all respondents in the final sample. Although the sample size was large, it was felt that the sample would permit a breakdown by individual company for separate analysis and presentation, and would also allow examination of small subgroups of individuals who use alternative modes of commuting.

A tabulation plan was developed by the study team. Cross tabulations were designed to allow examination of the data by such variables as current mode of travel and willingness to switch to alternative modes.

THE REGIONAL PICTURE

Demographics

Commuters to major work sites in southwestern Connecticut who responded to the survey are moderately young, with most (59 percent) falling in the 25 to 45 year old age bracket. Only 12 percent are below age 25, and 12 percent are above age 55. Reflecting the concentration of corporate headquarters and related service businesses in southwestern Connecticut, there are heavy concentrations of managerial or administrative, professional or technical, and clerical workers (see Figure 1).

The majority (95 percent) of respondents have an automobile available for their commute. Most come from households in which two or more people are employed, and have lived at their current residences for 8 to 9 years, on average.

Modes of Transportation

In a statewide telephone survey sponsored by the Connecticut Department of Transportation at about the same time as the SACIA/MetroPool survey, 83 percent of commuters reported driving alone to work. However, among the SACIA/MetroPool survey respondents, 92 percent drive alone to work (Figure 2). Use of carpools by survey respondents is slight; use of vanpools, trains, and buses even less.

Survey respondents not only do not use alternative modes now; they have little previous experience with commuting other than alone. Fewer than one in five (18 percent) have ever carpooled, on either a full- or part-time basis. Past train usage is slightly lower (14 percent). A small number of survey respondents have had experience with vanpools or buses (5 percent).

Hours and Duration of Travel

Survey respondents compete with plenty of other drivers for road space during their daily commutes, because of peak travel patterns and their relatively lengthy trips to work. In the morning, as many as half of them are beginning their commute within the 1-hr time period between 7:00 and 8:00 a.m.

During the evening rush period, most travel is initiated within a 1- to 1½-hr time frame between 4:30 and 6:00 p.m., with the 4:30- to 5:30-p.m. period representing the heaviest travel.

For most respondents, the trips to and from work represent a significant block of time (see Figure 3). Most have a trip of 21 min or more. The average lengths of the commute to work and the return home are 33 and 34 min, respectively. The proportion of respondents with a lengthy commute of more than 1 hr is fairly limited, but these dedicated commuters do exist.

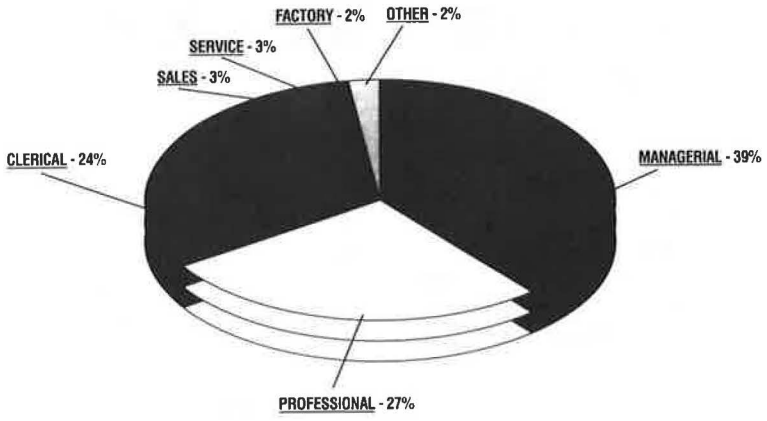

FIGURE 1 Survey respondents by occupation.

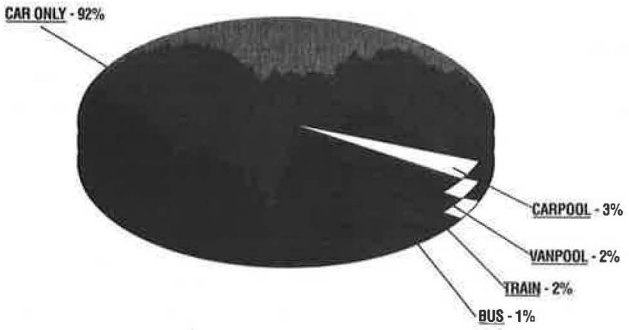

FIGURE 2 Principal commuting modes.

Changes in the Commuting Situation

With the rapid growth of employment in southwestern Connecticut, commuting to work is unlikely to be any easier now than it was several years ago. The survey respondents agreed. Although about half of the respondents report that the duration of their commute now compared to 1 or 2 years ago has remained the same, nearly one-third feel that their commutes have lengthened during this period.

Few respondents (9 percent) feel that they have a shorter commute. In fact, the commute has become more, rather than less, challenging over the past 1 to 2 years (see Figure 4). Although some respondents feel that the ease of their commute has remained the same, as many as one-third rate it "somewhat more difficult." Some are even suffering through "much more difficult" commutes. Those respondents commuting into the concentrated corporate areas of Stamford and Greenwich are especially likely to face greater difficulty in driving to work.

THE COMMUTER PROFILE ACCORDING TO MODE OF TRANSPORTATION

Demographic Profile

There are subtle demographic differences between those respondents who commute alone by car and the relatively small groups who are using alternative modes of travel. Because the percentage of drive-alone commuters is so large, it represents the demographic norm for all commuters.

The carpooling and vanpooling respondents are older than the survey average. The proportion of those under age 43 is 42 percent for carpoolers and 49 percent for vanpoolers. The number of professional or technical workers in these alternative commuter groups is mostly female and heavily concentrated in the 25- to 32-year-old age bracket. These train riders are also less likely than other respondents to have a car available for their use.

The small group of bus riders is virtually confined to women. This group consists mostly of clerical and factory workers, individuals under age 25, and those without automobiles at their disposal. This suggests that the bus may be their only means of transportation to work.

Commuting Positives

Although solitude and relaxation ranked high as commuting positives, the respondents' perception of the advantages offered by their commuting modes differs widely according to mode of travel (see Figure 5). For those who drive alone, time to be alone is the single most pleasant feature of their commute. A few solo drivers see their commute as a time to relax.

Carpoolers enjoy the cost saving and socializing opportunities afforded by their choice of commute mode. Vanpoolers see relaxation and saving money as strong advantages. The most relaxed commuters are those who take the train to and from work. Other advantages unique to the train commute are getting work done and sleeping.

Bus riders enjoy relaxation benefits (though less so than train riders and vanpoolers) and, occasionally, see their commute as a time to get work done and to socialize.

Automobile Commuting Advantages

Drive-alone commuters value flexibility. The main reason cited by nearly half of those using a car to commute alone to work is, "I can't be tied to a schedule." The unwillingness to commit to a schedule is stronger among managerial and professional

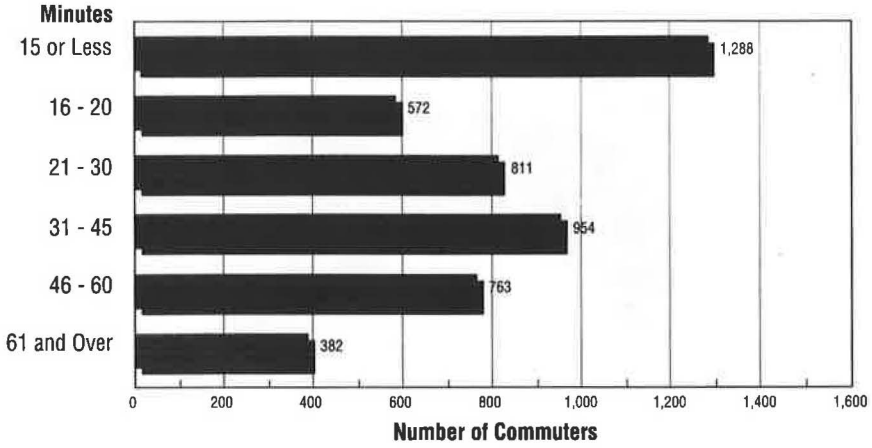

FIGURE 3 Lengths of commutes to work.

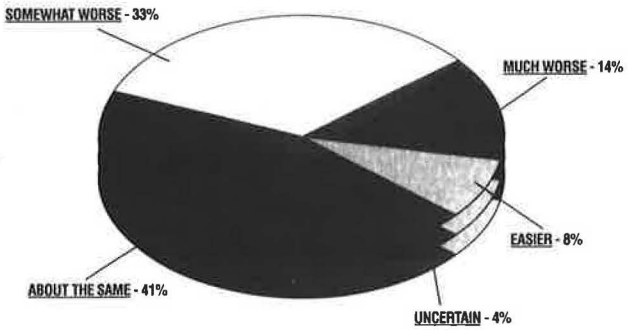

FIGURE 4 Perceived commuting difficulties today versus 2 years ago.

or technical workers (59 percent) than among clerical workers (37 percent).

Two additional strong reasons for commitment to driving alone also emerged: the belief that the commute is sufficiently short to prohibit other methods (36 percent), and the need for a car at work for personal reasons (33 percent). Some respondents dislike driving alone, but find other modes of commuting even less appealing.

Interest in Commuting Alternatives

The survey respondents are just moderately interested in commuting alternatives. Carpooling was the most likely choice of 24 percent of current drive-alone commuters if they were to change their method of commuting. Fourteen percent would choose the train, followed by express bus (8 percent), vanpool (8 percent), and local bus (4 percent). However, 48 percent would not consider any of these alternatives to driving to work alone in their cars.

Thirty-two percent of the drive-alone commuters surveyed would consider carpooling to work part time; 14 percent might take the train or express bus; 10 percent would consider vanpooling part time, and 7 percent the local bus. Another 32 percent would not consider any alternative to their current mode.

The two major categories of employees (professional, technical, or managerial and clerical or service) shared similar levels of interest in the various commuting alternatives. However, professional, technical, or managerial employees were slightly more likely to consider using the train full time (16 percent) or part time (17 percent) than clerical or service employees (12 percent full-time, 10 percent part-time train usage considered).

Willingness to Switch

Although the respondents, as indicated earlier, were able to indicate a preference when forced, there was little realistic consideration given to leaving their cars and actually making the change. Fewer than one in five (16 percent) said they considered switching their means of commuting in the past year. Among the small group of prospects (those who considered switching), the carpool and train, followed by vanpools, are the most appealing alternatives (see Figure 6).

Potential Advantages of Alternatives

Of those respondents who considered switching to alternative commuting modes over the past year, the benefit most sought (more than one benefit could be chosen) was avoiding the stress of driving (65 percent). Reducing expenses (54 percent), traffic congestion (47 percent), and accidents (35 percent) were also considered to be advantages of switching. Time to relax while they commuted appealed to 40 percent of the drive-alone respondents.

If they considered carpooling, they were seeking to cut down expenses (79 percent), reduce traffic congestion (60 percent), and relax (42 percent). Would-be vanpoolers were seeking reduced stress (82 percent) and expenses (69 percent), and more time to relax while commuting (52 percent). Potential train riders saw an advantage of avoiding the strain of driving (86 percent) and reducing the risk of accidents (51

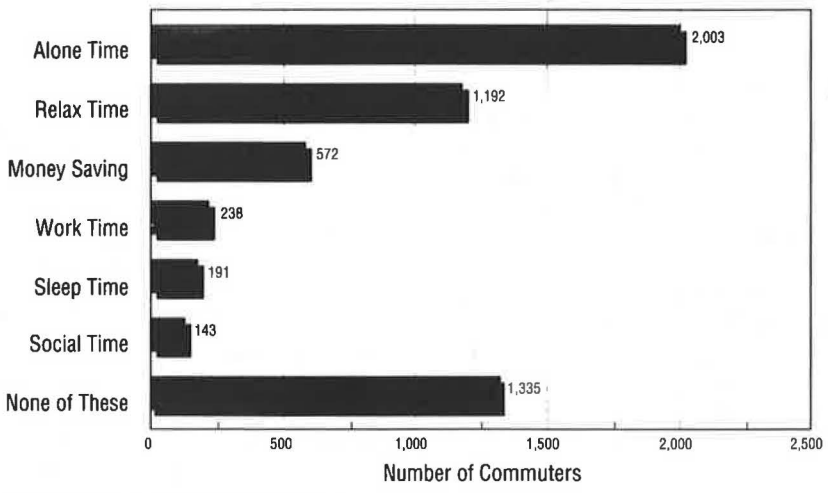

FIGURE 5 Most pleasant features of commutes.

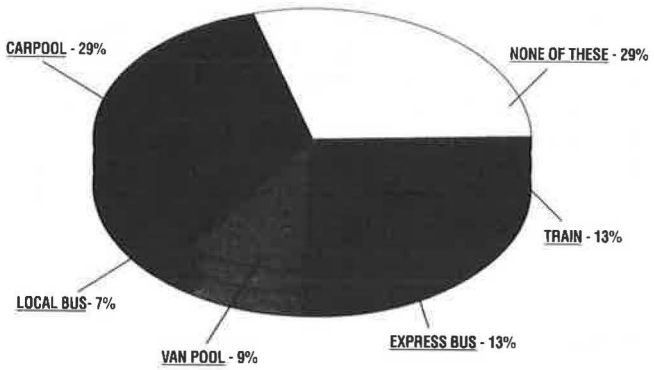

FIGURE 6 Modes that commuters would consider part time.

percent), and also valued the opportunity to relax while commuting (59 percent).

Potential bus riders emphasized reduced stress (81 percent), expenses (54 percent), congestion (56 percent), and accidents (56 percent), as well as relaxation (51 percent).

For prospective switchers in all occupational categories, reduced stress and expenses emerged as key benefits. Professional, technical, or managerial employees placed above average emphasis on the added benefits of relaxation time (53 percent) and time to work while commuting (23 percent). Clerical workers particularly valued the opportunity to reduce their risk of accidents (48 percent).

None of the commuter groups within the survey saw socialization opportunities, avoidance of parking problems, or freeing up cars for others in their households as significant benefits of alternative modes of travel.

Incentives for Switching

The variety of possible incentives available had only limited power in swaying respondents away from their personal automobile. In general, they appeared more likely to respond to the penalties of continuing their current commute behavior than to the possible rewards that could be associated with the alternative mode.

Incentives were ranked according to strong incentive to switch, would consider switching, and would still use my car.

The highest ranked motivation to switch, with the ability to strongly motivate 26 percent and to possibly motivate 23 percent of the respondents, is a $30- to $40-per-month parking charge at the work site. Other negative motivators included increased highway congestion (19 percent, strong motivator; 26 percent, possible motivator); loss of parking at the worksite (18 percent, strong motivator; 28 percent, possible motivator); and gasoline shortages or price increases (18 percent, strong motivator; 29 percent, possible motivator).

Of positive incentives to switch methods of commuting, flexible work hours appealed to 20 percent of respondents as a strong incentive to switch, and 18 percent as a possible motivator. Other positive incentives that had at least some power to motivate a switch in respondents included management commitment to alternatives (42 percent), an express bus to the work site (48 percent), and emergency transportation during the workday (40 percent).

The motivating power of certain incentives was especially apparent among those who would consider specific alternatives (this refers to subgroups who considered switching in the past year). Potential vanpoolers, in particular, would be more inclined to respond favorably to an express bus to the worksite (44 percent), emergency transportation home during the day (46 percent), and preferential parking for vans (35 percent). Potential train riders could be attracted by more frequent train service (53 percent), subsidized train fare (50 percent), and shuttles between the train station and work site (47 percent).

Would-be bus riders were likely to respond to an express bus to the work site (68 percent), subsidized fares (42 percent), and emergency transportation home during the day (43 percent). Most incentives carried equal weight across the various occupational categories.

Demographic Profile of Prospects

The demographic profile of drive-alone commuters who considered switching to an alternative mode differed somewhat from that of the total market, as well as from the profiles of those currently using the alternative.

The group of potential switchers to carpools, vanpools, and trains carried an above-average concentration of 25 to 34 year olds (47, 44, and 47 percent, respectively). Because the profiles of current carpoolers and vanpoolers were much older, this prospect profile revealed some opportunity to expand the market for alternatives.

Professional or technical and managerial or administrative employees made up the bulk of the prospect group for each alternative mode. The potential vanpool and express bus groups were mostly women (59 and 60 percent, respectively); the potential train riders group was 55 percent men.

IMPLICATIONS OF THE STUDY

The large number of respondents who currently drove alone to work by car were unlikely to automatically or easily switch to an alternative mode of travel. In fact, a significant subgroup (perhaps 30 to 45 percent of the total population) was virtually out of the market for alternatives, given the ease of their current commute.

However, there did appear to be opportunities to incrementally increase the proportion of commuters able and willing to make use of various alternatives. This was evidenced both by the number of drive-alone commuters able to consider the alternatives and the profile of potential switchers.

Because conversion is unlikely to be simple, it is apparent that active efforts by MetroPool, SACIA, and employers would be necessary to capture and actually move a significant proportion of this currently latent market.

The SACIA-MetroPool study uncovered several communication challenges. Marketing to potential ridesharers should relieve concerns about the regimentation that is associated with the alternatives—especially among the managerial or administrative sector. Awareness of the personal negatives associated with driving alone, like stress, should be reinforced.

The benefits that can be gained by switching to certain alternatives should also be highlighted. In all cases, this includes greater relaxation than is afforded by driving alone. There were specific advantages for each alternative, such as flexible scheduling, cost savings, and socialization (for carpools); maximum cost savings and greater ease of travel for the long-distance commuter (for vanpools); safety and a chance to get work done (for trains); and faster travel, cost savings, and safety (for buses).

The individual employer is likely to play a vital role in supporting change. Respondents feel that management commitment to alternatives is one of the key motivators to consider alternative modes of commuting. Flexible work hour schedules, financial incentives to decrease the cost of using alternatives, and rides home in case of emergencies (guaranteed ride home programs) are employer incentives that are likely to have a positive impact on employee willingness to switch commuting modes.

Certain new service offerings that would make train and bus travel easier may require the support of public officials as well as employers. Transportation directly to the worksite from the train station or bus stop, and improved parking at train and bus home site stations are examples of these potential new service improvements.

A core of commuters are responsive only to the penalties of driving alone by car to work. Imposing a daily dollar penalty for parking at the work site is the action most likely to sway such individuals.

Prime targets for potential switchers to alternative modes include those who travel more than 40 min to and from work—i.e., those who have the longest, most troublesome commute.

A COMPARATIVE LOOK AT OTHER COMMUTER STUDIES

Southern California Study by Commuter Transportation Services, Inc.

In 1989, Commuter Transportation Services Inc. (CTS) of Los Angeles conducted a telephone survey of over 1,200 commuters residing in Los Angeles, Riverside, San Bernardino, Ventura, and Imperial Counties.

These southern California commuters, like their counterparts in southwestern Connecticut, found that traffic was worse at the time of the survey than it was 1 year ago. The average length of the commute in the CTS survey was about 30 min to work, and 40 min home. This trip, as well as the trip of commuters in southwestern Connecticut, is greater than the national average of 20 min.

The fact that the commute is perceived as worsening on both coasts reinforces the industry-wide belief that traffic congestion, particularly during commuting hours, does indeed have a place on the national agenda of problems facing the country today.

Statewide Survey by the Connecticut Department of Transportation, 1989

In a telephone survey by the Connecticut Department of Transportation done at about the same time as the SACIA-MetroPool survey, almost one-third of the drive-alone respondents cited saving money as the primary benefit of sharing the ride to work. Southwestern Connecticut commuters believed that reduction of stress was the most desirable benefit to switching to an alternative mode.

In fact, those surveyed statewide placed less stress near the bottom of the list of benefits sought. Heavy traffic congestion in the southwestern area may cause more traffic-related stress in this part of the state than in others.

In the statewide survey, as in the SACIA-MetroPool survey, commuters responded more readily to the possible penalties imposed on their current behavior than to any rewards that might be sought. Heavy parking charges were a strong motivator to move into a ridesharing arrangement—up to 96 percent of those surveyed statewide indicated that they would be persuaded to rideshare if parking charges ranging from $50 to $150 per month were imposed.

Among other factors that might affect the commuters' willingness to switch their method of commuting, southwestern Connecticut commuters reacted more positively toward employer-based incentives such as management commitment to alternative modes, preferential parking, and flexible work schedules than did the respondents of the statewide survey, who essentially discounted the ability of any incentive (beside direct monetary compensation) to convince them to switch their commuting mode.

Survey of the Greater Bridgeport Area

MetroPool, along with business, planning, and transportation organizations serving the greater Bridgeport area of the state, conducted a survey similar to the original SACIA-MetroPool survey in the spring of 1990. This area lies about 30 mi east of the original survey area.

The two employment centers surveyed pulled employees from many of the same surrounding cities and towns. Commuters' attitudes about alternative modes were, as might be expected, similar among the respondents of both surveys. However, commuters in the eastern employment center were slightly more receptive to consideration of alternatives than those who worked further west—even though the commuters of the original study had longer, more stressful commutes. This result suggests that other factors, such as the demographic composition of the work force (particularly occupational titles and economic status) and exposure to alternative mode choices that are available in the area, affect commuter attitudes and their willingness to get out of their current commuting pattern.

The ability to gain information about the attitudes of commuters about various modes of commuting available to them has proven valuable in tailoring programs that promote the use of these alternatives. Similarly, the research gathered about specific commuting practices, both throughout an overall employment area and within specific companies, is essential in planning effective employer-based transportation demand management programs that meet the specific needs of the commuters and take advantage of the special mode choices available at the particular home and work site. By bringing together the public and private sector in the SACIA-MetroPool

survey, the attention of both the business community and the local and state governments could be focused on the increasing severity of the commuting situation in southwestern Connecticut—and a foundation of knowledge on which to build solid solutions to the problem could be provided.

ACKNOWLEDGMENT

This report was sponsored jointly by the Southwest Area Commerce and Industry Association and MetroPool, Inc., and was funded by the state of Connecticut Challenge Grant program.

Carol Dee Angell, President of MetroPool, Inc., and Joseph Ercolano, Vice President/Regional Economic Issues & Transportation for SACIA, provided oversight for the study. The initial questionnaire was designed by David Inouye, whose services were provided pro bono by Donnelly Marketing. The analysis and computer tabulation were conducted by CRC Information Systems, Inc. The original report was prepared by Cynthia S. Hoppe, an independent consultant; it was adapted for TRB publication by Margaret L. Hetherington of MetroPool, Inc.

Publication of this paper sponsored by Committee on Ridesharing.

Analysis of Carpool Survey Data from the Katy, Northwest, and Gulf Transitways in Houston, Texas

DIANE L. BULLARD

Within the Houston metropolitan area, a major commitment has been made to implement a system of high-occupancy vehicle lanes (known locally as transitways) in the medians of the existing freeway network. These lanes are reserved for the exclusive use of high-occupancy vehicles. As of October 1989, carpools were permitted to use three of the four transitways in operation. This paper presents the results of transitway carpool surveys performed on the Katy, Northwest, and Gulf Transitways in the fall of 1989. The primary intent of the surveys was to (a) identify why individuals have chosen to carpool; (b) assess what effect the transitways have had on the decision to carpool; (c) determine perceptions of transitway use with carpools present; and (d) assess carpooler attitudes and impacts pertaining to the transitways. From the results of the carpool surveys, it appears that carpoolers generally perceive they are receiving a number of benefits from carpooling on the transitway. In fact, between 19 and 42 percent of the current transitway carpoolers stated that they would not be ridesharing if not for the transitway in their area. Carpool survey data also indicate that (a) between 45 and 61 percent of the total transitway carpools may have been created as a result of the transitways and (b) perhaps carpools are remaining in existence longer because of the transitways. In addition, it appears that permitting carpools to use the transitways has proven successful in increasing both the actual and perceived use of the facilities without attracting a substantial number of persons away from other transitway modes. Furthermore, between 63 and 71 percent of the freeway motorists (nontransitway users) feel that the transitways are good transportation improvements.

In an effort to address the increasing traffic congestion problem and provide improved mobility within the Houston metropolitan area, a major commitment has been made to implement an extensive system of transitways in the medians of the city's freeway network. These lanes are reserved for exclusive use by high-occupancy vehicles. As of October 1989, carpools were permitted to use three of the four transitways in operation. The results of the most recent carpool surveys performed on the Katy, Northwest, and Gulf Transitways in the fall of 1989 are summarized. In addition to obtaining socioeconomic, demographic, and travel information, the surveys were designed to

1. Identify why individuals have chosen to carpool,
2. Assess what effect the transitways have had on the decision to carpool,
3. Determine perceptions of transitway use with carpools present, and
4. Assess carpooler attitudes and impacts pertaining to the transitways.

Also presented are data from surveys of motorists (nontransitway users) concerning why they have chosen to drive on the freeway mainlanes rather than travel in a bus or carpool on the transitway. In addition, motorists' attitudes regarding transitway use and the desirability of the transitway as a transportation improvement are briefly discussed. In some instances, data from previous carpool and motorist surveys are highlighted for comparative purposes.

OVERVIEW OF THE HOUSTON TRANSITWAY SYSTEM

The system of transitways being developed in Houston is a joint effort between the Metropolitan Transit Authority of Harris County (METRO) and the Texas State Department of Highways and Public Transportation (SDHPT). A total of 95.5 mi of transitways will ultimately be constructed on six of the city's freeways. By the end of 1989, approximately 36 mi of transitways on four separate freeways were operational (Figure 1). These lanes are typically located in the median of the freeway, are approximately 20 ft wide, are one-lane reversible, and are separated from the mixed-flow traffic lanes by concrete median barriers.

An area of critical importance to the success of the transitway project is the designation of the types of vehicles that are permitted to use these special lanes. On the basis of the highly successful operation of the I-45 North Freeway contraflow lane in north Houston, only authorized buses and 8+ passenger vanpools (truly high-occupancy vehicles) were initially envisioned to be eligible users of the transitway system. In order to become authorized, vanpools (and later carpools) had to have (a) certified drivers, (b) valid Texas vehicle inspection stickers no more than 6 months old, (c) the minimum state insurance coverage, (d) some familiarity with the transitway geometrics before actually driving in the facility, and (e) a visual inspection of the vehicle by METRO. Once these requirements were satisfied, the carpool or vanpool vehicles were issued authorization decals to be displayed on the front and rear windshields. Only vehicles that displayed the special

Texas Transportation Institute, Texas A&M University, College Station, Tex. 77843-3135.

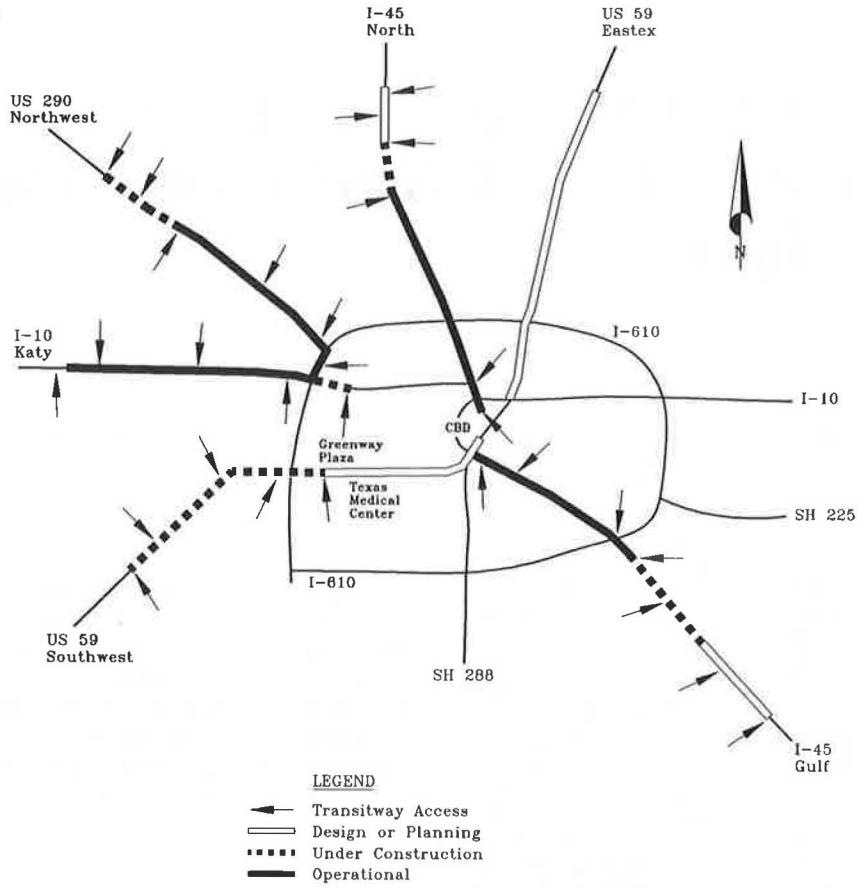

FIGURE 1 Status of the Houston Transitway Development, October 1989.

authorization permits were permitted access to the transitways by METRO transit police.

Consequently, when the first transitway opened in October 1984 on the Katy Freeway, its use was also limited to authorized buses and 8+ vanpools. Although this approach offered the potential to move large volumes of people, it did not result in moving large volumes of vehicles (or people). In fact, fewer than 150 vehicles per peak period traveled the transitway during its initial months of operation, giving the facility the appearance of being underused. To encourage increased vehicular use, the decision was made to permit authorized 4+ carpools on the transitway beginning April 1, 1985. This action only resulted in adding an average of five vehicles to the transitway during the peak period. Therefore, in October 1985, authorized 3+ carpools were permitted on the lane. Even with the 3+ designation, however, peak-hour carpool volumes remained less than 100 vehicles per hour, and the perception of underuse remained. As a result, in August 1986, the minimum passenger requirement for eligible vehicles was lowered to two persons and all authorization requirements were eliminated; METRO and the SDHPT agreed that both actions (lowering the carpool occupancy requirement and eliminating the authorization procedures) were necessary to encourage a substantial increase in transitway use.

However, by the fall of 1988 traffic volumes on the transitway during the a.m. peak hour (7:00 to 8:00 a.m.) increased to levels exceeding 1,500 vehicles per hour, normally assumed to be the capacity of the facility. This dramatic increase was beginning to have a negative effect on the facility's a.m. operation (lower travel speeds, increased travel times, and unreliable travel times). To relieve this peak-hour congestion, the minimum carpool occupancy requirement was raised from two to three persons between 6:45 and 8:15 a.m. effective October 17, 1988; two-person carpools were still permitted on the facility in the mornings before 6:45 a.m. or after 8:15 a.m. and during the entire p.m. operating period. Following this action, a.m. peak-hour traffic volumes on the transitway dropped to less than 1,000 vehicles per hour, resulting in improved transitway operation. Morning peak-hour person movement also declined (16 percent) as a result of raising the occupancy requirement.

Because of the success in permitting carpools on the Katy Transitway, METRO and the SDHPT agreed to permit 2+ carpools on the Gulf and Northwest Transitways when they became operational in May and August 1988, respectively.

By the end of 1989, peak-hour vehicle throughput in the Katy Freeway corridor (freeway and transitway) had increased 60 percent over pretransitway levels, and the number of persons moved increased 85 percent. Even in the newest transitway corridor, the Northwest, vehicle throughput increased 21 percent and person throughput increased 39 percent over pretransitway levels. Carpool use of the transitways

can be credited for much of the success of these facilities. In fact, as of October 1989, carpools represented at least 94 percent of the vehicles and carried more than 60 percent of the persons moved on the Katy Transitway during both a.m. and p.m. peak periods. On the Northwest Transitway, carpools accounted for approximately 97 percent of the peak-period vehicles and moved 74 percent of the peak-period persons. In the Gulf corridor, 90 percent of the peak-period vehicles traveling the Gulf Transitway were carpools; these carpools moved approximately 45 percent of the transitway users.

The Texas Transportation Institute (TTI) is currently monitoring the effects of allowing carpools to use the transitways. In addition, TTI is also engaged in the assessment of public attitudes concerning the transitways. This assessment is being accomplished through the periodic distribution of survey questionnaires to both transitway users and nonusers. Comprehensive survey efforts have been performed on five separate occasions in the Katy Freeway corridor (once yearly beginning in 1985) and on two separate occasions in the Northwest and Gulf Freeway corridors (once yearly beginning in 1988).

The results of the most recent carpool surveys conducted on the Katy, Northwest, and Gulf Transitways in October 1989 (approximately 4.5 years after carpools were allowed on the Katy Transitway, 14 months after the Northwest Transitway was completed, and 17 months after the Gulf Transitway became operational) are presented.

SURVEY METHODOLOGY

For the 1989 transitway carpool surveys, license plate numbers of carpools traveling inbound on each transitway during the a.m. operating period were recorded by TTI staff. The SDHPT Division of Motor Vehicles license plate files were accessed to obtain addresses. A survey was mailed to each address (excluding out-of-town addresses, corporate addresses, and leasing agencies). A postage-paid return envelope was included with each of the surveys. Carpool drivers were asked to complete the survey and return it to TTI. Response rates to the transitway carpool surveys are presented in Table 1.

During the 6:00 to 9:30 a.m. peak period, license plate numbers of motorists traveling inbound on the Katy, Northwest, and Gulf Freeway mainlanes were also recorded by TTI observers. SDHPT Division of Motor Vehicles license plate files were accessed to obtain addresses. A survey was mailed to each address (excluding out-of-town addresses, corporate addresses, and leasing agencies). Motorists were asked to complete the survey and return it to TTI in the postage-paid envelope provided. Response rates to the freeway motorist surveys are also presented in Table 1.

CARPOOL SURVEY FINDINGS

For presentation purposes, responses to the transitway carpool user surveys can be grouped into the following three categories:

1. Personal characteristics;
2. Travel patterns and trip characteristics; and
3. Attitudes and impacts pertaining to the transitways.

Personal Characteristics

In many respects, the characteristics of the current Katy, Northwest, and Gulf Transitway carpoolers are similar (see Table 2). In some instances, the characteristics of transitway

TABLE 1 TRANSITWAY CARPOOL AND FREEWAY MOTORIST SURVEY DISTRIBUTIONS, 1989

Survey Group	License Plates Read	Surveys Mailed	Surveys Returned Address Unknown or Vehicle Not on Freeway/Transitway	Surveys Completed	Response Rate (% of Surveys Mailed)
Transitway Carpoolers					
Katy Transitway	2,204	1,507	91	590	39%
Northwest Transitway	917	596	42	253	42%
Gulf Transitway	567	367	19	122	33%
Freeway Motorists					
Katy Freeway	4,876	3,069	207	1,135	37%
Northwest Freeway	5,045	3,271	215	1,133	35%
Gulf Freeway	3,820	2,290	172	656	29%

carpoolers are similar to the characteristics of the motorists traveling in the adjacent freeway mainlanes.

Age and Sex

The median age of the Katy, Northwest, and Gulf Transitway carpoolers is in the middle to upper 30s. At least half of the Katy and Northwest carpoolers are male, whereas 60 percent of the Gulf Transitway carpoolers are female.

Occupation

More than half of the transitway carpoolers are employed in positions which can be classified as either professional or managerial. An additional 15 to 28 percent are employed in clerical positions. The high percentage (28 percent) of clerical workers in the Gulf Transitway corridor may correlate to the high percentage (60 percent) of females in that corridor.

Education

In general, transitway carpoolers are a well-educated group. The average Katy Transitway carpooler has completed at least 3 years of college, and the average Northwest and Gulf Transitway carpooler has completed more than 2 years of college.

Travel Characteristics

Year Joined Present Carpool

As presented in Table 3, 60 percent of the Gulf Transitway carpoolers and 65 percent of the Northwest Transitway carpoolers reported joining their present pool after the opening of the transitway in their area. (The Gulf Transitway had been open 17 months and the Northwest Transitway had been open 14 months at the time of the 1989 survey.) As to be expected from the lengthy time the Katy Transitway has been in operation, 91 percent of those in the Katy corridor reported joining their present carpool after the transitway opened. (The Katy Transitway had been open to carpools for 54 months at the time of the 1989 survey.)

Number of Months Carpools Have Existed

Initial carpool surveys conducted on the Katy, Northwest, and Gulf Transitways just after the transitways opened found that the median age of carpools was 4, 3, and 6 months, respectively. Subsequent surveys (performed in 1989 after each of the transitways had been in operation at least a year) found the median age of carpools to be 13 months on the Katy Transitway, 9 months on the Northwest Transitway, and 12 months on the Gulf Transitway (Table 3). Thus, data are beginning to suggest that carpools may remain in existence longer as a result of the transitways.

TABLE 2 PERSONAL CHARACTERISTICS OF TRANSITWAY CARPOOLERS AND PEAK-PERIOD FREEWAY MOTORISTS, 1989

Characteristic	Katy Transitway Carpoolers	Katy Freeway Motorists	Northwest Transitway Carpoolers	Northwest Freeway Motorists	Gulf Transitway Carpoolers	Gulf Freeway Motorists
Age (years)	(n=537)	(n=1119)	(n=242)	(n=1124)	(n=112)	(n=648)
50th Percentile	37	41	36	37	38	37
Sex	(n=534)	(n=1096)	(n=240)	(n=1105)	(n=111)	(n=632)
Male	55%	61%	50%	61%	40%	49%
Female	45%	39%	50%	39%	60%	51%
Occupation	(n=513)	(n=1067)	(n=232)	(n=1081)	(n=112)	(n=625)
Professional	45%	45%	45%	38%	45%	30%
Managerial	19%	21%	19%	25%	15%	22%
Clerical	15%	7%	17%	14%	28%	20%
Sales	7%	13%	9%	11%	4%	6%
Other	14%	14%	10%	12%	8%	22%
Education (years)	(n=525)	(n=1101)	(n=237)	(n=1106)	(n=111)	(n=634)
Average	15.3	15.9	14.8	15.0	14.4	14.2

TABLE 3 CHARACTERISTICS OF TRANSITWAY CARPOOLS, 1989

Characteristic	Katy Transitway	Northwest Transitway	Gulf Transitway
Year Present Carpool Was Formed	(n=430)	(n=196)	(n=97)
Before 1985	9%	7%	18%
1985	1%	3%	2%
1986	6%	3%	3%
1987	17%	8%	8%
1988	31%	27%	23%
1989	36%	52%	46%
Joined Present Carpool	(n=430)	(n=196)	(n=97)
Before transitway opened	9%	35%	40%
After transitway opened	91%	65%	60%
No. Months Carpools Have Existed [a]	(n=430)	(n=196)	(n=97)
Average	20	17	29
Median	13	9	12
No. of Months Transitway Has Been Open	54	14	17

[a] *The discrepancy that exists between the average and median number of months carpools have existed is due to a few carpools being formed in the early 1970s (and one carpool in the Gulf corridor that was formed in 1963) which skews the averages. Thus, the median figures (rather than the average figures) are more representative of "typical" conditions.*

Carpool Make-Up

Transitway carpoolers were asked to identify the composition of their carpool group. As indicated below, between 56 and 69 percent of those responding are carpooling with family members; an additional 24 to 32 percent carpool with coworkers. It is of interest to note that the Katy Transitway (which has been open the longest) has the highest percentage of carpools composed of coworkers and neighbors.

	Carpool Membership (%)		
Transitway	*Family Members*	*Coworkers*	*Neighborhood Friends*
Katy	56	32	12
Northwest	69	24	7
Gulf	66	27	7

A cross tabulation of survey data further revealed that carpools composed of family members formed earlier than those composed of coworkers or neighbors. In fact, virtually all carpools formed before 1985 are composed of family members. Data also seem to indicate that transitways encourage the formation of carpools with nonfamily members.

Trip Purpose

It has been hypothesized that the majority of trips served by the transitways during the a.m. peak period are work or school trips. As indicated in the following list, the results of the transitway carpool surveys confirm this theory.

	Trip Purpose (%)		
Transitway	*Work*	*School*	*Other (Shopping, Personal Business, etc.)*
Katy	85	10	5
Northwest	93	6	1
Gulf	97	3	

Vehicle Occupancies

As mentioned previously, at the time of the 1989 survey, the Katy Transitway was restricted to vehicles carrying three or more persons between the hours of 6:45 and 8:15 a.m. Two-person carpools were still allowed to use the transitway during all other hours of operation. The average a.m. peak period occupancy of carpools observed traveling the Katy Transitway

was 2.3 persons; the average occupancy of carpools surveyed was 2.6 persons (Table 4).

Both the Gulf and Northwest Transitways were open to 2+ vehicles during all operating hours. The average a.m. peak-period occupancy of Northwest carpools was observed to be 2.1 persons (compared to 2.2 persons from the surveys), and the average occupancy of carpools observed on the Gulf Transitway was 2.1 persons (compared to 2.5 persons from the surveys) (Table 4).

Trip Destinations

The downtown area is the single largest attractor of transitway carpool trips (Table 4). In fact, 40 percent of the carpoolers using the Katy Transitway, 41 percent of those using the Northwest Transitway, and 77 percent of those using the Gulf Transitway were destined to the downtown area. However, carpools have also demonstrated the capability of serving trips to numerous locations other than downtown, as evidenced by the large number of trips to the Galleria, Texas Medical Center, Greenway Plaza, and other locations.

