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Current Status of Ridesharing Activities

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Spatial Relationships Between Carpool Members' Trip Ends

A.J. RICHARDSON AND W. YOUNG

The potential for carpool formation is a function of the density of common trip ends, both spatially and temporally. It is also a direct function of the deviation from a direct route that carpool drivers will tolerate in order to pick up and deliver carpool passengers. This paper examines the spatial relationships between the origins and destinations of members of the same carpool. The relationships are reported in terms of carpool trip lengths, passenger pickup and delivery radii and deviations, total deviations from a direct route, and deviations as a function of the direct route distance for the carpool driver. Data for this study were obtained by means of roadside questionnaire surveys at 20 sites in the metropolitan area of Melbourne, Australia.

The last decade has seen a considerable change in emphasis in the area of transportation planning. The former emphasis on substantial capital expenditure for the provision of new transport facilities has been replaced with a much greater emphasis on the efficient management of existing transportation systems. In such an environment, there has been a marked increase in interest in providing for and encouraging the use of high-occupancy vehicles for urban travel during peak hours. Such high-occupancy vehicles may generally be thought of as buses or some form of carpool.

Greater interest in the use of buses for peak-hour travel has been fairly widespread. Comprehensive reports have emanated from the United States (1), the United Kingdom (2), Europe (3), and Australia (4). The predominant increase in interest in carpooling, however, has been in the United States (e.g., 5-7), although recently a number of papers have emerged from the United Kingdom to describe their experiences with ridesharing (8-11). Australia has also produced a limited number of studies over the past few years (12-18).

Most of the reports have, with a few exceptions, been descriptive in nature, and many have simply discussed the application of ridesharing to a specific site. Few of the papers have attempted to investigate the basic characteristics of carpool participants or the way in which carpools form and operate. [Some notable exceptions in this respect are the works of Margolin and Misch (6), Dueker and Levin (19), Bonsall (11), Cousins (14), and Johnson, Sen, and Galloway (20).] In particular, little research has been directed at investigation of the spatial structure of carpools (i.e., the relationships between origins and destinations of members of the same carpool).

The study described in this paper is primarily concerned with determining such carpool spatial structures for a sample of carpool journeys to and from work in Melbourne, Australia. The results are reported in terms of the length of carpool trips, the relationships between carpool members' origins and destinations, and the deviations from a direct route that carpool drivers will tolerate in order to participate in a carpool.

STUDY METHOD

The data on which this paper is based were collected by means of roadside reply-paid questionnaire surveys conducted in April 1978 at several sites in the Melbourne metropolitan area (21). In all, 20 separate surveys were conducted at 11 different locations, as shown in Figure 1. The survey sites were selected to yield a variety of radial and circumferential routes in various sectors of the metropolitan area. Sixteen of the surveys were conducted in the morning peak period and four were conducted in the evening peak period.

Each survey was performed by handing a questionnaire to the drivers of both carpool and noncarpool vehicles as they waited at a red traffic signal. Only one questionnaire was handed to each vehicle since the details for all members of the carpool were to be recorded on the one survey form [see Richardson and others (21) for further details of the questionnaire]. Although this resulted in a slightly crowded format for the questionnaire, previous experience with carpool surveys (22) had shown that considerable difficulty existed in obtaining details for a complete carpool if each member in the carpool is given a separate survey form. By obtaining all details for one carpool on the one survey form, although the total number of returns may decrease, the amount of useful information on carpool formation and spatial structure (the object of the study) would increase because of increased complexity of the questionnaire. Over all sites, the questionnaire distribution rate was 22 percent (i.e., 22 out of every 100 private-passenger vehicles were handed questionnaires). The return rate was 33 percent. This response was considered adequate for the purposes of the analysis.

SURVEY RESULTS

This paper is concerned with carpools that are used for journeys to and from work. Such a distinction is necessary because a large number of trip purposes are being fulfilled by carpools observed on major roads during peak periods. To illustrate this multiplicity of carpool trip purposes, consider Table 1, which shows the distribution of trip purposes for carpools observed on radial routes in the morning and evening peak periods and on circumferential routes in the morning peak period.

Several features of this table are worth noting. First, for the morning trips in particular, a large number of nonwork carpools are primarily concerned with ferrying children to school. To ensure some degree of homogeneity in the carpools considered in this study, all carpools associated with school trips are eliminated from further consideration, as are those that serve passenger trips and carpools that have other (nonspecified) trip purposes. Second, it is obvious from the table that there are two fundamentally different types of work carpools--those in which all carpool members come from the same household (hereafter referred to as internal carpools) and those in which carpool members come from at least two households (external carpools). Although external carpools are generally considered to be more relevant to transportation policy decisions, both types of carpools will be considered in this study. Where comparisons are made with drive-alone vehicles in this paper, such drive-alone-vehicle trips also refer only to journey-to-work trip purposes.

Trip Lengths

Many previous studies of carpooling behavior (e.g.,

Figure 1. Carpool survey sites.

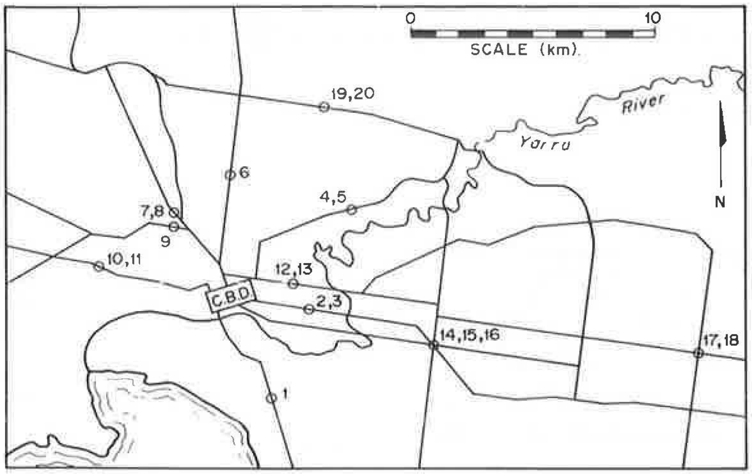


Table 1. Purpose of carpool vehicle trips.

Trip Purpose	Morning Radials		Evening Radials		Morning Circumferentials	
	No.	Percent	No.	Percent	No.	Percent
Work trip with occupants that come from more than one household	107	22	41	36	65	26
Work trip with occupants that come from same household	232	47	52	46	95	39
Trip with at least two work destinations and at least one school or nursery destination	27	5	1	1	13	5
Trip with only one work destination and at least one school or nursery destination	82	17	3	3	47	19
Serve passenger trip	10	2	2	2	2	1
Student or teacher carpools to university or college	9	2	0	0	8	3
Other trip purposes	27	5	14	12	17	7

23,24) have shown that the probability of carpooling is a function of the length of the trip in question. Generally, the probability of traveling in a carpool increases as the total trip length increases. However, at very large trip lengths, some studies (25) have found a tendency for this probability to decrease. Such trends may be explained by reference to two components of travel choice behavior: travel choice preferences and travel constraints. Thus, as the trip length increases, more people will prefer to travel by carpool since the financial savings to be had from reduced fuel consumption will, in absolute terms, be greater. Also, the effect of travel-time increases to pick up and deliver passengers will be relatively less noticeable. However, as the trip length increases, the residential density of potential carpool partners decreases and, hence, it is more difficult for a person to form a carpool (even though at such large distances, such a person may strongly prefer to travel by carpool). The combined effect of these two factors may therefore explain the trends outlined above.

Before proceeding to show the effect of trip length on the propensity to carpool, it is necessary to define the measure of trip length used in this study. Since no information was sought on the actual route traversed by carpools, the only information obtained in this study from which the trip distance could be estimated were the sets of (x,y) coordinates that describe the origins and destinations of each of the vehicle occupants. To find the distance between any two points by using this coordinate system, two possibilities exist:

1. Straight-line distance and
2. Rectangular-grid distance.

The simplest measure is the use of straight-line (or airline) distance between any two points, as given by

$$S_{12} = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \quad (1)$$

where

S_{12} = straight-line distance between points 1 and 2,
x_1 = x-coordinate for point 1, and
y_1 = y-coordinate for point 1.

Although straight-line distance may be a reasonable representation of actual distance traveled in an abstract city with no knowledge of the specific street system, it is likely that, in a grid system of streets, it may be more appropriate to calculate the distance between two points by moving along the sides of a rectangle (aligned in the direction of the grid street system) rather than across the diagonal of the rectangle. In such a case, and when the grid is aligned north-south, the grid distance between any two points is given by

$$G_{12} = |x_1 - x_2| + |y_1 - y_2| \quad (2)$$

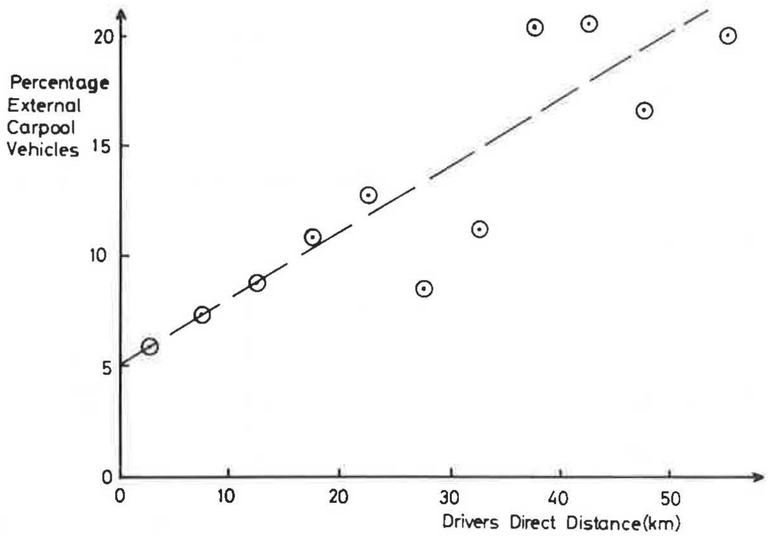
Because of the grid system of streets (aligned roughly north-south), which does occur in much of suburban Melbourne, grid distances were used in this study. As shall be seen later, grid-distance calculations are also more appropriate when calculating deviations from a route in a grid street system.

By using such grid-distance calculations, the distance between the driver's origin and destination was calculated for all three types of vehicle (i.e., drive alone, internal carpool, and external carpool) for the three different categories of survey site

Table 2. Trip length statistics.

Trip	Drive Alone			Carpool Internal			Carpool External		
	Mean (km)	SD (km)	N	Mean (km)	SD (km)	N	Mean (km)	SD (km)	N
Morning radial	17.7	10.1	688	18.4	11.1	204	22.4	11.2	99
Evening radial	16.8	14.3	193	16.6	10.1	47	20.7	13.7	39
Morning circumferential	19.2	10.8	642	17.9	9.0	96	20.2	11.0	75
All sites	18.2	11.1	1523	18.0	10.5	347	21.3	11.7	213

Figure 2. Probability of carpooling as a function of driver's direct distance.



(i.e., morning radials, evening radials, and morning circumferentials). The results of these calculations are shown in Table 2. For each of the three types of vehicle, no significant difference (at the 5 percent level) is found between the trip lengths obtained for each of the three survey site categories. For this reason, the trip length values were combined to produce an all-sites trip length value (in all subsequent analyses, no differences were found among survey site categories and, hence, all-sites values are used in all analyses).

By using a z-statistic on these all-sites values, it can be shown that there is no significant difference (at the 5 percent level) between the mean trip distance for drive-alone vehicles and internal carpools. However, the mean distance for external carpools is significantly greater (again at the 5 percent level) than the mean distance for internal carpools (or drive-alone vehicles).

This increased length of external carpool trips can be examined a second way by noting the probability of a vehicle trip being an external carpool as a function of the driver's direct trip length. This relationship is shown in Figure 2. A strong trend is shown for the proportion of external carpools to increase with increasing trip length (although this trend becomes more variable at higher trip lengths because of reducing sample sizes). It therefore appears that increased trip length does favor the formation of external carpools, as noted in previous studies. This trend does not exist, however, for internal carpools where the proportion fluctuates randomly about a mean value of 17 percent, irrespective of trip length.

Radii of Pickup and Delivery

A previous study (13) showed that substantial potential benefits could accrue from carpooling if residents of Melbourne were willing to pick up and deliver other travelers within a radius of 500 m of their own residence and work place. The present study offers the chance to determine whether such radii of pickup and delivery are feasible, at least in terms of existing carpool arrangements.