TABLE 4 TRAVEL CHARACTERISTICS OF TRANSITWAY CARPOOLERS, 1989

Characteristic	Katy Transitway	Northwest Transitway	Gulf Transitway
Vehicle Occupancy	(n=536)	(n=244)	(n=115)
2	61%	80%	74%
3	26%	18%	16%
4 or more	13%	2%	10%
Average	2.6	2.2	2.5
Trip Destination	(n=532)	(n=243)	(n=115)
Downtown	40%	41%	77%
Galleria	20%	22%	6%
Greenway Plaza	5%	4%	2%
Texas Medical Center	5%	2%	4%
Other	30%	31%	11%
Previous Travel Mode	(n=523)	(n=237)	(n=110)
Drove alone	50%	43%	40%
Carpool	27%	46%	46%
Bus or van	12%	6%	9%
Didn't make trip	11%	5%	5%

Note: The Galleria, Greenway Plaza, and the Texas Medical Center are three major employment/activity centers outside the downtown area (see Figure 1).

Previous Travel Mode

In order to estimate the number of new carpools created as a result of the transitway, carpoolers were asked to identify their previous mode of travel; that is, how was the trip made before carpooling on the transitway. Survey data suggest that somewhere between 40 and 50 percent of the current carpoolers on the transitway previously drove alone (Table 4). An additional 5 to 11 percent of those surveyed reported they did not make the trip before carpooling on the transitway. The sum of the drove alone plus new trips, which was in the range of 45 to 61 percent of the total carpools, could be considered as an initial indication of the volume of new carpools created as a result of the transitway.

A major concern of permitting carpools (particularly two-person carpools) to use the transitways was that they might simply attract riders from buses or vans, thereby moving no more people but requiring many more vehicles. However, such does not appear to be the case; 1989 survey data indicate that only 6 percent of the Northwest Transitway carpoolers, 9 percent of the Gulf Transitway carpoolers, and 12 percent of the Katy Transitway carpoolers formerly used a bus or van on the transitway. Thus, opening the transitways to carpools has attracted only a limited number of trips away from other transitway modes.

Reasons for Carpooling on the Transitways

Initial surveys performed in each transitway corridor found that the main reasons persons chose to carpool on the transitway were to (a) save time; (b) avoid freeway congestion; (c) reduce driving costs; and (d) have a reliable travel schedule. Three of these reasons relate specifically to benefits associated with being able to use a transitway.

Attitudes and Impacts Pertaining to the Transitways

Perceived Transitway Travel Time Savings

One of the primary reasons for implementing the transitways is to offer riders of high-occupancy vehicles both a travel time advantage and travel time reliability over traveling in the regular freeway lanes. Transitway carpoolers generally do perceive a travel time savings as a result of being able to use the priority lane (Table 5). In 1989, median travel time savings perceived by transitway carpoolers were in the range of 12 to 20 min in the a.m. and 15 to 20 min in the p.m. It is of interest to note that the travel time savings perceived by carpoolers can be several times greater than actual savings (if any) measured in the field.

Impacts of the Transitway on Mode Choice

In all likelihood, at least some of the carpools using the transitways would have formed regardless of whether a transitway

TABLE 5 PERCEIVED IMPACTS OF THE TRANSITWAYS ON TRAVEL TIME SAVINGS, 1989

Impact	Katy Transitway	Northwest Transitway	Gulf Transitway
Perceived Transitway Travel Time Savings (minutes)	(n=531)	(n=238)	(n=114)
a.m. (median)	20	15	12
p.m. (median)	20	15	15
Actual Transitway Travel Time Savings (minutes)*			
a.m. (6:00-9:30 a.m.)	7.9	-4.6	3.1
p.m. (3:30-7:00 p.m.)	1.1	-5.7	-3.1

* *Source: TTI Research Report 484-12 and TTI travel time studies.*

Note: In 1989, actual transitway travel time savings were low or negative in some instances due (in large part) to problems encountered in accessing the transitways. Many of these problems have since been resolved resulting in positive peak period travel time savings in most instances.

existed. In an effort to identify this portion of carpool demand, carpoolers in each corridor were asked questions that related to the transitway's role in their mode choice decision. The first question asked how important the transitway was in their decision to carpool. The responses (Table 6) suggest that the transitway was either very important or somewhat important to at least two-thirds of the carpoolers in each transitway corridor. As might be expected, this percentage is highest (88 percent) on the most mature of the transitways—the Katy—which is also the transitway that presently offers the greatest travel time savings.

A second question asked whether individuals would be carpooling if the transitways had not opened. Initial surveys performed in the Katy, Northwest, and Gulf Transitway corridors indicate strong similarities. Between 70 and 75 percent of the individuals surveyed in the Katy Transitway corridor in 1985 and in the Northwest and Gulf Transitway corridors in 1988 responded "yes." By 1989, however, 42 percent of the Katy Transitway carpoolers said that they would not. Thus it appears that the Katy Transitway has played a greater role in influencing mode choice decisions in its later years of operation. This same trend is being observed in the Northwest and Gulf Transitway corridors. Accordingly, it follows that the transitway can be credited with encouraging individuals to rideshare.

Perception of Transitway Use

One of the primary reasons for permitting carpools to use the Katy, Northwest, and Gulf Transitways is to maximize both the actual and perceived use of the facilities. Carpoolers were asked whether they felt the transitway they travel is sufficiently used to justify the project.

As might be expected, on the Katy Transitway, as actual transitway use has increased (1985–1987), so has the perception of use. In fact, in 1987 when a.m. peak-period vehicular use was approximately 2,400 vehicles, 82 percent of the carpoolers surveyed felt the transitway was sufficiently used. In 1988 (after the use of the transitway was restricted to 3+ vehicles between 6:45 and 8:15 a.m.), both the actual and perceived use of the facility declined; less than half of those surveyed in 1988 felt the transitway was sufficiently used with the 3+ restriction (although there were approximately 2,000 vehicles on the lane during the a.m. peak period). However,

TABLE 6 PERCEIVED IMPACTS OF THE TRANSITWAYS ON MODE CHOICE

Impact	Katy Transitway		Northwest Transitway		Gulf Transitway	
	1985	1989	1988	1989	1988	1989
Importance of Transitway in Decision to Carpool	(n=90)	(n=525)	(n=253)	(n=242)	(n=122)	(n=114)
Very important	47%	74%	53%	57%	43%	48%
Somewhat important	10%	14%	15%	19%	22%	19%
Not important	43%	12%	32%	24%	35%	33%
Carpool If No Transitway	(n=90)	(n=528)	(n=255)	(n=242)	(n=122)	(n=114)
Yes	70%	42%	70%	51%	75%	69%
No	16%	42%	21%	30%	14%	19%
Not sure	14%	16%	9%	19%	11%	12%

in 1989 both actual and perceived use increased; more than three-fourths of the Katy Transitway carpoolers now feel the transitway is sufficiently used to justify the project (Table 7).

Most recent (1989) survey results in the other transitway corridors are also very favorable. Approximately three-fourths of the Northwest and Gulf Transitway carpoolers felt these facilities are sufficiently used to justify the projects.

MOTORISTS' ATTITUDES CONCERNING THE TRANSITWAYS

The perception of whether or not the transitways are sufficiently used and the acceptance of the transitways as worthwhile transportation improvements are major concerns of METRO and the SDHPT. This is particularly true of the Katy Transitway, because fewer than 150 vehicles per peak period used the priority lane during its first 6 months of operation.

In the Northwest and Gulf Freeway corridors, less than one-third of the motorists traveling on the freeway mainlanes (nontransitway users surveyed) felt that the transitways are sufficiently used to justify the projects. Nevertheless, 71 percent of the Northwest Freeway motorists and 63 percent of the Gulf Freeway motorists surveyed did feel the transitways are good transportation improvements (Table 8).

In the Katy Freeway corridor, as transitway use has increased, acceptance of the transitway by freeway motorists has also increased significantly. In 1985 (before carpools were allowed on the transitway and a.m. peak-period vehicle volumes were less than 150), only 3 percent of the nontransitway motorists felt that the lane was sufficiently used to justify the project. The percentage of favorable responses did not increase the following year (1986, when only authorized 3+ carpools were permitted on the lane and a.m. peak-period vehicle volumes numbered 250). However, by 1989 (when a.m. peak-period transitway volumes rose to almost 2,200 vehicles), 30 percent of the nontransitway freeway motorists felt the transitway was sufficiently used. Furthermore, 66 percent of the motorists surveyed in 1989 stated the transitway is a good transportation improvement (Table 8). This percentage is up from 41 percent in 1985 and 36 percent in 1986. Thus, it appears that permitting carpools on the Katy Transitway has increased both the actual and perceived use of the priority facility.

TABLE 7 CARPOOLERS' PERCEPTION OF TRANSITWAY USE, 1989

Perception	Katy Transitway[a]	Northwest Transitway[b]	Gulf Transitway[b]
Is Transitway Sufficiently Utilized?	(n=530)	(n=239)	(n=112)
Yes	77%	75%	72%
No	14%	11%	15%
Not sure	9%	14%	13%
Transitway Vehicle Volumes (A.M. Peak Period)[c]	2186	1464	1139

[a] *3+ vehicles, no authorization between 6:45 a.m. and 8:15 a.m.; 2+ vehicles, no authorization at all other times.*

[b] *2+ vehicles, no authorization.*

[c] *Source: TTI Research Report 484-12 and TTI transitway volume counts.*

TABLE 8 FREEWAY MOTORISTS' ATTITUDES TOWARDS TRANSITWAYS, 1989

Attitude	Katy Transitway[a]	Northwest Transitway[b]	Gulf Transitway[b]
Is Transitway Sufficiently Utilized?	(n=1123)	(n=1109)	(n=643)
Yes	30%	22%	21%
No	53%	58%	61%
Not sure	17%	20%	18%
Transitway Vehicle Volumes (A.M. Peak Period)[c]	2186	1464	1139
Is Transitway a Good Transportation Improvement?	(n=1110)	(n=1109)	(n=647)
Yes	66%	71%	63%
No	20%	13%	21%
Not sure	14%	16%	16%

[a] *3+ vehicles, no authorization between 6:45 a.m. and 8:15 a.m.; 2+ vehicles, no authorization at all other times.*

[b] *2+ vehicles, no authorization.*

[c] *Source: TTI Research Report 484-12 and TTI transitway volume counts.*

TABLE 9 REASONS FREEWAY MOTORISTS SELECTED AUTOMOBILE TRAVEL MODE ON FREEWAY, 1989

Reasons for Selecting Auto Travel Mode on Freeway[a]	Katy Transitway	Northwest Transitway	Gulf Transitway
	(n=1176)	(n=1629)	(n=934)
Need car for job	24%	19%	17%
Convenience/flexibility	21%	22%	27%
No bus/carpool/vanpool available	16%	21%	20%
Work odd hours	22%	21%	21%
Don't work in area served by transitway	4%	5%	3%
Other	13%	12%	12%

[a] *Respondents were able to give more than one reason. Thus, the "n" value refers to the number of reasons given, not the number of surveys completed.*

REASONS FOR SELECTING THE AUTOMOBILE TRAVEL MODE ON THE FREEWAY

The reasons most often given for using an automobile in the mixed-flow lanes of the freeway rather than a carpool or other high-occupancy vehicle in the transitway are presented in Table 9. In general, most individuals stated they used an automobile because of the following reasons: (a) needed for job; (b) convenience and flexibility; (c) no convenient carpool, vanpool, or bus available; and (d) irregular work hours. Those individuals needing an automobile available during the day for business purposes would not be likely candidates for ridesharing programs.

CONCLUSIONS

From the results of the transitway carpool surveys, it appears that carpoolers generally perceive they are receiving a number of benefits from carpooling on the transitway (saving time, saving money, avoiding freeway traffic, and having a reliable travel schedule). In fact, between 19 and 42 percent of the current transitway carpoolers stated they would not be carpooling if not for the transitway in their area. Carpool survey data also indicate that (a) between 45 and 61 percent of the total transitway carpools may have been created as a result of the transitways; and (b) perhaps carpools are remaining in existence longer as a result of transitways. In addition, it appears that permitting carpools to use the transitways has proven successful in increasing both the actual and perceived use of the facilities without attracting a substantial number of persons away from other transitway modes. Furthermore, between 63 and 71 percent of the freeway motorists (nontransitway users) feel the transitways are good transportation improvements (even though they are not eligible to use the facilities).

STATUS OF CURRENT RESEARCH

Comprehensive surveys of Houston transitway users and nonusers (similar to those performed in 1989) were begun in October 1990. In addition, published survey data from other HOV operations in the United States are presently being collected for comparative purposes. Analyses of the Houston data (including a comparison of the 1990 data to that which was collected in previous years and a comparison of the Houston data to survey data from other HOV facilities) are scheduled for completion by August 1991.

ACKNOWLEDGMENTS

Beginning in 1974, the Texas State Department of Highways and Public Transportation has sponsored an ongoing research effort pertaining to priority treatment for high-occupancy vehicles. In more recent years, the Metropolitan Transit Authority of Harris County has also been actively involved in this research program. The information presented is a result of this research. The oversight and funding provided by the sponsoring agencies is gratefully acknowledged.

Publication of this paper sponsored by Committee on Ridesharing.

Impact of Suburban Employee Trip Chaining on Transportation Demand Management

DIANE DAVIDSON

Suburban commute trip-chaining findings, part of a broader study to assist in the design of transportation demand management (TDM) strategies at an emerging transportation management association, are presented. Data were collected from 42 employer sites and 1,845 employees (48 percent response rate), using a self-administered questionnaire. Travel pattern data revealed that the suburban employees rely heavily on their vehicles to gain access to everyday services. Because this creates a present and future deterrent to ridesharing, the results indicate the need for greater attention to the entire commute trip in the form of new rideshare support services and better land use patterns. Employees exhibited a legitimate need for access to a vehicle during the day. The data defined a full work trip as including stops for meals, shopping, and daycare. The study found that the employees were twice as likely to make stops on their way home from work as they were during the morning; predominant morning chaining was to get gas (45.2 percent), to go to the bank (22.7 percent), to go to the dry cleaners (19.4 percent) and to eat (16.4 percent). After work, travel behavior is to get gas (63 percent), to shop (55.8 percent), to go to the bank (49.6 percent), and to go to the dry cleaners (31.5 percent). Therefore, even if the need for gas is eliminated by forming a rideshare arrangement, access must also be provided to convenience shopping and banking and dry cleaning services to fully support the ability to regularly use a shared-ride mode. Policy recommendations are made for minimizing the negative impact of linked trips on the effective implementation of shared-ride services. These include a better mix of land uses and the delivery of services to employer sites. In summary, a complex system of incentives and personalized attention that rewards behavioral changes in trip making will be required to lessen suburban travel demand.

Suburban traffic congestion, trip reduction ordinances, and air pollution regulations have increased the reliance on the development of effective transportation demand management (TDM) measures. As never before, commute management professionals are called on to demonstrate the effectiveness of shared-ride options, such as carpools, vanpools, and buspools, in accomplishing TDM objectives to reduce the number of single-occupancy vehicles on congested road facilities (*1*). However, the impact of complex land use relationships and employee travel behaviors, especially work trip chaining, on changing employee commute modes may often be underestimated.

Commuters drive alone to work because they prefer the comfort and privacy of the automobile, but they may also legitimately need access to a vehicle before, during, and after work. The literature indicates that more than 60 percent of the office workers who drive make intermediate stops on the way to or from work at least three times a week (*2*). Complex social, economic, technological, and cultural factors determine this suburban transport behavior (*3*). Workers who totally depend on their cars to gain access to basic needs and everyday services are reluctant to make commute arrangements that limit their freedom of mobility. In such circumstances, TDM programs must offer commuters some other efficient way to conduct their personal business.

In order to design shared-ride services that induce drive-alones to modify their commute habits and modes, it is essential to gain a better understanding of why commuters need their private automobiles during the journey to work. Trip-chaining behavior was examined as part of a larger study of employee commute habits and perceptions in Brentwood, Tennessee. Aspects of trip chaining included why, to what extent, and for what reasons employees needed their vehicles before, during, and after work. The data were used to identify (a) the frequency of chained trips, and (b) the types of personal business activity or stopping that accompany the morning and evening work trip.

Finally, policy implications and methods for dealing with the problem by adjusting land use relationships and providing on-site services are identified. Trip-chaining destinations define the mix of retail services and land uses that support shared-ride objectives at employer sites. Modifying commute chaining behavior will influence mode choice and aid in the reduction of net peak-hour vehicle-miles of travel (VMT).

DESCRIPTION OF THE STUDY ENVIRONMENT

Brentwood, Tennessee, is a suburban community in the Nashville urban area characterized by trends such as rapid population and employment growth, vehicle availability, low residential density, and campus-style office developments with ample free parking. There was excellent highway access but no shared-ride initiatives until the development of the Brentwood Area Transportation Management Association (BATMA) in 1988. Brentwood incorporated in 1969 with only 2,169 people as a bedroom suburb immediately south of Nashville, and has become the premier office location in the region and the highest growth area in Williamson County. The 1990 population of 16,720 is projected to more than double again to 37,400 by 2010. Employment is expected to increase 150

Brentwood Area Transportation Management Association, 7003 Chadwick Drive, Suite 310, Brentwood, Tenn. 37027.

percent between 1990 and 2010 from 11,200 to 28,300. Vehicles available per household will increase from 2.4 in 1980 to 3.0 in 2000. Where there was less than 1,000,000 ft² of combined office-commercial space in 1980, 9,300,000 ft² is projected by 2000, including the largest retail mall in the state.

The predominant land use—single-family residential on large lots—occupies 89 percent of all uses. The majority of the 45 percent undeveloped land in the community is also zoned for low-density residential. The zoning ordinance makes no provision for planned unit developments and actually prohibits mixture of uses. For instance, most of the largest office park is zoned C-1, which prohibits location of any retail use within the office zone. It is evident that the trends under way favor the increased use of the private automobile and imply future traffic problems. Even with numerous planned improvements, projected traffic volumes will strain the capacity of many roads. In particular, the city's major thoroughfare and I-65 currently function at or near capacity during peak-hour operation, and projections indicate saturated traffic volumes (Level of Service E–F) on other major facilities by 2000. The map shown in Figure 1 locates Brentwood in relation to Nashville and presents traffic projections for 2010.

BATMA

BATMA was established in September 1988 to improve traffic congestion in the area. Brentwood was the first southern community successful in establishing a TMA. The major effort of the first year was the implementation and analysis of the employee travel needs survey. The survey evaluated baseline conditions and perceptions to match congestion management techniques to employee needs and problems. Occurring at the same time were activities to build transportation coalitions, expand mobility options, and strengthen land use and transportation.

RESEARCH METHODOLOGY

The employee travel needs survey assessed ambient commute conditions and baseline commuter travel patterns and perceptions to evaluate the appropriateness of various congestion management strategies and to gain an understanding of the area commuter travel market (*4*). All employer sites of more than 40 employees and representative sites with less than 40

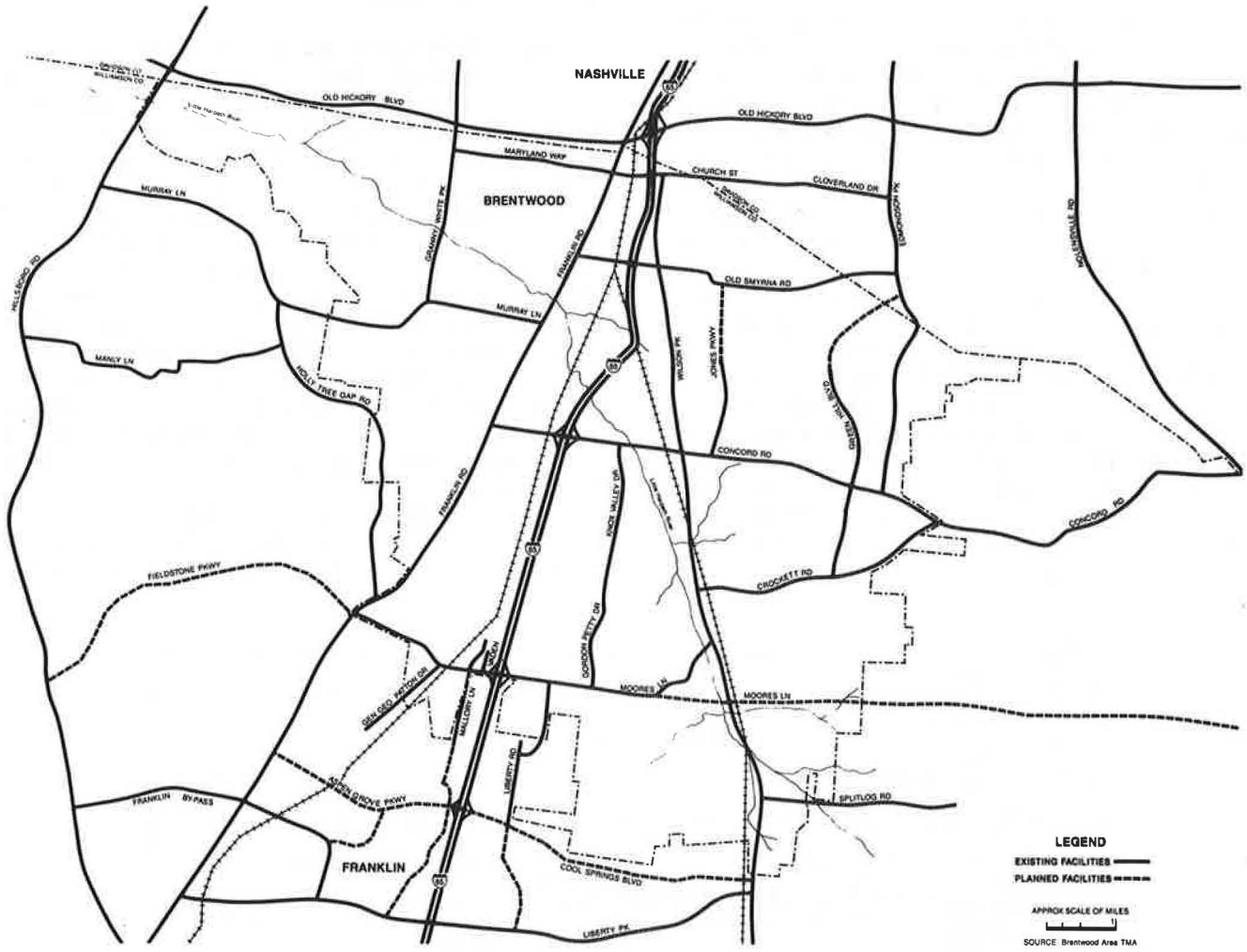

FIGURE 1 Brentwood area location map.

employees were included. Forty-two employer sites participated in the survey; 1,845 employee surveys were returned, for an overall employee response rate of 48 percent. The survey instrument was a self-administered questionnaire containing 31 questions on congestion, stress, travel patterns, current and potential mode, on-site services, and incentive preferences.

COMMUTER PROFILE

Before presenting the trip-chaining results, a brief commuter profile is presented to provide a better understanding of the suburban respondents. In general, the majority were female drive-alones, who characterized their commute as congested and stressful but who were interested in commute alternative incentives. Clerical, managerial, and professional or technical workers accounted for 78 percent of the total respondents. Thirty-seven percent of the respondents were male and 63 percent were female. The largest age category was 30 to 39 years old (34 percent) followed by 20 to 29 years old (27 percent) and 40 to 49 years old (22 percent). More than half of the total respondents had annual household incomes under $40,000.

Their current mobility appears reasonable in terms of commute distances and times. Two-thirds of the employees have one-way commutes of 25 min or less. Almost half (49 percent) live 10 mi or less from their workplace, whereas 42 percent live 15 mi or more from work. The majority reside in adjacent Davidson County (55 percent) or within Williamson County (31 percent), whereas only 15 percent live and work in Brentwood.

Stress and congestion are elevated at disproportionate levels to the reasonably mobile commute distances and times. Sixty-five percent of the total employees find their travel on the Interstate to be always or usually congested, compared with 59 percent who say local streets are always or usually congested. Overall, 85 percent of the total employees perceive some degree of congestion characterizing their commute. In addition, half of the total respondents rated their work trip to be as stressful as anything they do all day. One-quarter of the total respondents described their commute experience as more to much more stressful than anything they do all day.

Of the total 1,845 employees surveyed, 87 percent typically drive alone to work. Of the 11.2 percent who carpool, 9.5 percent ride in two-person carpools. The high drive-alone rate and low rideshare rates were to be expected in the suburban county lacking transit or an organized rideshare effort. However, almost half of the respondents were willing to consider a future mode other than driving alone to work, favoring carpools by 31 percent. Figure 2 shows the future mode choice data.

However, the employees indicated they would not change modes without the proper incentive. Ironically, more employees were able to identify an incentive to rideshare (63.3 percent) than were able to select a future alternative mode (48 percent). The preferred employee rideshare incentives included access to a park-and-ride lot near home (20 percent), a lunchtime shuttle (16 percent), flexible work schedules (14 percent), employee cafeterias (14 percent), employer-provided vanpools (12 percent), transit (12 percent) and matching assistance (11 percent). Also mentioned were on-site childcare (8 percent), priority parking (8 percent), recognition (7 percent), vanpool subsidy (6 percent), HOV lanes (5 percent), and other on-site services (4 percent).

Grouping the expressed incentives in relationship to site needs reveals that more than one-quarter identified a site-related incentive (lunch shuttle, cafeteria, child care, and other).

BEFORE AND AFTER WORK TRAVEL NEEDS

The data indicate that the majority of the employees chain other destinations onto their morning and evening commute trips. Only 9 percent of the total respondents go directly to and from work without any trip chaining. Evening stops were more than twice as likely to occur as morning stops. Figure 3 presents before and after work travel patterns. More than half of the employees chain trips onto the morning commute, whereas 49 percent go directly to work each morning without stopping. Of those who stop, 18 percent make a chained trip once a week, 11 percent stop twice a week, 5 percent stop three times, 2 percent stop four times, and 15 percent stop every day of the work week. Trip-chaining behavior is more prevalent on the return trip, with 81 percent making some stop during the week. Of these, 22 percent stop once a week, 26 percent stop twice a week, 15 percent stop three times a week, 5 percent stop four times a week, and 13 percent chain trips every day.

A pattern of overlapping morning and evening stops by number of days stopping is discernible. For instance, making no or only one stop in the morning correlates with making

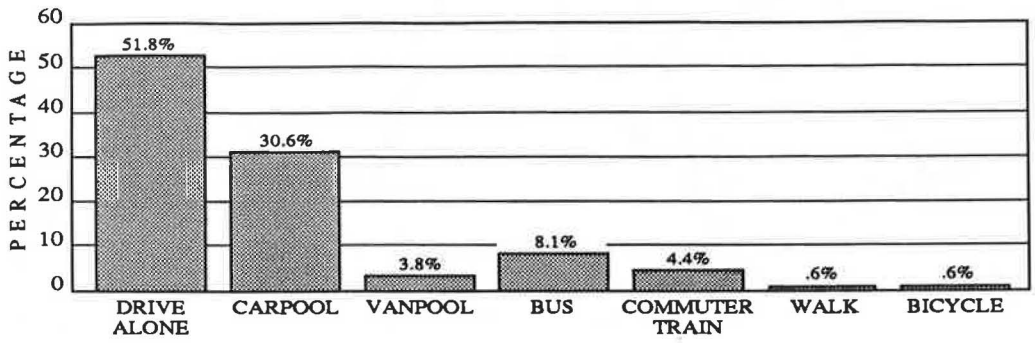

FIGURE 2 Potential commute modes (N = 1,819).

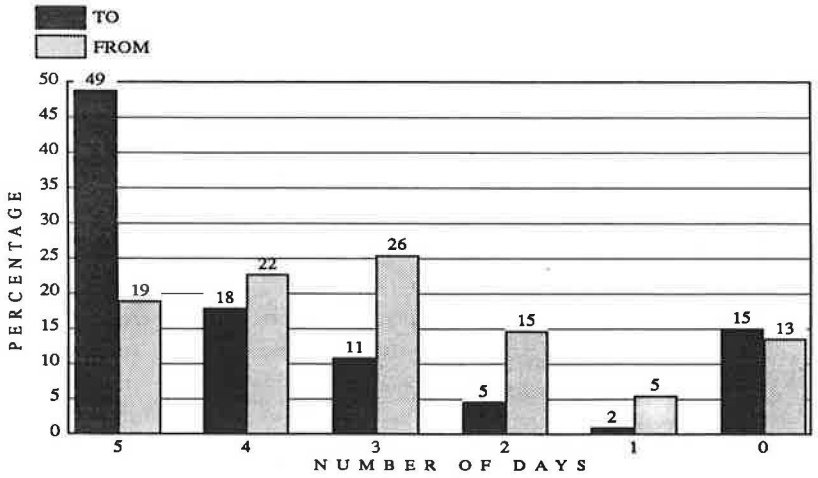

FIGURE 3 Number of days respondents go directly to and from work without chaining trips (N = 1,796 and 1,791, respectively).

few evening stops. Of those who stopped two mornings a week, 43 percent also stopped two evenings a week. More than half of the respondents who trip chain three mornings a week also trip chain three evenings a week, and so on. Table 1 presents the relationship between morning and evening stopping behavior by the number of days the behavior occurred.

BEFORE AND AFTER WORK STOPPING DESTINATIONS

The data also identified the most common employee chaining destinations or travel needs. Fulfilling employee trip needs can be provided for by modifying the environment of the work site, whether by varying land use configurations or by stimulating the market to respond to service demands by an innovative delivery system. Gaining insight into stopping destinations is key to exploring how the suburban environment might substitute or satisfy these needs with different land use types and densities or service delivery relationships. Table 2 presents the types of trips or destinations that Brentwood area employees chain to the work commute.

The predominant reason Brentwood area employees stop to and from work is to get gas (45 and 63 percent, respectively). Other trips that are frequently incorporated in the morning work trip include going to the bank (23 percent), to the dry cleaners (19 percent), to eat (16 percent), to shop (12 percent), to do work-related errands (10 percent), and to child care arrangements (10 percent).

Stops tend to be more frequent on the way home from work, presumably because employees have greater freedom with their time. Apart from fuel stops (63 percent), commuters frequently stop on the way home to shop (56 percent), to go to the bank (50 percent), to go to the dry cleaners (31 percent), to eat (20 percent), to go to the doctor (14 percent), and to perform work-related errands (13 percent).

Because most of the total respondents make stops for fuel, retail shopping, and banking during the commute, moderating or eliminating the need to travel to satisfy these needs could significantly improve employee opportunity to rideshare. The most obvious observation is that if a person joins a vanpool or rides the bus, the need for gas is eliminated. Then, mixing office and retail uses would enable employees to walk to perform other shopping errands. Banking needs can simply be provided by the installation of automated teller machines (ATMs) in building lobbies or snack rooms combined with direct-deposit opportunities.

Several child care–related observations result from comparing the stopping behavior of Brentwood area employees. More than 20 percent of the total morning stops are child-related, either to take young children to preschool or day care (10.4 percent) or to take older children to school (10.2 per-

TABLE 1 RELATIONSHIP BETWEEN A.M. AND P.M. STOPS (N = 1,736)

	P.M. Stops						
A.M. Stops	0 Days	1 Day	2 Days	3 Days	4 Days	5 Days	TOTAL
0 Days	60%	4%	9%	10%	10%	7%	266
1 Day	12	38	19	6	9	16	32
2 Days	6	10	43	24	11	6	80
3 Days	6	5	17	54	14	4	192
4 Days	4	6	14	26	44	6	316
5 Days	5	4	13	24	22	32	849
TOTAL	233	91	254	439	392	328	1736

TABLE 2 REASONS FOR STOPPING BEFORE AND AFTER WORK (N = 1,845)

	TO WORK		FROM WORK	
	%	#	%	#
To get gas	45	834	63	1163
Educational	1	15	5	97
Childcare	10	192	12	227
Children to School	10	188	6	114
Pick up/Drop off Carpooler	3	58	3	61
To Eat	16	302	20	366
Dry Cleaners	19	358	31	582
Bank	23	419	50	916
Doctor	6	103	14	258
Exercise	2	36	11	206
Entertainment	1	18	9	172
Shopping	12	218	56	1029
Pick up/Drop off Other	4	68	1	27
Work Related	10	194	13	234
None of Above	8	148	3	61

cent). In the evening, more commuters pick up preschool children than stop for school children, probably because school hours rarely coincide with work hours so that many children transfer to an afterschool care situation or ride home some other way. Company-provided exercise and child care facilities, cafeterias, and dry cleaning contracted through a concierge vendor, particularly in large single-employer buildings, could also improve TDM participation and aid in congestion reduction.

TRIP-CHAINING

The types of trips that employees typically chain during the commute are presented in Table 3. Because of their greater frequency, and consequent impact on both the highway system and ability to rideshare, the trip chaining that accompanies stops for gas, banking, dry cleaning, eating, work errands, and child care is of special concern. For instance, commuters who stop for gas on the way to work also most often stop for eating (21 percent), dry cleaning (16 percent), the bank (16 percent), and child care (12 percent). Therefore, assuming that gas stops could be reduced or eliminated through a vanpooling arrangement, an additional, comprehensive network of banking, child care, and eating services would be required to fully support a continuing ability to rideshare. Trip chaining most often associated with dry cleaning stops includes eating (23 percent), child care (13 percent), and performing work errands (11 percent). Assuming that the suburban site lacked midday transit, then even if concierge dry cleaning were made available, the eating and childcare needs must be provided for on or near the site. A child care facility, restaurants close to the work site, and use of fleet vehicles to do work-related errands could then fully eliminate the need for a vehicle during the day.

The findings validated an assumption that the greatest consistency of overlapping morning and evening stops would be for child care (91 percent), ridesharers (60 percent), and dry cleaning (33 percent). In addition, one-third of employees who eat in the morning also eat in the evening. In addition, certain typologies can be glimpsed according to the types of trip-chain destinations commonly accessed.

Eighty percent of employees who drop their children off at child care on the way to work also pick them up after work. This category of commuting employee performs little before or after work trip chaining other than the child care respon-

TABLE 3 RELATIONSHIP BETWEEN FACILITY USE BEFORE AND AFTER WORK (N = 2,459)

	Stops Made on Way From Work														
Stops to Work	Educat	Childcare	To Sch.	Carpool	To Eat	Wk Err	Cleaner	Bank	Doc	Enter	Exer	Gas	Shop	TOTAL	
Education	62%	12%	0%	0%	12%	0%	6%	0%	0%	0%	0%	6%	0%	100	16
Childcare	2	91	2	1	.5	.5	1	.5	0	0	0	0	0	100	192
Children to School	5	24	35	1	2	4	7	7	1	0	.5	4	3	100	188
Drop Carpooler	2	15	7	60	2	0	2	3	0	0	0	2	0	100	58
To Eat	9	9	4	3	34	3	10	11	1	1	1	6	2	100	302
Work Errands	10	8	10	.5	19	30	11	3	0	1	1	0	1	100	192
Dry Cleaners	6	13	6	.3	23	10	33	3	1	0	1	1	1	100	350
Bank	6	10	4	1	23	8	16	17	3	2	.5	4	2	100	375
Doctor	6	10	3	1	33	7	15	13	3	3	0	1	0	100	67
Entertainment	0	0	0	14	14	0	14	14	0	29	1	14	0	100	7
Exercise	6	0	6	0	25	12	12	0	0	6	12	6	6	100	16
To Get Gas	4	11	4	2	19	7	15	15	1	1	1	10	2	100	647
General Shopping	2	2	2	3	19	5	18	17	2	2	1	11	10	100	94
None	5	3	1	1	12	5	12	16	1	0	1	7	8	100	147

sibility. This is, presumably, because this single-trip task is demanding and constrained by elements of time. Thus, it is not their habit to make stops during their work trips. For these reasons, they might make ideal ridesharers provided that on-site child care was provided by the employer or child care facilities were incorporated within a convenient park-and-ride lot. Likewise, working parents dropping children at school in the morning perform minimal trip chaining on the way home, although one-quarter also travel to the child care arrangement and more than one-third also pick up school-age children.

Observing the generally limited trip chaining of working parents (and assuming the sacrifice of other trips altogether or the shifting of trips to other times of the day) leads to the conclusion that working parents would use additional site services and a better mix of retail within walking distance.

General shopping is most closely associated with stopping to eat.

Ridesharers tend to do little trip chaining other than child care responsibilities.

Employees who go out to eat are likely to perform a variety of other activities once they are in their vehicles.

Medical visits most typically chain with eating and dry cleaning.

Thirty percent of people who conduct business errands in the morning are also likely to do errands in the evening. They also eat, take children to school, pick up cleaning, and pursue educational goals, but they do not often make stops for gas, medical, entertainment, or exercise purposes.

Conversely, employees who stop for entertainment purposes rarely pursue education, have child care responsibilities, perform work errands, or go to the doctor, but they frequently get gas, go to the bank, go to the dry cleaners, and stop to eat. They are sociable types who are also likely to have someone rideshare with them.

Morning education stops correlate with evening eating (13 percent) and child care responsibilities (13 percent). Making no morning stops on the way to work correlates most frequently with stopping in the evening at banking establishments (16 percent), restaurants (12 percent), dry cleaning stores (12 percent), and general retail shops (8 percent).

EMPLOYEE PREFERENCE FOR ON-SITE SERVICES

An often-cited solution to moderating employee trip-chaining behavior is to provide a mixed-use multiservice environment on or near major work sites. In order to further pursue the relationship between the availability of services and trip-making characteristics, participants were asked to identify facilities

1. That they think they now have access to, and
2. To which they desired greater access where access was defined as within walking distance (three blocks).

The greatest employee interest is for additional on- or near-site post office facilities, restaurants, general retail, snack bars, and convenience shopping. By way of explanation, for most respondents, the existing post office is inconveniently located in the extreme northeast corner of the community, separated from the largest office park by a congested intersection. Then, C-1 zoning limits the location of snack bars, because although they may be located within a building for building occupants only, it is prohibited to advertise their establishment for use by the general public.

Table 4 presents data on facilities that the employees would like to have within three blocks and on facilities that the employees use outside Brentwood. This comparison reveals some unmet site needs. For instance, 49 percent of the 292 employees who identified a need for a more conveniently located restaurant to their work site frequent restaurants outside Brentwood. Of the 193 employees who identified a need for on-site convenience stores, more than one-quarter shop outside the community for convenience items.

In general, however, employees who identified the need for closer dry cleaning, exercise facilities, post office, and banks are not leaving the area to fulfill these needs. Only for medical, child care, and exercise facilities do greater numbers of employees conduct daytime business outside instead of inside the city. These data are promising in terms of the success and employee usage of concierge services and additional retail. They indicate that most employees prefer to shop closer to the workplace when it is possible to do so.

Types of facilities desired on or near the site were examined by income levels and current commute modes. Lower annual household income employees (<$20,000) are most likely to desire closer medical facilities; as incomes rise, preference diminishes. The most marked preference for closer child care and restaurants is in the $20,000 to $29,000 range. Employees in the $50,000 to $59,000 range identified a need for more convenient banking and snack bars. The lower incomes are the least interested in a closer post office, whereas incomes in the $40,000 to $69,000 range are the most interested. Lastly, employees in the $20,000 to $49,000 range are most interested in more convenient dry cleaning.

Drive-alones are most interested in a closer snack bar (17 percent), restaurants (11 percent), medical services (10 percent), and convenience stores (7 percent), whereas carpoolers desire closer medical services (14 percent), snack bars (13 percent), and restaurants (12 percent).

TABLE 4 FACILITIES ON SITE VERSUS FACILITIES DESIRED ON SITE (N = 1,845)

FACILITIES	NOW ON-SITE	DESIRED ON-SITE
Medical	38%	10%
Snack Bar	40	20
Convenience Store	38	18
Restaurant	50	31
Child care	18	10
Banking	60	13
Dry Cleaners	41	11
Exercise	20	19
Post Office	18	32
General Retail	32	25

POLICY IMPLICATIONS

The research defines a full work trip for most Brentwood area employees as including daycare stops, meals, and convenience shopping. These imply a legitimate need for access to a vehicle during, before, and after the work day, although these travel needs also interfere with the ability of the employees to share rides as evidenced by the high drive-alone rate (87 percent). Therefore, several conclusions are drawn:

1. Effective TDM programs must focus on the entire trip and not just computer matching of employees into vanpools, carpools, or transit and workplace surveys. Focusing on the whole trip entails providing access to a comprehensive range of employee needs.
2. In built-out suburban settings with campus-like sites, the provision of services on site through concierge arrangements that bring the service to the employee may offer the greatest relief. But in the long run, particularly at emerging activity centers, the best strategy is a better, richer mix of land use relationships. Infilling of density and a greater variety of uses may also be possible at mature low-density parks.
3. Workers need assurances that they will not be stranded if they must work late or make an emergency trip home. Guaranteed ride home programs using taxi vouchers or transit passes address this need for security.
4. Workers need services and amenities at or within convenient walking distance of their workplace. Mixed-use zoning regulations that allow a better blending of retail and office should be promoted. A suitable pedestrian environment links resources and uses with continuous sidewalks on both sides of the street and good lighting to encourage pedestrian activity. These elements should be promoted through the site-plan review process.
5. In order to fulfill their total daily travel needs in settings that lack transit or pedestrian access to a full range of services, commuters need access to some form of daytime transportation, whether it is the use of company fleet vehicles, taxi vouchers, shuttles, or transit.
6. Clustered buildings enable suburban employees to share service and be closer for sharing rides; they help overcome some of the limitations of low density.
7. Concierge services, such as dry cleaning pick-up and delivery, and in-house amenities, such as ATMs and direct banking deposit and cafeterias, promote a supportive environment for commute alternative programs. Location of services and facilities at park-and-ride lots is another method of delivering services to the ridesharing consumer.
8. The data identify a potential new rideshare product for rideshare agencies and particularly TMAs that seek nondues income sources. Although the need is clearly there to focus on the whole work trip to enhance rideshare rates, in most suburban markets there is a void in delivery of services to the workplace. An innovative response to the need would be to market the more traditional concierge services, such as dry cleaning, with packaging and delivery of innovative concierge services, such as delivery and pick-up of prescriptions, video tapes, gifts, and shoe repair. For instance, remote rental transaction booths are being test-marketed in several U.S. cities by Budget Rent A Car.
9. Private-sector provision of services must make good business sense to become acceptable. For instance, although food services may attract higher rents and help a property lease more quickly, health clubs may not. Federally funded market research is needed to stimulate private-sector confidence in implementing innovative practices.
10. New intelligent vehicle-highway system technology should take into account the trip-chaining behavior of commuters and install on-board systems to allow individuals to perform certain functions from their vehicles.