Because this study considers both morning and evening work trips, we must redefine the radii used in this analysis. Thus, instead of considering pickup and delivery radii, this study will consider home-end and work-end radii. This redefinition overcomes the problem that the work-end radius is a delivery radius in the morning and a pickup radius in the evening. The work-end radius is therefore defined as the maximum straight-line distance between the driver's work place and any one of the work places of his or her passengers. Similarly, the home-end radius is the maximum straight-line distance between the driver's home and any one of the homes of the passengers.

Obviously, the home-end radius for an internal carpool must be zero because all carpool members must, by definition, come from the same household. The distribution of home-end radii for external carpools is shown in Figure 3. The distributions of work-end radii for both internal and external carpools are shown in Figure 4.

Several features of Figures 3 and 4 are worth noting. First, both the average home-end and work-end radii for external carpools are greater than the value of 500 m proposed in the earlier study (13). This suggests that the benefits derived in that study may be realistic estimates of the potential benefits of carpooling in Melbourne.

Second, the average home-end radius for external carpools is significantly and substantially greater than the average work-end radius for external car-

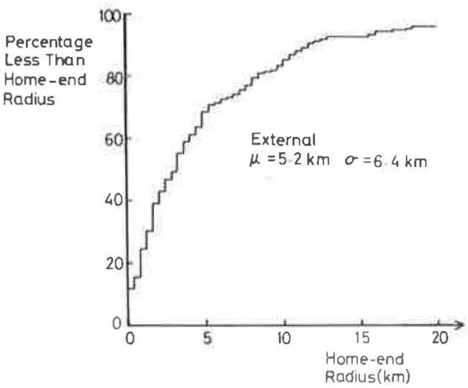


Figure 3. Distribution of home-end radii.

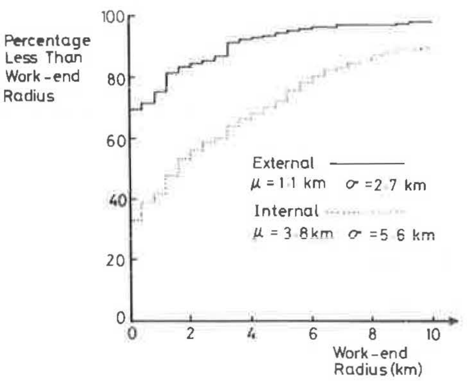


Figure 4. Distribution of work-end radii.

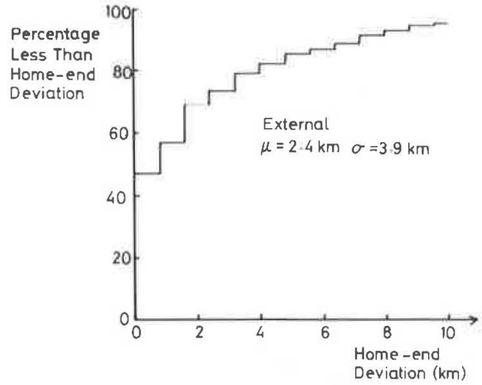


Figure 5. Distribution of home-end deviations.

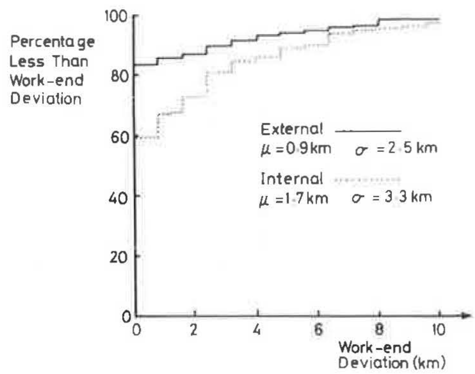


Figure 6. Distribution of work-end deviations.

pools. This indicates that most existing external carpools are work-based carpools. That is, such external carpools are mainly comprised of people who work together (or near each other). This is also demonstrated by the fact that 70 percent of external carpools have a zero work-end radius (i.e., all carpool members work together or at least within 0.4 km of each other), but only 12 percent of external carpools have a zero home-end radius. This natural tendency of travelers to form work-based carpools should be noted very strongly with respect to the encouragement of carpool matching schemes at work sites rather than within residential areas (7,18).

Third, note that the average work-end radius for internal carpools is significantly greater (at the 5 percent level) than the average work-end radius for external carpools. This is to be expected because all internal carpools are home-based and, as a result of family obligations, the driver is committed to delivering or picking up the passenger at the passenger's place of employment, irrespective of the location of that place of employment.

Home-End and Work-End Deviations

Home-end and work-end radii are but one way of specifying the inconvenience suffered by carpool drivers in forming carpools. A more realistic measure of inconvenience is the deviation from a direct route that a carpool driver will tolerate to pick up and deliver passengers. Thus, for example, a carpool driver may have a large home-end radius but if all of the passengers live along the normal route to work then he or she will have little or no route deviation to pick them up. On the other hand, if the carpool driver must first travel away from a final destination in order to pick up passengers, then the route deviation may well be greater than his or her home-end radius.

In this study, the home-end deviation is defined as the grid distance covered in traveling from the driver's home to each of the passengers' homes (in correct order) and then to the driver's work place minus the direct grid distance from the driver's home to the driver's work place (or vice versa for evening trips). The work place deviation is similarly defined as the grid distance covered in traveling from the driver's home to each of the passengers' work places (in correct order) and then to the driver's work place minus the direct grid distance from driver's home to work place.

Once again, the home-end deviation for internal carpools must, by definition, be equal to zero. The distribution of home-end deviations for external carpools is shown in Figure 5. The distributions of work-end deviations are shown in Figure 6.

Comparison of Figures 3 and 5 shows that the average home-end deviation is significantly less than the average home-end radius (2.4 km compared with 5.2 km). This indicates that carpool drivers tend to pick up passengers who live along their normal route to work. However, this implication should be drawn with some care, since the use of grid-distance calculations (and in fact the existence of the grid street system) ensures that many deviations will be zero even though the driver no longer traverses his or her normal route. The existence of this situation is borne out in the results of this study because, although only 12 percent of external carpools have home-end radii equal to zero,

Figure 7. Distribution of total deviations.

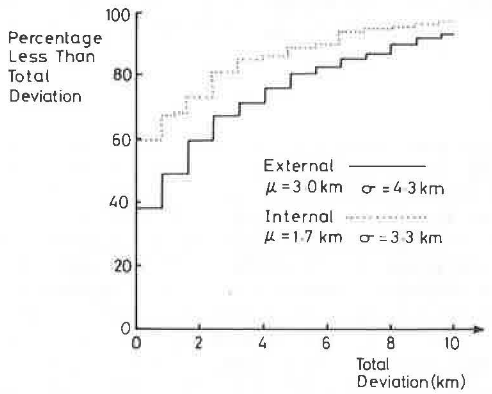
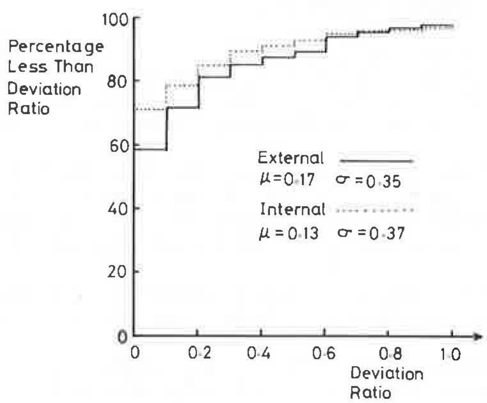


Figure 8. Distribution of deviation ratios.



47 percent of external carpools have home-end deviations equal to zero. The forgiving nature of grid street systems with respect to route deviations means that such grid street systems are more suited to carpool formation than the more recent types of hierarchical street systems where it is necessary for the driver to backtrack in order to continue the journey.

The average home-end deviation for external carpools is significantly greater (at the 5 percent level) than the average work-end deviation for external carpools. This reflects the work-based nature of external carpools, as noted earlier, but may also reflect the relative ease of making deviations at the home and work ends of the trip in terms of traffic congestion levels. Finally, the average work-end deviation for internal carpools is significantly greater than the average work-end deviation for external carpools even though the difference in work-end deviations is far smaller than the difference in average work-end radii.

Total Deviations

A further advantage of using deviations rather than radii as a measure of carpool inconvenience is that it enables the calculation of a total measure of inconvenience for the trip, namely the total deviation. This total deviation is defined as the grid distance covered in traveling from the driver's origin to all the passengers' origins and destinations (in correct order) and then to the driver's destination minus the direct grid distance from driver's origin to destination. The total deviation therefore accounts for both the home-end and work-end deviations and also for the dependence between home-end and work-end deviations. It is therefore unnecessary to try to apportion the total deviation to separate home-end and work-end components.

Because internal carpools have no home-end deviation, the total deviation for internal carpools is the same as the work-end deviation. The distributions of total deviations for both internal and external carpools are shown in Figure 7.

The average total deviation for external carpools is significantly greater (at the 5 percent level) than that for internal carpools, as expected. However, the total deviation for external carpools is not simply the sum of the home-end and work-end deviations. Rather, it is slightly less to account for the degree of dependence between the deviations at the home end and the work end. The average total deviation for external carpools is 3.0 km; 38 percent of the deviations are equal to zero and 10 percent are greater than 8 km.

Deviation Ratios

A measure of inconvenience that is perhaps more readily understood is given by the deviation ratio that relates the total deviation to the total direct distance for the carpool driver. It gives a percentage increase in total trip distance that the carpool driver will tolerate in order to form a carpool. Not only is the nondimensional nature of the ratio easily understood but the ratio also takes account of the different trip lengths of carpool types. Thus, although the total deviation for internal carpools is smaller, remember from Table 2 that the driver's direct distance for internal carpools is also smaller and hence these two factors will tend to even out, with the deviation ratios for internal and external carpools tending to be more equal.

The distributions of deviation ratios for all sites are shown in Figure 8. To some extent, the expectation of more equal deviation ratios for internal and external carpools is borne out by examination of Figure 8. Thus, although the ratio of average total deviations for external and internal carpools was 1.76 to 1, the ratio of the average deviation ratios is only 1.31 to 1. However, by using a Mann-Whitney rank-sum test, the deviation ratio for external carpools is still greater than the deviation ratio for internal carpools (at the 5 percent level).

The mean value of the deviation ratio for external carpools of 0.17 compares reasonably well with previous reported findings. Pratsch (26) suggests that a ratio of 0.25 (albeit measured in time) generally constitutes an acceptable carpool. Approximately 80 percent of the external carpools in the present study have deviation ratios less than Pratsch's value of 0.25.

Johnson, Sen, and Galloway (20) present empirical evidence from two pooling schemes that suggests a ratio between 0.25 and 0.33 (measured in distance). Two factors, however, need to be considered with respect to this study before comparisons can be made with the present study. First, the study by Johnson and others (20) is concerned with vanpools that have up to 12 passengers. This greater number of passengers would obviously tend to increase deviation ratios. Second, the deviation ratio was calculated in a slightly different manner, with the collection distance (i.e., the grid distance traveled to the last pickup) being divided by the line-haul distance (i.e., the grid distance from the last pickup to the final destination, which in that study was common for all passengers). Therefore, although the orders

Figure 9. Deviation ratio as a function of driver's direct distance for internal carpools.

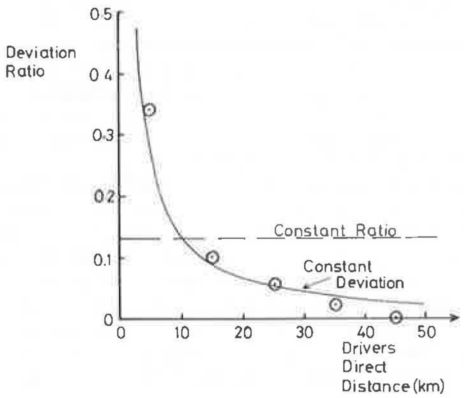
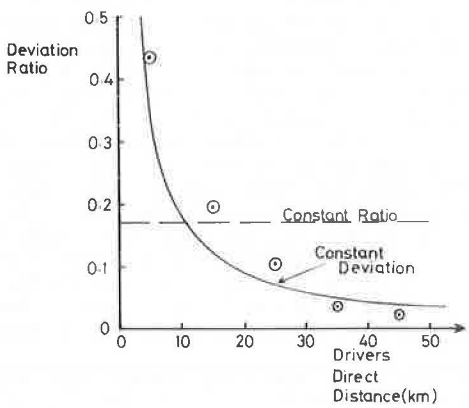


Figure 10. Deviation ratio as a function of driver's direct distance for external carpools.



of magnitude of the deviation ratios from both studies are similar, a detailed comparison cannot be made.

One problem with the use of the deviation ratio is that, although such a ratio is easy to understand and the ratio itself is easy to remember, there is the danger that the ratio may impute a generality that is unable to be substantiated. For example, it may be assumed that the deviation ratio is constant, irrespective of the carpool driver's total direct distance.

To test this assumption, the average deviation ratio for carpools that have driver direct distance that lie within 10-km intervals was calculated and plotted against the mean trip distance for that interval, as shown in Figure 9 for internal carpools and Figure 10 for external carpools. In general, the deviation ratio decreases with increasing driver direct distances. Thus, the constant deviation ratio hypothesis, as depicted by the dashed line in each figure, can be effectively discounted.

On the other hand, if a constant total deviation is assumed (of 3.0 km for external carpools and 1.7 km for internal carpools, as shown in Figure 7), then it is possible to postulate a theoretical curve to represent this hypothesis, as shown by the full line of Figures 9 and 10. In each case, there is reasonably good agreement between this constant deviation curve and the value calculated from the data sets.

It therefore appears that, even though the deviation ratio is a convenient conceptual measure of carpool inconvenience, the total deviation is a more stable measure of the inconvenience that will be tolerated by carpool drivers, irrespective of the driver's distance.

CONCLUSIONS

This paper has presented the results of a reply-paid questionnaire survey conducted at several sites on major roads in the morning and evening peak periods in Melbourne, Australia. It has concentrated on an analysis of the spatial relationships between the origins and destinations of members of the same carpool and has derived a measure of the inconvenience that carpool drivers will tolerate in order to form a carpool. Two types of work-trip carpool were identified and treated separately in the analysis: internal carpools, whose members all come from the same household, and external carpools, whose members come from at least two different households.

On the basis of the reported analysis, the following conclusions can be drawn about the spatial structure of carpool formation.

1. A substantial proportion of multioccupant vehicles could not be strictly classified as carpools; a large number of observed multioccupant vehicles were involved in ferrying schoolchildren to school.
2. No significant differences could be detected between the spatial structure of carpools observed on radial routes in the morning or evening peak periods and circumferential routes in the morning peak period.
3. Over all sites, external carpool driver-trip distances are significantly longer than drive-alone trip distances.
4. Internal carpool driver-trip distances exhibit the same distribution of trip distances as those of drive-alone trips.
5. The probability of a trip being made by an external carpool rises with increased trip distance, from 5 percent at distances less than 5 km up to approximately 20 percent at distances greater than 40 km.
6. The work-end radius for external carpools is significantly lower than the home-end radius, which indicates that most existing external carpools are organized around the work site.
7. The average home-end radius for external carpools is 5.2 km, and the average work-end radius for external carpools is 1.1 km.
8. The home-end and work-end deviations are smaller than the home-end and work-end radii, which indicates that pickups and deliveries can be made with minimal increase in the driver's direct distance.
9. The average total deviation for external carpools is 3.0 km, which is significantly greater than the average total deviation of 1.7 km for internal carpools.
10. The average deviation ratio for external carpools is 0.17, which is also significantly greater than the average deviation ratio of 0.13 for internal carpools.
11. The hypothesis of a constant total deviation appears to be more justified than the hypothesis of a constant deviation ratio (irrespective of driver's direct distance).

The results obtained should help to provide some objective measurements of the way in which journey-to-work carpools are formed and operated. The results should be of considerable assistance in determining the feasibility of carpool structures generated by carpool matching programs. They may also assist a work-site carpool coordinator, whose responsibility is to generate feasible carpools for employees at that site. Remember, however, that these results only assist in generating carpools that are physically feasible. The numerous influences that determine the overall feasibility of the carpool in terms of social acceptability must also be considered as described in other studies of carpooling behavior (6,11,19).

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Promotional Strategies for Ridesharing: Market Study for a Congested Major Urban Link

DAVID O. NELSON

The Port Authority of New York and New Jersey is developing programs to encourage ridesharing in the metropolitan New York region. Trans-Hudson vehicular commuter trips were analyzed to provide information for assessing the feasibility of such programs and to facilitating program development and promotion. The study analyzed strategies to induce single-occupant automobile drivers to switch to ridesharing. This paper reports on situational, sociodemographic, and attitudinal factors that may influence commuters' responses to ridesharing incentives and promotional strategies. A market segmentation approach is used to identify target groups in the study population that would be most likely to switch to ridesharing. The paper outlines the analytic procedures used to conduct the study and reports the major recommendations to the Port Authority.

The Port Authority of New York and New Jersey is developing programs to encourage ridesharing in the metropolitan New York region. Trans-Hudson vehicular commuter trips were analyzed in order to assess the feasibility of such programs and to facilitate their development and promotion. The study analyzed strategies to induce single-occupant automobile (SOA) drivers to switch to ridesharing.

The Port Authority operates numerous transportation facilities in the New York metropolitan area, including six highway crossings between New York and New Jersey [see Figure 1 (1)]. These bridges and tunnels carry approximately 600 000 automobile occupants on a typical weekday, or approximately 400 000 automobiles daily. At all three Manhattan crossings, capacity during the peak hour is rationed by queues at each of the eastbound toll facilities. Based on volumes, congestion, trip ends, and directional balance, each of the Hudson River crossings presents separate and distinct markets for ridesharing incentives. For instance, high-occupancy-vehicle (HOV) lanes would be more attractive at congested facilities that have long toll queues. It might be counterproductive to promote ridesharing at facilities that have high transit modal splits. Consequently, each facility group should be considered separately.

This paper focuses on the George Washington Bridge, which handles more daily work trips than all other trans-Hudson crossings combined. Trip ends for the bridge commuters are generally more dispersed than for users of the tunnels. Also, transit alternatives for most eastbound bridge commuters are less attractive than for commuters who use the tunnels to reach downtown Manhattan. These circumstances suggest that the George Washington Bridge may offer a large potential market for ridesharing promotion among current SOA commuters.

APPROACH

The approach used in this study relies on two basic assumptions:

1. Commuters' responses to ridesharing incentives and promotional strategies are preconditioned by observable situational, sociodemographic, and attitudinal factors. Consequently, a profile of the target market is useful in anticipating commuters' responses to ridesharing incentives.
2. The target market may not be homogeneous with respect to sociodemographic, situational, or attitudinal traits. Different market segments of the target population may differ in ways that would influence their proclivity to rideshare and affect their responses to various ridesharing incentives.

Factors That Affect Responses to Ridesharing Incentives

Based on the first assumption, we identified a number of sociodemographic, situational, and attitudinal characteristics of commuters that could be measured and used to analyze response to ridesharing incentives. Situational factors may be considered carpool opportunities and constraints. Among other things, they include sociodemographic (e.g., age, income, education, occupation, household composition, and automobile availability), and work-based influences (e.g., job schedule, employer subsidies of commuting expenses, and matching program availability).

Attitudinal factors fall into several categories, including life-style considerations and transportation attitudes. Life-style considerations include mastery, personal planning, life pace, intellectualism, and home orientation. These factors are commonly used in sociological and psychological studies of attitudes and behavior. For example, persons who have a high need for mastery or a sense of control are less likely to enter an arrangement that ties their daily schedule to other persons' schedules. Transportation attitudes include attitudes and beliefs with respect to air pollution, job

Figure 1. New York-New Jersey Port Authority crossings.

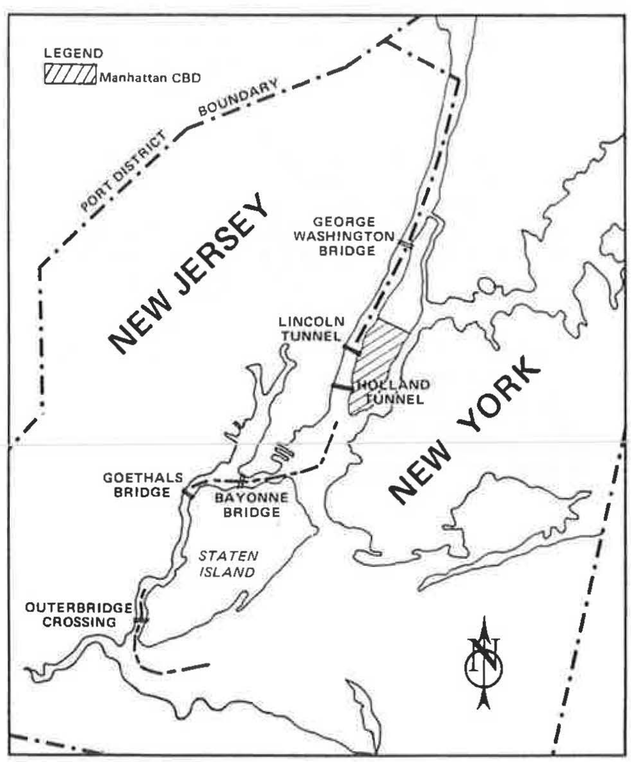


Table 1. Sociodemographic characteristics.

Item	CBD SOA[a] (n = 47) No.	CBD SOA[a] SD	CBD Carpool[a] (n = 21) No.	CBD Carpool[a] SD	CBD Transit[a] (n = 41) No.	CBD Transit[a] SD	Non-CBD SOA[b] (n = 171) No.	Non-CBD SOA[b] SD	Non-CBD Carpool[b] (n = 33) No.	Non-CBD Carpool[b] SD	Reverse SOA[c] (n = 99) No.	Reverse SOA[c] SD
Male (%)	85.1		85.7		70.7		72.9		69.7		84.7	
Licensed drivers (%)	100.0		100.0		100.0		97.1		100.0		97.9	
Avg age	43.9	10.8	43.3	11.2	43.2	12.7	42.4	11.9	37.7	11.0	40.7	12.2
Occupation (%)												
Professional or technical	47.7		36.8		46.4		50.1		53.2		44.9	
Manager, official, or proprietor	22.7		31.6		26.9		28.2		28.2		24.5	
Mean household income ($000s)	43.2	18.5	46.4	16.5	36.0	15.0	40.3	16.5	36.7	16.6	35.2	16.6
Household composition (mean number in household)												
Adults	2.5	1.3	2.2	0.5	2.2	1.1	2.6	1.1	2.5	1.0	2.3	0.8
Full-time workers	1.4	0.9	1.4	0.7	1.6	0.7	1.8	0.8	1.7	0.8	1.6	0.6
Automobiles	2.2	0.9	2.0	0.7	1.6	0.9	2.4	1.0	2.2	0.8	1.8	0.7
Children	1.0	1.4	1.0	1.0	0.9	1.2	1.0	1.2	1.1	1.3	0.9	1.2
Licensed drivers	2.4	1.3	2.0	0.7	2.2	1.1	2.4	1.0	2.2	0.8	2.0	0.8
Automobiles per licensed driver (% less than 1)	20.0		16.7		56.4		18.5		9.7		30.0	
Avg no. of months at current residence	102.8	98.7	106.2	88.0	99.3	107.0	115.8	111.8	98.6	88.6	90.6	86.6

[a]CBD = home location west of Hudson River and work location in central business district.
[b]Non-CBD = home location west of Hudson River and work location ouside of central business district.
[c]Reverse = home location east of Hudson River.

flexibility, noise in the car, commuter satisfaction, money, perceptions of carpools, and sociability. For example, attitudes about noise in a car, including the radio and conversation, may make individuals reluctant to share their ride to work.

Market Segmentation

The key to the market-segmentation approach is the identification of groups in the target market that are homogeneous with respect to important criteria that influence their travel choices. In this study, geography and current mode are important segmentation criteria. Geographically, the commuting environment, including personal requirements and constraints, varies by direction and destination. For instance, New Jersey residents bound for the Manhattan central business district (CBD) face different opportunities and constraints than their counterparts bound for the other boroughs. The principal market segments in these analyses were as follows:

1. CBD SOA--SOAs bound for downtown Manhattan,
2. CBD carpool--carpoolers bound for downtown Manhattan,
3. CBD transit--transit patrons bound for downtown Manhattan,
4. Non-CBD SOA--SOAs bound for elsewhere in New York,
5. Non-CBD carpool--carpoolers bound for elsewhere in New York, and
6. Reverse-commuting SOA--SOAs bound for New Jersey.

These six groups were best represented in the survey data. Other market segments are relatively less important at the George Washington Bridge.

A mailback survey instrument was designed to measure all the factors mentioned in the approach. The survey was distributed at all six Hudson crossing facilities; however, only the data from the George Washington Bridge were analyzed for this report.