In summary, the scale and dimension of many existing rideshare programs may need to transition to TDM programs to more fully address the range of commuter travel needs. Ridesharing services must evolve from priority on commuter matching to also promote full-service programs with integrated strategies that address the complex travel needs of today's commuter. At the same time, the impact of land use patterns on commuter trip chaining and the subsequent ability to rideshare necessitates program emphasis on both the macro, or regional, level and the micro, or corridor, cluster, and site levels. A closer working relationship between transit and ridesharing professionals and land use planners is the key to achieving integrated and effective transportation management strategies.

DIRECTIONS FOR ADDITIONAL RESEARCH

This study identified the frequency and types of trips made during the usual journey to work and proposed that mixed-used environments could satisfy a wide range of employee needs previously satisfied by automobile travel. Going beyond this identification, future research should

- Isolate the need for a vehicle before and after work for trip chaining from other reasons commuters prefer to drive alone (fuel costs, parking costs and availability, joy of driving, congestion levels, etc.).
- Identify the intensity, mix, and scale of land use that accomplishes the goal of supporting shared-ride trip making.
- Identify the economies of scale that may exist in the provision of suburban on-site services. What minimum employment densities are required to supply services profitably?
- Identify the types of services typically supplied to the worksite by vendors and the ways that they could be packaged more effectively.
- When minimum employment densities per building may not exist, are there ways to package and market the concierge concept in the lower floor area ratio settings?
- Examine the relationship between employee productivity and satisfaction and the provision of on-site services. Additional on-site services may appeal to managers and CEOs on the basis of these factors more than ridesharing, so research should be pursued in this area.

ACKNOWLEDGMENTS

The Brentwood Area Transportation Management Association recognizes the city of Brentwood and UMTA for supporting this research.

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The research findings described in this paper are the author's and do not reflect the policies of UMTA or the city of Brentwood.

Publication of this paper sponsored by Committee on Ridesharing.

Direct Comparison of Commuters' Interests in Using Different Modes of Transportation

KEVIN J. FLANNELLY, MALCOLM S. MCLEOD, JR., LAURA FLANNELLY, AND ROBERT W. BEHNKE

Interest in express bus service and carpooling was low (10 to 20 percent) among commuters surveyed in a western suburb of Honolulu, and the potential time savings of high-occupancy-vehicle lanes offered little incentive for creating the latter. Interest in both alternatives rose in response to increasing parking costs. Interest in rail transit was 36 percent higher than interest in local bus service at a comparable fare (50 cents), and rail transit appears to be equally attractive to people who now carpool and to many solo drivers, as well. But car commuters that explicitly object to carpooling (34.6 percent of all commuters) as being too time-consuming and unreliable also resist using rail, and interest in rail drops to 21 percent among all commuters if the one-way fare is raised to $1. The most widely preferred alternative among all commuters was paratransit that provides better service and a guaranteed seat. Interest reached 91 percent for door-to-door service at a $1 fare; substantially lower interest was exhibited for rail transit than paratransit, regardless of fare or access. These results suggest that if paratransit served the same area as a rail system, it could take at least two to four times more cars off the road than rail would. Because paratransit can serve wider areas at considerably less cost than rail—possibly at a profit—it is recommended that private providers be permitted to establish such service. The time has come to consider market solutions to transportation problems.

Mounting traffic congestion throughout the United States has caused government officials and transportation planners to search for alternative modes of transportation to entice commuters out of their automobiles (*1*,*2*). Even cities that have rapid transit systems are finding that other means are needed to stem the rising tide of congestion (*3*–*5*).

The intangible personal costs of traditional types of mass transit deter its use. Generally, the individual costs of such transit have more to do with time than money; they include time in getting to and from transit stops, time waiting at stops, and time making transfers. Add to these costs the sacrifice in comfort usually associated with mass transit (*6*,*7*), and it is not surprising that most people commute by car even when train or bus service is available (*3*,*5*). Carpools and vanpools carry two to three times as many commuters as standard forms of mass transit in the United States, but attempts to increase ridesharing have yielded minimal effects at considerable cost (*1*,*2*) and further expansion in this area is probably limited (*8*,*9*).

Economic and psychological factors both have major influences on commuters' choice of transportation mode (*9*,*10*). Economics affect the choice situation by placing constraints on it, such as car ownership and the amount of money available to spend on transportation (*11*,*12*). Personality variables and past experience set further limits and dispose the commuter to favor certain choices over others (*6*,*13*,*14*). Beyond this, a consumer's choice of travel mode represents a balance between personal costs and benefits, for example, time, convenience, and comfort (*13*,*15*,*16*). Although this cost-benefit analysis may not be a conscious process (*17*), it is rational in the economic sense of the word. Given the cost and service characteristics of transportation alternatives now available, the automobile is the rational choice for most people, and people's attitudes reflect this fact (*6*,*12*,*18*).

The interest of automobile commuters in using various transportation modes, including carpools and different forms of mass transit or paratransit, is examined. The study area encompassed a discrete subdivision in the western suburbs of Honolulu, on the Hawaiian island of Oahu, whose population has been particularly vocal in its support for a fixed-guideway, rapid transit system. For convenience, such a system is referred to as rail transit, or simply rail.

METHOD

Sample

As part of the Mililani Neighborhood Board's effort to assess support for a rail system and other commuter transportation alternatives, a questionnaire was sent to each of the approximately 8,400 households in its jurisdiction. A total of 908 questionnaires were returned, but not all of them were fully completed, possibly because of the questionnaire's extended length (nine pages) and some peculiarities in its format that were imposed by the neighborhood board.

Given the low return rate, the sample may not be representative because of nonresponse bias. To the degree that this is so, it is expected that the results are biased in favor of rail transit, because the community has vocally supported rail and opposed HOV lanes for carpools. The use of ratings instead

K. J. Flannelly, Center for Psychosocial Research, 777 Kapiolani Boulevard, Suite 1824, Honolulu, Hawaii 96813. M. S. McLeod, Jr., Hawaii Pacific University, 1166 Fort Street Mall, Honolulu, Hawaii 96813. L. Flannelly, University of Hawaii at Manoa, Webster Hall, Room 411, 2528 The Mall, Honolulu, Hawaii 96822. R. W. Behnke, Aegis Transportation Information Systems, 1188 Bishop Street, Suite 911, Honolulu, Hawaii 96813.

of forced-choice measures and the mathematical adjustment of the ratings to reflect actual behavior may have helped to overcome this bias.

Measures and Analyses

The survey instrument was designed to be similar to that previously used to collect data on commuting behavior and consumer attitudes towards using various transportation alternatives (*10,19,20*). Although the questionnaire was designed with great care, its final form differed substantially from what was originally intended. Among other things, the questionnaire more than doubled in length because the neighborhood board included numerous questions on related and unrelated topics at the insistence of board members and because the board decided to use computer-readable scoresheets that restricted the number of questions per page.

Interest in each alternative was typically measured by a series of related questions that described the alternative in terms of its cost and service characteristics. The respondent was asked to rate each alternative under different sets of hypothetical conditions rather than to choose between or among alternatives, per se. This approach permits the data to be analyzed by repeated-measures analysis of variance and higher-order factorial designs. Because these parametric techniques take individual (within-subject) variability into account and can statistically control for differences in sample size, they are less sensitive to sampling bias than nonparametric analyses of nominal (forced-choice) data. Nonparametric techniques, such as chi-square, were also used when appropriate.

Previous research suggests that people may respond more favorably to some alternatives than would be expected given their own behavior. Solo drivers, for instance, may express an interest in carpooling, whereas other car commuters may say they are interested in taking the bus, even though they do not take it. This response bias was corrected by weighting responses in terms of actual behavior. Thus, car commuters were asked to rate their interest in using the bus with the current fare and service characteristics (i.e., local bus service). Their rating of interest in local bus service was then used to calculate an adjusted score of their relative interest in other transit alternatives, according to the formula

$$\text{Adjusted score} = (\text{rating of alternative} - \text{rating of bus})/(\text{rating of bus})$$

These adjusted scores yielded a percentage measure of relative interest in which interest in using local bus service provided a zero baseline. Each person's interest in local bus service provided a baseline for that individual's relative interest in transit and paratransit alternatives. A similar formula was devised to adjust ratings of solo drivers' interest in carpooling.

RESULTS AND DISCUSSION

Current Commuting Conditions

The automobile is by far the most common mode of commuting (91.3 percent) among the people sampled. The bus (3.8 percent) came in a distant second, but below the combined total (4.9 percent) for all other modes (walk, bicycle, and motorcycle). Among those who drive to work, 74.7 percent drive alone (68.2 percent of all commuters), whereas the remaining 25.3 percent carpool (23.1 percent of all commuters). The extremely small samples of respondents that commute by modes other than the car make it impossible to perform any meaningful comparisons among them, or between them and car commuters. They therefore were excluded from further analyses.

In accord with previous work (*19,20*) done on Oahu, the present results indicate that almost two-thirds (64 percent) of carpools in the sample area contained only two people and the other one-third or so (36 percent) contained three people or more. The percentage of family carpools (72.3 percent) is also comparable with studies of other communities, but far higher than the nationwide average (*9*). Relatively few people (26.8 percent) in the sample commute with friends, and very few (<1 percent) carpool with coworkers.

Approximately 36 percent of the car commuters sampled worked in or around downtown Honolulu, 16 to 20 mi from home, and another 20 percent worked at sites just east of Pearl Harbor, in the same direction as downtown but only 11 to 13 mi away. The remainder are employed at less centralized work sites.

Carpool commuters differ significantly from solo drivers in terms of commute distance (chi-square = 25.59, df = 4, $p < .001$). Although the proportions of carpoolers (59.1 percent) and solo drivers (56.5 percent) who commute distances of 11 to 20 mi (one way) are similar, carpoolers are less likely to commute shorter distances and are more likely to commute longer distances than this, than are solo drivers. Carpoolers and solo drivers also differed significantly in terms of their parking costs (chi-square = 27.82, df = 4, $p < .001$). Roughly 82 percent of solo drivers park for free, compared with 64 percent of carpoolers; among those that pay to park, solo drivers tend to pay less. No relationship was found between carpool size or carpool composition and either commute distance or parking costs.

Interest in Carpools

Approximately 10 percent of solo drivers expressed positive interest in carpooling, more than half (51.2 percent, or 34.9 percent of all commuters) said they would refuse to carpool under any circumstances, and the remainder were essentially neutral. Those who refused to carpool were more likely to work in downtown Honolulu (chi-square = 9.63, df = 4, $p < .05$) and to pay significantly more for parking (chi-square = 9.86, df = 4, $p < .05$) than other solo drivers. They were also more likely to have longer travel times (chi-square = 10.03, df = 4, $p < .05$).

So why do they refuse to carpool? Table 1 provides at least a partial answer to this question. A technique used earlier by Margolin and Misch (*10*) and other researchers (*21*) was used to compare different characteristics of carpooling and driving alone with one another in a series of statements to which respondents were asked to agree or disagree. The statements are presented in Table 1 in abbreviated form, along with the percentage of respondents in each group that agreed with each statement. Significant differences were found among groups

TABLE 1 PERCENTAGE OF CAR COMMUTERS, BY CATEGORY, WHO AGREED WITH STATEMENTS ABOUT COSTS AND BENEFITS OF CARPOOLING

Statement	Won't Carpool	May Carpool	Do Carpool
Ability to do errands with own car outweighs HOV time-savings	69.4%	47.7%	42.3%
Ability to do errands outweighs monetary savings of carpooling	68.7%	44.8%	41.4%
Monetary savings of carpooling not worth the cost in time	65.1%	51.6%	50.2%
Having to depend on others not worth the money saved by carpool	61.8%	40.4%	35.6%
Having to depend on others not worth the time savings of HOV	57.8%	35.1%	34.9%
Time involved in carpooling outweighs its monetary savings	54.1%	36.3%	35.8%
Time picking up pool members cancels out time savings of HOV	51.3%	33.0%	34.4%

on each item (chi-square values ranged from 22.7 to 50.8, df = 4, $p < .001$ for all comparisons). The pattern of differences is consistent with previous research indicating that attitudes reflected mode choice and were good predictors of subsequent changes from one mode to another (*7,18*).

As indicated in the table, those who refused to carpool (labeled Won't Carpool) differed from other car commuters (May Carpool and Do Carpool) in their evaluations of the costs and benefits of carpools. They appeared to place a higher value on their time and independence, and they were wary of having to depend on others. Moreover, they tended to believe that the monetary savings of carpooling and the potential time savings of high-occupancy–vehicle (HOV) lanes were outweighed by the time spent picking up carpool members. In short, they thought that the costs of carpooling outweighed its benefits, at least under current conditions.

When asked if increasing the time saving provided by HOV lanes would encourage them to carpool, neither group of solo drivers (Won't Carpool and May Carpool) responded strongly to such incentives. Whether this response reflected the community attitude against restricting lane use or a skeptical attitude toward the ability of HOV lanes to actually provide time saving cannot be discerned. (Current HOV lanes only bring drivers into the congestion bottleneck.)

Solo drivers appear to be more likely to opt for carpooling in the face of disincentives. Solo drivers who may carpool and those who say they won't carpool express increasing interest in doing so, as measured by their adjusted scores, when faced with higher parking costs ($F = 56.18$; df = 4, 2448; $p < .001$). At an increase of $10 per month, some 35 percent of those who say they won't carpool change their minds, whereas interest in carpooling among those who may carpool rises to 53 percent. At increases of up to $50, almost 65 percent of those who are against carpooling decide that they would, and the interest of other solo drivers goes up to 81 percent.

Interest in Mass Transit

Roughly 21 percent of respondents currently in carpools and 15.5 percent of those who drive alone claim to be interested in express bus service. Interest among downtown and Pearl Harbor workers (20.1 percent) is nearly twice as high as that of car commuters that work elsewhere (11.8 percent). So why don't people use express buses instead of their cars? As presented in Table 2, the answers vary somewhat, depending on who was asked. People who won't carpool are more likely than others to claim that they sometimes need their cars for work (chi-square = 23.10, df = 2, $p < .001$) and that the bus does not match their schedule (chi-square = 13.18, df = 2, $p < .001$). But these are also the most frequent explanations chosen by other car commuters. (Respondents could give more than one answer.) The two other most common reasons that respondents select are that they do not like to stand on the bus and that there is no express bus service near their home.

Hypothetical increases in parking costs increase relative interest in express bus service ($F = 63.86$; df = 4, 2588; $p < .001$), but not as much as they do for carpooling. Even at parking costs of $50 more per month, interest in express bus service (which costs only $15 per month) is still less than 45 percent among all three groups of car commuters.

At 36 percent, relative interest in using rail transit (as measured by adjusted scores) is substantially higher than that for express buses, even though it was explicitly stated that the

TABLE 2 REASONS GIVEN BY THREE GROUPS OF CAR COMMUTERS FOR NOT USING EXPRESS BUSES

Reason	Won't Carpool	May Carpool	Do Carpool
Bus schedule does not match my work schedule	57.5%	50.5%	40.9%
I sometimes need my car for work	59.6%	40.7%	44.7%
I do not like to stand on the bus	29.1%	22.1%	33.0%
No express-service between where I live and work	20.0%	22.0%	20.5%

access to the train (the average distance to the nearest train stop) will be 5 mi from the Mililani subdivision. Because the higher capital and operating costs of a rail system may lead to fares increases, it was necessary to see if respondents were willing to pay higher fares. Other factors included in the analyses were worksite (broadly defined) and present mode of commuting.

Overall, relative interest in rail is reduced to 21 percent at a $1 fare each way, and to 3 percent at a one-way fare of $2. At more than $2, interest in rail transit becomes negative relative to interest in local bus service. Although worksite was not found to play a significant role in determining interest in rail transit, relative interest was highest among respondents working in and around downtown Honolulu and Pearl Harbor—those most likely to be served by the rail system.

The relative interest of downtown and Pearl Harbor commuters (approximately 56 percent of all commuters in the sample) is shown in Figure 1. Fare is the primary variable affecting interest in the train, among car commuters into these (and other) work locations ($F = 83.19$; df = 3, 1833; $p < .001$). Current commute mode (solo drivers versus carpoolers) also has an effect, but this effect is mainly attributable to differences between solo drivers that won't carpool and other car commuters, in response to different fares ($F = 2.55$; df = 6, 1883; $p < .05$). At lower fares, at least, rail appears to be an equally attractive alternative to many carpoolers and solo drivers. But it is far less attractive to solo drivers that do not want to carpool and these make up 34.9% of all commuters in our sample.

Interest in Paratransit

On the basis of previous research (*15,22,23*), including that of the authors (*12,19,20*), it was decided to examine how two service characteristics and fare contributed to people's interest in using paratransit. The service variables chosen for study were seating (a guaranteed seat versus no guaranteed seat) and access—the distance (or time) to transit stops from a commuter's origin and destination (*12,19,24*). Three levels of access were considered: (a) door-to-door service (door/door); (b) a 5-min walk between origin and pick-up point and be-

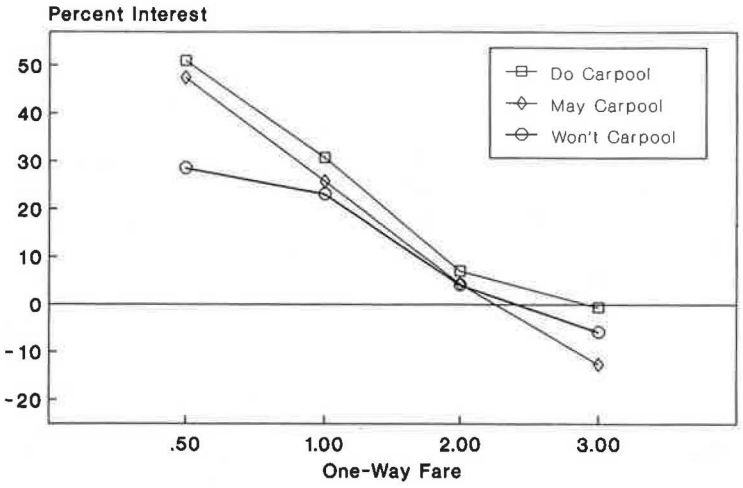

FIGURE 1 Interest in downtown and Pearl Harbor car commuters in using rail transit.

TABLE 3 RELATIVE INTEREST OF CAR COMMUTERS IN USING PARATRANSIT AS A FUNCTION OF FARE, ACCESS, SEAT AVAILABILITY, AND WORKSITE

			One-Way Fare		
Worksite	Seating	Access	$1.00	$2.00	$3.00
Downtown and Pearl Harbor	Seat	Door/Door	99.8	49.3	11.9
		5 Minutes	81.7	31.2	1.1
		10 Minutes	52.5	18.6	-5.1
	No Seat	Door/Door	67.9	24.1	-4.9
		5 Minutes	48.8	6.5	-14.3
		10 Minutes	24.5	-4.1	-15.3
All Other Worksites	Seat	Door/Door	77.9	31.4	-1.3
		5 Minutes	66.2	17.4	-9.2
		10 Minutes	35.6	3.2	-14.2
	No Seat	Door/Door	59.6	17.1	-2.5
		5 Minutes	43.8	4.6	-11.2
		10 Minutes	20.0	-4.0	-15.1

tween drop-off point and destination (5 min); and (c) a 10-min walk (10 min). Hypothetical fares of $1 or more were used because it seems unlikely that lower fares could cover the costs of the services being considered. Current mode and worksite were included in the statistical analyses along with fare, access, and seating.

Table 3 indicates that interest in paratransit relative to local bus service is high. Relative interest, in terms of adjusted scores, decreases with increasing fare (F = 203.18; df = 2, 1222; $p < .001$), with a fare increase from $1 to $2 reducing the relative interest by one-half or more. Increases in access time produce a similar, though less pronounced, effect (F = 112.44; df = 2, 1222; $p < .001$). At a $1 to $2 fare, each increment in access time reduces relative interest by 15 to 30 percent, depending on worksite and seating (F = 2.73; df = 4, 1222; $p < .05$). Yet these access times are probably far shorter for most of the people in the sample than those now afforded by local bus service.

Although downtown and Pearl Harbor workers place a greater value on a seat than do other workers (F = 9.06; df = 1, 611; $p < .01$), a guaranteed seat significantly increased relative interest in paratransit by 20 to 30 percent, overall (F = 51.04; df = 1, 611; $p < .001$). More important, a guaranteed seat can partially compensate for increases in fare (F = 22.44; df = 2, 1222; $p < .001$) and, to a lesser degree, so can decreases in access (F = 3.04; df = 2, 1222; $p < .05$). No significant effects of mode were found.

Interest in Paratransit versus Rail Transit

A direct comparison between paratransit and rail transit reveals a pronounced preference for paratransit with a guaranteed seat (F = 96.11, df = 3, 1845, $p < .001$), regardless of access time (Fs = 84.20 to 122.25, $p < .001$ for all three paired comparisons). As shown in Figure 2, there is greater relative interest in paratransit at all fare levels (F = 54.20, df = 6, 3690, $p < .001$), as measured by adjusted scores. All three of the paratransit options shown in Figure 2 (i.e., service variations in terms of access) received higher relative interest at a $1 fare than the 36 percent relative interest for rail at a 50-cent fare (not shown), whereas door-to-door service with a seat commands 42 percent interest even at a $2 one-way fare.

CONCLUSIONS AND RECOMMENDATIONS

As found in earlier studies (*12*,*19*,*20*), interest in carpools among Oahu's commuters is low and the proposed time saving of HOV lanes does not appear to provide a strong enough incentive to attract a substantial proportion of solo drivers to ridesharing. Under current conditions, the market for carpooling is limited; perhaps 10 percent of all solo drivers are willing to carpool. Most drivers regard the price of carpooling, in terms of loss of independence and added time, to be too high for incentives to make it worth their while. Hence, wide-scale efforts to encourage carpooling would not appear to be worth the cost, although targeting specific markets may be worthwhile.

Express bus service may offer an alternative for some 20 percent of people who now drive to work. But it would have to be expanded and operated in a way to overcome current criticisms about scheduling and crowding. What role parking costs play in determining current mode choice is not as clear because so few commuters pay for parking now. But increas-

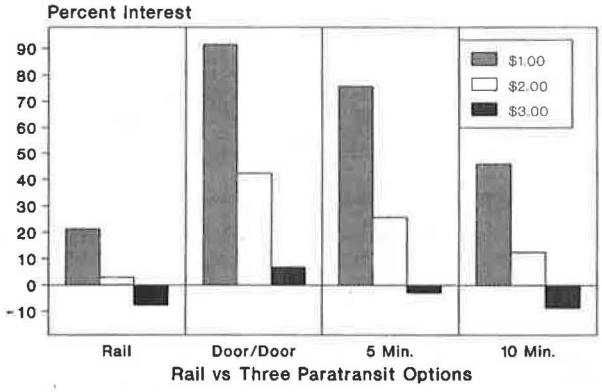

FIGURE 2 Interest in rail versus paratransit options with guaranteed seat, as function of fare.

ing those costs appears to be a powerful disincentive to driving alone, which could increase both express bus ridership and carpooling. Serious attention might be given to using disincentives once improved bus service was in place.

Rail transit is looked on more favorably by car commuters than either carpools or express buses, with rail receiving 36 percent interest at a 50-cent fare. It is equally attractive to people who now carpool and to many solo drivers, but those who are resistant to carpooling (34.6 percent of all commuters) are also resistant to using rail, presumably because it has some of the same limitations. Interest in rail declines quickly in the face of rising fares—down to 21 percent at a $1 fare—which would have to be imposed, in all likelihood, to help offset the higher capital and operating costs of a rail system.

As found in the past (*19*), the most widely accepted alternative mode is paratransit providing better service. The combination of reduced access and a guaranteed seat produces interest that is far higher than that exhibited for rail or any other mode. The same people, using the same rating scale, who express a 36 percent interest in rail at a 50-cent fare, express a 91 percent interest in paying $1 for door-to-door service with a guaranteed seat. In addition, paratransit is capable of attracting those same commuters that most strongly resist using other alternatives. Because interest in paratransit is substantially higher than interest in rail transit at all fares, it seems unwise to invest in a rail system for Honolulu when a far less expensive and apparently attractive alternative has yet to be tried.

It is not yet clear how the interest measures studied here translate into potential ridership (*19,24*). But regardless of the absolute numbers involved, the relative magnitude of the effects should be the same across all of the alternatives. If this is so, whatever the number of car commuters that a rail system will attract, two to four times that number could be expected to use paratransit serving the same areas. Paratransit systems could also attract comparable levels of ridership in areas that will not be served by the proposed rail system and, it appears, that paratransit is able to do so without the imposition of disincentives. Moreover, it is possible that such service could be provided without subsidy. But if subsidies are necessary, they would be far less than those needed for a rail system and they should be more cost effective.

Simply providing the transportation consumer with better service at a reasonable price may be the alternative that government officials and planners have long sought (*25*). Instead of investing in a rail system for Honolulu, opening up the transit market to private businesses, with government providing limited subsidies as needed, is urged.

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Publication of this paper sponsored by Committee on Ridesharing.

Transit and Ridesharing Information Study

PHILIP L. WINTERS, ROLLO C. AXTON, AND JAMES B. GUNNELL

The methodology, results, and conclusions of a market research study to identify the transit information needs of the rideshare agency's customers are described. The study identified demographic differences between the ridesharing program's customers and the transit patrons. It also assessed the benefit of increasing the detail of transit information to encourage a ridesharing customer to call the transit company or immediately begin riding transit. The study was based on a random sample of existing customers of Ridefinders, the nonprofit ridesharing organization for the Richmond, Virginia, metropolitan area. Some of the key findings were that ridesharing commuters were more white collar with a higher household income and had a greater degree of automobile ownership than transit patrons. Fifty-seven percent indicated that their home or work location was outside the transit service area. Less than 4 percent cited the lack of awareness of the bus schedule as the reason for not riding transit. In addition, 43 percent of the ridesharing customers had used the transit services within the past 6 months. Less than 10 percent of the customers increased their perceived value of the transit company's telephone number. Ridefinders is using the study results to continue to coordinate marketing efforts with the transit company while recognizing the differences between the markets and the occasional need to adjust its marketing strategies accordingly. Ridefinders will also place its marketing emphasis on highlighting transit features and benefits rather than investing in costly revisions to the computerized ridematching system to increase the level of routing and schedule information or indiscriminately distributing bus schedules.

Transit and ridesharing are complementary transportation options for the commuting public. Each mode has its own benefits and features for addressing different market needs. Transit offers commuters an inexpensive, reliable service and typically offers a range of arrival and departure times for individuals who live and work in high-density areas. Ridesharing by carpool or vanpool provides door-to-door service to commuters who live or work outside the transit company's service area.

In the Richmond, Virginia, metropolitan area, the Greater Richmond Transit Company (GRTC) and Ridefinders are two independent organizations responsible for the provision of transit services and the promotion of ridesharing options, respectively. Since Ridefinders' inception in 1980, under the auspices of the Richmond Area Metropolitan Transportation Planning Organization (MPO), GRTC and Ridefinders have worked in a cooperative manner to foster the use of all forms of ridesharing including public transit use.

P. Winters, Ridefinders, P.O. Box 1239, Richmond, Va. 23209; current affiliation: The Breen Consortium, Inc., 5309 Commonwealth Center Parkway, Suite 208, Midlothian, Va. 23112. R. Axton, Greater Richmond Transit Company, P.O. Box 27323, Richmond, Va. 23273.

GRTC and Ridefinders already provide a host of materials designed to provide or make available more information on public transit. A partial list includes the following:

- Nearest bus route name and number on matchlist (including special messages for commuters without transit service available).
- Individual route maps and schedules.
- GRTC's The Best Curb Service in Town campaign included a brochure indicating all the routes on a schematic map with a general route description and billboard advertising.
- GRTC's Take the Mystery Out of Riding the Bus campaign. This campaign is directed at informing commuters how they can get more information on services designed to meet their needs. This includes GRTC's computerized kiosks.
- GRTC's The Ultimate Riding Machine campaign described how the new buses are designed for the needs of the riders and will be reintroduced as the new buses arrive.
- GRTC's 24-hr Information Center.
- Postage-paid return card to Ridefinders enabling ridesharing customers to request specific information from GRTC.

During the past several years, Ridefinders has examined its customers' desire for transit information, and the effect on mode split of its computerized list of neighbors who work nearby and have similar schedules (i.e., matchlist). As a result of this examination, Ridefinders has provided its customers with transit information in a number of ways. An important goal of the study was to improve the focus of Ridefinders' role as a supplementary source of transit information to its customers. In particular, management was interested in determining whether Ridefinders should concentrate on increasing awareness of transit service availability by increasing the detail of transit information provided on the matchlist, providing bus schedules for every ridesharing customer, or marketing the benefits and features of transit.

Ridefinders compiled some information on clarifying its approach through several research efforts. The earliest effort was a focus group study to evaluate the clarity of its matchlist. Several formats for the transit output page were presented to a focus group of current customers. At the time of the focus group session, the transit page consisted of the names of two routes, headway information, general operating hours, and transfer information.

According to the market research firm's report, "Panelists do not expect [Ridefinders] to provide transit information on matchlists, but say the information would be 'nice to have.' " The focus group panelists also indicated a desire for much more detailed information than the current ridematching soft-

TABLE 1 COMMUTERS' MODE OF TRANSPORTATION BEFORE BEING PLACED IN CARPOOL

	DRIVE ALONE	TRANSIT	CAR-POOL	VAN POOL	OTHER	NO.
Ridefinders	74%	0%	11%	7%	7%	27
VA TOTALS	42%	24%	23%	10%	1%	577

ware was designed to produce. The research firm concluded that "the [Ridefinders] transit information is perceived to have serious drawbacks. It is perceived to be very vague."

In addition to qualitative feedback about Ridefinders' transit element, other quantitative information was compiled to analyze the market potential for Ridefinders' transit information services. An analysis of Ridefinders' market found that

- 33 percent of Ridefinders' customers live and work in GRTC's service area,
- 19 percent of those who live and work in the service area work in the central business district (CBD),
- 57 percent of all Ridefinders' customers work downtown,
- 25 percent of those customers who work in the CBD already ride the bus to work, and
- 8 percent of all Ridefinders' customers, regardless of home and work locations, rode the bus to work at the time they registered with Ridefinders.

Because Ridefinders and GRTC are both in the business of providing alternatives to driving alone to work, consideration was given to the effects of marketing on transit ridership. An evaluation of Ridefinders' performance by the Virginia Department of Transportation for fiscal year 1987, as indicated in Table 1, found no net diversion from transit to carpooling among those Ridefinders placed into a carpool as a direct result of receiving a matchlist.

Using the sample of 217 completed surveys of Ridefinders' customers, VDOT also reported that there was no loss in transit share among Ridefinders' customers whether or not they were placed into a carpool as a direct result of receiving a matchlist (see Table 2).

On the basis of the background information available, Ridefinders concluded that marketing transit was a desirable strategy for the ridesharing agency. The questions remained how to best integrate the marketing of transit and ridesharing alternatives. This study was designed to answer such questions as whether the lack of awareness about transit services or inexperience in riding a bus were significant marketing problems and, if so, what level of information desired by the customer would have a meaningful influence on current behavior.

STUDY OBJECTIVES

The general purpose of this research project was to conduct a study that would collect, analyze, and report data in a form to provide additional information to complement existing information sources used by GRTC and Ridefinders.

The primary objective of this study was to determine the effectiveness of providing selected transit-related information to Ridefinders' customers as a strategy for increasing the number of individuals using GRTC services.

The primary research question was, "What transit-related information is most effective in encouraging Ridefinders' customers to use the services of GRTC?" The independent variables considered were the GRTC phone number, a detailed route map for the nearest route, a general description of the nearest route, the name of the nearest route, travel time, frequency of service, and schedule. The dependent variables considered were getting the Ridefinders' customer to contact GRTC for additional information and to use GRTC services.

The need for transit information was based, in part, on current levels of transit awareness among Ridefinders' clients and the likelihood that any additional information would result in clients' calling or riding GRTC. One possible outcome of this study would be the modification of the transit component of the ridematching information to provide more detail than the route name and number, transfer options, and transit company's phone number.

METHODOLOGY

Two tasks were designed to carry out this market research study. The first task was to identify the demographic and travel characteristics of Ridefinders' customers. With this information, Ridefinders' customers were compared to GRTC peak-hour riders. For the purpose of this comparison, the data included in GRTC's Ridership Profile Study were used. The second task was to conduct an unbiased stratified random survey of Ridefinders' customers to produce quantifiably supported ratings on the effectiveness of the independent variables on influencing behavior.

TABLE 2 MODE SHARE BEFORE AND AFTER RIDEMATCHING ASSISTANCE

Mode	Before (N=217)	After (N=217)
Drive Alone	72%	60%
Transit	9%	9%
Carpool	12%	25%
Vanpool	0%	1%
Other	7%	5%
	100%	100%

Population and Sample

The list of names of existing Ridefinders' customers served as the population from which the systematic sample was drawn. The population element was stratified along the dimensions of the characteristics considered including such items as sex, age, household income, and educational level; traveling characteristics consisted of such factors as a knowledge of transit service area and work location.

The sample consisted of 900 individuals who were selected by use of the systematic random sample methodology from a listing of approximately 3,000 existing and former Ridefinders' customers.

Preparation of the Survey Instrument

The survey instrument was designed to elicit the information required to address the specific questions raised. The self-administered survey instrument comprised a measurement scale that enabled the research consultant to determine the effectiveness of the independent variables as contributors to increased ridership on buses. The scale used provided information regarding the extent to which the items were effective in influencing Ridefinders' customers' decisions to contact GRTC for more information and use GRTC's services.

Administering the Instrument

The survey instrument was mailed to each individual that composed the study sample. Also included was an appropriate cover letter from GRTC and Ridefinders and a stamped envelope for returning the completed form. The first administration took place during the first week of January 1988. Allowing approximately 2 weeks for the initial responses, the follow-up surveys were mailed approximately 1 month later.

STUDY RESULTS AND SAMPLE PROFILE

The data gathered were categorical in nature; thus, such descriptive statistical methods as frequencies, percentages, and cross tabulations were used to analyze the results. These methods were used to establish the sample profile and to determine the impact that the various variables had on the respondents' decision to use the services of GRTC.

Number of Surveys Administered

Eight hundred surveys were distributed during the initial survey. Of this number, 177 (22.1 percent) were returned. During the follow-up procedure, an additional 92 surveys were returned. Thus the total number of surveys returned was 269 or 33.6 percent. Sixty surveys were not delivered because of incorrect addresses. Therefore, 36.4 percent of those delivered were returned.

Characteristics of Nonrespondents

The typical percentage of response for a survey research project usually ranges from about 30 to 40 percent. These percentages usually exclude the surveys returned because of incorrect address. Because of the limited information about the sample individuals, it was practically impossible to describe the characteristics of the nonrespondents. The original sample comprised 365 males and 435 females, 45.6 and 54.5 percent, respectively.

The sample's mode split also closely approximated the mode split of the population from which it was drawn (see Table 3).

The sample was divided among six geographic regions:

1. City of Richmond
   a. Northside area
   b. West End area
   c. Southside area
   d. East End area
2. Richmond suburban area
3. Surrounding counties

The profiles of the respondents revealed the following information that proved helpful in generalizing the nature of the nonrespondents and also estimating the similarity between respondents and nonrespondents. The analysis of the sample data question that asked for the home address or nearest intersection revealed that responses were received from individuals of each of the six areas.

TABLE 3 CURRENT MODE OF TRANSPORTATION TO WORK

Mode of Transportation	Percent	
	Sample (N = 269)	Sample Population
Drive Alone	49.1	53.7
Transit	21.6	20.8
Carpool	22.7	23.0
Vanpool	1.8	0.3
Other	0.0	1.7
No response	4.8	0.0
	100.0	100.0

On the basis of the general characteristics of the sample in comparison with those of the respondents, the characteristics of the nonrespondents do not differ to a great extent from those of the responding individuals. Thus one would conclude that the sample statistics do not vary significantly from those for the population.

SUMMARY OF FINDINGS

Ridefinders' customers differed from GRTC's peak-period riders in several demographic characteristics. Ridefinders' customers tended to be more equally divided among males and females, work in more white-collar jobs, live in a household with a greater income, and have a higher degree of automobile ownership (see Table 4).

Although Ridefinders' market has significant demographic differences from GRTC's market, the market potential from the perspective of Ridefinders' customers who are served by GRTC at the destination end of their work trip is large. The result of the sampling process resulted in more than two-thirds of the respondents stating that GRTC serves their work area.

GRTC Service to Work Area	*Percentage*
Yes	68.0
No	30.1
Nonrespondents	1.9
	100.0

Although approximately two-thirds of the respondents had transit service to their work sites, only 16.4 percent make use of GRTC service directly from home. An additional 5.2 percent of Ridefinders' customers drive to access transit. About half of the commuters with service to their work site do not have transit service at the home end. Less than 4 percent indicate that they were unaware of the bus schedule. In support of the finding that the lack of awareness appeared to be a nonissue, there was a high level of recent experience with the service. Forty-three percent of the respondents indicated that they had made use of the services of GRTC within the last 6 months.

Reasons for Mode of Getting to Work	*Percentage (N = 269)*
GRTC does not serve area in which I work.	30.1
GRTC does not serve area in which I reside.	27.1
I currently use services of GRTC.	16.4
Schedule does not match work schedule.	8.9
I just don't want to ride the bus.	8.6
Unaware of bus schedule.	3.7
No response.	5.2
	100.0

Used GRTC Services in the Past 6 Months	*Percentage (N = 269)*
Yes	43.1
No	53.9
Nonrespondents	3.0
	100.0

Of the 85 percent of respondents who indicated that they were not currently using the services of GRTC, approximately 57 percent indicated that their areas of residence or work sites were not served by GRTC.

The demographic and travel characteristic distributions of Ridefinders' customers illustrate several key differences between Ridefinders' and GRTC patronage, as well as the service area population.

The following items were presented to the respondents as information sources available by GRTC or Ridefinders:

1. GRTC information number,
2. Route map for the nearest route,

TABLE 4 DEMOGRAPHIC COMPARISON OF CUSTOMERS OF GRTC AND RIDEFINDERS

	(Peak Period) GRTC Percent	Ridefinders Percent	No.
Sex			261
Male	32.5	45.6	
Female	67.5	54.4	
Occupation			263
Professional & Managerial	28.3	57.0	
Sales and Support	20.5	39.9	
Operator & Labor	19.4	3.0	
Other	31.8	0.0	
Household Income			257
Less than $15,000	51.2	8.6	
$15,000 to $24,999	23.0	36.2	
$25,000 to $34,999	12.4	28.8	
$35,000 to $49,999	8.9	18.7	
$50,000 to over	5.5	7.8	
Auto Ownership			256
Yes	65.9	87.4	
No	34.1	12.6	

3. Name of nearest route from place of residence to work site and home,
4. Transit listing with service times and frequency, and
5. Name of nearest route with time schedule.

The respondents were instructed to rate on a scale of 1 to 5 (1 being of most value) the value of each level of transit information in their decision to call GRTC for additional information, use the services of GRTC, and finally to give other factors that influence their decision to ride the bus (see Table 5).

On the basis of the consultant's findings, there is no significance to the level of transit schedule information provided and the likelihood of that person calling GRTC for more information or using GRTC's services. Only about 10 percent of the customers increased their perceived value rating between the lowest level of information (i.e., transit telephone number) and the highest level of information (i.e., name of nearest route with time schedule). Therefore, increasing the level of detailed information provided on or with matchlists is not likely to contribute to significant increases in Ridefinders' customers calling GRTC.