The survey was administered to these independent samples:

1. SOAs,
2. Carpoolers, and
3. Transit patrons.

This sampling design ensured that each modal group was sufficiently represented for a market segmentation study. The total response rate (26.4 percent) did not vary significantly among samples [see Charles River Associates study (2) for more detail on data collection].

SEGMENT PROFILES

Sociodemographics

Most of the commuters on the George Washington Bridge are male, have driver's licenses, and own their own automobiles (see Table 1). On the average, they are about 40 years of age. In the CBD segment, commuters tend to come from households of fewer full-time workers than do commuters from the reverse-commuting segment. Nearly half of the respondents in the CBD segment are employed in professional or technical positions. Household incomes tend to be high--in the neighborhood of $40 000/year. Reverse commuters tend to be somewhat younger and come from smaller, less-affluent households. Among SOAs, only the reverse commuters average less than $40 000/year.

Levels of automobile ownership do not significantly discriminate among segments. There tends to be one car for every driver, although automobile ownership levels may be somewhat lower for reverse commuters. Length of residence at the current home was highly variable over all segments, and no significant differences were found among segments.

Since it is generally believed that commuters who have higher income are more sensitive to time than to cost, the finding that George Washington Bridge commuters tend to be well-paid professionals who have their own automobiles available for commuting suggests that they are likely to be more sensitive to time-savings incentives than to the cost-saving advantages that are already available to carpoolers.

Work-Based Influences

The majority of all SOAs reported that their work schedule varied from day to day (see Table 2). Carpoolers were somewhat less likely to work variable schedules. Transit patrons tended to work the most regular hours. Strictly enforced work hours are

Table 2. Situational factors—work-based influences.

Work-Based Influences	CBD SOA (%) (n = 47)	CBD Carpool (%) (n = 21)	CBD Transit (%) (n = 41)	Non-CBD SOA (%) (n = 171)	Non-CBD Carpool (%) (n = 33)	Reverse SOA (%) (n = 99)
Variable work hours	70.2	47.6	37.5	56.7	40.6	51.0
Strict work hours	27.7	38.1	43.9	43.3	48.5	38.8
Frequent and unpredictable overtime	46.8	38.1	22.0	39.2	45.5	34.7
Frequent out-of-town travel	31.9	33.3	9.8	14.6	9.1	30.6
Varying shifts	14.9	4.8	0.0	9.4	15.2	8.2
Staggered hours	4.3	4.8	2.4	8.2	0.0	6.1
Flexible hours	36.2	52.4	43.9	36.8	39.4	41.2
Same daily work location	75.6	85.7	97.5	88.3	90.9	78.5
Need car for business	44.7	14.3	2.4	42.7	9.1	52.6
Carpool matching service	2.1	0.0	7.7	8.4	6.1	13.3

Table 3. Situational factors—employer-paid commuting expenses.

Employer-Paid Commuting Expenses	CBD SOA (%) (n = 47)	CBD Carpool (%) (n = 21)	CBD Transit (%) (n = 41)	Non-CBD SOA (%) (n = 171)	Non-CBD Carpool (%) (n = 33)	Reverse SOA (%) (n = 99)
Parking	38.3	23.8	0.0	22.2	6.1	26.3
Gasoline	36.2	14.3	0.0	17.5	6.1	34.3
Tolls	27.7	9.5	0.0	16.4	9.1	37.4
Automobile maintenance and repairs	34.0	4.8	0.0	13.5	9.1	26.3
Mileage allowance	4.3	4.8	0.0	7.6	3.0	8.1
Transit fare	4.3	0.0	0.0	1.2	3.0	9.1
Automobile insurance	31.9	9.5	0.0	11.1	9.1	25.3
Automobile purchase price	23.4	0.0	0.0	8.2	6.1	15.2
Parking tickets	12.8	0.0	0.0	5.9	6.1	4.0
Any of the above	53.2	28.6	0.0	36.8	15.2	48.5
Company-owned car	23.9	4.8	0.0	10.0	9.4	26.5
Average number of months at current work location	100.8[a]	147.4[b]	103.7[c]	106.0[d]	91.5[e]	66.3[f]

[a]SD = 104.6. [b]SD = 110.0. [c]SD = 112.1. [d]SD = 96.6. [e]SD = 74.8. [f]SD = 78.0.

most common in the non-CBD segment; approximately one-half of these respondents report strict hours. Frequent and unpredictable overtime characterizes the work hours of two-thirds of the CBD SOAs; only half the non-CBD SOAs often work late. About one-third of all CBD and reverse-commuter SOAs reported out-of-town travel. Out-of-town travel is much less common in the non-CBD segments. Only small proportions of any segment reported varying shifts or staggered hours. Stability of the work location was particularly high for non-CBD commuters; more than 90 percent work at the same site every day. Among CBD and reverse-commuting SOAs, only 75 percent work at the same place every day. Nearly one-half of these SOA groups need a car for work-related business on some days. Somewhat fewer of the non-CBD SOAs need cars for work-related business. These schedule considerations, particularly variability of the job site and job-related travel, suggest that the non-CBD SOAs would be least constrained in their responses to ridesharing promotional programs.

Only small proportions of any market segment's employers offer carpool matching services. This suggests that substantial early gains can be made by helping employers set up ridesharing services.

Subsidized Commuting Expenses

Employers currently subsidize a substantial portion of the George Washington Bridge market segment's commuting expenses (see Table 3). More than one-half of all CBD SOAs report that some or all of their expenses are paid by their firm: company car, 24 percent; free parking, 38 percent; free gasoline, 36 percent; free tolls, 28 percent; maintenance and repairs, 34 percent; and insurance, 32 percent. Less than one-third of the CBD carpoolers receive similar benefits. No CBD transit patron reported a subsidy.

Among non-CBD commuters, employer subsidies are less common; still, more than one-third of all SOAs receive some commuting subsidy. However, only 10 percent drive a company car. The pattern of employer-paid expenses for reverse commuters is similar to that for CBD SOAs.

Since larger proportions of CBD and reverse-commuting SOAs are subsidized, a non-CBD focus for a ridesharing program may reach more commuters who feel the pinch of increased commuting costs and would be responsive to the cost-saving incentives to carpool.

The pattern of subsidized commuting expenses and generally high incomes of George Washington Bridge commuters suggests that company cars and other commuting subsidies may serve to shelter employees from federal, state, and local income taxes, which would be levied on cash income. A company car is not generally taxable as personal income. Possible tax reforms could help eliminate unintentional side effects on choice of mode for work trips.

Attitudinal Factors

The attitudinal data were analyzed by using factor analysis techniques to identify common themes in the commuter's response sets. The most salient attitudinal findings are summarized below. In the interest of brevity, no statistical information is presented on the attitudinal factors.

SOAs tend to score somewhat higher on mastery needs. This is consistent with a theory that some SOAs may drive alone to satisfy a need for power and control.

With respect to personal planning, CBD carpoolers tend to be freer, but all respondents are generally conservative. Any carpool promotion campaign designed to appeal to SOAs should ensure potential ridesharers that the carpooling or vanpooling arrangement will not break down.

Under life pace, SOAs also appear to live more hectic lives than do carpoolers. They tend to be more often exhausted at the end of the day. SOAs tend to live more closely structured lives. This suggests that SOAs would not be attracted to join a ridesharing group that had slipshod aspects or the perceived potential to be unreliable.

All commuters tend to be home and family oriented. A ridesharing promotional campaign should emphasize benefits that accrue to the family and home from having the breadwinner carpool (e.g., home punctually and safely and the car is free for use at home). No group indicated that it particularly liked large social gatherings. A large work-based get together for potential carpoolers to meet one another may make commuters less comfortable with one another than would smaller, more personalized meetings. This supports the concept of carpool coordinators at the workplace who would help potential ridesharers meet one another on a more personal basis.

All groups feel that air pollution is a problem in New York. However, a simple media appeal to rideshare because it is good for the ecosystem is unlikely to shift many SOAs into carpools without added encouragement, incentives, and facilitation.

Ridesharing may be perceived as a sacrifice in job and schedule flexibility. Promotional campaigns should emphasize the flexibility of ridesharing relationships. Consistent with the professional and technical jobs they generally hold, most respondents indicated they could come and go as they pleased from their jobs. They tend to feel they need this flexibility.

In terms of satisfaction with their current commute mode, non-CBD carpoolers tended to be more satisfied than other groups. In the CBD, both SOAs and carpoolers report driving daily in bumper-to-bumper traffic, but it tends to bother SOAs more. Traffic is not as big a problem for non-CBD commuters, but it remains one of the biggest headaches for non-CBD SOAs and reverse commuters. Promotional appeals should indicate that carpooling is a good way to share the chores of driving in traffic, and that carpoolers have been shown to be more satisfied with their work trips than are SOAs. Heightened sensitivity to traffic snarls among SOAs also suggests that priority treatments, such as special lanes or toll booths for carpoolers, could shift disgruntled drive-alone motorists into the shared-ride mode.

RESPONSES TO RIDESHARING INCENTIVES

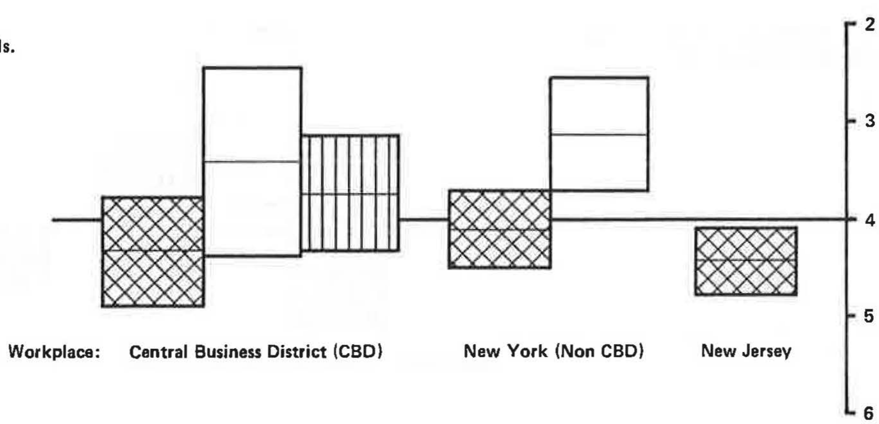
Respondents were asked to agree or disagree on their responses to seven specific transportation system management (TSM) incentives to encourage ridesharing. A seven-point scale was used; high values indicated disagreement and low values indicated agreement.

1. I would be more likely to carpool if I could travel in a special highway lane just for carpools,
2. I would be more likely to carpool if I could use toll boths just for carpools,
3. I would be more likely to carpool if I could go to the head of the line at toll booths,
4. I would be more likely to carpool if I were granted special parking privileges at work,
5. I would be more likely to carpool if carpoolers could go through toll booths free,
6. If I were rationed to 10 gal of gasoline a week I would be more likely to carpool, and
7. I would be more likely to carpool if we could use a van provided for the exclusive use of the carpool.

Reactions, in the form of agreement or disagreement, should be interpreted as the extent to which the respondent believed he or she would be persuaded to carpool by the relevant change in the commuting environment. Negative responses should not be interpreted as a rejection of the concept but rather as evidence that the respondent viewed it unlikely that a given incentive would influence him or her to carpool more often. Similarly, positive reactions should not be viewed as an endorsement of a particular policy option but rather as recognition that the policy would influence the respondent to carpool.

Analysis of the results of this portion of the questionnaire showed that different promotional strategies have different appeals for different market segments. Among SOAs, special highway lanes for carpools yielded the most positive response from non-CBD SOAs [see Figure 2 (2)]. (In Figures 2-9, the 95 percent confidence interval was for the George Washington Bridge market segment only. On a 1-7 scale, values less than 4 indicate agreement, and values greater than 4 indicate disagreement.) Priority treatments at toll booths, on the other hand, elicited few positive responses from SOAs [see Figures 3-5 (2)]. Special parking privileges for carpoolers were not perceived as a benefit for non-CBD and reverse SOAs, who already generally enjoy free parking [see Figure 6 (2)]. Gasoline rationing would probably have a dramatic positive effect on carpooling to job sites outside the CBD because commuters would tend to try to maximize

Figure 2. Confidence intervals for commuter responses to a special highway lane just for carpools.



their fuel allotment for discretionary trips by reducing their fuel use on nondiscretionary commuting travel [see Figure 7 (2)]. Vanpooling had a significant appeal for transit patrons [see Figure 8 (2)]. This may be due to the similarity of the modes; however, the vanpool is perceived as a more personalized mode. It may also be that the lower-income transit patrons would enjoy the use of a van. The Golden Gate Bridge Highway and Transportation District has experienced considerable success in filling vanpools by direct promotion at bridge toll plazas (3). Such a program would probably be successful at the George Washington Bridge but might have an adverse impact on peak-period transit ridership. The Port Authority wishes to minimize adverse effects on transit ridership that result from ridesharing promotion.

Work-Based Versus Community-Based Ridesharing

A separate question tested the appeal of carpooling with a neighbor rather than a coworker. The results are noteworthy [see Figure 9 (2)]. Among current carpoolers to the CBD, sharing the ride with a neighbor was seen as more likely than carpooling with a coworker. Non-CBD carpoolers stated they were more likely to carpool with a coworker.

This finding suggests that a work-based approach

Figure 3. Confidence intervals for commuter responses to toll booths just for carpools.

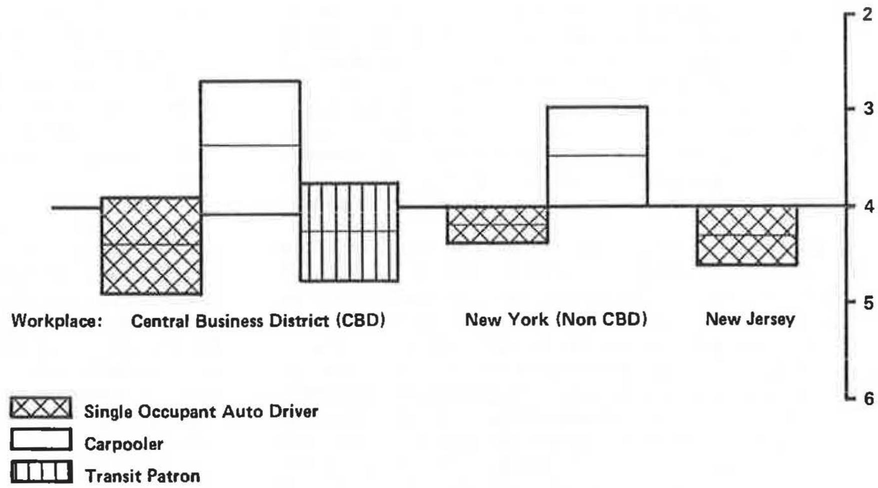


Figure 4. Confidence intervals for commuter responses to carpools going to the head of the line at toll booths.

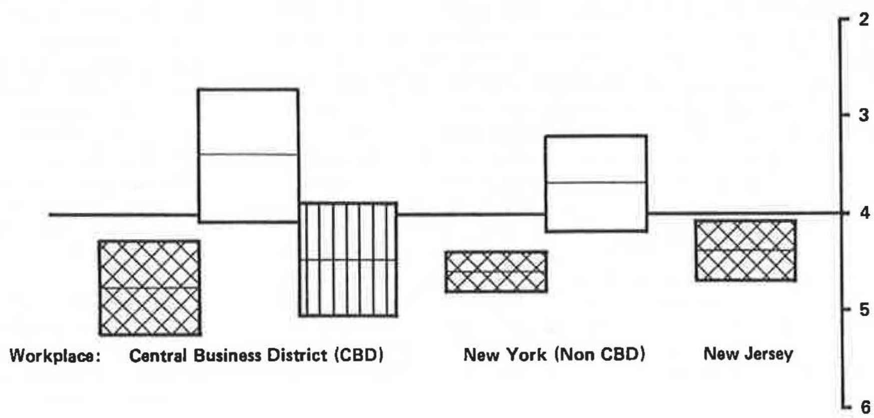
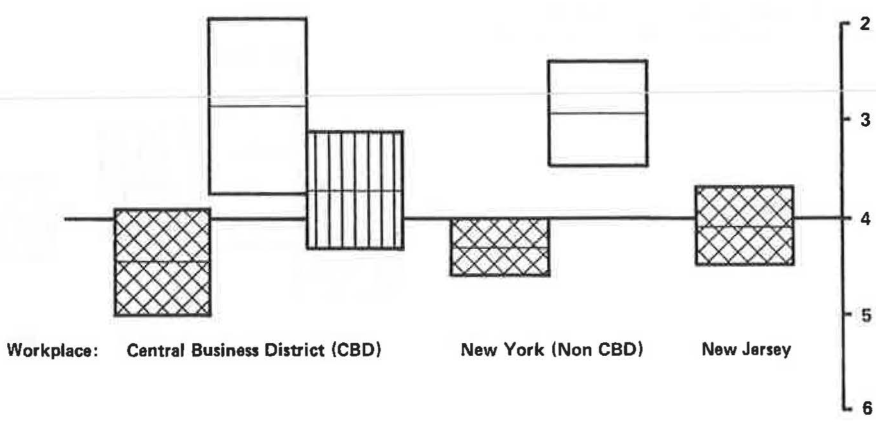


Figure 5. Confidence intervals for commuter responses to free tolls for carpools.



to ridesharing promotion would be a more effective strategy in recruiting non-CBD and reverse commuters. In contrast to CBD work trips, non-CBD work sites are geographically more dispersed. This reduces the chances that a commuter would find a neighbor working at his or her work place. There is a greater chance for successful matching with a work-based approach because potential ridersharers are known to have one trip end in common as well as common start and end times for work. With some creativity, matches could be made between coworkers who may not be neighbors but share a substantial portion of the route to work because they live in the same corridor. Each ridesharer would drive to a node on the highway system where he or she would park and ride with a coworker over the line-haul portion of the trip. Connecticut has experienced considerable success with roadside park-and-pool lots near major highway interchanges.

A neighborhood-based approach to ridesharing pro-

Figure 6. Confidence intervals for commuter responses to special parking privileges for carpools.

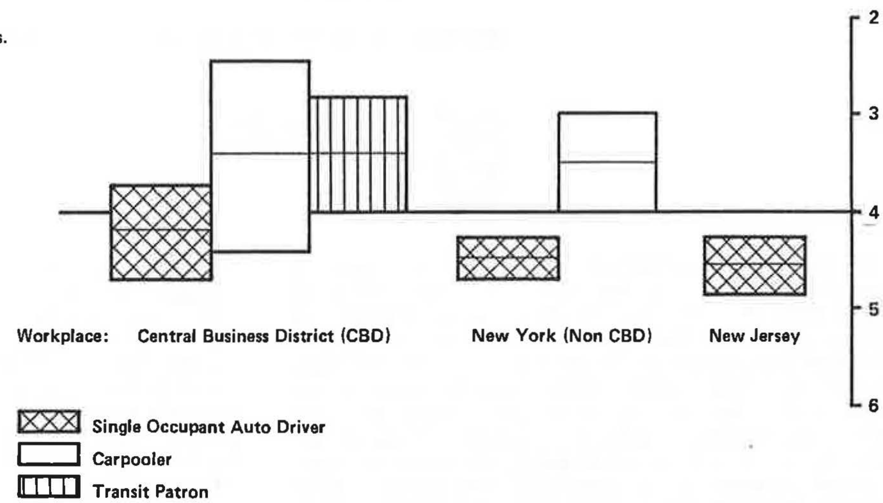


Figure 7. Confidence intervals for commuter response to carpooling if gasoline were rationed.

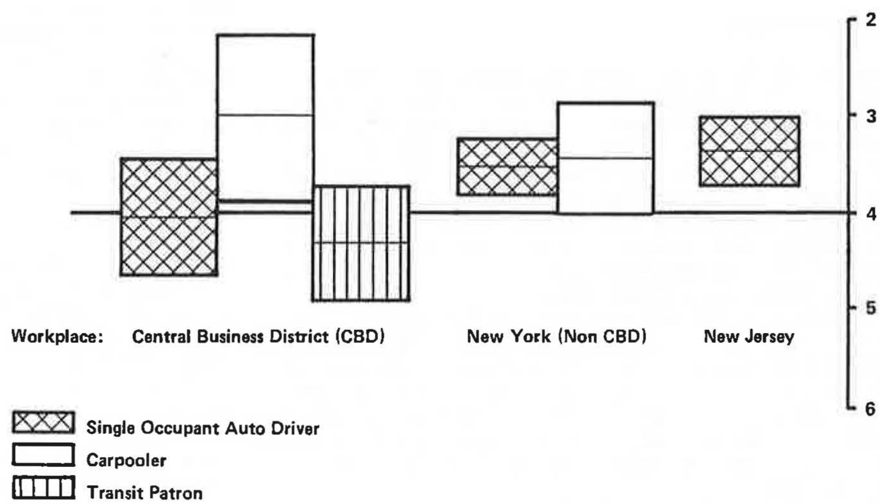


Figure 8. Confidence intervals for commuter responses to vanpooling.

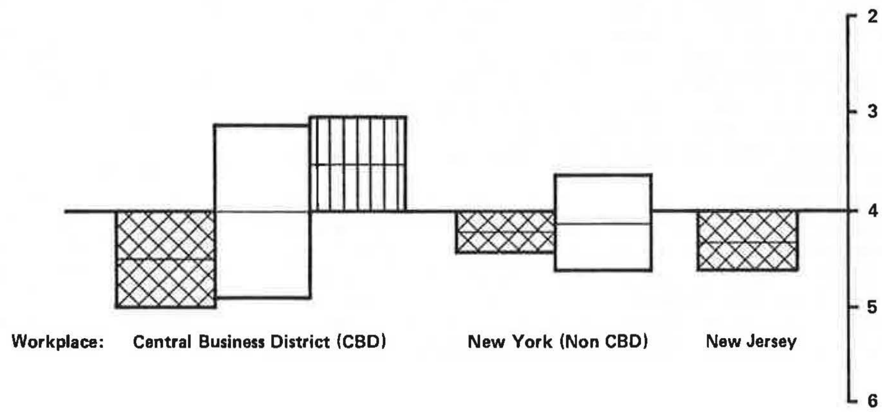
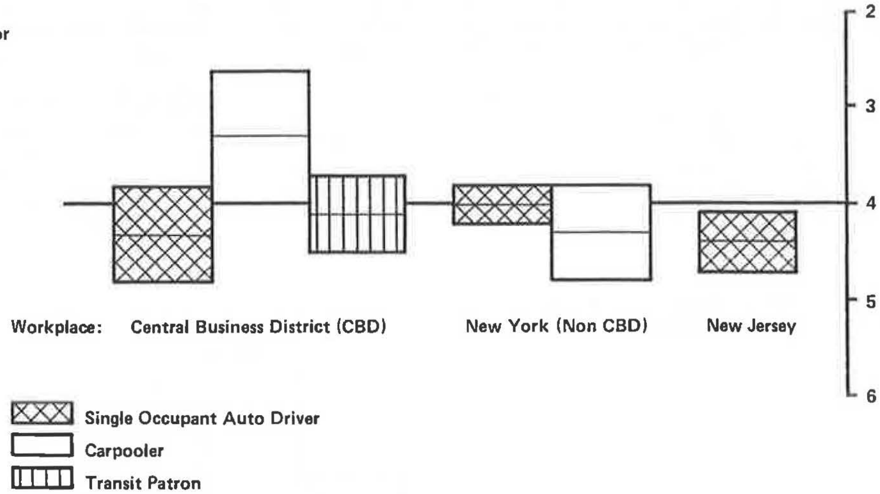


Figure 9. Confidence intervals for commuter responses to likelihood of carpooling with a neighbor versus a coworker.



motion could be particularly effective in creating successful matches for CBD commuters, many of whom now use transit. The CBD has the highest employment concentrations in the region; therefore, neighborhood-based matches would be most easily made to that destination. This could have adverse effects on transit ridership because most CBD commuters currently ride transit. With a neighborhood-based approach it would not be politically feasible to deny CBD-bound commuters ridesharing services. Consequently a work-based approach to ridesharing promotion, targeted to the non-CBD market, is favored for this project.

RECOMMENDATIONS

Analysis of the ridesharing opportunities and constraints that face SOAs in each of the George Washington Bridge directional segments suggests that non-CBD SOAs would be least constrained and most responsive in reacting to ridesharing incentives and promotions. A much smaller proportion of these SOAs are heavily subsidized with company cars, free gasoline, tolls, and parking. They also have greater stability of work location, more regular work hours, and make fewer out-of-town trips.

For the non-CBD and reverse-commuter market segments, a work-based approach is favored over a community-based approach to ridesharing. A system of park-and-pool lots along major corridors in New Jersey would facilitate carpool formation among groups of commuters who have a common schedule and work destination but disparate home origins in the same corridor.