Increasing the level of detailed information provided as part of the matchlists would also not result in increases in the commuter's decision to use GRTC services (see Table 6). About 10 percent of the respondents increased their rating between the lowest and highest level of transit information.

Other factors given by the respondents may influence the decision to use the services of GRTC. In particular, the majority of those that focused attention on the factor "service availability" were from areas that were not currently served by GRTC.

Factors That May Influence Decision To Use GRTC Services	*Percentage (N = 269)*
Service availability	29.7
Reasonable fare	25.3
Courtesy of driver	20.4
Comfort	11.2
Other	6.7
No responses	6.7
	100.0

CONCLUSIONS AND RECOMMENDATIONS

On the basis of the findings, the following conclusions can be drawn:

1. Middle-income, car-owning individuals are less likely to use transit services.
2. A knowledge of pertinent GRTC information is not sufficient to cause individuals (as characterized by the research sample) to use the services of GRTC.
3. To increase the service area of GRTC does not ensure increased ridership.
4. Strategies in addition to those currently being used by GRTC and Ridefinders must be developed and implemented if Ridefinders' customers are to become frequent users of GRTC's services.
5. Individuals within and outside the GRTC service area are knowledgeable of the nature of the service provided by GRTC.

TABLE 5 RATINGS, REQUEST FOR MORE INFORMATION

	RATING						
	Most Valuable				Least Valuable		
ITEM	1 %	2 %	3 %	4 %	5 %	TOTAL %	NO.
TRANSIT TELEPHONE INFORMATION NO.	31.8	22.5	18.1	7.5	20.3	100	227
ROUTE MAP FOR THE NEAREST ROUTE FROM HOME TO WORK	27.3	30.9	19.6	8.2	14.1	100	220
NAME OF NEAREST ROUTE FROM HOME TO WORK	26.1	24.3	18.5	8.6	22.1	100	222
TRANSIT LISTING WITH SERVICE TIME AND FREQUENCY	26.8	36.8	12.7	10.5	13.2	100	220
NAME OF NEAREST ROUTE WITH TIME SCHEDULE	34.2	28.4	11.6	13.3	12.4	100	225
TOTAL	29.3	28.4	16.1	9.6	16.4	100	1,114

TABLE 6 RATINGS, DECISION TO USE GRTC SERVICES

ITEM	RATING Most Valuable 1 %	2 %	3 %	4 %	Least Valuable 5 %	TOTAL	NO.
TRANSIT TELEPHONE INFORMATION NO.	28.3	22.9	16.6	6.8	25.4	100	205
ROUTE MAP FOR THE NEAREST ROUTE FROM HOME TO WORK	26.6	34.5	24.1	2.0	12.8	100	203
NAME OF NEAREST ROUTE FROM HOME TO WORK	27.6	28.1	21.2	7.9	15.3	100	203
TRANSIT LISTING WITH SERVICE TIME AND FREQUENCY	30.5	28.6	19.2	10.8	10.8	100	203
NAME OF NEAREST ROUTE WITH TIME SCHEDULE	35.0	26.6	16.7	8.4	13.3	100	203
TOTAL	29.6	28.1	19.6	7.2	15.5	100	1,017

A major effort to incorporate transit schedule, fare, and other operating data into the ridematching software is not recommended. Increasing the level of detail of transit information did not indicate a significant increase in the likelihood that the Ridefinders' customer will call or ride GRTC.

Furthermore, awareness of service availability does not appear to be an issue among Ridefinders' customers. Marketing approaches that seek to solely increase awareness that transit services can serve their commute trip are not recommended.

The fact that most of Ridefinders' customers differ demographically from GRTC riders, have a significant level of awareness and prior experience with transit, and have access to an automobile poses a substantial challenge to marketing transit to those customers. Transit agencies will need to design and implement a special marketing strategy, focusing on possible ways to increase ridership from the population of a ridesharing agency's customers as characterized by the profile of the research sample.

On the basis of the study's findings, Ridefinders and GRTC should develop marketing materials that supplement the transit page on the matchlist. These materials should highlight the features of transit service. Suggested approaches include promoting express service from park-and-ride lots; highlighting GRTC's friendly, courteous drivers; and meeting different work schedules on routes with multiple runs. Possible themes:

- "Your Chauffeur Awaits,"
- "It Pays to Ride With a Friend,"
- "We Are Ready When You Are," and
- "The Airlines Wish They Had Our On-Time Performance Record."

The need for continued cooperation between transit and ridesharing is essential. Both services need to be marketed to the commuter market to reduce traffic congestion, air pollution, and energy consumption. However, each service needs to be targeted to its market.

This research focused on what transit-related information is most effective in encouraging Ridefinders' customers to use transit services. However, the information services component of transit and ridesharing marketing strategies should not overshadow the need to change or introduce products or services, develop new distribution channels, or revise pricing tactics.

Such product strategies could include establishing a guaranteed ride home program to allow commuters who ride the bus or pool to work late. Remote transit stores that sell fare media and provide ridematching and transit information could serve as a new distribution channel. A pricing strategy could be used that charges commuters a commission in exchange for providing personalized assistance for placing them into a pool. Additional market research can determine how effective these and other strategies can be in increasing transit ridership or ridesharing.

Publication of this paper sponsored by Committee on Ridesharing.

Vanpools in Los Angeles

AJAY KUMAR AND MARGARET MOILOV

A survey of vanpool coordinators and riders was conducted in Los Angeles during 1988–1989. The specific issue was to understand the commuting behavior of the existing vanpool members and to identify the major concerns of vanpool program coordinators. The benefits of vanpooling to the rider, the employer, and the community are considerable. The family role may also be increasing vanpool program attractiveness.

The California Department of Transportation and FHWA conducted a vanpool survey to better understand vanpool programs operated by employers in the Los Angeles metropolitan region. The survey was developed with the assistance of the Association for Commuter Transportation (ACT) and pretested at one job site with more than 40 vanpools. In order to gain the participation of a broad, diverse group of vanpools, every major employer in Los Angeles known to operate a vanpool program was contacted. Information was sought from the vanpool coordinator (who was also the van driver in more than 90 percent of the cases) and the commuters riding in the vans. Mail-out surveys to vanpool program coordinators and riders served as the primary means of data collection. Surveys included more than 700 vans operated by 16 employers and carrying about 10,000 riders. (A sample of the survey questionnaire can be obtained from M. Moilov.)

Results of the first step in a continuing research effort to assess the potential of vanpooling are presented. The characteristics of vanpoolers have been researched less thoroughly than those of carpoolers or transit riders. However, the different modes differ substantially in their appeal to commuters. For example, a decision to vanpool involves much longer commitment and greater attitudinal adjustments. In addition, vanpoolers tend to travel farther to work than other commuters, an average of 72 mi round trip, compared with 45 mi for carpoolers and 19 mi for all commuters (*1*,p.15).

Specifically, the objectives of this study are

1. To understand the demographic characteristics and commuting behavior of the existing vanpool members, and
2. To identify the specific issues faced by vanpool program coordinators or drivers.

Understanding the commuter characteristics provides a necessary input to identifying more effective ways to encourage vanpool participation and to develop guidelines for future use. In addition, the evaluations will help determine the extent to which the program relates to commuter goals, such as comfort, speed, convenience, savings, reliability, and suitability of service. This paper can assist prospective vanpoolers as an information source on programs already under way, and it will further the exchange of information among vanpool leasing companies, employers with vanpool programs, vanpool coordinators or drivers, ridesharing agencies, riders, and various government organizations.

California Department of Transportation, 120 South Spring Street, Los Angeles, Calif. 90012.

SURVEY METHODOLOGY

Traditional surveys try to incorporate a random selection method to reduce sample bias. This survey, however, had a limited universe and therefore required investigation of employers and van providers to reach the appropriate vanpool user audience.

The regional rideshare agency was unable to assist in the selection of survey participants because of its desire to maintain client confidentiality. Therefore, the research team had to rely on the local transportation network and the Southern California chapter of ACT. A list of major employers compiled by the Los Angeles Times was the initial list from which 22 companies with vanpool programs were contacted. Sixteen companies agreed to participate in the distribution of the vanpool survey. The participating employers included representatives from manufacturers, government agencies, utilities, and service industries. (A listing of the participating vanpool programs can be obtained from M. Moilov.) There were 728 vanpool groups contacted, representing a total of 9,789 riders.

The survey instrument was extensive. Two surveys were prepared. One was directed exclusively to vanpool coordinators; it asked specific administrative questions. The second survey was completed by all riders, including the coordinators. Its questions asked riders about their perceptions of the benefits of vanpooling and their personal experiences.

A pretest was administered in spring 1988; the revised survey was conducted by direct mail in late summer and early fall 1988. Prepaid envelopes sent with the survey encouraged responses. The response rate was high: 2,400 responded to the rider survey, a 25 percent return. The coordinator surveys had 320 returned surveys, a 44 percent response rate.

In this study, the sample surveyed were obviously committed to vanpooling and biased the sample. However, without a survey of this nature, the important findings could not have been revealed.

PRESENTATION AND INTERPRETATION OF RESULTS

Personal Characteristics

In order to obtain the vanpool rider's profile in Los Angeles, questions were asked about age, sex, marital status, income, occupation, and vehicle ownership.

The hypothesis is that family role and demographics greatly influence the choice of vanpool as a commuting mode.

Age, Sex, and Marital Status

Table 1 presents the frequency distribution of the age of vanpool riders. The vanpool program appears to be more popular with the middle-aged and older population. The mean age of riders is 44 years. Only 12 percent of the riders are under 30 years of age; 11 percent are between 30 and 35; almost 75 percent of the riders are more than 35 years old. The age distribution of vanpool riders contrasts sharply with those of bus riders. Bus passengers tend to be fairly young: 70 percent are below 30 years (*2*).

The vanpool program also appears to be popular among married males. In a sample of 2,174 respondents, about 50 percent of the riders are married men, only 20 percent are married women. Four possible explanations can be given for the greater popularity of vanpooling as a commuting mode among men. First, men are more willing to leave early to save money than women. Second, men are more interested in avoiding repairs to their personal vehicles by vanpooling. A similar conclusion was made in an earlier study by Misch et al. (*1*,p.80). Third, women are more likely to prefer the use of their cars for travel to work to enable them to take care of household errands and to drop off and pick up children on the way. The need to link trips makes solo driving a more attractive choice. That women make more nonwork trips is shown in another study by Gordon et al. (*3*). Fourth, vanpools generally operate over long distances (more than 30-mi one-way trips). Men are more likely to work farther from home, making vanpooling more practicable. Earlier studies have indicated that a high proportion of women work closer to home (*3*,*4*).

Income, Education, and Occupation

The income distribution of vanpool riders is presented in Table 2. The mean income of vanpool riders in Los Angeles ($55,000 a year) appears to be much higher than the county average. Approximately 50 percent of the riders earn more than $50,000; only 5 percent earn less than $20,000.

The education distribution shows that almost 75 percent of the vanpool riders have a college or graduate degree. This amount is much higher than the educational level observed for bus riders, only 15 percent of whom have attained a college degree (*2*).

TABLE 1 AGE DISTRIBUTION OF VANPOOL MEMBERS

Age	Percentage
15 - 20	0.4
20 - 25	2.7
25 - 30	9.2
30 - 35	10.7
35 - 40	14.2
40 - 45	15.4
45 - 50	14.1
50 - 55	12.5
> 55	20.6
Mean age	43.6 years

Note: n = 2230

TABLE 2 INCOME DISTRIBUTION OF VANPOOL MEMBERS (IN DOLLARS PER ANNUM)

Income	Percentage
< 10,000	1.2
10,000 - 19,999	4.2
20,000 - 29,999	14.1
30,000 - 39,999	15.1
40,000 - 49,999	15.5
50,000 - 56,999	14.0
60,000 - 69,999	11.8
70,000 - 79,999	8.7
> 80,000	15.0
Mean Income	$55,000

Note: n = 2400

Education Level of Vanpool Members	*Percentage (n = 2,400)*
Grade or high school	17.3
Vocational school	6.8
College	47.9
Graduate	27.8

The majority of vanpool riders hold senior positions. Almost 65 percent of the 2,400 respondents belong to the professional or executive class. Only 8 percent of the riders are blue-collar workers. (However, it remains to be seen whether the blue-collar workers are not more responsive to economic incentives. Future research will address this issue.) More than 70 percent of the bus riders are housewives, students, retired, or unemployed persons (*2*).

Occupation of Vanpool Members	*Percentage (n = 2,400)*
Executive/managerial	15.3
Professional/technical	51.3
Administrative support	20.6
Sales/field staff	0.6
Production/skilled/unskilled	7.6
Other	4.6

Automobile Ownership

Vanpool riders were asked about the number of household vehicles and whether a vehicle was available for commuting on a regular basis. More than 80 percent of the riders had two or more vehicles in the household, and almost the same proportion reported having a private vehicle available for use on a regular basis. This fact indicates that the decision to vanpool is by choice for most riders.

Number of Household Vehicles	*Percentage (n = 2,445)*
1	19.3
2	45.3
3	21.6
4	8.5
5	3.5
> 5	1.8

Commuting Characteristics

Responses were elicited from the vanpool riders and coordinators on various aspects of travel. The questions addressed were duration of stay in the vanpool, travel mode before joining the vanpool, travel mode from and to the vanpool pick-up or drop-off point, distance (duration) to reach the pick-up point, time saving after joining the vanpool program, average monthly fare, and distance and duration of travel.

Period in Vanpool

The distribution of durations in the vanpool program was analyzed. The average duration is more than 3 years. About 40 percent of the vanpoolers have been in the program for more than 3 years; about 70 percent for more than 1 year. It appears that people who join the vanpool program see advantages in continuing to stay with it.

Commuting Mode Before Joining Vanpool

One of the survey questions sought to understand the usual means of travel to work before joining this vanpool and the principal reasons affecting the decision to vanpool. Almost 60 percent of the respondents drove alone to work before joining this program; 18 percent carpooled; only 7 percent used public transit. This suggests that most vanpoolers had little prior ridesharing experience. This finding is especially relevant considering that almost 50 percent of the riders have not changed either their home or work location since joining this vanpool (Table 3). About 40 percent of the respondents joined a vanpool program in response to changes in work or home location.

Changes in Commuting Time Since Joining Vanpool Program

The hypothesis examined is that joining a vanpool results in considerable time savings because of the use of high-occupancy lanes during the peak period. Table 4 displays the frequency distribution of changes in commuting time after joining the vanpool program. Although almost 50 percent of the riders did not experience any change in travel distance, 20 percent actually took less time in commuting; about 30 percent increased travel time. Increase in travel time may be associated with commuting longer distances in response to changes in home or work location—an observation borne out by analysis of trip speed, discussed in a later section. A similar analysis was also conducted only for the 48 percent of the respondents who did not register any change in residence or work location after joining the vanpool program. Although about 60 percent reported no change in travel time, 29 percent reported a decline in commuting time after joining a vanpool program. Only 12 percent observed an actual increase in commuting time after joining the vanpool program (see last column in Table 4).

TABLE 3 DISTRIBUTION OF FACTORS INFLUENCING DECISION TO JOIN VANPOOL PROGRAM

Factors	Percentage
Change employer	5.0
Change work location	16.2
Change home location	21.5
Change employer and work Location	5.3
Change employer, work, and home location	1.9
Change work and home location	1.6
No change in any location	48.4

Note: n = 2180

Distance, Duration, and Mode of Travel from Home to Van Pick-Up Point

Information was sought on distance, duration, and mode of travel from home to vanpool pick-up point in the morning (Tables 5 and 6). Average distance of travel is 4.8 mi and duration is 9.7 min. More than 50 percent of the members travel less than 5 mi to the van pick-up point in the morning, and take less than 10 min.

The most dominant access mode to van pick-up point in the morning is driving alone (68 percent), followed by walking (12 percent) and kiss-and-ride (7 percent). At the destination end, about 46 percent of the riders are dropped off at the work place and about 47 percent are dropped off close to the work place.

Distribution of Vanpool Riders Living in the Same Household or Working for the Same Employer

Although most of the riders work for the same employer (69.2 percent), very few live in the same household (4.8 percent). This finding is not surprising, but it is important in formulating vanpool programs in the future.

The survey highlights the importance of employer-oriented programs. Most of the riders work at the same place or within a few miles of each other. Employer-oriented matching greatly improves the success of a vanpool program, which can be provided by a transportation coordinator. Other studies have also reached a similar conclusion (*1*).

Trip Length, Duration, and Speed

Vanpool coordinators were asked for the following information about the morning and evening commute: distance and duration from the overnight storage location to the last pick-up point; line-haul distance and duration; and distance and duration from first drop-off point to daytime parking location (Figure 1). Similar information was obtained for the afternoon commute. From this information, trip speed for each segment as well as the total commute was calculated.

TABLE 4 DISTRIBUTION OF CHANGE IN COMMUTING TIME AFTER JOINING VANPOOL PROGRAM FOR ALL RESIDENTS

Time change (in minutes)			Proportion All Residents	Proportion Residents with unchanged Work/Home Location
L	<	-30	7.4	
E	-30 to	-20	3.1	
S	-20 to	-10	5.1	2.1
S	-10 to	- 1	3.2	26.7
SAME		0	48.3	59.2
M	1 to	10	1.2	7.8
O	10 to	20	15.2	4.2
R	20 to	30	6.8	
E	<	30	9.6	

Home-End Trip The first two columns in Table 7 display the distribution of travel distance from overnight storage location to the last pick-up point in the morning. Approximately 45 percent of the vans pick up the passengers within a distance of 5 mi, 17 percent travel 6 to 8 mi, and 40 percent travel more than 9 mi. These data indicate that origins are dispersed over a large area. Access to an expanded labor pool is one of the advantages to an employer of organizing vanpool programs.

Looking at the trip duration (Table 8), about 45 percent of the vans pick up passengers within 10 min at the home end, 21 percent between 11 and 15 min, and 35 percent take more than 15 min.

Line-Haul Trip The distributions of line-haul trip distance and duration are presented in the third and fourth columns in Tables 7 and 8. Almost 50 percent of the vans commute more than 30 mi and take more than 40 min. Generally, vanpools operate over distances of 25 mi or more, so this is not a surprising finding.

Work-End Trip The last columns in Tables 7 and 8 exhibit the trip distance and duration from the first drop-off point to the daytime parking location. Almost 70 percent of the vans drop off the passengers within 2 mi and take less than 5 min. That most van members have a common destination supports the earlier finding of a common employer.

Total Trip Speed Trip distance was divided by duration to obtain trip speed for each trip segment as well as for the total commute, during both morning and afternoon travel (Table 9). Three conclusions can be reached from this table. First, travel speed is much higher in the morning than afternoon, not a surprising finding in view of the increased traffic during the afternoon peak period.

Second, the travel speeds along the line-haul sector are much higher than at the pick-up or drop-off segments, again nothing surprising. Third, the average speed (37.4 mph) during the morning peak hour of the total commute is significantly higher than that observed for private cars (approximately 30 mph) in U.S. cities (*4*). This finding is important because it

TABLE 5 DISTRIBUTION OF DISTANCE FROM HOME TO VAN PICK-UP OR DROP-OFF POINT

Distance (In Miles)	Percentage Morning	Afternoon
0	14.1	15.7
1	15.1	14.4
2 - 5	33.0	32.0
5 -10	19.7	19.2
10 -15	7.1	7.0
15 -20	2.7	2.6
>20	8.3	9.0
Average Distance	4.8 miles	

Note: n = 2325

TABLE 6 DISTRIBUTION OF TIME TAKEN TO TRAVEL FROM HOME TO VAN PICK-UP OR DROP-OFF POINT

Duration (In Minutes)	Percentage Morning	Afternoon
0	8.8	10.3
1-10	42.4	8.3
10-20	33.8	28.1
20-30	7.4	21.5
30-40	2.3	12.3
>40	5.2	19.4

Average duration 9.7 minutes

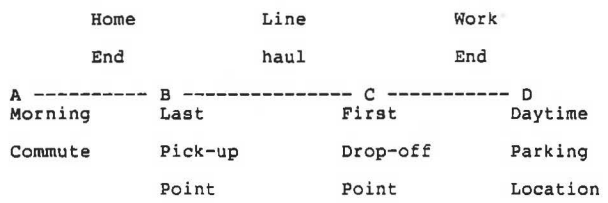

FIGURE 1 Morning trip segments.

TABLE 7 DISTRIBUTION OF TRIP SEGMENT DISTANCES, IN MILES

Home End		Line Haul		Work End	
Distance	Percentage (n = 291)	Distance	Percentage (n = 295)	Distance	Percentage (n = 315)
<2	18.2	1–20	18.0	0	28.3
3– 5	25.4	21–30	36.6	1– 2	42.9
6– 8	17.5	31–35	11.5	3– 4	14.6
9–10	11.7	36–40	12.5	5– 6	5.7
>10	27.1	41–45	6.4	7– 8	2.2
		>45	14.9	9–10	1.0
				>10	5.3

TABLE 8 DISTRIBUTION OF TRIP SEGMENT DURATIONS, IN MINUTES

Home End		Line Haul		Work End	
Duration	Percentage (n = 290)	Duration	Percentage (n = 296)	Duration	Percentage (n = 315)
<5	19.3	1–30	15.9	0	26.0
6–10	24.5	31–40	22.3	1– 5	28.9
11–15	20.7	41–50	26.4	6–10	25.7
16–20	14.5	51–60	20.3	11–15	10.5
>20	21.0	61–70	7.8	16–20	4.4
		>70	7.4	21–25	4.1

TABLE 9 DISTRIBUTION OF TRIP SPEED DURING MORNING AND AFTERNOON COMMUTES

Morning	Mean Speed (mph)
Home end	32.1
Line haul	41.1
Work end	22.6
Total commute	37.4
Afternoon	
Work end	20.7
Line haul	36.7
Home end	28.4
Total commute	33.0

is often believed that multiple stops made by vans cause considerable delay in the trip. It appears that the use of HOV lanes along line-haul segments offsets any delay caused at the pick-up or the drop-off segments. Higher speed in the vanpools can be used as a promotional strategy with the reluctant drivers. This can form the basis for developing techniques to meet the commuting demands of those target groups to whom travel time is critical in their decision to drive alone.

Fares and Savings

The monthly fare paid by vanpool members is presented in Table 10. On average, the riders pay $71.80 per month. Considering an average one-way trip of 30 mi (round trip of 60 mi), and a 20 work-day month, the riders pay 6 cents/mi. This is much less than driving and maintaining one's own car which is about 20 cents/mi. In addition, each 15-passenger vanpool is capable of removing up to 14 vehicles from the road, if all the riders were driving alone to work before vanpooling.

It is possible to estimate the saving in vehicle-miles traveled (VMT) by multiplying the total passengers in each van (excluding the driver) by total miles traveled. (The saving in VMT was calculated only for those riders who drove alone to work.) On average, the calculations indicate that more than 100,000 vehicle-mi are economized each day by the present vanpool program in Los Angeles. The subsidiary benefits of mitigating energy shortage, air pollution, congestion, and transportation emergencies resulting from vanpooling can be well appreciated.

Issues Faced by Vanpool Coordinators

Information was sought from the vanpool coordinators and drivers concerning the type of vanpool program, the nature of administrative policies, number of home pick-up and drop-off points, riders' occupations during the trip, and the benefits offered to the driver of the van.

Types of Vanpool Programs

The distribution of types of van ownership and operation was analyzed. More than 50 percent of the vans are owned and operated by the employee; 34 percent by Vanpool Services Inc., and 15 percent by other operators. None of the vans are employee-operated vans. Employer-operated programs have a much greater chance of success because (a) van operation tends to be cheaper; and (b) at least one of the destinations is common. The employees also have a far greater faith in a program developed by the employer. The employer also gains from operating vans—he has a better access to expanded labor pools.

TABLE 10 DISTRIBUTION OF MONTHLY VAN FARE (IN DOLLARS PER MONTH)

Fare	Frequency
4	9.2
40–50	6.0
50–60	12.1
60–70	20.6
70–80	23.8
80–90	14.3
90–100	6.3
>100	6.7
Mean Fare:	$71.8 per month

TABLE 11 DISTRIBUTION OF NUMBER OF HOME PICK-UP AND WORK DROP-OFF POINTS

# of Pick-up points	Proportion	
	Home pick-up	Work drop-off
1	36.2	28.0
2	18.4	33.1
3	14.1	16.8
4	14.8	8.8
5	7.7	6.2
6	4.4	2.6
>6	4.4	4.5

Vanpool coordinators were asked if there existed a formal set of rules governing the conduct and related issues for the members. The responses were evenly divided between vans with formal and informal sets of rules. The employer-operated vans were largely operated in an informal arrangement. The coordinators indicated that because a large proportion of the members were known to each other through a common employer, there was a greater tendency to cooperate.

Benefits to Vanpool Coordinators

The advantages to the vanpool coordinators and drivers included (a) free ride to workplace; and (b) use of vans during evenings and weekends. For about 30 percent of the vans there was a back-up driver who would drive if the primary driver was held up for some reason. But greater success was reported when one person assumed the responsibility of coordination and driving.

Number of Home Pick-up and Drop-off Points

The vanpool coordinator was asked about the number of home pick-up and work drop-off points made during the morning trip (Table 11). Approximately 55 percent of the vans make only one or two stops at the home end; 14 percent make three stops; 30 percent make more than three stops.

At the work end, the destinations are in greater proximity. About 60 percent of the vans make one or two stops; 17 percent make three stops; and 22 percent make more than three stops.

CONCLUSIONS

Considerable benefits of vanpooling accrue to the rider, the employer, and the community. The benefits to the riders include lower expenses (vanpooling costs 6 cents per mile), increased speed (37 mph in the morning and 33 mph in the afternoon), and reduced driving stress in sharp contrast to driving alone to work. The benefits to the employer include access to a wider labor pool and reduced parking requirements. The community gains through the alleviation of traffic congestion (more than 40,000 VMT saved per day) and subsidiary benefits of conserving energy and mitigating air pollution hazards.

Family role appears to be having considerable impact on the vanpool program attractiveness. The vanpoolers are patronized by a higher proportion of older, married men, in higher income brackets and with college or graduate degrees. Only a small proportion (35 percent) of the present vanpoolers had any prior experience with ridesharing. The differences can be effective in identifying target population as well as in developing incentives in the future vanpooling programs. A central issue in any future vanpooling development efforts relates to how best to accommodate the needs of younger, middle-income groups. Another issue facing vanpooling in the 1990s is the question of the relative roles and responsibilities of the federal, state, and local agencies in the delivery of vanpooling services.

ACKNOWLEDGMENTS

The authors wish to thank Eric Ferguson for his help with preparing the survey instruments. The authors are also grateful to Michael Kodama for his assistance in coordinating the research data and to an anonymous referee for making helpful suggestions on an earlier draft.

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Publication of this paper sponsored by Committee on Ridesharing.

Factors Affecting Transportation Demand Management Program Effectiveness at Six San Francisco Medical Institutions

RICHARD DOWLING, DAVE FELTHAM, AND WILLIAM WYCKO

The effects of on-site parking management programs, transportation demand management (TDM) promotional efforts, and off-site environmental factors on the success of TDM programs at six large medical institutions in San Francisco, California, are investigated. The monthly charge for employee parking on site was found to be the single most influential factor for determining the percent of employees that drive alone to work. This single factor accounted for up to 80 percent of the variation in mode splits among the six institutions. The monthly parking charge at each medical institution was found to be highly correlated to the severity of off-site parking restrictions and the abundance of off-site transit service. These latter two factors were the next most influential factors (after on-site parking pricing) on TDM program results. These latter two factors together explain 50 percent of the variation in TDM program success among the surveyed institutions. On-site parking supply was a much less significant factor because of the availability of off-site parking in the residential neighborhoods surrounding most of the institutions. Because of the general similarity of the six institutions surveyed, the relative size and characteristics of the medical institutions were found to be the least important of the factors studied for influencing mode split success. An increase of $8.00 a month in employee monthly parking charges was found to be necessary to decrease employee drive alone mode splits by one percentage point. (The 95 percent confidence interval for this result is between $5.00 and $33.00.) The monthly parking charge is highly correlated to off-site parking and transit conditions. Consequently, to achieve the mode split improvements implied by the results of this analysis it is necessary to parallel the on-site parking charge increases with increased restrictions on off-site on-street parking and improved transit service.

The city of San Francisco generally requires that the environmental impact reports (EIRs) for improvement projects at major medical institutions include an analysis of the likely benefits of transportation demand management (TDM) programs at the institution. This analysis must take into account different levels of TDM promotional activities at the institution, the on-site parking rates charged by the institution, potential new on-site parking garages, and the presence of neighborhood residential parking permit programs on city streets surrounding the hospital campus.

Analyses of medical institution TDM programs in San Francisco have generally relied on judgmental estimates of the likely effectiveness based on limited experience with TDM programs elsewhere. The more elaborate evaluations have divided the institution's employees into different market areas (based on their residential location and distance from the institute) and estimated the potential of ridesharing and public transit incentives to attract drive-alone commuters from each different market area (*1*).

This current study evolved out of an attempt to introduce a more quantitative approach to the forecasting of TDM program effectiveness as a function of the medical institution's promotional efforts, the institution's parking management program, and the surrounding environment in which the institution is located. Six large medical institutions in San Francisco were surveyed to determine the relative influence of off-site parking restrictions, on-site parking management (supply and cost), and in-house TDM promotional efforts on employee mode split. The data were quantified and a linear regression equation was developed for use in forecasting employee mode splits.

LITERATURE REVIEW

Although there is a growing body of literature and experience on the effectiveness of TDM programs at major employers and major suburban activity centers (*2–4*), there is considerably less experience with major medical institutions.

Major medical institutions consist of a hospital surrounded by supporting medical offices, out-patient clinics, and in some cases, research facilities. Medical institutions differ considerably from the usual city center and suburban activity center employers. Medical institutions have nonstandard working hours, 24-hr operations, rotating work shifts, a high percentage of part-time workers, and a relatively high annual turnover of employees (*5*). Other large institutions, such as universities, generally don't have the 24-hr operations and rotating work shifts of medical institutions.

Sawyer and Snow (*6,7*) described the results of the First Hill Action Plan for eight medical and university institutions in Seattle. Over a 3-year period, a combined program of peak-hour express bus service, guaranteed ride home for ridesharers, and free parking days for program participants improved the drive-alone mode split at Providence Hospital from 72 to 50 percent of employees. During this period, average monthly parking charges at the eight institutions were also increased from $21 to $38. The combination of program activities prevents isolating the relative influence of the parking charges and the other TDM program components on the re-

R. Dowling, 180 Grand Avenue, Suite 995, Oakland, Calif. 94612. D. Feltham and W. Wycko, Department of City Planning, City and County of San Francisco, 450 McAllister, San Francisco, Calif. 94102.

sults. The confidentiality requirements of the participating institutions also prevented the release of more complete and detailed statistics for the study.

An FHWA report (*5*) on ridesharing strategies for medical centers describes the TDM programs and results at four institutions in Texas, Nebraska, California, and South Carolina. However, all of these results are for the period 1978 to 1980 when there was a shortage of gasoline because of the crisis in Iran.

Fink and Twitchell (*8*) conducted a major study in 1980 of the effectiveness of Transportation System Management (TSM) programs at 12 major medical and educational institutions in San Francisco. Seven of these institutions were public or private hospitals or medical centers. One employer was an insurance company. The remaining four were public or private universities.

Each institution designated a transportation broker who implemented a TSM program consisting of ridesharing promotion, transit marketing, coordination of vanpools or carpools, priority parking for vanpools or carpools, and the creation of employee transportation committees. The TSM brokers also lobbied the transit agencies for improved service. The demonstration grant program funded a central TSM coordinator, and there was a high level of management involvement in the TSM program during the 12-month period of the study.

The 1-year TSM program was effective, reducing the average percent of employees who drove alone to work from 57 to 49 percent. The average percent ridesharing increased from 17 to 22 percent. The average percent taking transit increased from 16 to 18 percent. The total number of employees driving to work alone decreased from 13,105 to 11,640 (an 11 percent decrease in solo automobile drivers) at all 12 institutions.

However, this year-long study was conducted during the height of the Iran crisis. Fink and Twitchell focused their study primarily on the effect of in-house TDM promotional activities, and neglected the effects of on-site parking management decisions and off-site environmental conditions (such as gasoline availability, on-street parking availability, and the proximity of good transit service) on TDM program results.

SURVEY DESIGN

The purpose of this study was to determine and quantify where possible the effects of institutional TDM promotional efforts, on-site parking management, and off-site environmental factors on TDM program success. The intent was to use the data to develop a methodology for forecasting the effects of various on-site and off-site actions on TDM program success.

A total of nine major medical institutions in San Francisco were contacted to obtain TDM program information and to update the information contained in the literature. Data were obtained for each institution describing its employment, patient activity, parking supply, parking rates, TDM brokerage services offered, off-site parking restrictions, transit service, and employee mode splits. Sufficiently complete data were obtained for six institutions, San Francisco General Hospital, St. Mary's, Davies, Kaiser, St. Francis, and Mt. Zion. The other three institutions either did not have available or declined to release the necessary data.

The nine institutions were selected for their general similarity in size, functions, and location so as to minimize the effects of differing employment characteristics (work hours, salaries, etc.) and global factors such as congestion on regional facilities serving each institution. Thus, only large medical institutions that are located within the city of San Francisco were selected for the survey. This ensured that on-site activities, general employment characteristics, and global environmental factors would be kept as similar as possible among the institutions surveyed.

Identification of Factors Affecting TDM Performance

Extensive practical experience in the TDM field has indicated that the effectiveness of an employer's TDM program is dependent on many different individual factors that can be grouped into on-site and off-site factors.

The on-site factors are generally under the control or influence of the employer. These factors are generally the major components of an employer's TDM program.

The on-site factors can be grouped into three categories as follows:

1. Employment characteristics,
2. Employer parking management program, and
3. Employer ridesharing and transit promotional efforts.

Employment characteristics include working hours, salaries, benefits, regularity of work schedules and location, and need for off-site business travel during the day. Except for working hours, employment characteristics are usually fixed and not subject to manipulation for the purposes of improving employee commute habits.

The employer parking management program consists of the number of spaces provided on site for employees and the monthly charge for the parking. The parking program also includes priority reserved parking and discounts for rideshare parking. On-site parking supply and pricing are recognized to be important, but there has been a general reluctance to manipulate parking supply and cost for the purposes of improving employee ridesharing and transit use.

Employer ridesharing and transit promotional efforts include marketing transit and ridesharing, information distribution, subsidies, and provision of supplemental transit services. These promotional efforts have to date received the most attention in the attempt to shift employee commute patterns.

Off-site environmental factors include those factors over which the typical employer has little or no control. These off-site factors are also recognized to be important but they are difficult to quantify. Off-site environmental factors may be grouped into localized environmental factors and global environmental factors.

Localized environmental factors affect each employer differently. Global factors tend to affect all employers in a general area in a uniform manner. Localized environmental factors include off-site parking availability, off-site parking cost; off-site transit service, and the availability of support services within walking distance (banks, copy centers, lunch stands,

and convenience stores) for errands during the day. Global environmental factors include gas price, gas availability, congestion on commute routes, tolls, automobile ownership, and automobile operating costs.

Quantification of Explanatory Variables—On-Site Factors

The medical institutions were intentionally selected to equalize as much as possible the working hours, salary levels, and other employment characteristics among the institutions. The number of employees, number of beds, and number of annual patient-days were selected as measures of the relative size and activity at each institution.

Each institution's parking management program was quantified in terms of on-site spaces, charge rates, and number of spaces reserved for carpoolers.

The level of each institution's rideshare or transit promotional effort was more difficult to quantify. Each institution's ridesharing or transit promotional efforts were compared to the city of San Francisco's draft Transportation Management Program (TMP) guidelines (see Figure 1) established by the Joint Institutional Transportation Brokers Association (JITBA) (*9*). The available documentation unfortunately allowed only yes or no answers and did not allow quantification of the intensity of effort devoted to each activity.

I. TRANSPORTATION MANAGEMENT COORDINATION

- A. Parking Management Program
  1. Spaces Controlled by Institution
  2. Parking Charge Rates
  3. Typical Parking Occupancy
  4. Reserved Spaces for Ridesharers
  5. Parking Allocation Policies
  6. Transportation Coordinator's Authority Over Parking Policy
- B. Overall Coordination and Liaison
  1. Participate in JITBA
  2. Management Coordination
  3. Liaison With City

II. TRANSPORTATION BROKERAGE SERVICES

- A. Overall Marketing Program
  1. Information Packets
  2. Promotional Materials
  3. Special Events
  4. Newsletters
- B. Public Transit Promotion
  1. Transit Pass/Ticket Sales
  2. Transit Subsidy Program
  3. Transit Information Distribution
  4. Targeted Promotional Events
- C. Ridesharing Promotion
  1. Match List Applications Distribution
  2. Targeted Promotional Events
  3. Club Bus Services
  4. Shuttle Services
- D. Flextime Promotion
  1. Constraints
  2. Potential Employee Groups
  3. Promotional Materials

III. PROGRAM EVALUATION

IV. PROGRAM GOALS AND WORK PLAN

FIGURE 1 Draft Joint Institutional Transportation Brokers Association TMP reporting guidelines.

Quantification of Explanatory Variables—Off-Site Factors

Off-site local environmental parking and transit factors were quantified in terms of the length of on-street parking time limits, and the number of transit vehicles stopping within a quarter-mile of each institution during the morning peak hour.

The number of transit vehicles per hour is admittedly a proxy variable for the general level of transit service in the area. It does not take into account route coverage, connections, and the relationship of this service to the residential location of the employees. The six institutions surveyed are all located within 3 mi of each other, and because of this close proximity, the variation of employee residential locations is not expected to be a significant influence on the quality of transit service.

Field checks were made of each of the six institutions to determine off-site parking availability and on-street parking time limits.

Most institutions surveyed were located in residential areas that had established residential parking permit programs (RPP) within the last 5 years. These programs restrict on-street parking to 2 hr with local residents allowed to purchase a sticker that allows them to park longer on the street.

Recognizing that parking time limits and residential permit programs (RPP) have different levels of effectiveness given different enforcement levels, an attempt was made to obtain parking enforcement data by RPP zone. However, the San Francisco Police Department does not track citations according to RPP zones.

Parking meters were considered to be a more effective restriction on on-street parking than the simple 2-hr zone signs used in RPP areas. Consequently, unmetered 2-hr zones were estimated to have an effective limit of 3 hr because of the less frequent patrols in these zones and the need to mark tires to verify violations.

The availability of off-site support services within walking distance of each institution was not measured. The institutions surveyed generally are essentially self-contained with on-site cafeteria services for employees, and nearby or on-site medical office buildings for physicians. Other medical support and supply services were generally beyond walking distances for virtually all the institutions. All except two of the institutions surveyed, St. Francis and Mount Zion, are located in primarily residential areas.

Measurement of Institutional TDM Program Success

The percent of employees that drive alone, share a ride, and take transit are measures typically used to evaluate the effectiveness of TDM programs. Kuzmyak and Schreffler (*3*) selected mode split as a principal criterion for their study of TDM program effectiveness. However, these three measures of mode split can conflict and confuse the determination as to the relative effectiveness of different institution's TDM programs. For example, as presented in Table 1, Davies Hospital has a better drive-alone mode split than San Francisco General Hospital (SFGH), but Davies has a poorer transit mode split than SFGH.

TABLE 1 COMPARISON OF INSTITUTIONAL TDM PROGRAM EFFORTS

	DAVIES	SFGH	ST.MARY'S	KAISER	ST.FRANCIS	MT. ZION
I. GENERAL INSTITUTIONAL CHARACTERISTICS						
A. Licensed Beds	341	582	531	323	362	439
B. Patient-Days	43,000	144,000	93,000	88,800	51,000	69,682
C. Day-time Employment	850	2,600	1,150	1,500	1,000	1,400
D. Patient-days/Bed	126.10	247.42	175.14	274.92	140.88	158.73
E. Patient-Days/Employee	50.59	55.38	80.87	59.20	51.00	49.77
II. ON-SITE PARKING MANAGEMENT PROGRAM						
A. Spaces Controlled by Institution:						
On-site & Near-site spaces:	333	610	293	507	406	270
Remote Lot spaces:	0	0	200	475	0	0
Total:	333	610	493	982	406	270
Total Spaces/Employee:	0.39	0.23	0.43	0.65	0.41	0.19
B. On-Site Parking Charge Rates						
Per Hour:	$1.75	$0.00	$1.00	$1.00	$3.00	$0.75
Max. Per Day:	$20.00	$0.00	$7.50	$9.50	$13.00	$7.50
Monthly on-site lots:	$20.00	$0.00	None	$62.00	$95.00	$90.00
Monthly remote lots:	None	None	$40.00	$35.00	None	None
C. Reserved Spaces for Ridesharers						
Reserved Spaces:	30	0	15	182	4	20
Percent of Total Spaces:	9.01%	0.00%	3.04%	18.53%	0.99%	7.41%
Carpool Rates ($/day):	Free	Free	$15.00	Free	Free	Free
III. TDM BROKERAGE/PROMOTIONAL SERVICES						
A. Overall Marketing Program						
Information Packets (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes
Special Events/Year:	1	2	2	2	1	1
B. Public Transit Promotion						
Transit Pass Sales (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes
Transit Pass Subsidy/Month:	None	None	None	$4.00	None	None
C. Ridesharing Promotion						
Match List Applications (yes/no)	Yes	Yes	Yes	Yes	No	Yes
Club Bus (yes/no)	No	No	No	No	No	No
Shuttle Services (yes/no)	No	No	Yes	Extensive	Yes	Yes
D. Flextime Promotion	No	No	No	No	No	No
E. Overall Program Management						
1. Participate in JITBA (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes
2. Management Coordination (y/n)	Yes	Yes	Yes	Yes	Yes	Yes
3. Liaison With City (yes/no)	Yes	Yes	Yes	Yes	Yes	Yes
4. Evaluation Completed?	Yes	Yes	Yes	Yes	No	No
5. Most Recent Survey Year:	1989	1989	1989	1990	1988	1989
6. Submit TSM Plan Per JITBA:	Yes	Yes	Yes	Yes	In Progress	No
IV. LOCAL ENVIRONMENTAL FACTORS						
A. Off-Site Parking						
Residential Parking Permits:	Yes	No	Yes	Yes	Yes	Yes
On-Street Time Limits:	2 Hrs.	No Limit	2 Hrs.	2 Hrs.	2 Hrs.	2 Hrs.
Parking Meters:	No	No	No	No	Yes	Yes
B. Transit Service						
Bus Lines within 2 blocks:	2	3	3	8	7	5
Rail Lines within 2 blocks:	1	0	0	0	0	0
Bus & Trains/Hour:	19	14	22	48	45	34
V. TDM PROGRAM SUCCESS						
A. Percent of Employees That:						
Drive Alone:	55%	59%	54%	51%	51%	43%
Share Ride:	19%	10%	14%	20%	12%	19%
Public Transit:	19%	25%	22%	24%	27%	26%
Other Modes:	7%	6%	10%	5%	10%	12%
B. Percent Employees Drive Car:	63%	63%	60%	59%	56%	51%
C. Average Auto Occupancy:	1.18	1.09	1.14	1.20	1.13	1.22

In order to avoid the potential evaluation conflicts that might arise from using multiple criteria, only two measures of TDM program success were used in this study: percent of regular, full-time, daytime employees driving alone to work; and the percent of the same employees driving a vehicle to work (whether alone or in a carpool or vanpool). The first measure (drive-alone mode split) provides a measure of the TDM program's effectiveness at shifting commuters out of drive-alone vehicles. The second measure (drive alone plus drive carpool) provides a more comprehensive measure of total TDM program effectiveness, taking into account the average automobile occupancy and the shift to nonautomobile modes (transit, bicycle, walking, etc.).

The percent of vehicle drivers (drive-alone plus carpool drivers) is obtained by adding up the drive-alone vehicles and carpooling or vanpooling vehicles, and dividing by the total regular, full-time, daytime employment at the medical institution. This measure must sometimes be estimated (in the absence of carpool occupancy data), and consequently, is not always as reliable as the percent who drive alone, which can be estimated directly from the available employee surveys.

DESCRIPTION OF INSTITUTIONS

The six medical institutions surveyed are primarily private health care providers. Only San Francisco General Hospital is a public hospital, being the provider of last resort for the City and County of San Francisco. Kaiser Hospital is a Health Maintenance Organization (HMO) providing in-patient and out-patient care to its plan members.

Davies Medical Center

Davies Medical Center is a private medical institution that consists of an acute care hospital, a skilled nursing facility, and a medical office building located 2 mi west of downtown San Francisco (*10*). Davies is licensed for 341 beds and has about 850 daytime employees. The annual patient load at Davies was equivalent to a total of 43,000 patient-days in 1988 (*11*).

Davies is located in a residential area. On-street parking is limited to 2 hr except for residents with a residential parking permit. There are no parking meters in the area.

The residential parking permit program (RPP) was implemented by the City of San Francisco between the 1986 and 1989 employee surveys at Davies. The percent of employees driving alone to Davies dropped from 63 percent in 1986 to 55 percent in 1989. In 1986, 59 percent of those employees who drove to Davies parked on city streets in the neighborhood. After implementation of the RPP, 52 percent of the employees who continued to drive their cars to Davies continued to park on the street.

A total of 333 parking spaces are provided in on-site lots. Key employees, on-site physicians, and administrators park in 149 reserved parking spaces. The remaining 184 on-site spaces are shared by nonkey employees, off-site physicians, visitors, and patients.

Visitors parking on site pay $1.50 per hour up to $20 per day if parking over 8 hr. Davies employees circumvent this penalty by pulling out of the visitors' lot during lunch and returning after lunch. Employees pay $20 a month to park. Monthly parking fees have traditionally been kept low by Davies to minimize employee parking on neighboring streets.

Davies is served by MUNI lines 24-Divisadero, 37-Corbett, and N-Judah (*12*). The N-Judah light rail line provides direct service to downtown with convenient connections to most regional transit services.

Davies provides free carpool parking, bike lockers, staggered work hours, transit information, and rideshare information. No shuttle service is provided. Davies sells transit passes on site.

San Francisco General Hospital

San Francisco General Hospital (SFGH) is a county hospital designated as the provider of last resort for the residents of San Francisco City and County (*13*). It is located 2 mi south of downtown San Francisco.

SFGH provides inpatient services, emergency services, ambulance care services, and special services. It also provides community-based outpatient service through three satellite clinics staffed by SFGH physicians.

SFGH is the teaching hospital for the University of California (UCSF). UCSF (which is located about 3 mi away) provides all professional medical staff at SFGH. UCSF staff at SFGH include 233 full-time physicians, 601 clinical faculty, 273 post-graduates, and 700 nonacademic staff.

SFGH ambulatory care services treat an average of 1,000 patients a day. SFGH is the designated trauma center for San Francisco. Its emergency department treats an average of 280 patients per day. Total occupiable floor space at SFGH is 1.2 million ft^2 in nine buildings on campus.

SFGH is licensed for 582 beds, having an average of 372 beds available. The annual patient load was equivalent to 144,000 patient-days in 1988. There are about 2,600 dayshift employees.

SFGH provides 472 marked parking spaces for its employees on site. An additional 156 vehicles park illegally on site in unmarked spaces. Visitors may park in a 112-space lot limited to 2 hr parking. There is no charge for visitor or employee parking on campus.

SFGH is located in a residential area. On-street parking in the area is free, with no time limits. There is no residential parking permit program in the neighborhoods surrounding SFGH.

SFGH is served by MUNI lines 9-San Bruno, 33-Stanyan, 48-Quintara. The No. 48 line provides bus service to the 24th Street BART station, which provides regional transit service for commuters from the Eastbay.

SFGH has an in-house TDM coordinator, sells transit passes on site, has a shuttle service to UCSF, and promotes ridesharing through distribution of matchlist applications. An additional shuttle to the BART station was started by SFGH after the October 1989 earthquake. However, this service was implemented after the employee surveys cited here.

St. Mary's Hospital and Medical Center

St. Mary's Hospital is a private medical institution with an acute care hospital and medical office building located 3 miles west of downtown San Francisco (*14,15*). St. Mary's is licensed for 531 beds, having an average 403 beds available. The annual patient load at St. Mary's was equivalent to 93,000 patient-days in 1988. St. Mary's employed about 1,150 people in 1988 (Nancy Oliva, St. Mary's Hospital, unpublished data).

St. Mary's is located in a residential area next to Golden Gate Park. On-street parking is limited to 2 hr without an L residential parking permit. On-street parking in nearby Golden Gate Park is prohibited before 9 a.m., and limited to 3 hr after 9 a.m.; however, enforcement of these restrictions is limited.

The residential parking permit program was established in the Saint Mary's area in 1987. Employee surveys in 1985 and 1989 indicated a drop in the percent of employee drive alones from 65 to 54 percent. This modal shift is probably caused in part by the implementation of a residential parking permit program.

St. Mary's provides 293 parking spaces on site and an additional 200 spaces (reserved for employees) in a remote lot ⅔ of a mile away at Kezar Stadium. Seventy-nine of the on-site spaces are reserved for physicians. The remaining 214 on-site spaces are for visitors and patients.

The St. Mary's garage charges $1.00 per hour up to $7.50 per day to the general public. The on-site visitors lot charges $2.00 per day.

Monthly parking is provided for employees only at Kezar Stadium. The monthly parking cost at Kezar Stadium is $40.00 per month. The rate is $15.00 per month for carpools at Kezar Stadium.

The following MUNI lines stop within two blocks of St. Mary's: 5-Fulton, 21-Hayes, and 33-Stanyan. Commuters from outside San Francisco must first go to downtown San Francisco and then transfer to a bus (the No. 5 or No. 21 lines) to reach St. Mary's.

St. Mary's sells transit passes on site and provides shuttle services for its employees. A subsidized free shuttle service is provided between St. Mary's and the Kezar Stadium lot.

Kaiser Hospital

Kaiser Plan Medical Center is a health maintenance organization (HMO) hospital and outpatient clinic located 2 miles

west of downtown San Francisco (*16,17*). Kaiser is licensed for 323 beds, having an average of 268 beds available. The annual patient load was equivalent to 89,000 patient-days in 1988. Kaiser recently purchased the French Hospital (located 1 mi west of Kaiser) to expand its patient handling capacity.

There are currently (1989) about 2,500 employees, up from 2,200 employees in 1986. The day shift employment is estimated at 1,500 employees (or 60 percent of the total employment) (*17*). The breakdown by employee classification is 9 percent executive, 28 percent professional or technical, 12 percent physician, 28 percent nurse, and 23 percent clerical or other. Approximately 23 percent of their employees start work between 6:01 and 7:00 a.m., 23 percent between 7:01 and 8:00 a.m., and 28 percent between 8:01 and 9:00 a.m. (*16*).

Kaiser is located next to a residential area. Commercial development is located along Geary and Masonic avenues. On-street parking is generally restricted to 2 hr without a residential parking permit. There are no parking meters on streets in the immediate area.

Kaiser is constructing a second garage and a North Wing addition, which are expected to be completed in 1991. During this period, medical center physicians, residents, surgical staff, and carpoolers have been the only employees allowed to park on site. A total of 507 parking spaces are available during construction in two small lots and one large garage. About 175 of these spaces on site are reserved for physicians. Another 200 spaces are reserved for residents. Up to 200 spaces are set aside for carpoolers.

Kaiser leases (or owns) an additional 475 parking spaces at five off-site locations. Kaiser has committed to relinquishing all off-site parking when the construction is complete.

The Kaiser garage charges 50 cents the first hour, $1.00 for each additional hour up to the $9.50 daily maximum. The monthly rate at the on-site garage is $62.00. Carpoolers park for free on-site. Off-site monthly parking costs each employee $35.00 a month.

Kaiser is served by the following MUNI lines: 24-Divisadero, 38-Geary, 38L-Geary Limited, 2-Clement, 4-Sutter, 31BX-Balboa B Express, 38BX-Geary B Express, and 43-Masonic. These lines provide frequent service to downtown San Francisco, where connections can be made to most regional transit providers. Golden Gate Transit also provides direct regional transit service to the North Bay counties.

Kaiser operates the most active TDM program among the six institutions surveyed. Kaiser recently received an award from the San Francisco Bay Area Metropolitan Transportation Commission for its TDM program.

Kaiser provides free shuttle services for employees and health plan members to downtown San Francisco, the French Hospital, and the remote parking lots. Kaiser offers free pickup service for health plan members living within 12 blocks of the medical center. Out-of-town visitors wishing to visit family members at the hospital can also request the pickup service if they are staying within 14 blocks of the center.

Monthly bus passes are sold on site, with Kaiser paying $4.00 toward the cost of each employee's pass.

Kaiser also holds several transportation fairs each year to promote alternative commute modes and publishes weekly news items in the Medical Center's Newsletter.

In 1984–1985, about 67 percent of the visitors or outpatients and 76 percent of the employees came to Kaiser in automobiles. The average automobile occupancy for employees was 1.15 persons per vehicle. The ratio of parked employee vehicles per employee was 0.66 in 1984–1985 (*18*).

St. Francis Memorial Hospital

St. Francis Hospital is located on the northwest fringe of Downtown San Francisco (*18*). St. Francis is licensed for 362 beds and has available an average of 274 beds. The annual patient load in 1988 at St. Francis was equivalent to 51,000 patient-days. St. Francis employs about 1,000 people.

The area around St. Francis is partly commercial and high-density residential. On-street parking is partly metered 1- and 2-hr zones, and partly 2-hr unmetered zones. A residential parking permit zone (2-hr parking without a permit) covers Sutter, Leavenworth, and Pine Streets.

St. Francis has 442 parking spaces in its 909 Hyde Street garage and in the medical office building garage. Employee parking costs $95 per month. Daily parking for the general public costs $13.00 per day (George Li, Pansini Corp., unpublished data).

St. Francis is served by MUNI lines 1-California, 2-Clement, 3-Jackson, 4-Sutter, 19-Polk, 27-Bryant, and the California Street Cable Car within two blocks of the hospital.

St. Francis sells transit passes on-site and provides door-to-door pick-up and drop-off services for many of its patients. However, St. Francis has not developed in-house carpool matching lists, nor prepared a program evaluation and work plan according to the JITBA guidelines.

Mount Zion Hospital

Mount Zion Hospital and Medical Center (*19*) is located two city blocks east of Kaiser Hospital. Mount Zion is licensed for 439 beds. Mt. Zion's annual patient load was equivalent to 69,682 patient-days in 1988. Mount Zion employs about 1,400 people.

The area around Mt. Zion is mostly residential with some commercial uses along the major arterials. Parking meters and posted signs limit on-street parking in the area to 1 to 2 hr. Several blocks fronting the hospital and along Divisadero have parking meters. Parking is limited to 2 hr by residential parking permit area G on nearby residential streets.

Mount Zion is served by the following MUNI lines within two blocks of the hospital: 24-Divisadero, 38-Geary, 38L-Geary Limited, 2-Clement, and 4-Sutter. These lines provide service to downtown San Francisco where connections can be made to regional transit services. Golden Gate Transit also provides service to the North Bay counties.

Mount Zion has a 120-space lot on site. Another 150 spaces are available in the medical office building garage. The garage charges 75 cents/hr up to a maximum $7.50/day. The monthly rate is $90.00.

Mount Zion provides carpool matching assistance, holds TSM fairs, and sells transit passes on site.

Mode Split Trends

The employee mode splits have varied over the years at these six institutions because of variations in environmental conditions and variations in institutional commitments to their TDM programs (see Figure 2). Fink and Twitchell (*8*) documented a significant improvement in mode splits in 1979 and 1980. These improvements occurred at the same time as a rapid increase in gasoline prices and a temporary fuel scarcity caused by the Iranian oil embargo. However, employee drive-alone mode splits continued at their improved levels through 1982, as gasoline prices stabilized. During this period, there was a continuing high level of management involvement in the TDM program.

Drive-alone mode splits then increased between 1982 and 1987 when the institutions generally slacked off in their TDM efforts (JITBA was disbanded during this period).

Since 1987, drive-alone mode splits have again returned to 1980 levels, thanks to a renewed commitment to TSM programs on the part of the institutions (JITBA was reestablished in 1987) and increasing regulation of on-street parking (through residential parking permit programs) by the city of San Francisco in the vicinity of the institutions. The renewed commitment to JITBA was spurred by city-imposed conditions on the expansion of several of these institutions. Others were motivated to rejoin JITBA through institutional peer pressure.

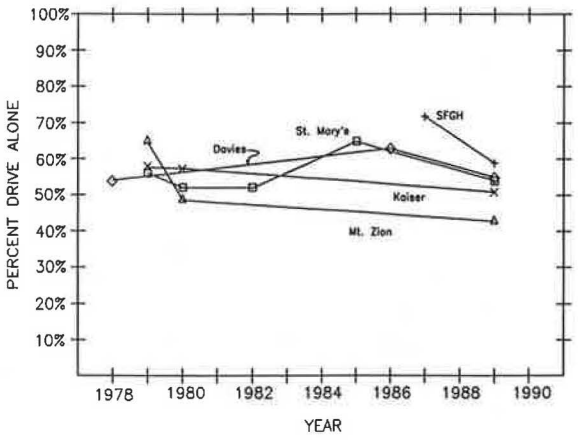

FIGURE 2 Mode split trends for San Francisco medical institutions.

RESULTS

Kaiser, St. Francis, and Mt. Zion hospitals all have generally superior mode split results (43 to 51 percent drive alone) in comparison to the other institutions (see Table 1). These three medical institutions have higher on-site monthly parking charges and more frequent public transit service than the other institutions surveyed. St. Francis and Mt. Zion are located in neighborhoods where on-street parking is regulated by parking meters. However, of these three institutions, Kaiser alone has an active in-house TDM program. The other two have relatively modest TDM brokerage services. (The yes or no answers in Table 1 do not give Kaiser full credit for the extra effort it devotes to its TDM brokerage services.)

The number of on-site parking spaces per employee, by itself, appears to have relatively little effect at these three successful institutions because they all achieve low employee automobile use with parking ratios of 0.19 to 0.65 space per employee.

The relative size of these major institutions also appears to have little effect on TDM success because these three low-automobile-use institutions range from 323 to 439 beds and from 51,000 to 89,000 patient-days per year.

Davies, SFGH, and St. Mary's have relatively higher employee automobile use. They share the common characteristics of lower on-site monthly parking charges, no on-street parking meters regulating off-site parking, and less frequent public transit service.

Again, the scarcity of on-site parking supply, by itself, appears to have little effect on employee automobile use among the poorer-performing institutions. SFGH has the lowest ratio of on-site parking spaces to employees and yet has one of the highest employee automobile uses. St. Mary's also has a relatively active TDM brokerage service and prohibits on-site employee parking; however, St. Mary's is still unable to achieve the low automobile usage of the better-performing institutions surveyed here.

There is free off-site parking with no time limits next to SFGH, which explains its high automobile use. St. Mary's employees can park in nearby Golden Gate Park to partially avoid the residential street 2-hr time limits surrounding the hospital.

Correlation Analysis

As the previous discussion has indicated, it is difficult to extract qualitatively a predominant factor or series of factors affecting TDM program success at these institutions. Consequently, a statistical correlation analysis was performed to determine which factors were most highly correlated to institutional TDM program performance.

Table 2 presents the correlation of the factors among themselves as well as their correlation with percent drive-alone and percent drive-a-car. The factors are generally listed in order of decreasing correlation with employee automobile use. Factors correlated by 50 percent or more are highlighted in bold.

Monthly on-site parking cost was found to be the most highly correlated factor to employee automobile use (with correlation coefficients of -0.85 to -0.91), followed by the off-site factors of on-street parking limits, and nearby transit service (with correlation coefficients of -0.57 to $+0.71$). (Note that TDM brokerage services were not quantifiable based on the data available from the survey and thus could not be included in this correlation analysis.)

Institutional characteristics such as employment, patient-days, and number of beds turned out to be relatively less correlated to employee automobile use (correlation coefficients of 0.19 to 0.48). These results are strongly influenced by SFGH, which tends to dominate the other institutions in these categories. However, SFGH has twice the employment and 50 percent more patient-days per year than the next larger

TABLE 2 CORRELATION MATRIX

CORRELATION MATRIX	Monthly Park Cost	On-Street Park Time	Transit Veh/hr	Parking Spaces	Patient Days	Daytime Employment	Parking/ Employee	Available Beds	Parking/ Patient	Percent Drive Al.	Percent Drive Car
Monthly Parking Cost	1.00	-0.74	0.76	-0.57	-0.27	-0.50	0.04	-0.42	0.14	-0.85	-0.91
On-Street Park Limit	-0.74	1.00	-0.61	0.86	0.24	0.91	-0.37	0.69	-0.39	0.71	0.59
Transit Veh/hr.	0.76	-0.61	1.00	-0.40	0.39	-0.35	0.59	-0.68	0.68	-0.60	-0.57
Annual Patient-Days	-0.57	0.86	-0.40	1.00	0.46	0.93	-0.22	0.78	-0.40	0.48	0.37
On-site Park Spaces	-0.27	0.24	0.39	0.46	1.00	0.37	0.72	-0.14	0.61	0.27	0.34
Daytime Employment	-0.50	0.91	-0.35	0.93	0.37	1.00	-0.37	0.66	-0.40	0.39	0.27
Park Spaces/Employ.	0.04	-0.37	0.59	-0.22	0.72	-0.37	1.00	-0.60	0.92	0.10	0.24
Available Beds	-0.42	0.69	-0.68	0.78	-0.14	0.66	-0.60	1.00	-0.82	0.38	0.19
Spaces/Patient-day	0.14	-0.39	0.68	-0.40	0.61	-0.40	0.92	-0.82	1.00	0.03	0.17
% Drive Alone	-0.85	0.71	-0.60	0.48	0.27	0.39	0.10	0.38	0.03	1.00	0.95
% Drive Car	-0.91	0.59	-0.57	0.37	0.34	0.27	0.24	0.19	0.17	0.95	1.00

Note: Correlation of explanatory factors to each other and to employee mode split (Plus or minus 1.00 indicate a high degree of correlation. Zero indicates no correlation.)

institution in the survey; the number of licensed beds at SFGH is within 10 percent of the next larger institution.

On-site parking supply characteristics are poorly correlated (0.03 to 0.34) to employee automobile use at each institution. This is probably because of the availability of on-street parking at all institutions. Unfortunately, employees can and do use visitor parking facilities at many of the institutions, so it was not possible to develop separate data on employee parking spaces per employee.

Predicting TDM Effectiveness

The correlation analysis results were used to identify the most promising factors for inclusion in a linear equation for predicting employee drive-alone and drive-car mode splits. The on-site parking cost was identified in the correlation analysis as the single most significant factor influencing employee automobile use at these medical institutions. Linear regression analysis was used to construct equations for predicting employee mode splits given this factor, as follows:

$$\text{Percent who drive alone} = 0.581 - 0.0012\ (\text{monthly parking cost in dollars})$$

For this relationship, $R^2 = 0.72$, standard error of estimate = 0.047, standard error of parking cost coefficient = 0.0004, and the 95 percent confidence interval for cost coefficient = −0.0021 to −0.0003.

$$\text{Percent who drive car} = 0.596 - 0.0011\ (\text{monthly parking cost in dollars})$$

For this relationship, R^2 = 83 percent, standard error of estimate = 0.046, standard error of parking cost coefficient = 0.0003, and the 95 percent confidence interval for cost coefficient = −0.0017 to −0.0005.

Figure 3 shows the predictions of a drive-car mode split using the latter equation versus the observed mode splits at these institutions. These predictions, solely on the basis of monthly parking cost, are within 1 percent of actual for all but two of the institutions. Automobile use by employees at St. Francis is noticeably higher (3 to 4 percent) than predicted, whereas automobile use at Mt. Zion is significantly lower (3 to 4 percent) than expected on the basis of monthly parking cost alone.

The addition of on-site parking supply measures (total spaces, spaces per employee, etc.) to the above regression equations did not significantly improve the fit of the regression line, and resulted in coefficients for these variables not significantly different from zero.

The combination of the other two most significant factors (transit service and on-street parking limits) with parking cost in the equation also resulted in only modest improvements to the explanatory power of the equations. This is primarily because the on-site parking charges are so highly correlated to on-street parking supply and coincidentally to the frequency of transit service (see Table 2). Davies Medical Center has stated that it purposely sets its parking rates low to avoid employee overflow onto residential neighborhoods. Indeed, institutions often set their parking rates according to the prevailing parking charge rates in their vicinity.

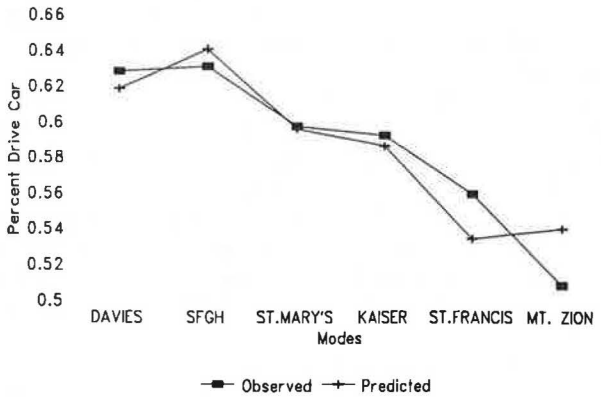

FIGURE 3 Predicted versus actual drive-car mode splits.

The other factors of total employment, annual patient-days and available beds, also did not significantly improve the explanatory powers of the equations and resulted in illogical coefficients for the variables, or coefficients not significantly different from zero.

The number of parking spaces reserved by each institution for carpoolers was not included in the analysis because institutions adjust this number to roughly match demand. Thus the number of carpool spaces could not be used as an explanatory variable for employee mode split.

CONCLUSIONS

The analysis has demonstrated that on-site parking charge rates, off-site parking restrictions, and frequent transit service are major factors in successful TDM programs at the major medical institutions in San Francisco. On-site parking supply turned out to be a less critical factor, primarily because of the availability of abundant free parking on nearby city streets at these institutions.

Because of the high degree of correlation between the parking charge rates, off-site parking restrictions, and transit service, it was possible to build a satisfactory predictive equation for employee mode split solely on the basis of the on-site parking charge rate. This equation indicated that the employee drive-alone mode split could be reduced by one percentage point for every $8.00 increase in monthly parking charges at these major medical institutions. (The 95 percent confidence interval for this result is between $5.00 and $33.00 per month.)

The analysis also indicated that on-site parking charges are currently highly correlated with off-site parking restrictions and transit service improvements. Consequently, to obtain the reductions in employee automobile use cited, it would be necessary to coordinate the parking charge increases with increased off-site parking restrictions and improved transit service.

ACKNOWLEDGMENTS

The authors would like to thank Pamela Hodgins, Tom Burton, Gil Bendix, and Selina Bendix of Bendix Environmental Research for their extensive assistance in this study. Ms. Hodgins was an extremely valuable resource on the parking and TSM studies that had been done for other hospitals in San Francisco.

The authors would also like to thank the TSM coordinators of SFGH (Fran Tate), St. Mary's Hospital (Nancy Oliva), and Kaiser Hospital (Barbara Jarvis) for providing information on the current employee mode splits at their respective institutions.

Arul Edwin, of Bechtel Engineers, was responsible for processing the survey results.

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Publication of this paper sponsored by Task Force on Transportation Demand Management.

Monitoring and Evaluating Employer-Based Demand Management Programs

THOMAS J. HIGGINS

With the growth of employer-based transportation demand management (TDM), employers and local governments need to monitor and evaluate program results. A model program for local governments to monitor the impacts of local TDM programs is suggested. The program is described by means of outlines of suggested reports and manuals; mock tables to illustrate exactly which data need to be collected; recommended wording and format for employee and manager survey questions; hypothetical findings and conclusions for recommended reports to illustrate how data should be presented and interpreted; suggested language for policy instruments involving developers in the TDM program monitoring effort; specific guidance for a transportation management association (TMA) in setting out a monitoring role in its by-laws (language suggested), contracting for survey and data processing services, and holding workshops (agenda and resources included); and recommended procedures and cautions for carrying out the evaluation of traffic generation at TDM and control sites, as well as example interpretations of results.

Employer-based transportation demand management (TDM) and transportation systems management (TSM) programs aim at reducing traffic congestion and associated problems, especially air pollution. Employers and developers undertake the programs in response to local government urging or requirements in ordinances, developer agreements, parking codes, or air quality regulations.

Although local governments usually track TDM and TSM programs through annual reporting of program activities and a survey of employees, there is much need to improve tracking and evaluation of local programs. At least, local governments need to know what employer programs are doing year by year and what program and policy changes are planned for subsequent years. When developers are required to play a role in local programs, they also should be part of the evaluation system. Local transportation management associations (TMAs) are another logical party in the evaluation, though they rarely play a strong evaluation role.

Aside from establishing roles for relevant parties, local governments face the methodological issue of what to measure and how to measure it. Sometimes local governments simply track mode share at employment sites with TSM and TDM programs. Without control sites, this measure may reveal little. In any case, mode share trends do not necessarily reveal effects on vehicle trips, trip lengths, time of trips, and other measures important to both congestion and air quality. Evaluations lacking on the subject of vehicle trip making will prevent government from encouraging appropriate TDM and TSM strategies. Such evaluations also will make it difficult to justify either program continuation or termination, and leave the fate of TDM and TSM more to purely political considerations.

There are examples of good TDM and TSM program evaluations that should be useful to local governments. However, because the focus is on results rather than on methodology, the busy local planner or analyst is left to deduce details of the methodology or implementation particulars. Examples include the following:

- *HOV/TSM Evaluation Study, Second Year Findings*, Metro of Seattle, April, 1989. The study measures effects of employer-based programs over 3 years at a large number of study and control sites.
- *An Evaluation of Employer Ridesharing Programs in Southern California*, Erik Ferguson, Georgia Institute of Technology, presentation paper for the Transportation Research Board, July 1989. The study analyzes the effects of ridesharing programs at employment sites through regression analysis. Regression allows for assessment of the unique effects of each of several variables, including rideshare assistance, flextime, and vanpool assistance.
- *Non-Retail Commercial Office Trip Generation Study*, Parsons Brinckerhoff Quade and Douglas, Inc., for the City of Irvine, February 1988. The study assesses traffic generation at the Irvine Business Complex and sites external to the complex. Although not the main purpose of the study, it provides a method for comparing peak-period vehicle trip generation at sites with and without demand management.
- *Preliminary Evaluation of the Coastal Transportation Corridor Ordinance in Los Angeles*, Charles Blankson and Martin Wachs, University of California at Los Angeles, for the Transportation Research Board, December 1989. The study compares the effects of TDM programs at 44 firms with a control group of 117 firms, particularly comparing control and test employees relative to demographic characteristics. The study also provides statistical tests of differences in travel behavior between the two groups.

Other useful literature provides guidance on evaluating the effects of regional rideshare programs. This literature discusses the use of commuter surveys and controls, as well as issues of sampling, bias, and statistical significance. Although useful for local planners, the literature does not address the current context of TSM and TDM at employers, developers, and TMAs. Some examples that provide specific guidance on structuring evaluations include the following:

- The Organization and Operation of Ridesharing Programs, A Manual of Current Information, Marion Misch,

K. T. Analytics, Inc., 885 Rosemount Road, Oakland, Calif. 94610.

Joseph Margolin, George Washington University, and David Curry, Lawrence Glazer, Guillaume Shearin, Crain and Associates, for the NCHRP, March 1980.

- Carpool Program Evaluation, Volume II, Jarvia Shu and Lawrence Glazer, Commuter Transportation Services, Los Angeles, May 1979.
- Evaluation of Carpool Demonstration Projects, Frederick Wagner, for the FHWA, August, 1978.

An annual reporting system to track and evaluate TSM and TDM programs as carried out by employers, developers, and TMAs is suggested, based in part on work done under the support of the Santa Cruz County Regional Transportation Commission in July 1990. The system comprises five elements, each with important purposes in tracking TDM programs. Specifically, Element 1 suggests an annual report form for employers. It focuses both on employee responses to the program and on management perspectives. Element 2 outlines possible roles for a local TMA in implementing the monitoring program, including possible survey processing and help with reporting. Element 3 suggests roles for developers in monitoring, relevant conditions, and fees. Element 4 specifies a traffic monitoring system, comparing sites with and without TDM programs to gauge program effectiveness. Element 5 provides an annual report format and contents to inform local decision makers of overall program effectiveness.

ELEMENT 1: ANNUAL REPORT, EMPLOYEE AND MANAGER SURVEYS

The first element of the monitoring program is an employer annual report. The report should be prepared annually by employers carrying out TDM programs. It would contain a brief summary of employer TDM activities for the past year and planned activities for the next year. It also would contain employee survey results. The purpose of the report is to enable local government and employers to know what TDM activities are ongoing and what results the employer perceives coming from the program. The report also should be available to the local TMA so it can track employer activities.

The employer annual report ought to be consistent across employers. To ensure consistency, the local government should develop a standard report form and survey for employers to use. The form and survey should be included in a single document or manual. The document might be called "Employer TDM Manual."

The manual should contain more than just the annual report form and survey. It should also inform and help companies in TDM. Figure 1 suggests an outline of the manual, which should provide background on the purposes of the TDM program, a summary of applicable regulations, a list of resource services and people, and suggestions for carrying out employee surveys in-house or through TMA or contract services.

A. Jurisdiction TDM Program Highlights
   - TDM definitions and purposes
   - Legislation/requirements (e.g. TDM ordinance or air quality regulations, if in place)
   - Introduction to the Employer TDM Annual Report

B. Resources
   - Jurisdiction staff
   - TMA personnel and program
   - Transit services and contacts
   - Ridematching services
   - Cycling routes and resources
   - Model employer program contacts

C. Transportation Survey Procedures
   - Survey options: in-house or contract services
   - Getting an acceptable response rate (70 percent or valid random sample)
   - Model CEO letter/newsletter article supporting survey
   - Employee and manager survey

D. TDM Annual Report
   - Name of company transportation coordinator
   - Main location and subsidiary sites
   - Company background (number of employees, job classifications, foreseeable expansions or changes in employee make-up bearing on TDM.)
   - Description of parking availability and utilization
   - Description of TDM measures to date and planned for next year
   - Summary of annual program results to date as indicated by survey

E. Request Form
   - Check off list for information on TDM strategies, TMA, survey contractors, other company programs, ordinances, TDM conferences, literature.

FIGURE 1 Outline of employer TDM manual.

A minimum 70 percent response rate should be set out as the goal for survey returns. An even higher response rate is preferred. Poor response rates may bias results. For example, employees interested in carpooling and transit probably are more likely to respond than those not interested. Thus, planners may conclude there is more interest in ridesharing among the population than would be the case with a higher response rate. Even if a good response rate is obtained, it is wise to pursue a sample of employees not responding to see in what ways, if any, they differ from respondents. The resulting information will provide a measure of confidence in survey results.

Random sampling is one possible way around the difficulty of obtaining survey results from a large population of employees. For large companies, a random sample can provide reliable results provided the survey sample is stratified to represent all departments and work shifts and the sample is truly random. However, a random survey should not be allowed at smaller firms because cross tabulations focusing on subsets of employees using small sample sizes will bring unreliable results.

Included in the manual ought to be a standard employee survey and manager survey. The manual should contain questions about mode of travel to work, home location, distance to work, interest in alternatives to solo driving, and other questions that are important to local agencies and air quality management districts. Also important to consider are questions about use of critical road facilities (congested streets, intersections, ramps), route-to-work, work hours, and interest in alternatives to solo driving. Because air quality regulations are developing in many localities, the survey also should allow calculation of not just mode shares but volume of trip making (by regular and occasional mode), trip length, and trip reduction. With information on trips, air quality planners can calculate vehicle-miles of travel, possible reductions, and implications for emissions. Figure 2 shows suggested questions for the key survey sections.

The manual also should include a short manager survey to assess management attitudes about TDM program development, transit and rideshare services, TMA functions, and company policy bearing on work hours, telecommuting, parking management, and other issues important for TDM program development. Figure 3 suggests questions for the manager survey.

Employers, TMA, and local government should share in the survey procedure. Employers should be responsible for survey distribution and collection. Employers should carry out the survey directly or through a survey research contractor (perhaps supported in part by the TMA). However, processing of survey results and development of summary tabulations should be centralized. Centralization would

- Reduce the analytic burden on smaller employers and the possibility of errors,
- Gain economies of scale possible in batch processing (especially with optical scanners), and
- Allow the local government to compile and review results across all employers to assess overall program effectiveness.

Probably the best way to centralize survey processing is for the survey forms to be processed and tabulated by a data processing firm using optical scanners, presuming survey volumes justify use of scanners. The TMA could contract with the data processing firm for these services. Summary tabulations for all survey questions should be prepared for each employer. The TMA and locality staff should each review results and annually prepare summaries and interpretations of results for their decision makers and managers.

ELEMENT 2: TMA SUPPORT

A local TMA could take several actions with respect to the TDM evaluation program:

1. Ensure that bylaws and marketing plans refer to TMA roles in the monitoring and reporting of TDM activity and results. Specifically, the following statement should be considered by the TMA for adoption under the usual Authority and Purpose Article:

> The Corporation will develop baseline and annual evaluation information on employer based TDM programs in [Jurisdiction]. The purpose shall be to assess the types of TDM strategies undertaken by employers and the effectiveness of these strategies. The Corporation shall assist employers carry out transportation surveys among employees, whether directly by way of implementing such surveys at employment sites or indirectly through contract survey services. Annually, the Corporation will summarize the results of employer surveys and make these available to public entities with interest in TDM, including but not limited to the [Jurisdiction] and [name appropriate others here].

2. Contract for transportation survey and data processing services, alert all jurisdiction employers to these services, and make them available to TMA members at favorable rates. Such services should be solicited through competitive bid and a request for proposal (RFP) process. The RFP should

- Specify the number of employers and employees potentially making up the universe to be sampled;
- Specify that the response rate must be sufficient to result in statistically representative results at each company, within usually accepted confidence levels; and
- Request bids that presume low and high ranges for the number of employers and employees involved.

The TMA should price survey and data processing services on the basis of number of employees and member or nonmember status. However, the price should not vary below companies of 50 or 100 employees, because some proportion of survey costs are incurred irrespective of company size.

Once a firm is selected, the TMA must manage its services. The TMA must check that response rates are met and that data entry is accurate. Some data entry errors are inevitable. Informal interviews with data entry companies suggest that error rates depend on the complexity of the data entry task. Error rates on simple mailing labels and addresses may be as low as one in several hundred, or less. Data entry errors on complex survey forms may be higher, but careful spot checking reduces errors to the range of 1 or 2 percent.

3. For employers not using survey services of the TMA, offer workshops on conducting in-house surveys. Workshops

BACKGROUND INFORMATION

1. Your Name _____ 2. Department/Organization No: _____ / _____

3. Your job title _____ 4. Your home zip code _____ 5. Home City _____

TRAVEL INFORMATION

Before completing the following questions, please read these definitions:

Carpool: two (2) to five (5) persons commuting to and from work in a car owned by a driver or passenger.

Vanpool: six (6) or more people commuting to and from work in a personal, company or public agency van.

Transit: public transportation, including bus or fixed rail services for commuting.

Buspool: eight (8) or more people commuting by private or public bus service contracted by commuters or their employer, and with routes and schedules determined by riders.

Bicycle: non-motorized bicycle to and from work.

Telecommute: work normally done "at the office" which instead is done at home or a remote worksite, thus eliminating or reducing the usual home to work trip.

Drive alone: use of a car or motorcycle to and from work without a passenger.

Walk: Travel from home to work on foot (walk from a transit stop or a parking lot doesn't count).

6. Count the trip to work as one trip, and count the trip home also as one trip (i.e. two trips per day). How many total work trips do you make in a typical work week?

_____ Trips per typical work week

7. Based on the above definitions, how do you usually get to work? Check only one:

[ ] A. Drive alone
[ ] B. Carpool driver
[ ] C. Carpool passenger
[ ] D. Vanpool driver
[ ] E. Vanpool passenger
[ ] F. Walk
[ ] G. Transit
[ ] H. Bicycle
[ ] I. Buspool driver
[ ] J. Buspool Passenger
[ ] K. Telecommute (don't usually go to worksite)
[ ] L. Other _____

8. What other modes of travel to work do you sometimes use? If you don't use an occasional means of travel, check here and go to question 9: [ ] None. Otherwise, check only one:

-- Same options as in question 7 --

8A. How many of the weekly trips you reported in question 6 are made by this occasional means of travel? If you telecommute, count the number of trips you avoided making:

_____ Trips per typical week by occasional mode of travel

9. Usual work schedule: Start time _____ End time _____

10. Check the days you work in a typical week: [ ] MN [ ] TU [ ] WED [ ] TH [ ] FR [ ] SAT [ ] SUN

11. Does your department allow you to start work anytime within a band of time, for example, 7 to 9 a.m. ("Flextime")? Check one: Yes ___ No ___

11A. If flextime, how flexible are your start/end times: [ ] <30 Mins. [ ] 30-60 Mins. [ ] >60 Mins.

12. How far from work do you live (one way only)? Check one:

[ ] A. 0 - 0.9 miles
[ ] B. 1.0 - 2.9 miles
[ ] C. 3.0 - 5.0 miles
[ ] D. 5.1 - 9.9 miles
[ ] E. 10.0 - 14.9 miles
[ ] F. 15.0 - 19.9 miles
[ ] G. 20.0 - 24.9 miles
[ ] H. 25 or more miles

- Please Go To The Next Page -

FIGURE 2 Suggested employee survey sections and questions. (*continued on next page*)

should use employer and jurisdiction transportation coordinators from the region who can speak about how to carry out effective employee surveys. TDM consultants with experience in TDM evaluation also could be involved. A workshop might follow the following agenda:

- Review of locality TDM program (TMA and locality staff) (10 min);
- Survey services of TMA (TMA representative and survey contractor) (15 min);
- Pointers on survey procedures (survey contractor, successful employer TDM coordinator) (15 min);
- Case study experience (locality representative) (15 min);
- Questions and answers (all participants) (15 min); and
- Wrap up and materials distribution (jurisdiction staff and TMA) (10 min).