The work-based approach could work through the employer to promote carpooling at individual employment sites. Once an employer is committed to ridesharing, he or she should be informed about ways in which schedule and work travel policies could be changed to facilitate carpool formation. Changes in the work environment might include a motor pool of employer-owned vehicles for occasional employee use in place of company cars that carry so many SOAs in this corridor.

Nothwithstanding the emphasis on a work-based approach, the Port Authority should also avail itself of opportunities for ridesharing promotion at the bridge itself. Signs that give a telephone number to call for carpool information are a low-cost channel to reach first-acceptors for ridesharing services. This assumes that the Port Authority would establish some telephone information system capability for the work-based approach. The phone-line signs would probably be most effective at the new HOV lane proposed for the bridge. Commuters would have an opportunity for first-hand observation of a timesaving incentive to rideshare. Similarly, vanpool promotion at the toll plazas could capture substantial ridership. However, vanpool marketing at toll plazas would not screen out potential diversion from transit.

Analysis of TSM incentives to encourage ridesharing suggests that techniques that save time or make carpools more reliable would more effectively induce carpool formation in this relatively affluent market than would techniques that save commuters money.

Analysis of attitudinal factors suggests that they are not an overriding influence in responding to ridesharing incentives. Nonetheless, a ridesharing promotional campaign should be sensitive to the attitudinal complexes that characterize the different target market segments.

ACKNOWLEDGMENT

This paper summarizes the results of a behavioral research study conducted by Charles River Associates, Inc., under contract to the Port Authority of New York and New Jersey. Some funds for questionnaire development and survey analysis were provided under a contract with the U.S. Department of Energy to develop a consumer representation plan. I wish to acknowledge the cooperation and guidance provided by Walter Colvin and Lona Mayer of the Port Authority and the contributions of Daniel Maxfield of the U.S. Department of Energy. This study was conducted under the direction of Daniel Brand. Kim Honetschlager provided invaluable technical assistance. Timothy Tardiff, Frederick Dunbar, Peter Allaman, and Harrison Campbell served as internal consultants on the project.

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Abridgment

Vanpool Travel Characteristics in Southeast Michigan

R. CRAIG HUPP

This paper describes the results of a travel survey that was distributed by the Southeast Michigan Council of Governments to all participants in employer-sponsored vanpool programs in the seven-county southeast Michigan region. The purpose of the survey was to collect socioeconomic, travel, and attitudinal data from participating vanpoolers. This paper summarizes the results of the socioeconomic and travel portions of the survey. Data were collected that describe the vanpoolers' modal shift to pooling, use or disposal of the automobile left home by commuters who previously drove, and total vanpooler travel before and after joining the pool. Vanpooling in the Detroit area attracts few transit users and draws riders nearly equally from drive alone and ridesharing. Vanpooling does not have a significant impact on automobile ownership. Only 15 percent of the respondents reported that either a vehicle was sold or its purchase postponed as a result of vanpooling. However, only 20 percent of respondents reported that the vehicle left home was used by other household members and its use was substantially less in terms of mileage than the former commuting use. Finally, the total travel impact of vanpooling was a reduction in automobile travel of 339 miles/month for the average vanpooler.

In April 1980 the Southeast Michigan Council of Governments (SEMCOG) conducted a travel survey of all people who participated in employer-sponsored vanpool programs. SEMCOG is the metropolitan planning organization (MPO) for a seven-county region centered in Detroit. As MPO, SEMCOG has been active in planning for ridesharing in the region since 1975.

The vanpool survey was undertaken to satisfy several purposes. There was a need to collect data to identify what travel impacts had been achieved in order to evaluate the success of SEMCOG's vanpool promotion program. For transportation system management (TSM) and air quality planning activities there was a need to collect vanpooling data specific to the region that could be used as a basis for ongoing planning activities. Ridesharing staff felt that attitudinal information from vanpoolers would be of assistance in refining SEMCOG's and employers' in-house promotional campaigns. Finally, there was a certain amount of curiosity about certain vanpool characteristics that had not been discussed in vanpool literature, such as, "How much is the car left home used during the day?"

This paper summarizes the socioeconomic and travel portions of the vanpool survey. In particular, the information that follows is intended to answer the following questions:

1. What are the socioeconomics of vanpoolers in the region?
2. What are their present travel characteristics?
3. What has been the mode shift to vanpools?
4. What has happened to the automobile formerly used for the work commute?
5. What net travel reduction has been achieved by the shift to vanpools?

THE SURVEY

The survey contained 52 questions and was five pages long. Concern was expressed that the survey was too long. However, in 1978 Michigan distributed a detailed four-page survey to its vanpoolers and experienced an excellent response rate. It was decided that the relatively long and comfortable travel time in the van together with the well-known vanpooler's esprit de corps would yield a good response rate. Such was the case.

All employers in the region who sponsored vanpool programs agreed to participate in the survey. Surveys were distributed to all vanpoolers at each company with the exception of Chrysler, where only a sample of vanpoolers were included due to the size of its program (112 vans). Surveys were distributed through each company's vanpool coordinator. The coordinator distributed the surveys to each vanpool driver. The driver was responsible for distributing and collecting the surveys from the passengers. The survey was distributed to 98 vans and approximately 1000 vanpoolers. A 77 percent response rate was achieved.

RESULTS

Vanpoolers tend to have larger families, more employed family members, more cars, and higher incomes than the average commuter in the region. They also travel significantly greater distances to work, on the order of 24 miles.

Vanpoolers' Travel Characteristics

The length of time survey respondents had been vanpooling was only eight months. The majority of respondents had been pooling for less than a year. The data were not representative of the total vanpooling population because vanpoolers were only sampled at Chrysler, which has the oldest (operational for more than five years) and largest program in the region. As will be seen in later discussion, because such a large proportion of survey respondents were relatively recent converts to vanpooling, the effects of vanpooling on the decision to reduce household automobile ownership were masked.

More than 40 percent of the survey respondents reported being picked up at home. Of the vanpoolers who were not picked up at home, more than 50 percent met the vanpool at a shopping center. Nearly 75 percent of the vanpoolers who were not picked up at home drove alone to the pick-up point. The average distance from home to the pick-up location was 3.9 miles. Vanpoolers reported missing an average of 2.5 one-way trips/month. About 25 percent of the respondents indicated they missed some trips per month.

Vanpool drivers reported driving their vans up to 1000 miles/month for personal use. Most drivers reported monthly personal use mileage in the range of 50-300 miles. The average mileage reported was 175 miles/month. About 10 percent of vanpoolers reported an increase in their use of their employer's staff vehicles. The average increase in use was about 100 miles/month; 400-500 miles/month represented the high end of the range.

Some other data related to the vanpooler's travel decision are as follows. Automobile insurance reductions have been received by 44 percent of vanpoolers. Thirty percent of respondents changed their work hours when they began vanpooling. More than 43 percent of respondents reported their employers offered at least one incentive to vanpooling, including the following:

1. Parking closer to work entrance (30 percent of respondents),
2. Parking at reduced cost (6 percent of respondents), and
3. Other incentives (13 percent of respondents).

Table 1. Variables that influence automobile ownership decision.

Variable	No-Change[a] Mean	Purchase Postponed[a] Mean	Purchase Postponed Significance[b]	Vehicle Sold[a] Mean	Vehicle Sold Significance[b]
Household size	3.09	3.82	0.0058	3.44	0.2649
No. of employed persons	1.84	2.07	0.0557	1.81	0.8145
Vehicle ownership[c]	1.97	2.97	0.0000	2.76	0.0000
No. of employed persons per vehicle[c]	1.00	0.72	0.0006	0.68	0.0000
Licensed drivers per vehicle[c]	1.14	0.91	0.0000	0.91	0.0001
Avg. income ($)	26 600	28 500	0.1564	31 200	0.0043
No. of months in pool	8.30	10.47	0.0256	11.55	0.0040
No. of miles to work	24.10	22.73	0.3659	20.96	0.0785

[a]Although the number of samples in each vehicle ownership decision category varies by variable depending on nonresponses, typical sample size is 570 responses for no change, 70 responses for purchase postponed, and 48 responses for vehicle sold.
[b]F-test comparison of variable means for purchase postponed and vehicle sold responses with no change responses.
[c]Vehicle ownership is vehicle ownership before respondent began vanpooling.

Table 2. Variables that influence use of vehicle left home.

Variable	Automobile Used[a] Mean	Automobile Not Used[a] Mean	Automobile Not Used Significance[b]
Household size	3.67	3.08	0.0057
Employed persons	2.04	1.82	0.0182
Vehicle ownership	3.01	1.98	0.8006
Employed persons per vehicle	1.14	0.98	0.0015
Licensed driver per vehicle	1.51	1.12	0.0000
Avg. income ($)	28 600	26 700	0.0774
Months in pool	11.19	8.16	0.0001
Miles to work	21.67	24.45	0.0223

[a]Although the number of samples varies by variable depending on nonresponses, typical sample size is 125 responses for automobile used and 550 responses for automobile not used.
[b]F-test comparison of variable means for automobile not used respondents with automobile used respondents.

Employer incentives influenced the vanpooling decision of 13 percent of respondents.

Mode Shift to Vanpools

Almost all respondents (89 percent), were users of private vehicles and about equally split between drive alone and ridesharing. Only 7.5 percent of respondents reported transit as their prior mode. Respondents who formerly carpooled reported that the average carpool size was 3.1 people and that 80 percent of the carpools involved shared driving responsibilities.

The shift to vanpools involved an increase in travel time and distance for most respondents. Increases in time are associated with waiting for the van and any extra trip distance. Increases in distance are associated with travel to the pick-up location and trip circuity once in the van as other poolers are picked up. The average increase in travel time was 12 min, and the average increase in travel distance was 2.9 miles.

Use of the Vehicles Left Home

Concern has been expressed that the vehicle left home when the shift to vanpooling is made is used by other household members for work and nonwork travel. This use could offset some or even all of the private vehicular travel reduced by the vanpooler's work trip.

Vehicle Ownership Decision

About 6 percent of respondents indicated that they had sold the vehicle formerly used for commuting. Another 9 percent indicated that they had postponed the purchase of another vehicle. The vehicle ownership decision was analyzed in regard to several variables to determine whether certain socioeconomic or other factors were related to the vehicle ownership decision. Table 1 shows a statistical comparison of variable means for respondents who reported either

1. No change in household vehicle ownership due to vanpooling (no change),
2. Postponement of the purchase of a vehicle (purchase postponed), or
3. The sale of a vehicle (vehicle sold).

Note that vehicle ownership as used in this table is vehicle ownership before the respondent began vanpooling. The significance value shown in the table is based on the F-test. It represents the probability that, for a given variable, the mean for either the vehicle-sold or purchase-postponed populations is the same as the mean of the no-change population.

A review of Table 1 reveals that the mean vehicle ownership, employed persons per vehicle, and licensed drivers per vehicle were the most significantly different between the three automobile ownership decisions. All were significantly different at the 1 percent level. The table also shows that the respondents' automobile ownership decision is dependent on the length of time he or she has been vanpooling (months in pool). The longer the respondent had been in the pool, the greater the likelihood of selling a vehicle.

Vehicle Use Decision

Approximately 20 percent of respondents who reported either no change or purchase postponed indicated that the vehicle left home was used by another person for work or nonwork travel. An analysis was performed to determine how the variables previously discussed affected the automobile-use decision of the respondent. The results are presented in Table 2. Unlike Table 1, no distinction need be made about whether the vehicle ownership used in the analysis is before or after vanpooling because, obviously, no vehicle ownership change was reported by these respondents.

Ten percent of total respondents indicated that the vehicle left home was used for work trips an average of 280 miles/month. Thirteen percent of total respondents indicated that the vehicle left home was used for nonwork trips an average of 180 miles/month. Intuitively, survey respondents could not be expected to have an accurate idea of how much the vehicle left home is used. If anything, this mileage was previously underestimated by survey respondents.

Total Travel Impact of Vanpooling

The bottom line in the evaluation of vanpooling's travel impacts is how much a vanpooler's household travel by private vehicle changed after the vanpooler began vanpooling. The basis for the comparison is the vanpooler's commuting mileage before versus the sum of the following:

1. Vanpooler's mileage by private vehicle to the vanpool pick-up location,
2. Vanpool's mileage, and
3. Mileage put on the vehicle left home.

For the purposes of this analysis, total travel impacts were calculated for the total group of respondents. The basic unit for comparison should be the travel associated with a vanpool's members before and after in order to properly account for the van's mileage. In addition, the sample collected has a representative number of vanpool drivers (10 percent of the total).