4. Assist employers with the annual report. Employers should complete their own annual TDM reports on forms developed by the jurisdiction staff and should base the report on survey results tabulated by the survey contractor or through in-house survey. The TMA might prepare a mock report to show employers how the report would be developed. The mock report could be done for both a hypothetical large and small employer and contain the following sections:

- Name of company transportation coordinator;
- Main location and subsidiary sites;

13. Where do you normally park if you drive a car or motorcycle to work? Check one:

[ ] A. City owned/leased lot/garage
[ ] B. On street at 10 Hr. meter
[ ] C. On street at 2 Hr. meter
[ ] D. On street - no time limit zone
[ ] E. On street - time zone/no meter
[ ] F. Commercial lot/garage open to all
[ ] G. Private restricted facilities (e.g. employees only)
[ ] H. Private driveway
[ ] I. Vacant lot, rail right of way, other open land
[ ] J. Other (explain): _____

14. Do you personally pay for parking? Check one: [ ] Yes [ ] No

14A. If you do not pay for parking, why not? Check one:

[ ] A. There is no charge for parking where I park.
[ ] B. My employer pays for my parking or provides it free.
[ ] C. Other. Please explain: _____

14B. If you personally do pay for parking, please indicate how much you pay. Check one:

[ ] A. $ 1.00 - $10.00 per month
[ ] B. $10.01 - $20.00 per month
[ ] C. $21.01 - $30.00 per month
[ ] D. $30.01 - $40.00 per month
[ ] E. $41.01 - $50.00 per month
[ ] F. Over $50 per month

15. If you drive, which of the following streets, intersections, ramps do you usually use to and from work? Make sure you have designated all the facilities you use to and from work. Check as many as apply: [facilities may vary by location of companies]

[ ] A. Street X
[ ] B. Street X/street Y
[ ] C. Ramp L
[ ] D. Highway M/between N and O

COMMUTE PERSPECTIVES

16. If you are interested in receiving information on one or more of the following "modes" to work, please indicate by checking the box. Check as many as apply:

[ ] A. Carpool [ ] C. Bus Pool [ ] E. Bike [ ] G. Telecommuting
[ ] B. Vanpool [ ] D. Transit [ ] F. Moped/Motorcycle [ ] H. Other _____

17. Flextime often encourages car and vanpoolers by making it easier to match pick-up schedules with work hours. Would you be more likely to use carpooling or vanpooling if you worked under flextime? Check one:

[ ] A. Much more likely
[ ] B. Somewhat more likely
[ ] C. Not more likely
[ ] D. Already on flextime
[ ] E. Does not apply since I telecommute

18. Would you be more likely to use a bicycle to/from work if there were showers and/or secure parking areas at work? If there already is cycle parking at work, check NA. Check one:

[ ] A. Much more likely
[ ] B. Somewhat more likely
[ ] C. Not more likely
[ ] D. NA

19. Would you be more likely to use car or vanpooling if you could get discount taxi service to home, day care or school in emergency situations? If company car/van were available for pooling? If parking stalls close to your work place were reserved for car and vanpoolers? Check one:

Discount taxi:	[ ] A. Much more likely	[ ] B. Somewhat more likely	[ ] C. Not more likely
Company car/van:	[ ] A. Much more likely	[ ] B. Somewhat more likely	[ ] C. Not more likely
Carpool stalls:	[ ] A. Much more likely	[ ] B. Somewhat more likely	[ ] C. Not more likely

20. If you could buy transit passes at a 50 percent discount, would you be more likely to use transit? Current fares are _____. More likely to use transit if it were more frequent for your trips? Check one:

Pass discount:	[ ] A. Much more likely	[ ] B. Somewhat more likely	[ ] C. Not more likely
Frequent transit:	[ ] A. Much more likely	[ ] B. Somewhat more likely	[ ] C. Not more likely

THANK YOU!

Thank you for your time! Please return the survey to _____ at _____. The deadline for completing the survey is _____. Thank you!

FIGURE 2 (*continued from previous page*)

- Company background (number of employees, job classifications, foreseeable expansions or changes in employee make-up bearing on TDM);
- Description of parking availability and use;
- Description of TDM measures to date and planned for next year;
- Summary of annual program results to date as indicated by survey; and
- Check off list for information on TDM strategies, TMA, survey contractors, other company programs, ordinances, TDM conferences, and literature.

The mock report should pay particular attention to Sections 5 and 6. The report should indicate how certain TDM strategies are best to consider depending on survey results, and how effectiveness is assessed. Figure 4 shows an example of the kind of discussion that might be included in the mock report for these sections.

In addition, the TMA might provide workshops and telephone consultation on completing the annual report.

ELEMENT 3: DEVELOPER ROLES

New developments conditioned with TDM requirements ought to include requirements for annual TDM reporting by project tenant and employers, especially during the period before any TDM ordinance or air quality regulations come into effect.

1. Your Name _____ 2. Name of employer _____

MANAGEMENT PERSPECTIVES

3. Are you aware of the [Jurisdiction] Transportation Management Association? _____ (if no, skip to Q4)
If yes, are you a member? _____ If yes, please rank the services of the TMA:

A. Information on transportation issues, events, modes of travel: [ ] Good [ ] Fair [ ] Poor [ ] Uncertain

B. Employee transportation survey services [if applicable]: [ ] Good [ ] Fair [ ] Poor [ ] Uncertain

C. Transit pass sales program [if applicable]: [ ] Good [ ] Fair [ ] Poor [ ] Uncertain

4. How many employees in your company now? _____ How likely is it your company will be adding employees in the next six months? Check one:

[ ] A. Very likely [ ] C. Unlikely
[ ] B. Somewhat likely [ ] D. Uncertain

About how many employees might be added? _____

5. Please indicate whether your company might consider the following alternatives to auto commuting to and from your place of employment. Indicate Yes, Maybe or No in the space provided for each option:

A. Allow the [Name] Transportation Management Association or [Jurisdiction] Ridematch Program to distribute car and vanpooling ("ridesharing") information and applications to your employees, and to help connect employees in your company who are interested in ridesharing.

[ ] Yes [ ] Maybe [ ] No

B. Allow the Transportation Management Association or Ridematch to connect your employees interested in ridesharing with interested employees in other [Jurisdiction] companies.

[ ] Yes [ ] Maybe [ ] No

C. Allow some of your employees to arrive within a one hour band of time (e.g. 8 to 9 a.m.) and depart 8 hours later ("flextime").

[ ] Yes [ ] Maybe [ ] No

D. Periodically, purchase bus passes and sell them to employees at reduced cost.

[ ] Yes [ ] Maybe [ ] No

E. Allow compressed work weeks (four days/40 hours) or telecommuting (work from home or satellite office).

Compressed Week: [ ] Yes [ ] Maybe [ ] No Telecommuting: [ ] Yes [ ] Maybe [ ] No

F. Share cost with the Transportation Management Association for the periodic promotion of bicycles, mopeds and motorcycles, perhaps by supporting prize drawings for commuters using these modes.

[ ] Yes [ ] Maybe [ ] No

G. Allow carpoolers and vanpoolers to use company cars or vans (when available) for business trips during the day. If there are no company cars, check NA.

[ ] Yes [ ] Maybe [ ] No [ ] NA

6. Does your company have a designated Transportation Coordinator?

[ ] Yes [ ] No If yes, please list: Name: _____ Phone: _____

Thank you for your time! Please return the survey to _____ at _____. The deadline for completing the survey is _____. Thank you!

FIGURE 3 Suggested manager survey questions.

If and when these policies are in effect, they may supersede project conditions.

The conditions also should specify mitigation fees in support of the TDM monitoring program. Fees should be used to support either the TDM monitoring activities of the jurisdiction staff or the TMA or both. It is important that such fees bear a reasonable relationship to the cost of the TMA and jurisdiction monitoring and evaluation.

Presuming a fee in support of monitoring, a role for the TMA in monitoring and the development of a TDM annual report form, language of the developer agreement might read as follows:

> Applicant will submit, for approval of the [proper locality officer] a lease exhibit which requires, as a condition of occupying the building, cooperation with the [jurisdiction] and [relevant Transportation Management Association] in the monitoring of a Transportation Demand Management program. Lease condition must specify tenants will complete an annual employee transportation survey and report using guidelines provided by the [jurisdiction], and tenants may elect to conduct the survey directly or through contract survey services as may be arranged through the [relevant TMA]. Applicant will pay annual fees in support of the [jurisdiction] and [relevant Transportation Management Association] Transportation Demand Management monitoring program. Annual fees will be established by the [jurisdiction] and based on the annual costs of the respective monitoring programs, but shall be no less than $xx per employee [fee should be based at a minimum on the unit cost of employee survey and data tabulation for locality, usually $10 to $20] based on estimated occupancy for the year.

DISCUSSION OF TDM MEASURES TO DATE AND PLANNED

"... the commute distances and home cities of Company X employees strongly favor ridesharing, transit and bicycling. As QUESTION XX shows, almost half the employees say they are traveling 15 or more miles one way to work. Also, as QUESTION X about home City shows, some employees traveling long distances live in the same City. Such commuters are much better candidates for ridesharing than persons making short trips to work. The employee survey also reveals 15 percent travel less than 3 miles to work. At least some of these employees should be candidates for cycling, especially with only one percent now cycling. Consequently, we plan in-house matching services for our long tripper employees, and bike racks and special promotions for our short trippers ..."

"... In another repeat of last year's results, large proportions of employees are not familiar with the service or schedule of transit or the availability of discounted transit passes through the TMA. About 45 percent (40 percent in 19xx) of the employees indicate no awareness of transit service or schedules. Forty six percent (43 percent in 19xx) are not aware the Association offers discounted transit passes. Clearly, there is room for better communication of these options to employees. See QUESTIONS XX and XX...These result suggests potential for better promotion in next year's program. Instead of simply passing out brochures and schedules, we plan a transit day promotion this year. The promotion would ... "

"... As expected, employees did not express great interest in alternatives to driving alone. However, enough employees did express sufficient interest to warrant certain actions on the part of the TDM Coordinator. Table x summarizes the responses to the interest in alternatives to solo driving over the past three years. This year, the relevant question is QUESTION XX. The table summarizes the proportion of respondents expressing medium to high interest in the mode presented. Interest in carpooling leads the pack each year. Vanpooling and flextime were rated next most favored. Interest in Transit was next in interest in only one year, 198x ...Overall, results suggest more potential for ridesharing. We plan preferential parking for poolers in our front lot where parking is preferred and supply is tight. We also plan a flextime demonstration with employees in one department where rideshare interest is highest..."

TDM EFFECTIVENESS TO DATE

"... We have compared selected results across 198X, 198X and 198X. We analyzed employee mode choice and interest in alternatives to solo driving in the three years. Table X shows the cities in which employees live for across the three years. The distribution of employees responding by City of residence shows good stability from 198x to 198x. For example, the proportions of employees living in xxxxxxxxxxx, xxxxxxx, and xxxxxxx are fairly consistent across the three years. Thus, we may be fairly confident the comparison of mode shares is not biased by very different trip lengths or commute patterns of employees responding across the three years."

"... Table X shows the mode shares of employees across 198x, 198x and 198x. As the table indicates, there is very little difference in the proportion of solo drivers across the years, or in the proportion of employees cycling, carpooling or taking transit. There is a small decline in solo shares, but the decline may not be significant. However, it is encouraging that the proportion of solo drivers is not increasing as is the case in the overall vehicle occupancy counts conducted by the [agency] across the same years. Overall, we conclude TDM is holding the line on solo driving at our company ..."

FIGURE 4 Examples of Sections 5 and 6 of the employer annual report.

For large projects, conditions also might specify installation of vehicle counters. Such counters will provide a checkpoint for site-specific TDM monitoring discussed in Section IV. Suggested condition language follows:

> The applicant shall install automatic vehicle counters to the specifications of the [jurisdiction] at all driveways entering and exiting the development.

If standard developer agreements for the jurisdiction do not provide for continuity of conditions, then language of the following sort should be added:

> The agreement and conditions contained herein shall be a covenant running with the building and occupancy permit for the project binding on applicant, its successors and assigns.

ELEMENT 4: TRAFFIC MONITORING OF TDM SITES AND CONTROLS

Jurisdiction staff should carry out a specific traffic monitoring program at selected employment sites with and without TDM programs. The usual traffic monitoring system carried out by jurisdictions on arterials and collectors is useful for tracking general trends, but cannot provide conclusive findings about TDM program effectiveness.

For the most reliable possible findings, vehicles entering and exiting sites with and without TDM programs need to be counted at driveways and compared over time. Only by such a comparative treatment and control methodology can TDM effectiveness be determined separate and distinct from other influences on traffic.

Presuming the objective is to monitor the effect of TDM on vehicle traffic, only vehicles need to be counted. It is not important to know the proportion of cyclists or walkers (whether coming from car drop offs, transit stop, or from a residence) or even vehicle occupancy. Not only is it labor-intensive to monitor pedestrian traffic and vehicle occupancy (especially if transit crosses the cordon), it is not necessary. What is important is the comparative vehicle generation of the TDM and control sites normalized on a per square foot or per employee basis. If TDM is effective over time and increases carpooling, transit use, cycling, and walking, the result will be detected in reduced vehicle generation at the TDM sites compared with the control sites.

Comparing the vehicle trip generations between sites with and without TDM controls for the influences of weather, gasoline prices, overall state of the economy, and other influences acting on both the TDM and non-TDM programs provides direct and independent observation of vehicle and person movement without relying on reports from commuters about travel behavior.

Guidelines for the specific methodology to be used are as follows:

- Counts should take place over at least a 1- to 2-week period during the same time each year. The fall of the year is preferred as the survey season when summer vacations are over and business is conducted as usual. If economy of resources is important, counts could be taken on Tuesday through Thursday, though the entire week is preferred.
- Counts should be over 12 hr (e.g., 7 a.m. to 7 p.m.) or at peak period only, depending on the air quality rule and TDM ordinance in place at the time the monitoring program begins. Air quality regulations usually are directed to trips at all hours; TDM ordinances usually focus on the peak hours. In either case, counters should employ 15-min worksheets.
- Cordons should be set to ensure that only TDM site traffic is counted. If an employer with a TDM program shares a site with other services or users, it may not be possible to set the cordon appropriately. Such sites should be excluded from the sample.
- The number of treatment and control sites should be as large as possible given staff and student resources. A large number of treatment and control sites reduces the probability of unique circumstances influencing the comparative results. For example, if, over the survey period, treatment sites generally are not changing in the make-up of the work force but control sites are, then comparing treatments and controls does not give valid results. The larger the number of treatment and controls, the less is the risk of unique changes at treatment or control sites. Seattle Metro uses 48 combined treatment and control sites in its monitoring program. If the number cannot be this large, treatment and control sites ought to be matched and monitored as much as possible along key variables that may change over time. Key variables include the make-up of the work force, availability of parking, and proximity to transit.
- Vehicle counts should be normalized on the basis of gross floor area and per employee. Employee populations at both treatment and control sites can be expected to grow over the years they are monitored. It is important to control for growth by calculating counts on a per-employee basis. Also important are results on the basis of gross floor area. The latter results will be useful for projecting the traffic impacts of future development proposals and for environmental reviews. To obtain information on gross floor area and employees, the jurisdiction transportation staff must contact building owners and assess total gross floor area and average number of daytime employees that work at the site at the time of the survey. It may be necessary to contact the site employer about the number of employees. It is good procedure in trip generation surveys of work sites to ask cooperation and permission to make driveway counts and offer the owner the results of the survey once completed.

ELEMENT 5: ANNUAL TDM MONITORING REPORT

The annual TDM monitoring report to jurisdiction decision makers should bring together all the above sources of information into a coherent appraisal of TDM effectiveness. It should bring together information from several sources and might be organized in four chapters:

- Results of Vehicle Counts At TDM and Control Sites,
- Summary of Employer Surveys and Annual Reports,
- Results of Overall Trends in Traffic and Vehicle Occupancies, and
- Conclusions.

Results of Vehicle Counts At TDM and Control Sites

The site-specific traffic count program results should be summarized and discussed. Table 1 presents an outline that should be used to summarize and analyze results. The purpose of the table is to indicate peak-period traffic generation rates for the TDM and control sites and whether there is any significant difference between sites for both the current year and the several years over which monitoring takes place. If the TDM program is effective, there should be a statistically significant difference between the two groups of sites, perhaps not in every year but at least in later years as programs mature.

Of course, a narrative should accompany the table to present

- Any problems in data gathering;
- Possible unique changes in either the TDM or control sites (as noted, this will not be a problem as the number of sites increases); and
- Overall conclusions about effectiveness based on the results.

In the case of the mock results in the table, the conclusion would be that there is a significant difference between the exiting p.m. peak traffic between the TDM and control sites, at least in 2 years. There is no difference in the entering p.m. traffic in any years, though this might well be expected because outbound traffic is more likely to be employee generated and affected by TDM programs.

Summary of Employer Surveys and Annual Reports

This chapter ought to summarize employee surveys as tabulated by individual employers and the TMA. An appendix should contain the summary tabulations by employer. Not all tabulations need to be discussed and summarized. The most important for this chapter are the following key indicators by employer over at least the most recent 3 years:

- Proportion of solo and alternative mode users,
- Average trip length,
- Proportion of peak-period commuters,
- Proportion of employees using critical intersections, and
- Proportional interest in alternatives to solo driving.

The narrative for this section should point to trends in these indicators. For example, in the worst case proportions of solo shares might be climbing across employers, trip lengths increasing, use of critical intersections increasing, and interest in alternatives to solo driving declining. The narrative also

TABLE 1 MOCK TABLE ON TDM AND CONTROL SITE VEHICLE COUNTS

CURRENT YEAR P.M. PEAK TRIP RATES BY SITES

TDM SITES	VEHICLE TRIPS/1000 GFA*		VEHICLE TRIPS/EMPLOYEE	
	Enter	Exit	Enter	Exit
XYZ Semiconductors	0.55	3.10	0.65	3.66
Blue Sky Freight	1.35	2.70	1.40	3.80
ABC Hospital	2.05	3.39	1.10	4.68
...	....	....	....	....
Means	....	....	....	....
Standard Deviations	....	....	....	....

CONTROL SITES	VEHICLE TRIPS/1000 GFA*		VEHICLE TRIPS/EMPLOYEE	
	Enter	Exit	Enter	Exit
Klean Sand	0.55	3.10	0.65	3.66
Someone Johnson	1.35	2.70	1.40	3.80
West Marine	2.05	3.39	1.10	4.68
...	....	....	....	....
Means	....	....	....	....
Standard Deviations	....	....	....	....

MEAN P.M. PEAK TRIP RATES BY TDM AND CONTROLS

Year	MEAN TRIPS/1000 GFA* TDM Sites		MEAN TRIPS/EMPLOYEE Control Sites		DIFFERENCE IN MEANS (+ = Significant)	
	Enter	Exit	Enter	Exit	Enter	Exit
199X	1.25	3.00	1.30	3.15	0.05	0.15
199X	1.70	2.50	1.70	2.75	0.00	0.25+
199X	1.80	3.00	1.90	3.40	0.10	0.40+
....	....	....	....	....	....	....

* Gross Floor Area

should point to the most and least successful employers and analyze possible reasons for variations in success. Perhaps the most successful employers tend to be the largest companies with better TDM program resources and larger pools of clerical and data processing personnel. A breakdown by employer size would test this hypothesis. Or, success may be related to program duration, with the longest-running programs exhibiting the most success. Again, a breakdown and tabulation by age of program will test this hypothesis. Overall, the purpose of this chapter is to glean as much as possible from the employee survey data about effectiveness trends and probable reasons for success.

This chapter also should highlight employer annual plans. The most important parts of the plans to summarize are the descriptions of annual program results as provided in the plans, as well as descriptions of TDM measures to date and planned. Again, the discussion ought to be more than a mere summary. It should compare and contrast the types of programs that seem to be associated with more and less successful programs. It should point to any common problems pointed to across employers, and the type of information and assistance most often requested.

Results of Overall Trends in Traffic and Vehicle Occupancies

This chapter would summarize any key data now gathered by traffic engineering staff and reported to the jurisdiction in the form of an annual report perhaps entitled, *Traffic Monitoring Program*. The key data to report are a minimum of the past 3-year trends in

- Peak-period (not just all day, as now reported) traffic volumes on arterials, by jurisdiction subareas.
- Peak-period vehicle occupancy counts on local highways and on arterials used by commuters. Transit vehicle occupancies should not be transit district averages. Surveyors should estimate occupancy at less than 33 percent, from 33 to 66 percent, and over 66 percent, and estimate occupancy on the basis of bus capacity.
- State DOT data on vehicle-miles of travel and vehicle registration presented per unit of population. Many state DOTs collect this information for localities.

The chapter should not just present the data. It should draw specific conclusions about increases or decreases in vehicle occupancies, vehicle registrations, and vehicle-miles of travel per population unit. This information is important to drawing overall conclusions in the last section.

Finally, the results of peak-period traffic volumes on arterials should be categorized and presented in a table comparing volumes for high- and low-growth areas. Growth indicators such as building permits or business licenses should be used to categorize high-, medium- and low-growth areas. This breakdown will indicate to what extent traffic growth is a general phenomenon perhaps related to broad economic and social trends (e.g., changes in vehicle ownership, type of economic activity, and workers per household), or a phenomenon more related to growth and development in specific areas.

Overall Conclusions About TDM Effectiveness

The final chapter would draw overall conclusions about TDM effectiveness on the basis of the findings in the previous three sections. The chapter should draw two conclusions:

- Given the results discussed in report Chapters 1–3, is TDM effective or not in reducing solo driving, peak-period travel, vehicle trip generation, and use of critical intersections?
- If TDM is effective, what is the range of effectiveness along the key indicators?

A specific example will help illustrate the types of conclusions possible from findings in the report chapters. Table 2 presents hypothetical results of the chapters and overall conclusions. In the clear cut case, the traffic generation studies at TDM and control sites reveals significant differences in trip generation; employer surveys of employees indicate declines in proportions of solo drivers and use of critical intersections; at the same time overall traffic is up, especially in high-growth areas, and vehicle occupancies are down. The combined evidence strongly supports the conclusion that TDM is effective. Furthermore, levels of effectiveness can be measured in percent declines. In the inconclusive case, results are mixed or not completely reliable. The site-specific traffic studies exhibit no change, though the number of control sites is limited, making reliable comparisons and conclusions more difficult; the employee surveys exhibit modest declines in solo shares, but the proportions of employees using critical intersections remain the same; on the other hand, overall traffic is up in the locality and vehicle occupancies are down.

Overall, the findings suggest that TDM may be modestly effective in reducing solo driving though not use of critical intersections. It is possible that TDM is reducing not only solo driving (in light of employee survey findings contrasted with locality-wide declines in vehicle occupancies), but is reducing traffic generation at TDM employment sites. However, only by improving the number or type of control sites can this conclusion be made with more confidence.

Clearly, other combinations of findings are possible. Locality traffic and transportation staff must weigh findings carefully and draw conclusions on the basis of the concurrence or disparity of findings and results. In this task, there are no mechanical or set procedures to follow. Good analysis and judgment are required.

The annual report should be submitted to locality decision makers with conclusions about overall program effectiveness and levels of effectiveness. The report should be used to

- Inform the locality decision makers about the effectiveness of TDM, and enable policy decisions about future directions in TDM regulations, TMA roles, monitoring systems, and resources devoted to TDM;
- Inform air quality planners of changes in vehicle-miles of travel attributable to the TDM program to support estimates in emission reductions and conformance to emission reduction goals; and
- Inform the TMA of overall progress in TDM and enable the organization to inform employers about effectiveness, problems, successes, and suggestions for most effective strategies.

COSTS

The cost to a city or county of implementing the evaluation system as proposed will vary considerably. Much depends on

TABLE 2 HYPOTHETICAL OVERALL TDM FINDINGS AND CONCLUSIONS

CLEAR CUT CASE

CHAPTER 1 RESULTS SITE TRAFFIC STUDIES	CHAPTER 2 RESULTS EMPLOYEE SURVEYS	CHAPTER 3 RESULTS LOCALITY-WIDE TRAFFIC	OVERALL CONCLUSIONS
5-10 percent significant difference in last two years	0-10 percent decline in solo shares at larger employers; critical intersection use down	ADT and peak traffic up 3 percent on all arterials, up 6 percent in high growth areas; vehicle occupancies down 2 percent	TDM definitely effective: P.M. traffic: - 10% VMT: - 4% Intersection: - 2%

INCONCLUSIVE CASE

CHAPTER 1 RESULTS SITE TRAFFIC STUDIES	CHAPTER 2 RESULTS EMPLOYEE SURVEYS	CHAPTER 3 RESULTS LOCALITY-WIDE TRAFFIC	OVERALL CONCLUSIONS
No significant difference in last two years, but control sites limited	0-5 percent decline in solo shares, critical intersection use steady	ADT and peak traffic up 2 percent on all arterials, up 4 percent in high growth areas; vehicle occupancies down 5 percent	TDM possibly effective. Based on solo share declines, best case results are: P.M. traffic: - 3% VMT: - 2% Intersection: 0

local cost of labor, survey and data processing contract services, as well as the complexity of developer requirements, role of the local TMAs, and the number of project and control sites used in the traffic analysis. Additionally, there may be costs to local developers (e.g., embedding traffic counters at sites) and costs to TMAs (e.g., contract costs for survey and data entry).

Some indication of cost is provided by the example of Santa Cruz County in California, which recently adopted the evaluation system. The population of the county is 217,000, about twice the median for counties in the state. Obviously, costs may be somewhat lower in smaller jurisdictions and probably much higher in larger jurisdictions. The county program assumes that local TMAs forming in the county will contract for survey processing services. County costs then include those associated with

- Preparing the employer TSM manual,
- Assisting the TMAs to get started with survey contractors,
- Developing and negotiating conditions and covenants as new developments come on line,
- Carrying out traffic monitoring at TSM and control sites (20 total sites are estimated), and
- Preparing the annual report.

The county already carries out regular traffic counts at many locations and does not need many new hose counters. The county traffic engineer has successfully used student interns for manual counting and will add several more for this program. Annual county costs are estimated to range from $40,000 to $70,000 (excluding $13,000 in equipment costs), with costs in the initial year probably toward the high side of the range to allow for start-up planning and development.

CONCLUSION

Local jurisdictions initiating employer-based TDM programs should develop a comprehensive monitoring and evaluation system to track the actions of employers and to assess program results. For best results, the system should incorporate more than the usual annual employee survey. Suggested here is a system of employee and manager surveys, an employer report, roles for the local TMA and developers, and a method for evaluating traffic impacts of demand management. With such a system, local jurisdictions can track not only employer actions and perceptions of results, but jurisdictions also can make their own independent assessments of traffic impacts of demand management. Such assessments are important for continuing, modifying, or curtailing employer-based programs, and developing realistic assessments of whether and how much demand management can lessen traffic and air pollution problems.

Publication of this paper sponsored by Task Force on Transportation Demand Management.

Abridgment

Using Trip Reduction and Growth Management to Provide Affordable Housing

PATRICK H. HARE AND CAROLINE E. HONIG

Several methods exist to both provide affordable housing and reduce single-occupant vehicle trips. Trip reduction measures can reduce the need for parking, and free up land from surface parking for new development opportunities. That land could be used for both market rate and affordable housing. Second-car ownership costs about $3,000 per year. By giving up a second car and using public transportation, a household could save $150 to $250 a month, which could be spent on either rental or owned housing. Local governments could require that parking costs in rental housing be separated from housing costs. This would mean that tenants would save about $40 per month for each car they gave up.

A review of transportation demand management for the FHWA estimates that area trip reduction figures as high as 40 percent may be achievable (*1*). Vehicle trip reductions on this scale obviously reduce the need for parking. TDM not only gets vehicles off the road, it also is a means of freeing up land in existing office and research park developments from surface parking. That land could be used for housing. Providing housing close to jobs should reduce average trip length and congestion.

RECYCLING OF LAND

An analysis of a typical 13-acre office development in Montgomery County, Maryland, indicates that approximately 22 percent of the site could be made available for housing. This recycling would require few changes to the zoning ordinance.

First, parking that exceeds ordinance requirements would be eliminated. Second, parking reduction provisions currently in the zoning ordinance for share-a-ride and shuttle-bus programs would be used. These would provide space for approximately 88 units in an apartment building. An additional 9 units of housing would be provided through a zoning amendment permitting a 10 percent parking credit in residential zones in return for providing shuttlebus service to transit. A similar credit is already in place for office developments in Montgomery County. Another 4 units could be provided through a zoning amendment that provided a 5 percent parking credit for charging tenants separately for apartments and parking spaces. Estimated operating and amortization costs for surface parking, according to adjustments made for residential parking, on the basis of a recent study completed by the Eno Foundation, are $480 per year, or $40 per month (*2*). The incentive of saving $40 a month per car should be high enough to reduce car ownership by 5 percent in all but the most expensive apartment complexes.

Finally, a zoning amendment to permit shared parking between office and residential uses would permit an additional 23 units. Demand for parking near jobs peaks when demand for parking near homes is lowest. On the basis of the Parking Policies Study for Montgomery County, Maryland, and the ratio of housing units to office workers on the site, 40 percent of the parking for housing could be provided through shared parking with the office complex. Before calculating the number of spaces that could be saved through shared parking, 30 percent of the spaces required by the housing were set aside for reserved parking for tenants who wanted their own individually marked space available to them at all times. In total, land freed up from surface parking could provide space for 124 residential units.

OWNER-TENANT AGREEMENTS

If the occupant of the office, research, or light industrial space is not the property owner, he or she would not directly profit from the housing development, and there may be little or no incentive to reduce surface parking or to provide housing. Some kind of financial gain must be provided to tenants. One method would be for a building owner to provide a reduction in rent to tenants who reduced their parking requirements. The tenant in turn could pass on some of the rent reduction to its employees who gave up free parking.

A second possibility would be for a local government to pass legislation requiring an equalization of commuter subsidies. Under such a law, employers would be required to offer all employees the same dollar amount in transportation subsidy, regardless of their means of commuting. Where parking was worth $5 a day, employees who did not use it would get $5 a day, or $1,250 a year to use for transit. If they walked or carpooled, they could keep nearly all of it as extra income.

FORMER SITES

When creating housing on former parking sites, it would be important to ensure that the housing was not isolated from

Transportation Planning Division, Maryland National Capital Park and Planning Commission, 8787 Georgia Avenue, Silver Spring, Md. 20910.

neighborhood amenities, such as schools, parks, and local shopping. Providing local shopping may not be a problem. In fact, it might be wise to require local convenience shopping and day care as part of the residential complex with the intention of having it serve adjacent office buildings as well.

HOUSING REQUIREMENTS

Landowners may say that they have a right to use land freed up from surface parking for commercial or industrial uses because the land is zoned for those uses. For those sites in which zoned development has a vertical cap, the issues of housing versus other, more profitable, uses may not arise. In such cases, local jurisdictions can make housing development the owner's only option for land freed up from surface parking. In other cases, where zoning capacity for office or industrial development remains, the local jurisdiction should consider passing a zoning amendment that required the development of housing on some percentage of land freed from parking before any development of office or industrial buildings on that land. Owners who did not want to develop housing, or who could only free up enough surface parking for a small project, could be allowed to develop nonresidential buildings in return for a contribution to a housing development fund.

CAR OWNERSHIP AND HOUSING

It is a surprise to most people that 20 percent of the average household budget is spent for transportation, and that the percentage varies little with income. It is less surprising that almost all the household income spent for transportation goes for travel by car. If people could spend less on cars, they could spend more on housing. The result would be less congestion, less pollution, less greenhousing, and more affordable housing.

How much can an entry-level, two-worker household save and apply to housing costs by living where the household could give up one car and still walk, bike, or take transit to work? A 1984 FHWA report, *Cost of Owning and Operating a Car* (*3*), indicates that giving up a 7-year-old compact car, a typical second car, would save $3,118 a year. To be conservative, a figure of $3,000 is used in this analysis, even though the figure has increased since 1984.

Many households that give up a second car will have increased transit expenses. Allowing $5 a day for transit fares for 250 working days a year, or $1,250, a household's net gain will be $1,750 ($3,000 − $1,250) per year, or $146 per month. This amount can make a significant difference in whether or not a rental unit is affordable. It can also make homeownership more affordable. At 12 percent interest over 30 years, each $1,000 in the cost of a home requires $10.29 a month in payments. An additional $146 means a household can purchase a home that costs $14,189 more. That is a significant jump in affordability.

If a household is within walking or biking distance of work, it could keep the total $3,000 saved annually by giving up the second car. Some bicycles are expensive, but they are typically owned for recreation anyway. The costs of keeping a utilitarian three-speed bicycle for commuting are negligible. However, saving $3,000 a year, or $250 a month, means a household could purchase a home that costs over $24,400 more, or rent an apartment for $250 more per month.

LIVING NEAR TRANSIT

There is a great deal of information available to people searching for a home to buy. Little of it, however, addresses the fact that homes on the exurban fringe may be affordable housing but they lock households into the expense of owning two or more cars. A locally published brochure could emphasize other key points in addition to those mentioned earlier:

1. Cars depreciate every year, meaning the owner loses roughly $3,000 each year. After 5 years, the car owner would lose $15,000. However, after 5 years a house or condominium could appreciate by 10 percent, providing a homeowner who invested the $1,750 per month in housing, rather than a car, with an additional $7,500 in appreciation.
2. Bicycle commuting allows commuters to live further from a transit stop than is possible if the commuter walks to transit. A typical cyclist covers 2 mi in the same time a typical pedestrian covers ⅓ mi (Figure 1). (Seasonal variations in bicycle use tend to vary from 60 to 140 percent of the annual mean in many temperate-climate areas with significant bicycle travel.) From the point of view of the home buyer, willingness to use a bicycle results in a much better choice of homes and prices.
3. Choosing a home on the outskirts of a metropolitan area affects career mobility. A person's opportunity to change jobs within a metropolitan region is limited if he or she lives so far on an edge of the region that many commutes will be impractical without relocating. This problem is compounded for a two-worker household. In contrast, a home with good access to a region's transit system means good access to a large proportion of the region's jobs, without unreasonable commutes or the need to move.

EFFECT ON MORTGAGE CAPACITY

Unfortunately, giving up a car may not help homebuyers qualify for mortgages. Banker's formulas typically do not take car ownership into account. They do take into account car loans owed by applicants, but in many cases the second car will be paid off. Giving this type of car up will not enable a household to qualify for a larger loan. Local governments might want to take a more aggressive approach than a brochure by offering mortgage insurance to lenders that would increase lending limits to potential homeowners who signed a binding agreement not to purchase a second car. A lender, for example, by agreement with the local government, would permit a homeowner to have an additional $14,000 in credit for not having a second car. The county in return would provide insurance to the lender for up to $14,000 in losses in the event of default.

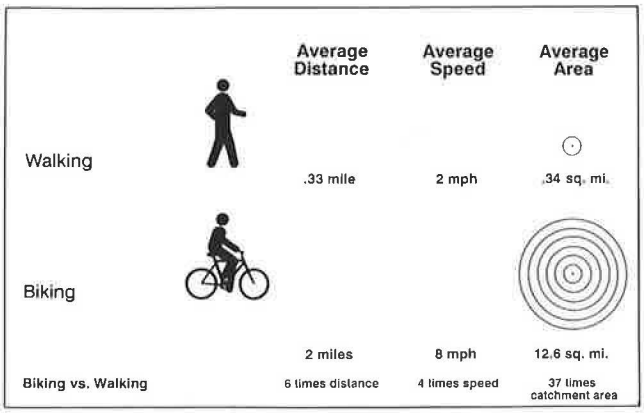

FIGURE 1 Pedestrian and bicycle transit access distances.

SUBDIVISION DESIGN

Local governments should also consider working with developers to design subdivisions that do not require second-car ownership. Such subdivisions would probably have pedestrian easements that ensure that all homes are within walking distance of bus stops with frequent peak-hour service, as currently required in Ottawa, Canada. The subdivisions should also have convenience retail shops within walking or cycling distance. It might also be worthwhile to consider including a car rental agency nearby. The easy opportunity to rent a second car when needed can reduce anxiety about giving up a second car.

PARKING IN RENTAL HOUSING

A policy that required landlords and condominiums to separate housing and parking costs would enable residents to know how much they were paying for parking. A recent study of parking costs by the Eno Foundation estimated that the annual costs of a surface parking space in a commercial district is $995 ($83 per month) (*2*). After eliminating costs for lot attendants, and cutting land costs in half to reflect the lower value of residential land, the costs of a surface residential parking space in a suburban area are approximately $40 a month.

If a local zoning ordinance required landlords to charge separately for housing and parking, tenants would have an additional $40 per month if they give up a second car, and $80 per month if they could give up two cars. If an apartment with parking cost $600, the projected savings to the tenant of giving up one car would be 7 percent, a significant rent reduction.

Obviously, existing landlords would object because they would not want to see their income reduced. The ordinance should therefore also allow landlords the opportunity to use surface parking land for income-producing uses that helped tenants get along with fewer cars. Examples would be day care centers, convenience retail for use of residents only, and car rental agencies.

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Publication of this paper sponsored by Task Force on Transportation Demand Management.

North Brunswick Traffic Management Program, 1987 to 1990

MICHAEL L. KISH AND RICHARD L. ORAM

In October 1987, the township of North Brunswick, New Jersey, passed an innovative traffic management ordinance that required commercial and residential developers, property managers, and employers of 50 or more employees to make annual travel surveys, promote ridesharing, and set aside preferential parking for ridesharers and van pool staging and park-and-ride lots for commuter bus service to New York City. Work schedules must be concentrated so that no more than 60 percent of the total workforce is scheduled to begin or end work regularly during the morning and afternoon peak periods (7:20 to 9:10 a.m. and 3:50 to 5:40 p.m.). The traffic management ordinance is reviewed from the appointment of a task force to its implementation through December 1990.

This document is a comprehensive report on the evolution and implementation of the township of North Brunswick, New Jersey, Traffic Management Program. North Brunswick's efforts are nationally significant because of the adoption of a comprehensive traffic management ordinance in October 1987.

The traffic management ordinance required all employers of 50 or more employees in the township to survey their employee commute patterns to North Brunswick. They were also required to submit surveys from at least 75 percent of their workforce, both full- and part-time employees. If 60 percent or more of these employees commuted in the a.m. peak period (7:20 to 9:10 a.m.) or p.m. peak period (3:50 to 5:40 p.m.), or if 40 percent or more were concentrated to begin or end work regularly during any specific 15-min time slot in the defined a.m. or p.m. peak periods, they were required to prepare and submit traffic management plans to the Office of Traffic Management (OTM).

Developers of 20 or more new residential units were also required to survey buyers of these units as to their commute patterns and interest in park-and-ride facilities, shuttle service to mass transit, and vanpooling opportunities. Developers of 350 or more new residential units were required to construct park-and-ride facilities at a ratio of one parking space for every 10 units in the development. There were also requirements for developers of 15,000 ft^2 or more of nonresidential complexes, such as submission of traffic management plans.

An employment survey was also developed and distributed to the 23 largest employers in the township to gather information on scheduled work hours. The results revealed that the concentration of starting and ending times during rush hours for employees with fixed schedules were a major factor contributing to the existing levels of traffic congestion.

M. L. Kish, Office of Traffic Management, Township of North Brunswick, 711 Hermann Road, P.O. Box 182, North Brunswick, N.J. 08902. R. L. Oram, Oram Associates, 247 West 87th Street, Suite 14C, New York, N.Y. 10024.

1988

In January 1988, the township implemented the ordinance's first requirement, that companies of 100 or more employees participate in surveying their employee commute patterns. A total of 29 employers of 100 or more employees were identified, and all ultimately submitted survey results of their work force.

In this first year, the responses from the affected companies were mixed. According to the ordinance, companies required to perform surveys were also required to submit surveys from 75 percent of their entire work force. As a result of their surveys, 10 companies were found to be out of compliance. Three companies failed to receive a 75 percent response from their employees, yet, this was considered to be a huge success because this action was the first that the Office of Traffic Management required of the businesses. Few businesses, however, were induced to develop significant traffic reduction plans. An obvious conclusion was that additional staff effort to work with employers was needed.

One major accomplishment of the first year was the appointment of 29 employee transportation coordinators (ETCs), one at each township firm with more than 50 employees. These people are charged with the responsibility of putting forth their company's traffic management program. This established a good foundation from which a partnership could be developed between the township and the private sector.

1989

It had become evident that it was necessary for OTM to not only simplify the survey form, but also provide assistance in processing the survey data and implementing plans. By providing these services, OTM took a considerable burden off the companies, especially concerning data analysis. Data reliability was also improved. As in the first year, all the companies were still required to survey their entire work force and receive at least a 75 percent response rate. The number of businesses required to participate in the survey process (29) remained the same as the first year. The image of program materials was also upgraded considerably in the second year.

The key aggregate results of the 1989 employee transportation surveys were as follows.

- 46 percent of the responding employees commuted in the a.m. peak period (7:20 to 8:40 a.m.),
- 40 percent of the responding employees commuted in the p.m. peak period (3:50 to 5:10 p.m.),

- 14 percent of the responding employees commuted in the largest-concentration period of 7:47 to 8:01 a.m.,
- 87.2 percent of the responding employees drove alone,
- 5.9 percent of the responding employees were either car- or vanpool drivers,
- 3 percent of the responding employees were car- or vanpool passengers,
- 2.1 percent of the responding employees were dropped off at work,
- 0.7 percent of the responding employees walked to work,
- 0.7 percent of the responding employees took the bus,
- 0.3 percent of the responding employees took the train, and
- 0.1 percent of the responding employees said "other."

In October 1989, after considerable assessment by OTM of the overall results achieved to date, the ordinance was amended by the township council to improve its impact. The 1989 survey data base was used to assess the impacts of a number of alternate formal changes to the ordinance. Modifications were also made concerning administrative procedures. As a result of these changes, employers of 50 to 99 employees became subject to the same requirements as those with 100 or more employees. The specified peak periods were also broadened to reflect congested conditions that existed over longer periods of time compared with those that existed in 1987 when the ordinance was adopted. The new designated peak periods were 7:20 to 9:10 a.m. and 3:50 to 5:10 p.m., versus the original indicated hours of 7:20 to 8:40 a.m. and 3:50 to 4:40 p.m. These changes resulted in more companies being required to develop traffic management plans. Additional administrative changes were also adopted at this time.

1990

As a result of the expansion of one-half hour on each of the designated peak periods, and applying the new peak hours to the 1989 company data base indicated that 16 businesses were out of compliance with the ordinance. Recognizing the burden of annual surveys and that the objective of the program was to implement traffic management techniques, as opposed to surveys per se, the Traffic Management Committee decided to give businesses the option of performing employee transportation surveys in 1990. If they chose not to survey, a procedure was established by which 1990 compliance was calculated using 1989 survey data. Combined with the 1989 data and the new, broader peak hours, a penalty factor was assessed for incomplete surveys. This was done because it could be assumed that most nonrespondents were single-occupancy vehicle drivers. For 1990, figures from the combination of a 50 percent penalty factor for nonresponse and incomplete surveys were applied.

If the businesses accepted OTM's findings and also were found to be out of compliance in 1990, definite recommendations were provided concerning areas of attention and specific actions that were expected to be addressed.

These typically were as follows:

1. Establish preferential parking for employees who rideshare (by carpool or vanpool).
2. Implement an employee rideshare program (by offering matching services, promotions, etc.).
3. Announce that the company would provide emergency midday travel services for ridesharers (a guaranteed ride home).
4. Establish a permanent bulletin board dedicated to the township's traffic management program (posting rideshare information, the township's traffic management F.Y.I. materials, flyers, etc.).
5. Consider adopting flextime for all employees where it is feasible (with staggered work hours or an alternate work schedule).

These five actions are now being actively pursued by the employers. OTM is visiting all affected businesses to monitor their progress.

OTHER PROGRAM ACCOMPLISHMENTS

Perhaps ultimately having the most impact on the state level, Senator Walter Rand of Camden sponsored legislation (S–348) in the New Jersey State Senate, *The New Jersey Traffic Management Act of 1990*. This legislation was modeled after North Brunswick's traffic management ordinance. It would require every business located in designated traffic "hot spots" with 250 or more employees to participate in an annual transportation survey. It would also require these employers to reduce the peak-period automobile trips of its employees to 70 percent of the trips that would be made if all employee trips were made in single-occupancy vehicles. This legislation is currently in the New Jersey State Senate Transportation and Communications Committee of which Senator Rand is the Chairman, for review. The OTM has participated in numerous hearings concerning this important initiative. This legislation is cosponsored in the New Jersey State Assembly by Assemblymen George Spadoro of Middlesex and Frank Pelly of Middlesex.

KEY INSIGHTS

There have been many insights gained from the process of implementing North Brunswick's ordinance. One is the need for flexibility. This refers to realizing that not all businesses in the township could successfully implement all of the actions that were initially required. Each business has its unique operating methods and style, and of late, employment conditions have changed in the local economy. As a result of the differing nature of the businesses, each must be considered unique. Keeping these differences in mind, the Traffic Management Committee decided that there were some actions that all employers could be required to address. Some examples of these areas are preferential parking for those who rideshare, appointment of an ETC, and dedication of a bulletin board for all traffic reduction information provided by OTM. Other actions from the traffic management agenda had to be considered more discretionary. The percentage-based standards on which the ordinance is based are a more acceptable framework for the ordinance than are any mandated specific actions.

The practice of transportation demand management is in its infancy, whereas traffic congestion has been evolving through the years. It is a function of long-term land use, employee benefits, development policies, and related factors that are deeply entrenched. The primary thing to do is to achieve small positives. Transportation demand management does not take huge amounts of traffic off the roads, but it does have valuable incremental effects. Also the public and the business community should be educated on alternatives to commuting by single-occupancy vehicles, standard working hours, etc.

CONCLUSION

Communication is key to any endeavor. Communication may be used as a way to gain and frame cooperation and consensus behavior. It is possible to downplay the punitive elements of the ordinance, because it is essentially an effective communications tool. A good example of the public-private partnership approach is a traffic management seminar that OTM recently provided for companies to assist employees who commuted to North Brunswick. A majority of the 29 businesses required to comply with the ordinance were represented at this seminar. This seminar featured speakers on the practice of and positive results experienced from using transportation demand management.

What the future holds for traffic management in New Jersey is yet to be unveiled. Ideally, it is hoped that the ordinance concept gains acceptance and becomes a state-wide program. Yet, the pace of change has been influenced and real processes, policies, and practices to this end have been originated.

In summation, the program is growing in many directions. The ordinance holds promise as an effective tool for reducing traffic congestion. The ordinance has been proven to be an effective method for obtaining continued cooperation of all parties involved. Its continued local implementation and successful expansion geographically now seem promising.

Publication of this paper sponsored by Task Force on Transportation Demand Management.

Abridgment

Overview of Trip Reduction Ordinances in the United States: The Vote Is Still Out on Their Effectiveness

ELIZABETH SANFORD AND ERIK FERGUSON

Trip reduction ordinances (TROs) are local or regional regulations for implementing transportation supply or demand management strategies that improve transportation system efficiency. Perhaps as many as 50 local, regional, and state TROs have been passed, depending on how TROs are defined. Most TROs operate at the municipal level of government, and are intended to mitigate existing or future traffic congestion. Most TROs apply to both new and existing development. TRO implementation strategies vary considerably, but often include the provision of employee transportation coordinators and the development of site-specific transportation management plans. TROs lean slightly toward demand side provisions, but often include supply side provisions as well. Most TROs encompass some mandatory provisions, but voluntary and optional measures usually are included as well. The vote is still out on TRO effectiveness. Many jurisdictions are grappling with the issue of TRO performance monitoring and evaluation. Recommendations for promoting greater consistency in TRO evaluation across jurisdictions are made, including suggested sample design and survey methods.

Transportation planning in the United States for decades has placed primary emphasis on providing additional infrastructure to accommodate increasing travel demand over time. This supply side emphasis is no longer completely accurate in representing transportation planning activities in the United States (*1*). The original goal, to meet urban transportation needs, is still the same. What has changed are the means available to accomplish this aim. A new framework for transportation demand management (TDM) recently has emerged (*2*). Innovative strategies for meeting mobility needs include mechanisms to oversee the supply of infrastructure and programs to alter the demand for transportation. Particular focus has been placed on managing the travel needs of commuters, i.e., the bulk of those who travel during the hours of heaviest traffic congestion. The growing number of work trips, and the adverse consequences of too many vehicles on the road, have led to a variety of mainly local government initiatives aimed at reducing the number of vehicle trips generated during peak hours.

TDM initiatives include, but are not limited to, the formation of public-private transportation management associations (TMAs), the imposition of impact fees for traffic generated by new development, increased maintenance for existing infrastructure, and the formulation of trip reduction ordinances (TROs). Since 1982, as many as 50 TROs have been enacted in the United States. TROs have been legislated primarily by local governments. Several TROs have been established by county, regional, and even state governments. Approximately two-thirds of all TROs are located in the state of California (*3–5*). TRO legislation has been passed at one or more levels of government in at least 10 other states, including Arizona, Connecticut, Georgia, Maryland, Minnesota, New Jersey, Oregon, Texas, Virginia, and Washington.

E. Sanford, TAMS Consultants, Inc., 1855 Gateway Boulevard, Concord, Calif. 94520. E. Ferguson, Graduate City Planning Program, Georgia Institute of Technology, Atlanta, Ga. 30332-0155.

DATA AND RESEARCH METHODOLOGY

Data for this analysis were collected from a number of sources, including a national survey administered by the second author in conjunction with Jesse Glazer and Jennifer Dill of Crain & Associates in Los Angeles and the Association for Commuter Transportation. Information on all known TROs in the United States as of about September 1989 was included in the sample, which serves as a national census of TROs.

Summary data on the more salient features of TROs are described in simple statistical terms. In general, more information was available for TROs that had been in effect for longer periods of time. These more established TROs tended to have greater experience in the implementation of TRO provisions, as well as in the evaluation of TRO programmatic results.

OPERATIONAL DEFINITION OF TROs

Most TROs are aimed primarily at reducing traffic congestion caused by a surfeit of vehicle trips on existing roadways. TROs are not indistinguishable from one another, however, nor are they uniformly defined (*6*). Instead, each TRO uniquely blends available transportation management approaches and incentives. Further definition requires characterizing the specific goals of each ordinance, who the ordinance applies to, and the means by which identified goals are to be achieved. Two distinct goal orientations are found in TROs. The first is to mitigate existing or future traffic congestion, in specified areas, often at specified times. The second tends to be more com-

prehensive in nature, often using TROs to promote objectives related to improving air quality and decreasing energy consumption, as well as alleviating traffic congestion. In some cases, TROs are also used to generate revenues through the imposition of development impact fees.

Another characteristic of TROs concerns who is affected by it. Applicability is usually related to the goals of the ordinance. When objectives target the mitigation of future traffic congestion, TROs tend to focus on new development or the expansion of existing employment centers only. If mitigation of existing traffic conditions is paramount, TROs often are aimed at all private employers. Target populations can be identified by square footage of office space, number of persons employed, or location of their facility. In addition, new residential development can be placed under the umbrella of a TRO, although this is far less common.

A broader approach to devising TROs is often taken by state or regional legislation and is aimed at encouraging planning or zoning changes at the local level, so as to indirectly promote a reduction in travel.

A third characteristic of TROs concerns implementation strategies (i.e., how to achieve stated TRO goals). TROs can be implemented through management of the supply of transportation infrastructure (i.e., road maintenance, traffic signalization, other highway improvements, or the provision of alternative modes) or through management of demand (i.e., ridesharing incentives, vanpool programs, travel subsidies, flexible hours, or the employment of on-site employee transportation coordinators (ETCs). TROs that focus exclusively on either the demand or the supply side tend to make all TRO provisions mandatory, with little flexibility in response from regulated parties. TROs that include both supply and demand side provisions often include both mandatory and voluntary provisions, with commensurately greater flexibility in response allowed.

EVALUATING TRO SUCCESS

Evaluating TRO programmatic success is often problematic because of an indirect linkage between stated goals and actual effects. Specific objectives of mitigative TROs (excluding ordinances designed solely to generate revenues) might include reductions in vehicle-miles of travel (VMT) or improvements in the level of service (LOS) on given streets or highways. Some TROs are aimed at reducing the number or percentage of single-occupant vehicles (SOVs) on the road at a given time. Improvement in air quality by reductions in vehicle emissions through reduced VMT is an objective of some regional TROs.

The dilemma of TRO evaluation arises because achievement of TRO ends is sought through fairly indirect means. Often the mandatory aspects of TRO legislation involve designating an on-site ETC or installing bike lockers and showers at work places. These mandates are not linked directly to traffic reduction. The TRO can be "successful," in that all business concerns in an area have complied with its mandates, yet not make much if any progress toward its goal of trip reduction. The intermediate step between successful implementation of a TRO and achievement of its objectives is the formulation of specific goals by parties affected by the TRO. The challenge is to define success in such a way that progress toward the given objective can be measured.

If a TRO states that a reduction in VMT is the end sought, and the strategy to attain that end is to mandate that all businesses with greater than 100 employees hire an ETC, then the first measure of success is placement of ETCs at all businesses of the required size. The next step is entirely contingent on goals to be achieved at each specified firm. It is critical that behavioral goals be defined and made measurable at the lowest level of program implementation possible.

A fair contribution by any given firm might be defined as a 25 percent reduction in the number of employees who drove alone to work at the beginning of the program. With an operational definition at this level of implementation, parties affected by the ordinance can be monitored through identification of baseline conditions, preparation of an initial transportation management plan (TMP), and submission of periodic progress reports, at least until conformance is achieved. With relevant employee data in hand, an agency can then calculate the resultant impact on VMT or emissions.

Several facets of existing TROs may hamper efforts at evaluating their success. Foremost among these is that data collection is not always required by the ordinance. Nor are employer-based transportation program goals always specified. Without adequate program structure, TROs may be a form of wishful thinking. A second constraint lies in the ambiguity found in the stated goals of some other TROs. Without specific objectives, there is nothing really to be measured in terms of actual performance. TRO evaluation is a rhetorical question in such cases. A third constraint lies in the voluntary nature of some program elements. If a TRO suggests rather than requires specific behavioral changes, there may be no way to define TRO success in any objective fashion.

Given the chasm between ideals and the current reality of TROs, it is necessary to consider ways and means to improve evaluation efforts. In the case of traffic mitigation goals, a standard for employee participation that is rationally linked to VMT should be considered. Some TROs do set standards such as this. However, many agencies do not know how successful a TRO has been, because few means of evaluation are possible given the constraints of existing legislation.

One might preface more adequate TRO evaluation with a preliminary study aimed at identifying program elements that seem to work in a variety of different organizational settings and locations. More preliminary research is needed because there is no model TRO legislation that incorporates the need for comprehensive performance monitoring and program evaluation at this time. Lacking the development of more realistic standards for TRO success that explicitly link changes in employee travel behavior to changes in ambient traffic conditions, evaluation of the effectiveness of TRO programs is infeasible from a methodological perspective.

OVERALL ASSESSMENT OF RECENT TRO EVALUATION EXPERIENCES

Although a comparative evaluation of existing TROs indicates significant variations in the methods used to lessen traffic, less variation exists in terms of preliminary findings and conclusions. Preliminary findings include the following:

Designing a Community for Transportation Demand Management: The Laguna West Pedestrian Pocket

STEPHEN P. GORDON AND JOHN B. PEERS

The field of transportation demand management has, until now, focused on reducing automobile use at suburban activity centers that are largely dependent on automobile access. Recent research has indicated that at sites where nonautomobile alternatives are inferior and parking is plentiful, mode choice for work, shopping, recreational, and linked trips can be influenced to a limited extent. In Sacramento County, California, a new mixed-use community currently under development may significantly affect the degree to which site design is used to influence mode choice. Known as the pedestrian pocket, new design elements and guidelines for site planning, density, and access are incorporated that may significantly affect lifestyles and travel mode choice for its inhabitants. Key design features include concentration of commercial, shopping, and office uses in a town center that is surrounded by high-density residential neighborhoods and large public spaces. The town center contains a transportation center, which acts as a focal and transfer point for transit services to internal and external points. Innovative roadway geometric designs, residential proximity to the town center, and landscaping are used to influence mode choice by encouraging nonvehicular travel and limiting automobile use for certain internal trip paths. Analyses of the potential for reduced automobile use indicate that project design alone may result in average daily vehicle-miles travelled reduction of 20 to 25 percent, and up to 15 percent in the peak hour alone. These reductions are based on travel patterns and mode splits typically associated with suburban activity centers of standard design.

A new type of mixed-use community is being developed in Sacramento County, California, that may have significant impacts on lifestyles and travel habits in future urban developments. Known commercially as Laguna West, this project is based on the pedestrian pocket concept, a unique approach to designing a planned unit development (PUD) developed by Calthorpe & Associates. This represents a new-generation PUD, whose design will preserve open space and minimize automobile use, and hence, average daily vehicle-miles of travel (VMT)—a key goal of any transportation demand management (TDM) or transportation system management (TSM) plan. The mixed-use site plan combines light industrial, office, commercial, recreational, and retail land uses with a large residential component.

The pedestrian pocket concept is unique in the way it redefines the spatial relationships among different activities within the community. A key design characteristic is higher development density, both within land use zones and between them. For example, residential densities close to the central commercial hub or town center will be 20 units per acre (R–20), and 14 per acre for the entire development. This is double the average for new suburban subdivisions in northern California. Residential density is reduced with distance from the town center to a low of R–7. The reduction of individual lot size is balanced by a presence of large, accessible public spaces and preserved open spaces nearby. As a consequence, overall residential densities are the same as for the standard subdivision in Sacramento County.

Many residential areas are located within walking distance of commercial and recreational facilities. Most of these would be located within or adjacent to the town center, a concentration of commercial, retail, and office uses, which will include a transportation center. At full buildout, the 1,000-acre Laguna West development will contain 3,400 residences of various size and density and up to 7,000 jobs. It will also include an elementary school, day care sites, offices, and sufficient convenience retail for the residents of the area. Approximately 35 percent of all residences lie within a ¼-mi radius of the town center, making it a popular, accessible destination.

The adopted street pattern is a radial hub and spoke system, providing direct links between all residential areas and the town center. Many residential streets are laid in a grid pattern, creating an interconnected, clear street system that provides multiple short, direct paths for both pedestrian and automobile circulation. Streets are narrow, in some cases 45 percent narrower than standards used for more typically designed subdivisions. Winding street patterns with dead ends and cul-de-sacs, typical in many suburban subdivisions, are avoided to prevent traffic concentration on major arterials and at key intersections, and longer travel distances for pedestrians and cyclists.

Capacity along arterial streets and thoroughfares adjacent to or outside of the pedestrian pocket must be sufficient to allow for the efficient movement of through-traffic. This procedure minimizes the amount of through-traffic attempting to pass through the development. These roads are typically located between the pocket and an outer, or secondary, area zoned for less-dense commercial or industrial development.

Finally, the emphasis and ultimately the acceptance of alternate modes of mobility, primarily walking and mass transit, are key to the potential success of this type of community.

Fehr & Peers Associates, Inc., 3685 Mount Diablo Boulevard, Suite 301, Lafayette, Calif. 94549.

1. Observed changes in travel behavior can be large or small. TROs may not have had major impacts on employee mode choice in most cases, at least not through the first several years of operation. Southern California provides a partial exception to this finding. TROs have had more success in altering the timing of commute travel, primarily through encouraging employers to provide alternative work hours to their employees.
2. Data collection needs are generally large. Even in the smallest jurisdictions, thousands of employee surveys must be collected in order to identify observed changes in employee travel behavior resulting from TRO implementation. Most jurisdictions currently require annual employee survey updates.
3. Analysis often is not carried through. Given the cost of collecting employee travel data, information provided may not be used to the fullest extent possible. In most cases, the data are tabulated and synthesized into frequency distributions. The relations between variables often are not considered explicitly. The effectiveness of specific TRO program elements cannot be differentiated under these all-too-common circumstances.
4. Feedback is important. The key to more effective TROs lies in providing adequate feedback to decision makers on whether or not goals and objectives are, in fact, being met through implementation over time. A small number of TROs seems to have achieved their objectives, more or less, whereas most of the others are still working hard on accomplishing theirs. Some jurisdictions that have evaluated program effectiveness have modified certain provisions of their TROs in response to short-term evaluation results. This reiteration is part of a difficult but ultimately necessary process if innovative TROs are to develop into effective public policy instruments.

FUTURE DIRECTIONS

The incentive to implement TDM initiatives such as TROs lies in the degree to which local or regional mobility has been adversely affected by low service levels. When the problem is painful enough, the political system reacts. It is not likely that TROs will be the preferred alternative for mitigating congestion problems throughout the country because not all regions accept proactive local government intervention. Alternatives such as TMAs seem better suited for areas with a history of business community involvement in local governance or with an orientation toward negotiation and consensus building.

Whether TROs gain in popularity is clearly dependent on adequate resolution of the program evaluation issues discussed here. Without appropriate methods to gauge the effectiveness of existing TROs, there will be little incentive to consider them in areas uncomfortable with mandated changes in travel behavior. With the vote still out on which TDM strategies are most effective, more rigorous program evaluation is the next step needed.

ACKNOWLEDGMENTS

This research was funded partially by a grant from the Association for Commuter Transportation.

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Publication of this paper sponsored by Task Force on Transportation Demand Management.

TRANSPORTATION AND TRAFFIC GOALS

The term "pedestrian pocket" does not indicate that vehicular traffic is prohibited or unwelcome in this development. Rather, it describes an environment intended to be safe and inviting to pedestrian activity and interaction. In the pedestrian pocket, all modes of travel have a role. Thus, the transportation objectives are

1. To limit automobile use to the most appropriate or necessary purposes, e.g., by minimizing automobile use for intracommunity trips or errands, and commuting;
2. To maximize the opportunities for and attractiveness of alternative travel modes, particularly for pedestrians and cyclists;
3. To enhance public safety through designed separation of pedestrian and cyclist traffic from motor vehicles; and
4. To promote strategies to encourage mass transit use.

The combined, intended effects of these objectives are reduced dependence on automobiles for many routine trips, reduced average trip lengths, and hence, a reduction in community-wide VMT.

EVOLUTION IN LAND USE PLANNING

This section contains a brief discussion on the evolution of postwar land use planning methods, culminating in the pedestrian pocket concept. Each method of land use planning was shaped by the transportation facilities that serve them, from the postwar freeway-induced sprawl to mixed-use sites that deemphasize automobile use.

First Generation

Pre–World War II suburban development patterns were often constrained by the need for access to the commercial core of the central city, and by poorly developed networks of regional highways. Thus, commercial or residential subdivision development rarely took place far from existing major arterial roadways and public transportation facilities.

After the war, these constraints quickly disappeared with the rapid expansion of regional highway systems. Freeway expansion and the proliferation of inexpensive property and energy encouraged rapid suburban sprawl surrounding most large American cities. Often, the availability of highway access was the only guideline affecting location and density. Provision of nonautomobile travel alternatives was rarely a primary consideration.

Second Generation

The second generation of land use planning marked the introduction of specific plans and PUDs. These often consist of large tracts (3,000+ acres) zoned for a single (and more recently, multiple) use, and are designed to function independently of adjacent developments. Transportation access and distribution is designed for and dominated by the automobile for residential, business or professional, and commercial land uses. For example, many typical suburban business developments or business parks could be characterized as "islands in a sea of parking," often served by access systems segregated from local roadway networks. Interaction between buildings within a development is often automobile-dominated as well.

Roadway design commonly limits rather than promotes access within or between PUDs and adjacent areas. The hierarchy of roads, ranging from major arterial to minor street, is designed to limit exterior access to a few key points, exacerbating peak-hour traffic congestion. As with first-generation developments, little provision is made for alternative forms of access and circulation.

Third Generation

The third generation of planned development is characterized by the pedestrian pocket concept. In this case, the same large tract of property (3,000+ acres) is divided into smaller (1,000-acre) parcels, each developed as a mixed-use site. Each parcel contains a town center, with a mix of business, professional, and commercial development, surrounded by high-density residential areas. Outlying lower-density residential neighborhoods, though separated from the town center with large parks and public spaces, are connected by direct, radial arterial streets with clear view lines.

Most residential lots are smaller than in standard subdivisions. However, the absence of larger residential lots is balanced by the availability of numerous recreational amenities and large, nearby open spaces. These developments will have an average of 10,000 residents, considered by many to be an optimal size for community interaction within a village environment (e.g., such as Columbia, Maryland).

The pedestrian pocket transportation system incorporates walkways and bikeways that are physically separate from the street system. Mass transit services, including an internal circulation shuttle and services to exterior points, are easily accommodated. The latter may involve either bus or light rail service. The town center transportation center can be designed to accommodate either mode. However, achieving significant VMT reductions does not depend on heavily patronized transit service. Most VMT reductions would be attributable to the internalization of many routine trips and shorter average trip distances, which make nonvehicular travel alternatives more practical and attractive.

TRANSPORTATION SYSTEM DESIGN FOR THE PEDESTRIAN POCKET

Design Theory

The pedestrian pocket street network is designed to accommodate a balanced transportation system, where all travel modes promote pedestrian presence and activity. The design complements and reinforces increased community interaction in large public (as opposed to private) spaces. Public transportation is within walking distance of most residential areas. The town center is also accessible by foot or a short shuttle bus ride (35 percent of all residences are within ¼ mi).

Design standards were developed to match each street type to its respective role or function, in terms of speed limitations and circuitousness. These include residential streets, internal circulation streets, and major arterials that connect to regional roadways. The road network is designed to bring the key elements of the community together, while minimizing traffic within other areas. For example, major thoroughfares (primary residential boulevards) link the town center with key residential areas as well as commercial and industrial sites. At a lower level of performance, residential collectors and minor residential streets circulate among the various neighborhoods; minor residential streets provide access to individual homes at still lower performance levels.

Design Application

Innovative design criteria have been developed for the project's transportation system. The goals are to modify driver behavior, enhance safety, and limit the dominance of motorized traffic. The design criteria are summarized in the following subsections.

Orientation to Town Center

The town center is served by a system of major streets that radiate symmetrically to the surrounding residential areas. Radial access provides excellent view corridors between these areas, which will encourage travel to and from the town center, particularly nonvehicular travel from close-in neighborhoods.

Grid Street Pattern

Many of the streets are laid out in a grid pattern, particularly within residential areas. This pattern results in multiple short routes between the town center and residential neighborhoods and external areas, and traffic is evenly dispersed onto parallel routes. This is a significant departure from circulation systems commonly found in northern California subdivisions characterized by circuitous collector streets, numerous cul-de-sacs and dead ends, and limited points of external access. The grid pattern also benefits pedestrians and cyclists by providing shorter and less congested paths to internal and external destinations. A graphic comparison of these two systems is shown in Figure 1.

Success of this plan depends on the provision of adequate

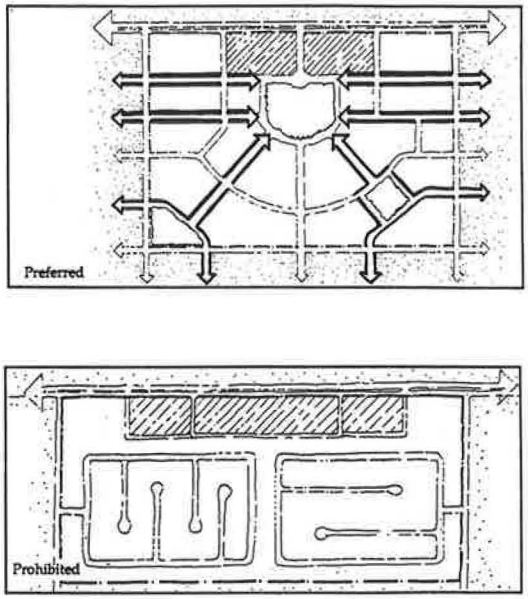


FIGURE 1 Street network comparison: pedestrian pocket (*top*) versus standard development design (*bottom*) (Calthorpe & Associates).

TABLE 1 LANE WIDTHS

Laguna Creek Lane Type	Total #Lanes	Lane Width	Parking Lane Width	1 Side/ Both Sides	County Standard Lane Width
Minor Residential (Lakeside)	2	11'/9' **	6'(+3' curb)	One (Next to 9' lane)	13'
Minor Residential (School/Park)	2	9'	6'(+3')	Both	13'
Minor Residential (Town Neighborhood)	2	9'	6'(+3')	Both	13'
Minor Residential (Neighborhoods)	2	7'	6'(+3')*	Both	13'
Minor Residential (Parkside Town Neighborhood)	1	11'	6'(+3')*	Both	N/A
Primary Residential (Boulevard)	2	16'	6'(+3')*	Both	18' (12'+6' Park)
Primary Residential (Boulevard-Lake)	2	16'	None	--	18' (12'+6' Park)
Major Residential (Neighborhoods)	2	11'	6'(+3')*	Both	13'
Residential Collector	2	11'	6'(+3')	Both	13'
Commercial (Town Center)	2	11' or 12'	6'(+3')	Both	13'
Commercial (Main Street)	2	10'	6'(+3')*	Both	13'

* Interspersed with tree boxes
** Wide lane on lakeside

arterial roadway capacity outside of the pocket to accommodate through traffic. Sufficient capacity on major streets and thoroughfares separating the pedestrian pocket from secondary areas or adjacent communities will minimize congestion within the pocket from through traffic seeking to divert from primary routes.

Roadway Design Elements

The goals of the roadway geometric design criteria are a departure from the automobile-oriented nature of standard tract development design in northern California. The following standards were selected to realize the goals of reduced automobile dependence and VMT.

1. Narrow Street Widths. Streets within the pedestrian pocket are significantly narrower than Sacramento County standards applied to standard subdivisions. Street widths throughout the development are 15 to 45 percent lower than county standards for similar street classifications, and in some cases are as low as 7 ft on some residential blocks. Design widths for each street type and comparisons with Sacramento County standards are presented in Table 1.
2. Sidewalks or Pedestrian Walkways. These are installed on both sides of all streets. In the pedestrian pocket, most residential sidewalks are 4 ft wide, ranging up to 10 ft in densely developed areas. Three-foot curb widths separate sidewalks from streets.
3. Curb Radii. Intersection curb radii for all street types are lower than county standards. Radii reductions range from 17 percent for neighborhood collectors to 58 percent for minor residential streets. These reductions result in lower vehicular turning speeds, thus improving safety. These radii and comparisons to county standards are presented in Table 2.

For some primary residential boulevards, curb radius is narrowed with "necked" intersections, at which street widths are suddenly narrowed as intersections are approached. A typical necked intersection with 6-ft neck widths is shown in Figure 2. This configuration induces motorists to reduce speed as they approach intersections.

4. Parallel Parking. On-street parallel parking is encouraged in residential areas with 9-ft parking lanes (6-ft lanes with 3-ft curbs). Continuous on-street parking acts as a buffer between vehicular traffic and pedestrians, further enhancing safety.

TABLE 2 CURB RADII

Intersection Type	# Lanes	Curb Radius*	Necked	Neck Width	County Std. Radius*
Minor Residential	2	10'	No	--	24'
Commercial (Town Center & Main Street)	2	20'	No	--	24'
Primary Residential (Boulevards)	2	20'	Yes	6'	24'
Major Residential (Neighborhoods)	2	20'	No	---	--
Collectors (Neighborhood)	2	20'	No	--	24'

* Radius to raised curb edge (not including 3' curb)

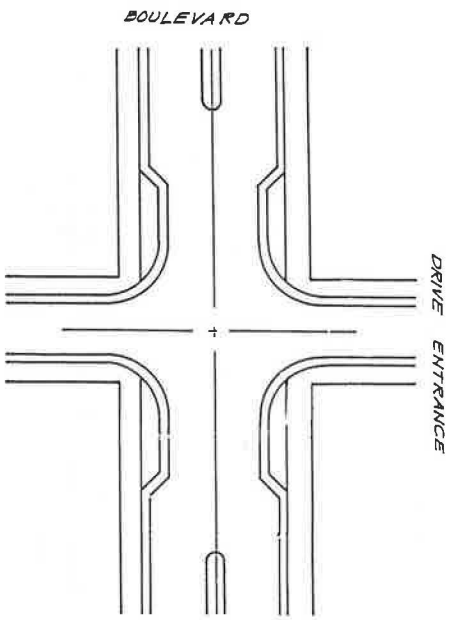


FIGURE 2 Typical necked intersection.

On streets shown as solid lines in Figure 3, tree planters are situated within the parking lanes at regular intervals. This strategy eliminates the use of parking lanes by through traffic. A typical design is shown in Figure 4. Potential safety impacts of trees in pavement were researched by contacting various local governments that had similar streets in their jurisdictions. Several municipalities (Sacramento, Larkspur, Mountain View, and Palo Alto) in northern Californian cities have adopted this measure in recent years, with no apparent detriment to safety.

5. Speed Control. Devices used to control vehicular speed are used on the long, straight primary residential boulevards. Stop signs are placed at key intersections along the boulevards to eliminate long high-speed stretches.

Residential Lot Configuration

Laguna West will contain 3,400 residential units. Approximately half of these will be multifamily housing, in densities of up to 20 units per acre. Of the outlying single-family home sites, lot configurations will be 40 percent smaller than those normally used in standard residential subdivisions. For example, 100-ft-wide × 80-ft-deep lots normally used for home sites in developments zoned R–5 will be reduced to 45 ft wide × 110 ft deep, producing R–7 lots. Street frontage per unit will be less than half of the standard design, although lots are 30 ft deeper. Building setbacks will be shallow, from 5 to 15 ft.

Another departure from standard lot configuration will be garage location and layout. In many cases, garages will be detached and located behind each residence. They will not be visible from the street. Garages will be accessible by back alleyways that will run in between rows of houses. In addition, several garages will contain "granny flats," which are separate small dwellings located in the second level of garage structures. Partial occupancy of these flats will further increase

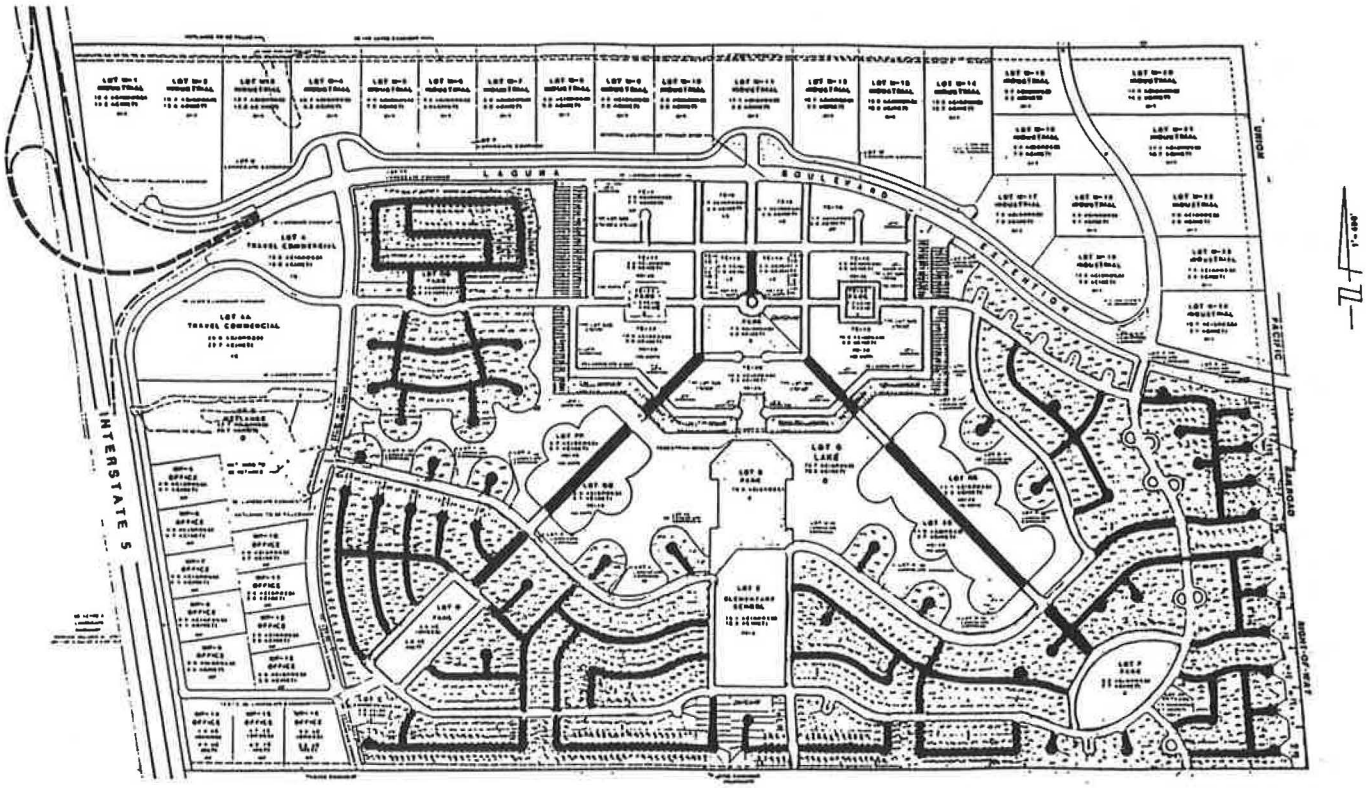


FIGURE 3 Streets with trees in the parking lane.

residential density. The intended effect of this configuration is to increase pedestrian activity on residential streets, thereby enhancing safety. Use of alleys for garage access and garbage collection will further enhance street safety. Schematic drawings of a typical residential site plan are shown in Figure 5.

Landscaping

Approximately 10,000 trees will be planted in Laguna West, nearly 3 trees for every residential unit. This is considered an important design element for both aesthetic reasons and to provide protection from the summer heat for pedestrians, cyclists, and parked cars. Shade trees will be planted along all streets. Trees placed in street planters will be no more than 30 ft apart, within a 6-ft-wide strip. Within 10 years of planting, most walkway areas and on-street parking spaces will be completely under shade. Trees planted in and along streets will also provide a buffer between pedestrians and cyclists, and automobiles. Separation of pedestrians and cyclists from busy streets is planned throughout the development.

MOBILITY ALTERNATIVES

Transit Center

A transit center is integrated into the town center. The transit center will be the focal point for all transit services provided within the project and to or from external points. It will be accessible to all residents and centers of employment within the project. One or more internal routes would link all project areas by circulating within the development along major boulevards and residential collectors. Routes to external points such as Sacramento will be provided as well. The nature of these services would be to respond to demand as the project matures. For example, vanpools or a limited subscription type of service may be provided during early construction phases, and evolve into regularly scheduled fixed routes, as warranted.

Potential Future Light Rail Service

Six acres have been set aside on the east side of the project, for a possible future extension of the Sacramento light-rail

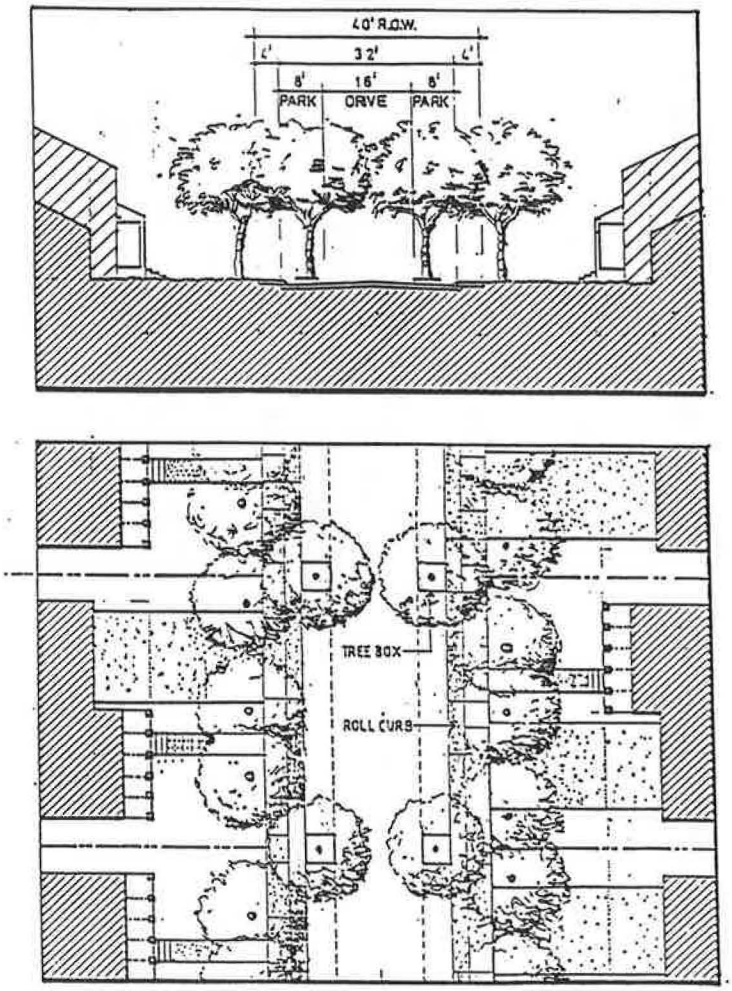


FIGURE 4 Use of tree boxes to widen street-sidewalk boundaries.

system. As Laguna West is fully built out and becomes a job magnet itself, the demand for transit service between Laguna West and the urbanized area to the north may justify an extension of the light-rail system to the project site. Thus, a sufficient land allotment for a rail station will be retained in the project, and the transit center will be modified as needed to provide shuttle services to the light-rail station.