In the after case, mileage on the vehicle left home is calculated directly from the survey responses and added to the after-commuting total. Carpools were assumed to stay in operation after the vanpooler left it to join the vanpool. Calculated on this basis, the average survey respondent traveled 578 miles/month to work in a private vehicle before beginning to vanpool. After joining the vanpool, the vanpooler's average household private vehicle use consisted of the following:

1. 188 miles/month to work including access miles and van miles prorated to the survey respondent,
2. 28 miles/month for commuting in the vehicle left home per survey respondent (235 miles/month per automobile left home that is used x 10 percent of survey respondents who reported automobile left home is used for commuting trips), and
3. 23 miles/month for noncommuting trips in the vehicle left home per survey respondent (180 miles/month per automobile x 13 percent of survey respondents who reported automobile left home is used for noncommuting trips).

This totals to an average of 239 miles/month per survey respondent. Hence, the shift to vanpooling resulted in a reduction of 339 miles/month per vanpooler. This is an average saving. Vanpoolers who drove alone would save much more. Vanpoolers who previously used transit would save nothing.

SUMMARY AND CONCLUSIONS

In April 1980, SEMCOG conducted a comprehensive survey of all employer-sponsored vanpools in the southeast Michigan region. An excellent response rate was achieved; therefore, I believe that the survey results provide an accurate picture of the vanpoolers and their travel habits in the Detroit area. There is one important exception, however. The survey undersampled long-term vanpoolers in the region because

1. Only a small sample (5 percent) of vanpoolers was surveyed from the oldest and largest vanpool program in the region (i.e., Chrysler Corporation, which has 112 vans in operation for five years) and
2. No other vanpool programs in the region were more than 18 months old at the time of the survey.

As a result, the impact of vanpooling on the automobile ownership decision cannot be completely identified from the survey results because this decision is highly correlated with length of time in a vanpool.

A review of survey results indicated several areas where the survey could be improved. More details about travel habits of former ridesharers are desirable, particularly the fate of the carpool after the ridesharer left it for the vanpool. Responses to questions on travel time and distance before vanpooling were not always consistent (e.g., some respondents indicated their travel distance to work was 5 or more miles less after vanpooling), which indicates a need to revise these questions. The question about the vehicle ownership decision is potentially ambiguous in regard to the purchase-postponed decision--it could be interpreted to relate to the decision of whether or not to replace an existing vehicle or to the decision of whether or not to increase the total number of vehicles owned. Both decisions are of interest. Finally, an independent means of checking the respondent's estimate of the use of the vehicle left home needs to be found.

The principal travel results of the survey are as follows. Vanpooling attracts few transit users and draws riders nearly equally from drive alone and ridesharing. Vanpooling does not have a significant impact on automobile ownership. Only 15 percent of respondents reported that either a vehicle was sold or its purchase postponed as a result of vanpooling. (As discussed above, the estimate is probably low.) However, only 20 percent of respondents reported that the vehicle left home was used by other household members and their use was substantially less in terms of mileage than the former commuting use. Finally, the total travel impact of vanpooling was a reduction of 339 miles/month for the average vanpooler.

Abridgment

Commuter Demand for Ridesharing Services

PETER J. VALK

Ridesharing has recently become one of the most discussed topics in the fields of transportation system management and energy conservation. It is increasingly being looked on by both public and private sectors as a short-term answer to a variety of economic and environmental ills. Ridesharing behavior is manifested in two distinct ways: Regular ridesharing refers to the adoption of shared commuting on an ongoing basis; emergency ridesharing is characterized by swift, but short-term, shifts from driving alone to pooling for the home-to-work trip. This paper characterizes both types of behavior and addresses the implications for providing assistance to commuters in both settings.

Table 1. Rideshare adoption process by type of ridesharers.

Rideshare Adoption Process	Ridesharers: Regular Period: Normal–1	Regular Period: Normal–2	Emergency Period: Long Term	Emergency Period: Short Term
Motivational factors	High price of gasoline, too much travel time, costly wear and tear on vehicle	Change jobs, residential relocation, greater family mobility needs	Prevent anticipated loss of mobility due to emergency, e.g., no gasoline	Get to work
Behavioral predisposition	Socioeconomic profile, current mode, prior experience with other modes, new information on other modes	Socioeconomic profile, current mode, prior experience with other modes, new information on other modes	Socioeconomic profile, current mode, prior experience with other modes, new information on other modes	Current mode, prior experience with other modes
Consideration factors	Cost, convenience[a], scheduling, comfort[b]	Convenience, scheduling, cost, comfort[b]	Convenience[c], reliability, cost, scheduling	Reliability, scheduling
Mode switch	Carpool, vanpool, buspool, bicycle, other	Carpool, vanpool, buspool, bicycle, other	Carpool, bus	Carpool, bus
Evaluation				
Trial period	Perception of positive performance on consideration factors, compatibility with others, comfort[d]	Compatibility with others, comfort[d], perception of positive performance on consideration factors	Actual positive performance on consideration factors	Satisfactory status quo performance
Continued use	Receipt of economic benefits, e.g., time or money	Receipt of economic benefits, e.g., time or money	Receipt of economic benefits, e.g., time or money, comfort[d], compatibility with others	

[a]Ease of access. [b]Physical. [c]Ease of use. [d]Psychological.

Ridesharing has recently become one of the most discussed topics in the fields of transportation system management (TSM) and energy conservation. It is increasingly being looked on by both public and private sectors as a short-term answer to a variety of economic and environmental ills.

Ridesharing behavior is manifested in two distinct ways: Regular ridesharing refers to the adoption of shared commuting on an ongoing basis; emergency ridesharing is characterized by swift, short-term shifts from driving alone to pooling for the home-to-work trip. This paper characterizes both types of behavior and addresses the implications for providing assistance to commuters in both settings.

RIDESHARING AS A TSM STRATEGY

The attractiveness of ridesharing as an integral part of a TSM effort stems largely from its ability to help achieve transportation program objectives (e.g., decreased congestion or reduced energy consumption) without the expenditure of large sums of new capital. Ridesharing programs attempt to use private vehicles more efficiently as the basis for moving a given commuter population in as few vehicles as possible. By not having to invest large amounts of public capital in new transportation facilities, communities can get more use out of already dwindling public resources. Ridesharing's lure is also due to the short lead time necessary to provide accessible transportation options to the commuter population. In both instances, investments in ridesharing programs have the effect of leveraging additional investments from individuals, corporations, and the community and thus increase the effectiveness of each dollar spent. For example, public dollars used to support local ridesharing organizations' employer outreach programs are supplemented with an employer's dedication of resources (cash or in-kind) to making the program operational at the work site. The most common payoff to both the individual and the community is realized as a result of long-term shifts in both vehicular use and attitudes toward commuter travel.

RIDESHARING AS A CONSERVATION STRATEGY

Historically, ridesharing has been viewed as a conservation strategy aimed at reducing energy consumption, reducing air pollution, and increasing disposable income. The development of ridesharing organizations (RSOs) after the 1973-1974 Arab oil embargo is testimony to the recognition of pooling as a means to reduce the nation's consumption of gasoline. However, as is the case with all conservation strategies, benefits accrue over time as the result of a continual and long-term change in behavior (e.g., residential energy conservation).

Given the emphasis on conservation, RSOs and corporate ridesharing programs have concentrated their efforts on convincing commuters to share the ride on a regular basis. Measurable efforts have been marginally successful to date, given that many ridesharing efforts only go as far as providing information to commuters and then asking them to form the pool themselves.

The consideration of ridesharing as an alternative to driving alone is often brought about either by a change in a commuter's perception of the economic burdens he or she is enduring or is associated with other changes in individual routines. In the first circumstance (as indicated in Table 1), successive increases in the price of gasoline have generated heightened interest for ridesharing information throughout the nation. As a gallon of gasoline has become more expensive, ridesharing programs have seen an increase in the number of commuters who seek information on travel options. At lower fuel prices, these individuals did not perceive their economic (money and time) burden as being burdensome.

In the second scenario, individuals may consider ridesharing when they are also anticipating a change in their normal routine, such as a residential relocation, job change, or the need to purchase a new vehicle. A ridesharing arrangement in this situation can be considered a personal plan to the potential negative side effects of the change in routine.

In either instance, an individual's interest may be motivated by economic considerations. However, the decision process of whether to adopt ridesharing encompasses not only monetary considerations but, more importantly, social and psychological factors. This process is indicative of a decision made out of choice not necessity.

Several research studies (1-3) on ridesharing behavior agree that ridesharing is more a social than an economic phenomenon. Regular pooling, it seems, is initially chosen more for its compatibility with an individual's personality than for its monetary rewards. These same studies assert, and actual experiences confirm, that use of economic pressures are less likely to induce a higher incidence of ridesharing than would be found by employing a more personalized means of bringing commuters together. In almost every evaluation or research study done on ridesharing programs, personal sources, word of mouth, or friends are cited as sources of referral by commuters who eventually carpool. Moreover, most people who end up carpooling do so with either a friend or coworker. Each of these responses indicates a careful and deliberate review of choice to change commuting routine.

Having once made the decision to switch travel modes, most ridesharers will continue their new routines for some time, although the majority of those who discontinue ridesharing do so within the first month. This decision process is not unlike that used in the purchase of comparison goods. As opposed to convenience goods, where price plays an important role in consideration and adoption, most comparison goods are reviewed on a wide set of criteria, including performance, durability, and reliability.

The selection and trial of a comparison good often involves careful evaluation of the product's performance during the initial purchase period. If the product satisfies or exceeds the purchaser's expectations, then it is not unusual for the purchaser to continue using the good. In ridesharing, if the shift from driving alone to some form of pooling (usually carpooling) integrates well with an individual's routine, then some form of ridesharing can be expected to continue.

Moreover, experiences in Los Angeles (4) have shown that the selection of ridesharing modes follows a maturation process. Observations over the last several years have found that carpoolers are predominantly composed of former solo drivers who seek alternatives to driving alone, whereas vanpoolers are largely former carpoolers (especially vanpool drivers) who see vanpooling as a way to continue ridesharing and at the same time eliminate the use of their personal vehicle. Moreover, many buspoolers are former vanpoolers who see economic gains to commuting in an even larger vehicle, without severely compromising comfort found in vans.

MARKET POTENTIAL

The greatest potential for widespread adoption of ridesharing can be realized through carpooling. As opposed to most vanpooling and buspooling programs, the rolling stock for carpooling has been acquired, routes already exist, and the market area has the broadest definition (physical and psychological) of all potential ridesharing modes. Vanpooling achieves the most efficient vehicular use (when fully occupied) and represents a potential step-up for carpoolers. Buspooling's share of the ridesharing market often coincides with that of vanpooling and can more efficiently serve areas where three or more vanpools originate. In each instance little, if any, new investment must be made in order to begin (or continue) travel in a shared-ride mode.

Armed with the knowledge of this mode-shift process, many programs (either company-based or areawide) have been established in order to assist an even greater number of individuals in ridesharing. Both government, through the establishment of RSOs, and businesses, through the initiation of their own programs, have recently invested resources in a multitude of efforts aimed at generating an increasing number of routine ridesharers to thereby conserve energy resources.

RIDESHARING AS AN EMERGENCY STRATEGY

Interest in ridesharing programs has increased dramatically as planners have concerned themselves with emergency energy programs and activities. Ridesharing is being considered the answer for satisfying the demand for fuel-saving alternatives. A variety of governmental efforts, including the Energy Emergency Conservation Act of 1979 guidelines, state energy office programs, and local energy management studies call for ridesharing programs to play a major role in responding to extraordinary levels of demand for assistance during crisis periods. Although the RSO or company ridesharing program may be the logical entity to provide such a response, it is not clear that these units are capable of an adequate response to crisis-proportion demands.

The ability to perform efficiently and effectively in an emergency period is the result of first, understanding the nature of demand for ridesharing and second, taking the necessary preparatory steps in advance of the actual crisis period.

A review of experiences from the 1979 gasoline shortage is helpful in differentiating between the nature and level of demand for regular and emergency ridesharing. The April-July period of 1979 saw the demand for ridesharing information rise as commuters faced a sudden and severe shortage of normal transportation services and sought an immediate resolution to their dilemma. Moreover, individual actions, such as bus riding, curtailment of discretionary trips, carpooling with a spouse, or requests for assistance from a ridesharing program, were taken out of necessity rather than choice. The process of selecting an alternative, as compared with a normal mode-choice decision, was abbreviated and may have followed a different path altogether (see Table 2).