TDM Plan

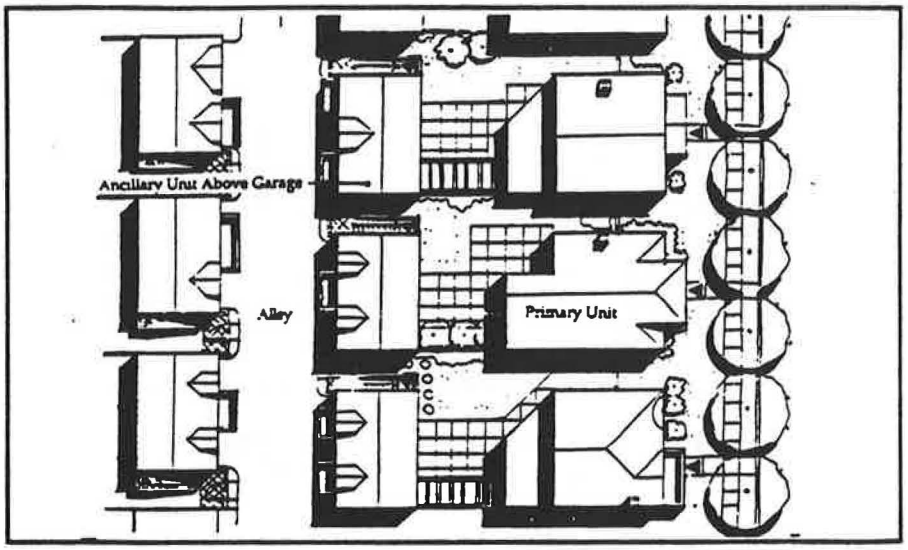
A comprehensive, appropriately phased TDM plan will be prepared for the project. This plan will go one step beyond the traditional TDM plans most frequently developed by new projects, because both employment and residential travel demand will be addressed. As the project is designed to mitigate automobile use, strategies with realistic automobile demand reduction goals will be adopted. TDM measures may include vanpool and carpool matching, subscription bus services, variable work hours (for on-site employers), and some of the transit services described earlier. A financing plan will also be adopted. Costs for these services would probably be largely borne by the developer during the early project phases. As the project matures, a gradually larger share of these services can be borne by on-site employers and residents.

Pedestrian Walkways and Bikeways

Many of the streets in Laguna West have lanes for bicyclists, and most have sidewalks for pedestrians. On streets that may have heavy bicycle and pedestrian use, there are separate paths for bicycles and pedestrians. The minimum sidewalk width is 4 ft, but many of the streets have sidewalk widths of up to 10 ft. The more spacious sidewalks are located on the boulevards where pedestrians are more likely to gravitate. Class 1 bikeways (no shared right-of-way with streets) are planned for selected collector streets and will converge on the town center. In these areas, bikeways will be separate from sidewalks. Bike routes on residential streets will consist of marked lanes or shared space with automobiles.

POTENTIAL VMT REDUCTION

Fehr & Peers Associates has analyzed the potential for VMT reduction attributable to the pedestrian pocket design. VMT reductions were calculated for key trip types, including home-work, home-shopping, and home–social or recreational activity (*1*). The results of this analysis were compared with research findings recently published by the National Re-



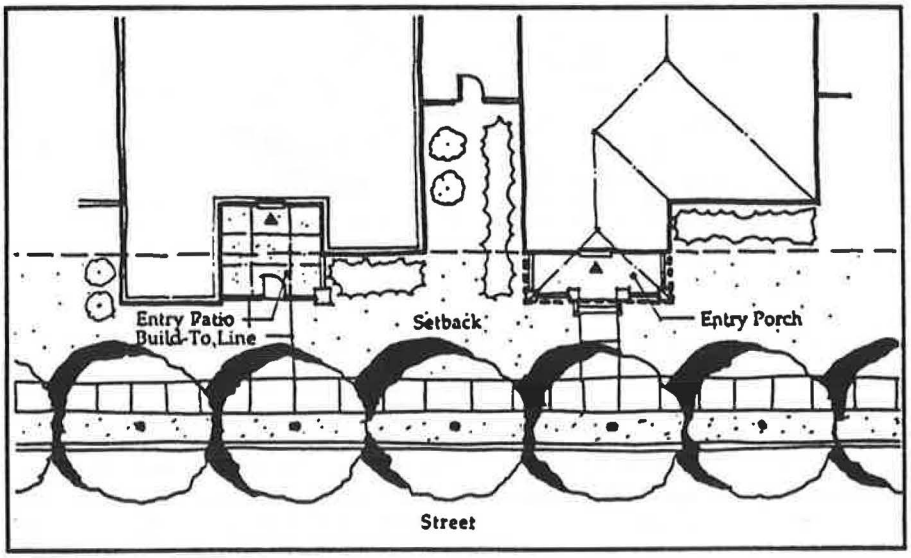


FIGURE 5 Typical residential site layout (Calthorpe & Associates).

sources Defense Council (NRDC), which established a statistical correlation between urban density and automobile use (2). Comparison and correlation of the findings from the two studies indicate that daily VMT reductions of 20 to 25 percent may result from the innovative design of the pedestrian pocket. These reductions are taken from travel behavior normally associated with a typically designed suburban development (i.e., 80 percent automobile mode split)—not from an unlikely situation in which 100 percent of all trips are made by automobile. Thus, the impact on VMT may be significant.

Three factors contribute to VMT reduction: internalization of many routine trips, reduced automobile mode split, and a higher capture rate of internal jobs by residents.

1. Internalization of Trips. The dense development of commercial, retail, and other nonresidential land uses within the town center will exert a strong attraction on local residents. A substantially higher percentage of nonwork travel, particularly home-to-shopping trips, will remain within the development than would be the case in a standard-design development. The concentration of several desirable destinations within the town center will also increase the number of linked trips that occur there. Regardless of the effect on automobile mode split, the attraction of the town center on local residents will result in short trips and hence lower VMT.

2. Reduced Automobile Mode Split. The NRDC research found that proximity of a downtown or town center to local

residents, availability of good transit service, and a high proportion of non-work-linked trips will substantially reduce the automobile mode split for daily trips. A high correlation occurs between dense communities with centralized commercial activity centers and the availability of mass transit services. Automobile use and ownership are lower in dense, pedestrian, and transit-oriented areas.

3. High Job Capture Rate. Although no recent research is available, anecdotal evidence of trends in other planned, pedestrian-oriented communities indicates that a higher percentage of jobs located within the pedestrian pocket and secondary areas will be taken by development residents. Data provided by planners of Reston, Virginia, and Columbia, Maryland, indicate that 35 to 40 percent of all internal jobs are filled by local residents. This statistic compares favorably with an average of 15 to 20 percent of jobs in second-generation-type mixed-use developments captured by local residents. Therefore, fewer residents will make long commutes to external areas.

CONSEQUENCES AND CONCLUSIONS

Past application of transportation system design standards similar to those proposed for the Laguna West pedestrian pocket indicate that they can be effective in reducing automobile travel and VMT. Unlike most second-generation-type developments, they should provide a creative, safe environment for pedestrians and cyclists, as well as for motorists. Automobile travel will remain an essential component of the transportation system, but will not dominate internal circulation or render nonvehicular modes irrelevant.

Laguna West will be the first planned community of this type in the western United States. Its design is a significant departure from that of suburban and exurban planned development typical of northern California. The project incorporates a unique approach to the spatial relationships between major on-site activities, and is served with an innovative set of roadway geometrics and features.

The compatibility of the pedestrian pocket's site design, land use, and transportation system and its management has been described. Among the intended benefits of this approach is significant VMT reduction. A comparison of travel behavior documented at second-generation-type suburban activity centers (SACs) indicates the difficulty in altering travel behavior within existing or planned automobile-oriented developments. A recent NCHRP study on travel characteristics at suburban activity centers established relationships between building and site characteristics and travel behavior. The findings indicated that although there is often a great deal of interaction between buildings within large second-generation-type SACs, traffic congestion within the development and on access routes is perceived to be a significant problem by virtually all tenants and visitors. The reason is the near total reliance on the private automobile and lack of suitable travel alternatives. The study recommends three strategies for reducing the reliance on automobiles at existing or planned SACs:

- Cluster buildings to increase their proximity;
- Establish radial bus transit service, with a transit center (the practical limit on transit mode share is estimated at 6 percent (*3*)); and
- Establish continuous, direct pedestrian systems between buildings.

The costs of such retrofit programs can be high, with limited success. The pedestrian pocket incorporates all of these elements into its design and represents a promising solution to enhancing suburban mobility.

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Publication of this paper sponsored by Task Force on Transportation Demand Management.

Overview of Evaluation Methods with Applications to Transportation Demand Management

ERIK T. FERGUSON

Transportation demand management (TDM) is increasingly popular as a response to traffic congestion, air pollution, and related problems. Innovative institutional arrangements have been conceived to implement TDM in a more efficient and effective manner. Careful evaluation is necessary to determine whether TDM has been successful, however. TDM evaluation efforts have tended to lag behind TDM implementation efforts. Results of few TDM evaluation studies have been published. TDM evaluation may be based on direct observation, revealed preference, stated preference, or organizational survey sampling methods of data collection. TDM programs generally are complex policy instruments with modest goals and objectives, providing marginal impacts on travel behavior that are difficult to discern. This description suggests that TDM evaluation methods should be complex in order to be accurate. Yet, effects of TDM programs may not be sufficient to justify costly TDM evaluation efforts. The challenge to the TDM evaluator is to develop tools appropriate to the task in terms of both cost and accuracy. This challenge could be accomplished by integrating TDM evaluation into the general framework of transportation system performance monitoring at the regional level. The urban transportation planning system is in use in most urban areas where TDM is likely to be implemented. Additional data are needed to assess TDM impacts in such areas. The art of TDM evaluation has a long way to go before it reaches maturity as a practical transportation planning and evaluation tool. The time for greater action on TDM evaluation, as in TDM implementation, is now.

Transportation demand management (TDM) is the art of slightly and gradually modifying individual travel behavior, rather than always expanding transportation capacity in response to observed or anticipated traffic congestion at the local and regional levels. TDM has most often been used in dealing with problems related to surface transportation, though examples exist of applications to reducing congestion during peak periods at airports, managing general aviation, operating ferry services, and the like. Recent examples from fields beyond transportation include least-cost energy sector planning, drug interdiction on the demand side (reorientation of drug control programs toward preventive strategies and drug treatment programs), and many similar examples.

Evaluation is the art of determining whether policies, programs, or projects are effective in accomplishing goals and objectives related to an organization's mission. TDM evaluation is the art of determining how, when, and where individual travel behavior actually is modified in response to specific types of TDM strategies. This is often a surprisingly difficult mission to accomplish, given the mobility of TDM subjects, and the typically modest (marginal) impact of TDM strategies on the travel decisions made by individual travelers on a daily basis.

College of Architecture, Georgia Institute of Technology, Atlanta, Ga. 30332–0155.

TDM EVALUATION METHODS

TDM evaluation methods may be grouped into four major classes of activity, on the basis of their underlying data requirements. These include direct observation (DO), revealed preference (RP), stated preference (SP), and organizational sampling (OS) methods. Each of these methods is discussed in turn. RP and SP methods may be implemented through random, stratified, or clustered survey samples, administered over the telephone, through the mail, or, most recently, interactively on the video display screen of a personal or mainframe computer. DO methods require no direct participation on the part of individual travelers thus observed. OS methods are perhaps the most recent of the four methods in terms of application. OS methods are a direct outgrowth of researchers' attempts to understand the nature of employer-employee interactions, primarily in terms of carpool and vanpool formation, in response to employer TDM program implementation efforts.

DO Methods

DO methods are the oldest though no longer the most common methods used in obtaining travel behavior information related to transportation system use. DO methods have the advantage of being simple, direct, and subject to few biases in sampling or estimation (other than systematic observer error), most of which are relatively easy to identify and correct.

DO methods are implemented at the site level by stationing observers at a single point, if only one entrance or exit point exists, or at multiple points, to cover all possible entry and exit points to the site selected for analysis. DO methods are implemented at the corridor level by selecting a point or points along a specific travel corridor, such as a major arterial or highway, and placing observers at all critical points thus selected. DO methods are implemented at the areal or regional level by drawing a cordon line around the area selected for

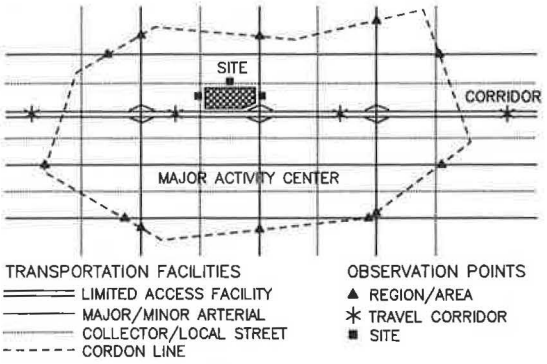

FIGURE 1 Direct observation of travel behavior.

study, and placing observers at all major entry and exit points to the cordoned area (Figure 1).

DO methods are often used to collect data for highway capacity analysis, and can be useful in calibrating regional travel demand forecasting models. DO methods are not often used solely for TDM evaluation, but may be useful in checking the validity of more detailed travel demand information obtained from other sources. Recently, photographic equipment occasionally has been used to obtain license plate numbers for vehicles directly observed along major travel corridors with newly installed high-occupancy-vehicle (HOV) lanes. License plate information was used to obtain mailing addresses for observed facility users through state motor vehicle departments, allowing RP and SP surveys to be distributed through the mail to all users thus identified.

DO methods have virtually unlimited potential for increasing the accuracy and precision of certain travel behavior parameter measurements, such as the number of vehicle trips and the number of vehicle-miles of travel along specific corridors. DO methods are extremely limited in terms of the variety of data that can be observed, without invading the privacy of individuals in fundamentally obtrusive ways. DO methods are not suitable for identifying the intentions as opposed to the actions of individual travelers. Neither can DO methods be used to identify travel origins and destinations in a broader regional context. This argues against relying on DO as the sole method for collecting data relevant to TDM evaluation.

RP Methods

DO methods can be used to obtain behavioral characteristics of users, but they are highly problematic in determining economic and demographic factors that may be important factors in individual and household travel behavior decision making. RP survey methods were developed to capture more information relevant to individual decison making in transportation and other fields. RP surveys ask respondents to identify their current travel behavior, often in much greater detail than is possible through the use of DO methods alone. RP surveys may ask questions about past travel behavior as well. RP surveys usually make some attempt to identify ambient working conditions, household characteristics, and individual attributes such as income or automobile availability, which have been found to influence travel behavior decisions previously.

A particularly useful type of RP method is choice-based survey sampling. For example, on-board transit surveys are choice-based, in that only transit users are asked to reveal their preferences through the implementation of on-board transit surveys. Choice-based sampling generally is more efficient than random sampling for rare or elusive populations. An on-board transit survey would not be necessary in New York City. Random telephone or mail surveys would elicit adequate information on transit use and competitive modes in New York City, at a lower cost per survey completed. In typical suburban transit markets, the use of on-board surveys is often critical for keeping data collection costs low, while providing adequate information on the characteristics of transit users in these areas.

RP methods generally are subject to greater variation and error in measurement than are DO methods. Survey participation frequently is far less than 100 percent, introducing the potential for unknown sampling biases. Participants may make mistakes in completing RP surveys because of misunderstanding of technical terms, lack of knowledge, transcription error, faulty memory, plain old mistakes, and other factors. Most people estimate travel distance only to the nearest mile, and travel time only to the nearest 5-min increment. If greater precision in measurement than this is required for adequate modeling of behavior, it can generally be had only through the use of DO methods. Despite these caveats, RP methods are inherently more useful than DO methods in TDM evaluation, because RP methods provide far more information on observed travel behavior and factors only indirectly observable that may influence such travel behavior.

SP Methods

RP methods are in turn limited to collecting information on what has already transpired, i.e., preferences revealed in the form of actual, at least theoretically observable, travel behavior choices. In some cases, this information may be insufficient or even entirely irrelevant. When a new type of service, such as a new transportation technology, is contemplated for implementation, forecasts of the eventual usage this new technology may achieve usually are required to gain critical project funding. Asking members of the local population if they had ever used the new technology, for example in a different city, might be interesting. Yet, basing forecasts of future local new technology usage on such prior experience in a different regional setting would be absurd. Similarly, asking them whether they would use a mode of transportation of which they were not aware, and might only dimly understand in the context of prior experience, would be equally problematic for forecasting purposes.

SP methods were developed to model consumer attitudes in relation to observed behavior, usually for marketing purposes. In the latter regard, it was determined that perceptions did not always reflect reality in the minds of consumers, and that actual choices might modify perceived differences in the usefulness of available choice sets. Focus groups were invented to bring groups of people together to informally discuss hypothetical or future choice sets, as opposed to actual or

current choice sets, in a constructive manner, with a little bit of organizational purpose injected into the proceedings for good measure, to keep the general tone of the group discussion on the right track. Focus groups were found to be useful in constructing more realistic hypothetical choice sets, which could then be tested more rigorously (in statistical terms) through surveys aimed at asking what people might do under certain situations, modeled on the present, but with structural changes such as new or improved transit service, parking pricing and supply control measures, and the like, included in detailed descriptions of highly realistic and probable future scenarios.

SP methods are subject to even greater variability and error in measurement than are RP methods. How people react on an individual basis to the description of hypothetical choice sets, and how well they can gauge their sensitivity to changes in transportation system design, are still poorly understood as research issues. Nonetheless, SP methods are critical for evaluating scenarios that differ from the present in significant ways, and are therefore important in long-range planning (not so relevant to TDM) and in understanding whether or not transportation service or product innovations are adopted by significant numbers of individual travelers within specific travel markets (very relevant to TDM).

OS Methods

The most recent innovation in transportation evaluation methodology has come in the form of OS methods, used in what might be called quantitative (comparative) institutional analysis. OS methods require only that an organization exists in some form (firm, household, carpool, etc.), and that at least two levels of organizational structure be included explicitly in survey sampling for later statistical analysis purposes.

DO methods fail to reveal all objective aspects of behavior, unless the object of study is followed around for a rather extended period of time. RP methods fail to consider changes in transportation systems that may require structured speculation on the part of study participants concerning hypothetical choice sets or future travel behavioral modifications. SP methods allow the study participant to speculate more freely, but cannot capture information that the participants do not have at their personal disposal on indirect causal factors influencing the relative usefulness of various travel options, or the travel behavior choice set itself. Examples of such information might include the total supply of parking spaces available to all employees at a particular work site for a particular price or at different prices, whether or not a potential carpool partner has been offered flexible work hours, which may be preferred to carpooling by some employees as a congestion avoidance technique, and so on.

OS methods allow the TDM evaluator to link directly observed, revealed, or stated preferences of study participants to the organizational environment in which travel behavior decisions are made. Travel behavior decisions are not made under antiseptic laboratory conditions, far removed from the concerns of family, work, and social activities, but rather are integrated in complex ways into multilayered patterns of living, lifestyles, or lifecycles. These complex organizational ties can be modeled explicitly in terms of the context of travel demand forecasting and TDM evaluation only through the application of OS methods. Activity analysis usually focuses solely on household activities because these may relate to individual travel behavior, but otherwise it is similar in principle to OS methods for most practical purposes.

OS methods may be at one and the same time both more and less subject to variability and error than the methods previously discussed. Defining what organizations are and how they operate is more difficult and complex than simply observing the behavior of a single individual at a single point in time and space. Thus, OS methods are only as good or as relevant as the strength of the organizational linkage between an individual under observation and the organizational principle suggested as one determinant of behavior may be.

Perhaps some of the organizational ties to travel behavior are influenced by yet other organizational ties, further complicating this already rather messy picture. The policies and procedures of individual organizations may exert different qualitative influences and certainly have different quantitative impacts on different individuals within the organization. Some organizations may even have entirely different sets of policies and procedures for different individuals or classes of individuals within the organization. All of these separate policy analytic activities may exert weak influences on some individuals, and strong influences on yet other individuals. The possible relationship between these institutional factors and TDM have only recently come under study in a quantitative and objective fashion, through the use of rigorous statistical analysis techniques for examination and evaluation purposes.

OS methods may be less variable than some other methods, to the extent that OS techniques build on the others to provide measures of effectiveness for specific policies and procedures across many rather than just one or a few independent organizational observations in analysis. Reducing variability in measurement of such key organizational influences as parking pricing and supply control policies from one firm to another is a major potential benefit of OS methods. This is important, because OS methods do impose significantly higher costs in terms of both data collection and data analysis. The use of OS methods is not justified without the provision of additional benefits. Such benefits do seem to exist, and are not available in the same guise through application of DO, RP, or SP methods, either together or in isolation.

OS methods may be of particular importance in evaluating TDM, because of the highly dispersed nature of TDM program implementation, and the close relationship between successful TDM implementation and the creation of entirely new kinds of organizations, such as transportation management associations, trip reduction ordinances, and the like.

ANALYTICAL FOCUS

Which data collection method or combination of methods to apply to TDM evaluation will vary, depending on the analytical framework or focus, the mission of the TDM program to be evaluated, and the measure or measures of effectiveness selected to indicate attainment or nonattainment of TDM program goals and objectives. The analytical focus of TDM

evaluation may be spatial, temporal, or organizational in nature, or some combination of all three.

Spatial Focus

The scale of TDM implementation efforts will determine the geographic focus of evaluation efforts, which may be site-specific, corridor-oriented, or regional in scope. OS methods have been applied to activity centers in the form of site-specific surveys of employers and employees in Southern California and Brentwood, Tennessee. OS methods have been applied on a corridor basis to vanpool coordinators and vanpool members in the Ventura Improvement District (Ventura Freeway Corridor) in the San Fernando Valley.

OS methods have been applied on a supraregional basis in the form of the Nationwide Personal Transportation Studies (NPTS) of 1969, 1977, 1983, and 1990. The NPTS surveys were all conducted in the form of a stratified, clustered, random sample of housing units within both metropolitan and nonmetropolitan areas of the United States taken as a whole. The latest NPTS was based on a telephone survey sample, whereas the previous three relied on personal interviews conducted in the home of each responding household. Most TDM programs are site-specific, but may include service areas ranging in size from a single employer to a single large building to an activity center covering hundreds of acres, with thousands of employees potentially involved.

Temporal Focus

Recently, researchers have begun to explore the use of longitudinal analysis based on panel surveys to gather discrete data on dynamic changes in location and travel behavior. A panel survey is composed of two or more waves, where a wave is defined as a repeated survey of a specific group of survey respondents, who are asked in advance to participate in the survey process over a number of days, weeks, months, or even years. Because of the time and expense involved in conducting longitudinal panel surveys, these are perhaps best suited in the context of TDM to the evaluation of TDM measures associated with large capital investments, such as ridesharing promotions in support of the operation of new HOV capital facilities on major surface arterials or highways.

Organizational Focus

Potential organizational scales of analysis include national, state, regional, or local, in terms of unitary public policy, and activity centers, office buildings, and firms, in terms of typically more competitive and thus more fractionated private TDM policies. Public policy is often viewed as a single holistic determinant of travel and other forms of behavior, with equally weighted impacts across all potentially affected parties. This is often a questionable assumption. In practice, it is more likely that unequal effects may be observed, depending on prior knowledge and experience of individual travelers, the distribution of information and transaction costs across time, space, and organizational operating environments, the specific form of TDM implementation practices used, performance monitoring considerations, and enforcement provisions, if any. Private policies are probably more often subject to major differences among firms in terms of impacts than are public policies, but even this simplifying assumption will not always hold.

OS methods most clearly are useful where many actors are involved in different types and levels of policy making. Given that TDM is often implemented as a result of public-private partnerships, with many firms and public agencies involved at varying levels of decision making and in varying degrees of interest or compliance, OS methods seem particularly suitable for evaluating TDM programs across firms, activity centers, and the like.

Combined Foci

Even more complex are analytical foci that combine spatial, temporal, and organizational measures of variability. At the national level, the NPTS provides an organizational data base composed of four separate files, including household characteristics, individual characteristics and intraurban travel, individual characteristics and interurban travel, and vehicle characteristics.

These NPTS data are available for 1969, 1977, and 1983, and soon will be available for 1990 as well. The four files can be and often are treated independently for analysis purposes. These files also can be combined. The household file is the highest level of organization, with the vehicle file perhaps the lowest, in organizational terms. An analysis of mode choice for the work trip under the assumption of household influences or constraints on travel might require data from the first, second, and fourth NPTS files. Automobile ownership is often posited to influence various aspects of urban travel, such as vehicle-miles of travel and mode choice decision making. The level of inter- (and perhaps intra-) urban travel may influence automobile ownership simultaneously, or with a lagged temporal effect (Figure 2).

At the subregional or activity center level, the recent formation of transportation management associations as public-private partnerships to promote TDM is a phenomenon of apparently increasing importance. TMA evaluation potentially might require data at four levels of organization, including the TMA board of directors (executive decision makers), the TMA executive director (or line staff), participating private firms or public agencies (often formally recognized as association members), and the employees of any or all such participating organizations. Complex linkages between various levels of TMA organization might have to be taken into

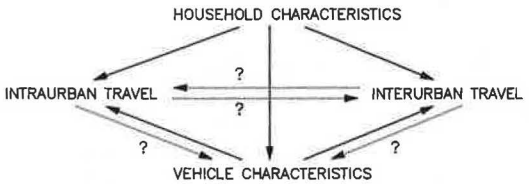

FIGURE 2 Organizational relationships in the NTPS.

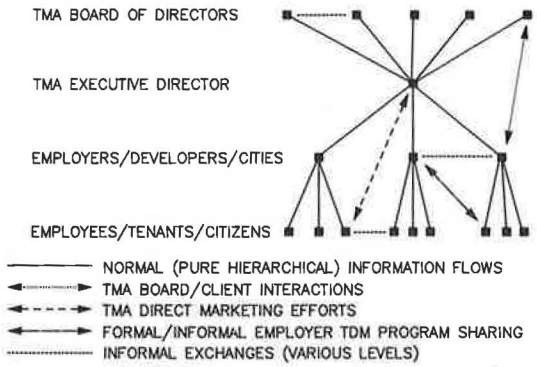

FIGURE 3 Organizational structure of TMAs.

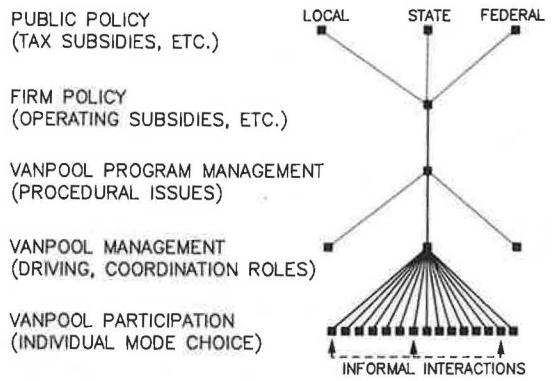

FIGURE 4 Organizational structure of vanpool programs.

account in evaluating TMA performance with precision and accuracy (Figure 3).

Most TMA evaluation efforts so far undertaken have been of relatively modest scope, often involving employee travel behavior surveys, employer ridesharing program surveys, and occasionally CEO surveys, but generally not all of these, simultaneously, before and after implementation. One exception is the South Coast Metro study conducted by the Orange County Transit District in Southern California. Few TMA studies have attempted to identify differences among participating firms in terms of incentives offered to employees. Fewer still have tried to identify the mix of supply and demand side measures used by TMAs to achieve their goals and objectives.

At the individual firm level, an organizational model of TDM implementation might include three levels of participation, including the CEO (policy), the TDM program manager (procedures), and the employees potentially or actually influenced by TDM program incentives and disincentives offered by the firm. At the individual TDM program level, an organizational mode of vanpool formation might include five major elements, as follows:

1. Public policy (federal, state, and local tax and regulatory policies);
2. Firm policy (private firm or public agency rules and regulations concerning issues such as vehicle type, vehicle ownership, operating subsidies, and driver perquisites);
3. Vanpool or ridesharing program management (procedural issues and orientation);
4. Vanpool management (vanpool coordinator and vanpool driver roles and responsibilities); and
5. Vanpool participation (formal and informal rules governing conduct within the vanpool, thereby influencing individual mode choice).

Although it might appear that vanpool formation is a relatively simple and straightforward process (Figure 4), it is in fact complex, and might be difficult to predict, in the absence of good information on both spatial and organizational factors influencing the relative size of potential vanpool markets. The author is studying vanpool formation on the basis of 2,400 vanpool members belonging to 400 vanpools serving 16 private firms and public agencies located in widely different parts of Southern California.

As these various examples illustrate, TDM implementation at all geographic levels of analysis may require an explicit organizational focus if relevant travel behavior parameters are to be identified in terms of comprehensive evaluation efforts. OS methods would be highly useful in most such efforts, if improved quantitative measures of TDM program impacts are desired as an outcome of the TDM evaluation process.

THE TDM MISSION

The mission of a TDM program is critical in determining the purpose and scope of evaluation efforts eventually undertaken. TDM programs with specific, i.e., numerical, performance targets generally begin with a baseline survey to determine the level of effort needed to attain specific changes or levels of change in observed travel behavior. TDM programs with few specific performance targets may engage in no such preliminary studies and often do not conduct evaluations ex post facto either.

Goals

TDM goals may be as specific as (a) maintaining Level of Service C on all streets and highways within a particular community, (b) providing adequate financing for all necessary transportation system improvements within the community, and (c) reducing peak period travel to eliminate traffic congestion for as long as possible. TDM goals may also be as general as (a) mitigating traffic congestion without further definition, (b) improving air quality, (c) conserving energy, (d) making local or regional housing more affordable (e.g., through higher densities on smaller lots, with compensating transportation system changes), (e) maintaining regional mobility, (f) providing an adequate degree of redundancy in the transportation system, and (g) being prepared for emergencies and other contingencies that might crop up at some time in the future. Obviously, evaluation efforts should, in general, conform in outline to the goals that are being sought through TDM implementation.

Objectives

TDM objectives relate more specifically to how TDM goals are to be achieved. In most cases, the principal objective of TDM implementation is to enhance regional or suburban mobility. This general description is overly broad, and provides insufficient guidance in developing adequate TDM evaluation tools. TDM objectives may be further separated into four classes of programmatic intent, including (a) increased supply, (b) improved system management, (c) improved demand management, and (d) reduced demand. It might seem odd to include supply enhancement among TDM objectives, but it is unavoidable in practice, because of the interrelated themes of supply and demand that are affected by TDM policies and procedures.

MEASURES OF TDM EFFECTIVENESS

Measures of effectiveness in TDM evaluation also exhibit great variability, as might be expected from the broad range of goals and objectives that typically are meant to be served through the successful implementation of TDM programs in practice. Specific measures of TDM effectiveness often include changes in mode choice on an individual basis, changes in mode split on an organizational or geographic basis, and reductions in the number of (vehicle) trips generated by specific activities at specific activity centers. These specific measures of TDM effectiveness are usually directly measurable, at least theoretically speaking, but often not without great difficulty and cost, and always with uncertainty remaining *ex post*. Less specific performance measures may include (a) reduced traffic congestion (e.g., hours of traffic delay eliminated), (b) improved air quality (e.g., reduced automobile exhaust emissions), and (c) energy conservation (e.g., reduced gasoline consumption).

Indirect measures of TDM effectiveness often require sophisticated models in order to conduct adequate valuative efforts. More specific TDM performance measures often are necessary as direct input to more comprehensive regional travel demand, airshed, and energy consumption models. The cost of evaluating TDM effectiveness in these more general terms is considerably higher, but perhaps more useful, than simply counting the number of trips made (or not made), and the proportion of trips modified in some way (altered, diverted, restructured, etc.). Expanded TDM programs gradually may influence patterns of land use and development, at least indirectly and over longer periods of time. TDM may serve as one alternative to requiring developers to provide adequate transportation facilities as an explicit condition of development approval in urban areas experiencing rapid growth and increasing traffic congestion.

Mode Choice, Mode Split, and Trip Reduction

Changes in mode choice are the most common form of effectiveness measure used in TDM evaluation. Trip reduction ordinances often specify a target mode split, or change in mode split, to be achieved through mandatory or voluntary TDM programs, implemented by developers, employers, or both, at the local or regional level. A major problem with mode choice studies is variability in day-to-day travel, which often exceeds targeted goals for trip reduction, making measurement problems particularly acute. This measurement problem can be controlled to some extent through the adoption of dynamic, time-series analysis, with data collected in multiple time periods, at higher overall cost, of course.

Examples of longitudinal studies include weekly travel diaries, travel behavior surveys repeated on a periodic (e.g., monthly or annual) basis, etc. Intertemporal survey sampling imposes much higher data collection and analysis costs, not to mention significant time delays, particularly in the case of annual sampling. A lower-cost alternative is to ask questions explicitly related to temporal changes in travel behavior (weekly variability in mode choice, long-term loyalty to a particular mode, etc.) on a one-shot survey form. Dynamic changes in travel behavior are less cleanly specified in such one-shot cross-sectional survey designs, of course.

Traffic Congestion, Air Quality, and Energy Conservation

Indirect effects of successful TDM program implementation frequently are defined to include reduced traffic congestion, improved air quality, and energy conservation. If measuring (or still more problematic, forecasting) the direct effects of TDM program implementation is a difficult undertaking, anticipating indirect TDM benefits may seem virtually impossible to achieve with any degree of accuracy at a reasonable cost. Traffic congestion can be identified at the local (microscopic) level through intersection analysis. However, normal variability in day-to-day travel once again may make estimating even the direct effects of site-specific TDM programs on local traffic flows difficult to identify, unless the site happens to be the predominant source of local traffic, local traffic congestion, and perhaps local traffic variability.

More difficult is the estimation of changes in regional traffic delays or air quality impacts associated with local TDM program implementation. The measurement of these TDM impacts typically requires the use of highly sophisticated, large-scale regional travel demand forecasting models and air pollutant emissions inventory and dispersion models. In their current forms, these large-scale models often ignore both daily and individual variability in travel behavior, with much greater emphasis being placed on the differential effects of various transportation technologies for personal travel or air pollution emissions control. The Urban Transportation Planning System (UTPS) definitions of trip purpose (home-based work, etc.) were reasonably good in describing important attributes of travel behavior in the 1960s, but are much less adequate in today's urban and suburban travel markets. To date, travel behavior market segmentation studies have rarely been implemented on a wide enough scale to be used in regional travel demand forecasting models.

There are few behavioral links currently drawn between technologies for different types of vehicle (e.g., cars, vans, and trucks) that are important in determining marginal emission rates in air quality analysis, insofar as these relate to travel behavior. In fact, most regional emissions inventories

rely on regional or state vehicle ownership data as the sole source of travel behavior inference, with the explicit assumption that newer vehicles are driven more miles per year than older vehicles, but with no other travel behavioral variability used in the analysis. This is a scattered approach to understanding the air quality implications of travel behavior decision making at the disaggregate level, where TDM programs presumably have their greatest marginal impacts.

Land Use, Development, and Affordable Housing

Recently, some attempts have been made to link TDM implementation to even broader societal goals, including more effective land use management, appropriate and sustainable development, maintaining jobs and housing balances, facilitating the provision of more affordable housing, and the like. Modeling the influence of short-term TDM strategies on these longer-term trends in urban growth and economic development at the regional level realistically is beyond current capabilities for accurate measurement, and will remain so for much of the current decade, at the least. This limitation does not imply that TDM programs cannot or will not contribute in some small measure to the attainment of such broader (and much longer term) societal goals. Identifying the strength of such relationships, should they exist, given current analytical capabilities is simply not feasible under reasonable cost constraints on data collection and analysis in 1991.

MODELING TDM EFFECTIVENESS

More specific issues related to modeling TDM effectiveness in real time include data availability, model compatibility, and multiple model interfaces. Some of these issues already have been alluded to in previous sections. A few more explicit references to the current state of the art in aggregate and disaggregate travel demand forecasting follow.

Aggregate Travel Demand Forecasting

Aggregate travel demand forecasting is currently undergoing a major transformation in response to declining computing costs and the advent of powerful PC-based computer operating environments. A plethora of new models have been developed for the PC, that are still usually based fairly close on the UTPS mainframe programs from the past. Both new and old models may be faulted for their failure to include nontechnological modes of travel such as walking and bicycling explicitly, for treating ridesharing as being entirely subsumed within the automobile mode of travel, and for treating regional travel demand as more or less permanently fixed, once the trip generation stage of modeling has been completed. Unless these limitations are lifted, aggregate models will serve TDM evaluation needs only poorly. Similarly, ways and means of incorporating variations in organizational policies and procedures explicitly within aggregate models probably also will be needed, if true measures of policy sensitivity are to be identified for locally implemented TDM strategies within such larger-scale aggregate models of location and travel behavior. Direct linkages between aggregate and disaggregate travel demand models and the analytical methods used in estimating such models may be required to achieve these objectives meaningfully.

Disaggregate Travel Demand Forecasting

Disaggregate methods are better suited to TDM evaluation, but are severely limited in scope when regional impacts are to be estimated. Disaggregate methods can be readily adjusted to include nontechnological modes of travel, and ridesharing can be separated from the drive-alone automobile mode through nested modeling techniques. Similarly, the effects of organizational variations in TDM program implementation can be tested directly through multiple-tier OS methods. Presumably, as the body of literature describing disaggregate responses to TDM programs in the public and private sectors continues to grow, a knowledge base will be created that eventually might inform important innovations in both aggregate and disaggregate travel demand forecasting techniques. Only when these changes occur will TDM alternatives be directly comparable with supply-side options, ensuring confidence in the resulting predictions.

Two of the critical data needs for linking aggregate and disaggregate methods in travel demand forecasting for TDM evaluation include the following:

1. Identifying explicit behavioral linkages between vehicle technologies used and factors influencing travel demand directly. NPTS data are available for partial comparisons at the national level of analysis. Region-specific data on interurban and intraurban trip making also are needed. These data obviously would help in air quality analysis, but might also provide new insights into travel behavior analysis for its own sake.
2. Identifying new sets of trip purposes and trip patterns, which are internally more homogeneous and externally more heterogenous with respect to TDM influences and travel behavior determinants in the current decade. Ideally, this procedure might be considered for inclusion in the 1990 Census data used to create dual independent map encoding (DIME) files for use in UTPS and its derivative travel demand forecasting models. Alternatively, setting the groundwork now for such a development as part of the 2000 Census at minimum should be considered.

Modeling TDM Dynamics

A key problem in TDM implementation is maintaining the effects of short-term stimuli over the longer term. Programs that are successful one year may suffer losses the next, depending on changes in the level of resources allocated, TDM staff turnover, other staff turnover, and the like. Similarly, people rarely respond instantaneously to changes in ambient operating conditions, such as parking price increases, transit fare reductions, or the provision of personalized matching assistance through a trained professional employee transportation coordinator. In fact, it is more often true that travel behavior changes reflect a stochastic process, in which 4 or 5 years may be required before a new equilibrium point actually

is achieved. This is, no doubt, particularly the case when significant changes in TDM program incentives are involved.

Given the marginal impacts of 5 to 15 percent in aggregate travel reduction often attributed to TDM programs a priori, adding long lead times to equilibrium adjustment exacerbates measurement problems in TDM evaluation. During the time that TDM programs gradually modify travel behavior, external changes in local employment conditions, regional economic growth, or national transportation policy may occur, with travel behavior implications that could easily dwarf the expected changes from even a highly successful and very ambitious TDM program. This process can only make TDM evaluation more difficult to perform well, if at all. Finding cost-effective methods to deal with intertemporal changes in geographic and organizational operating environments for TDM implementation should be a high priority in improving the accuracy and precision of TDM evaluation efforts in the future.

CONCLUSIONS

Innovative TDM evaluation efforts are currently underway in several parts of the country. Studies are underway or have been completed in Seattle, Southern California, Washington, D.C., Brentwood, Tennessee, and several other locations. Much more work needs to be done to encourage sound TDM evaluation practices in all those areas of the country where TDM implementation is proceeding at full speed, often without proper consideration being given to the need for generating more accurate and reliable information on TDM effectiveness, prospectively or retrospectively. Federal, state, and local governments, and particularly state, regional, and local transportation agencies, can and should assist the often much newer private sector participants in TDM program implementation efforts to identify more appropriate TDM evaluation methods.

ACKNOWLEDGMENTS

Many people provided direct or indirect guidance in developing this paper, including, but not limited to, Babuji Ambikapathi, Darin Atteberry, Wayne Berman, Mark Bryant, Bob Cervero, Bob Dunphy, Gary Edson, Gen Giuliano, Jesse Glazer, Tony Gomez-Ibanez, Peter Gordon, David Hartgen, Judy van Hein, Alex Hekimian, David Hensher, Thomas Higgins, Tom Horan, Ryuichi Kitamura, Richard Kuzmyak, Douglass Lee, David Levinson, Ben Lin, Maria Mehranian, Michael Meyer, Tom Nissalke, Ken Orski, Adele Pearlstein, Don Pickrell, Catherine Ross, Elizabeth Sanford, Eric Schreffler, Don Shoup, Don Torluemke, Roberta Valdez, Martin Wachs, Frederick Wegmann, and Mark Wright. The author is responsible for any errors that remain.

Publication of this paper sponsored by Task Force on Transportation Demand Management.