In late 1979 the Los Angeles area ridesharing program, Commuter Transportation Services (CTS), Inc., conducted a series of surveys in order to determine the impacts of the 1979 gasoline crisis on travel behavior and CTS, Inc.'s services (5). Responses from the surveys reveal the process by which commuters in southern California sought alternatives to long gasoline lines and rapidly escalating fuel prices. For the most part, those who eventually requested help from CTS were those who did not have a readily apparent alternative and thus were forced to rely on an outside source for help. Most of this group had known about CTS prior to the crisis; however, they had not considered a switch to ridesharing during normal times. These crisis-compelled individuals eventually registered with CTS, Inc., because they could not get to work or because gasoline prices were too high, as opposed to the normal-period registrant who wanted to consider carpooling as an alternative to driving alone.

The timely receipt of information on personal travel options was of utmost importance during the crisis periods. Survey respondents reported that it took 4-5 weeks to receive information (carpool matchlists) from CTS, Inc. Although this time period may initially appear to be too lengthy, only 12 percent of the emergency period respondents considered it too long. This finding, however strange, is also found among normal period commuters. Responses from case crisis registrants indicate that personal urgency (and expectations) may have been diminished due to the formation of informal carpools among acquaintances, while at the same time CTS, Inc.'s (or other rideshare program) information was used as a contingency measure.

Short-Term Versus Long-Term Ridesharing

The changes in commuter travel behavior during the 1979 gasoline shortage were short lived. Results

Table 2. Carpooler characteristics by type of carpool.

Data Item	Normal Carpooler (%)	Emergency Period: Long-Term Carpooler (%)	Emergency Period: Short-Term Carpooler (%)
Prior mode of travel			
Drive alone	72	83	85
Another carpool	13	9	0
Bus	10	3	8
Vanpool	3	2	0
Walk or bicycle	2	3[a]	7
Previous carpooling experience	33	37	98
Current mode after emergency period			
Drive alone			77
Carpool	100	100	0
Bus			0
Walk or bicycle			15
Motorcycle			0
Vanpool			
Other			8
Knowledge of partners prior to carpooling			
Complete		16	17
Partial		24	30
None		60	53
Importance of prior acquaintanceship			
Very		33	43
Somewhat		15	12
None		50	45
		2	
Importance of time spent picking up partners			
Very		45	79
Somewhat		41	
Never		14	
Would quicker matchlist receipt help in forming carpool?			
Yes	18	13	11
Maybe		12	8
No	63	75	81
Do not remember	21		
Continuing interest in ridesharing information			
Yes		86	64
No		14	36
Motivating source of information			
Employer		64	58
Mass media		15	25
Word of mouth		21	17
Age			
Less than 25	5	11	17
26-29	9	9	33
30-39	29	34	9
40-49	31	26	33
50-65	26	20	8
Household income			
Less than $10 000/year	5	6	10
$10 000-$19 999/year	24	34	30
$20 000-$29 999/year	36	22	50
$30 000+/year	24	38	10
No response	12		
Sex			
Male	73	43	65
Female	27	57	35

Note: The average distance traveled to work is 23 miles for normal carpoolers, 18 miles for long-term emergency carpoolers, and 11 miles for short-term emergency carpoolers.

[a]Motorcycle.

from CTS, Inc.'s survey indicate that, although a significant number of commuters chose carpooling during the crisis, much of this change lasted for the duration of the shortage. Furthermore, once the crisis passed, individuals reverted to their solo driving habits. In fact, vehicular use (and energy consumption) was reduced not for commute purposes, but rather for discretionary travel (6). However, a small number of emergency poolers did adopt ridesharing as a long-term change in travel mode.

A contrast of long-term and short-term poolers suggests that the latter group experienced a change in travel behavior, as opposed to changes in attitudes and behavior as related by long-term carpoolers. More importantly, the decision process for long-term carpoolers, as viewed through survey responses, is similar to that of the normal period carpooler.

The demographic characteristics of long-term poolers more closely resemble normal ridesharers than that of short-term poolers (see Table 2). Long-term poolers tend to be in the same age brackets (20 percent ages 50-65 versus 8 percent for short term) and have similar household incomes (38 percent in the $30 000/year bracket) to normal period carpoolers. Interestingly, both long- and short-term poolers have a greater number (57 and 35 percent, respectively) of females than did normal period poolers (27 percent). This may be indicative of household decisions to allocate the family automobile to primary wage earners in times of emergencies and seek alternative travel options for the family member who earns the secondary income.

Long-term emergency poolers also resemble normal period poolers in their motivations and attitudes toward ridesharing. Both of these groups express greater sensitivity to monetary concerns (i.e., price of gasoline) as opposed to the short-term fuel availability concerns of the short-term poolers. Fifty-eight percent of the short-term carpoolers (versus 64 percent of long-term poolers) sought assistance as a result of mass audience messages (e.g., freeway signs or radio) on emergency ridesharing. This medium, as contrasted with CTS, Inc.'s employer program, does not include educational or promotional information aimed at changing long-held attitudes on commuter travel.

Prior experience with ridesharing also has an effect on how long a commuter may carpool. Almost 98 percent of those identified as short-term carpoolers reported they had carpooled at some earlier time, but not quite 40 percent of long-term carpoolers reported similar experiences. This observation might seem contrary to what might be expected; however, short-term poolers also exhibit less flexibility (or possibly desire) in adapting to ridesharing. When asked why they stopped pooling, long-term poolers (and normal poolers) cited circumstances beyond their control (i.e., moved residence or work relocation), although short-term poolers more-often cited personal conflicts and irreconcilable time differences. Consequently, the finding that short-term carpoolers express a greater desire for prior acquaintanceship with potential carpoolers than do long-term carpoolers is not unusual. The foregoing observations suggest that short-term carpoolers, although they had had an unsuccessful experience with carpooling in the past, saw it as a ready alternative to driving alone, but only during crisis periods. Moreover, their prior negative experience with carpooling further suggests that attitude formation (positive or negative) plays a strong role in the trial and, more importantly, in the continued use of ridesharing modes.

Factors such as personal habits and reliability of potential partners were cited as critical in establishing long-term carpools; short-term carpoolers cited more travel-specific variables, such as living and working within short distances and similarity of work start and stop times.

Implications for Preparation of Emergency Plans

The implication of these user profiles is important in identifying activities during a crisis period.

The mission of any effort aimed at reducing energy consumption during shortages should be to facilitate speedy individual action. The point was made earlier that carpooling holds the most potential for a sustained reduction of energy consumption. The potential for quick initiation of carpooling during an energy crisis is even greater and thus should be the prime strategy of any emergency plan.

The preceding sections on crisis-oriented demand noted that readily accessible alternatives were those most often used (i.e., carpooling with spouse) and required little, if any, educational or promotional information to generate. The ridesharing program is thus relieved of its normal period mission of motivating individual action and thus can concentrate its efforts on providing mode-specific information with the assumption that individuals will act accordingly.

The ridesharing program can act more expediently by providing basic ridesharing information, which consists of instructions on how to arrange a carpool by oneself and a list of potential carpool partners. Although transit and vanpooling are attractive in that more individuals can be carried in one vehicle, the lead time to getting the vehicle on the road often exceeds the time individuals can wait to switch to a fuel-saving mode. In addition, new capital investments must be made to procure the vehicle (if vehicles are even available). Emergency plans often contain strategies aimed at stockpiling buses for use during shortages. This tactic will reduce implementation lead time; however, precious public dollars are being invested in equipment that has little ongoing productivity. Although this tactic is necessary for meeting increased transit ridership, much of that same demand could possibly be shifted to carpooling during the crisis and thus avoid the low-yield investment.

In terms of vanpooling, concern must also be given to lead time. However, in this case the money invested to acquire vehicles are eventually recapped through fares. A potential vanpooling tactic in emergencies would be to use carpools as a seeding mechanism for vanpools until vehicles could be acquired. Once the vehicles are available, several carpools could be questioned for their interest in vanpooling. This should be helpful in ensuring the long-term success of the vanpool because those who do not find ridesharing compatible with their demands will drop out prior to entering the vanpool.

Experiences from the 1979 gasoline crisis can also be helpful in guiding the preparation of future emergency plans. Activity at CTS, Inc., in Los Angeles at one point during the fuel shortage period increased by 1900 percent over the same month in the previous year. Although an emergency plan for increased ridesharing program activities had been prepared to meet the anticipated demand, implementation was not carried out until funding was provided after the start of the crisis. Demand for crisis services continued unabated, due in part to only responding to the crisis and not taking preparatory measures. Although this may seem obvious, only after the 1979 experience can the level and nature of demand be reported. Several findings emerge from these observations:

1. Dissemination of self-help information through mass media sources can be instrumental in modifying demand for a ridesharing program (i.e., most short-term ridesharers cited the media as source of information about CTS, Inc., services).
2. Dissemination of ridesharing information in more permanent packaging will enable users to recall where information is stored. In addition, a more substantial format will connote a greater significance to the information piece. More emergency carpools were formed among those who received a matchlist during the crisis as opposed to those in the program prior to the crisis. In addition, a much smaller percentage of the precrisis group recall having a matchlist on hand to use than do the crisis groups.
3. A data file should be established and updated for use during an emergency period and matchlists (and materials) should be generated at the earliest indication of crisis.
4. Employee-commuter emergency readiness should be maintained through fire-drill type exercises at work sites.

The value in understanding emergency ridesharing (short- and long-term) lies not in research findings but rather in the implications for providing ridesharing services during regular and emergency times. The expression of interest in ridesharing, albeit short lived, is a clear indication of the likelihood of switching modes if concerns can be addressed. Moreover, if the short-term carpool group can be identified, self-help information can be provided prior to the crisis and thus demands on ridesharing programs can be reduced. Last, knowledge of the relation between the demand for ridesharing services and variables that affect vehicular use (e.g., price and availability of fuel) can be developed and reviewed periodically as a mechanism to forecast upcoming demand. These preparedness actions are only a sample of tactics aimed at modifying the extraordinary surge of demand for emergency response services. Although response activities cannot be avoided, only by reducing the potential volume can crisis-compelled commuters receive an adequate response.

ACKNOWLEDGMENT

The views expressed herein are mine and do not necessarily represent those of Commuter Transportation Services, Inc., or its sponsors.

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Abridgment

Ridesharing at Construction Sites: TVA Experience

STAN STOKEY, FREDERICK WEGMANN, KATALIN MENENDEZ, AND TOM WHITNEY

This paper provides a case study of Tennessee Valley Authority's (TVA) rideshare experience at the Hartsville nuclear power plant, which is under construction in middle Tennessee. As part of a formal mitigation program, TVA has developed an extensive rideshare program that involves 132 vans and 17 buses that transport 56 percent of the day-shift employees. The costs and benefits derived from this rideshare program are described as is the administrative structure of the program. The TVA experience has shown that an employer-based program can benefit employees and employer as well as the community. The Hartsville rideshare program results in an estimated annual reduction of 19.7 million annual vehicle miles of travel. Ridesharing has meant a net annual savings to TVA employees of $1.2 million in commuting cost and the conservation of 800 000 gal of gasoline. TVA has benefited by avoiding the need to construct additional lanes along TN-25, which has little or any developmental potential for the area. Also, through improved commuter transportation, the construction labor pool can be geographically expanded so that relocations can be held to a minimum. At the Hartsville site, 40 percent of the work force resides outside the immediate five-county impact area. Transportation is the linkage to relieve pressure on local housing, schools, utilities, public services, and road networks.

Concern about energy costs and availability has stimulated interest in construction of large-scale energy projects, such as nuclear, coal, and synfuel plants. Because of non-transportation-oriented site-location factors, these projects are often located in rural areas. These areas do not have an infrastructure that can adapt easily to the massive influx of people and machines. A large, temporary influx of construction workers can cause a multitude of socioeconomic impacts in these rural areas. Ridesharing (the use of carpools, vanpools, and buspools) is one alternative to mitigating these impacts.

Workers either have to be attracted from neighboring metropolitan areas, from which commuting distances will be lengthy, or reliance must be placed on attracting migrant workers who, when in residence in the local area, place pressure on local housing and public services. In many situations the local roadway systems are unable to accommodate the influx of construction-oriented commuter traffic without undue hazards or congestion. Serious questions must be addressed concerning the investment of scarce resources in the construction of roadway facilities that will result in underused roadway capacities after completion of construction. Roadway construction can also involve serious environmental consequences, which may delay the implementation of the construction project.

The question then is, In what alternative ways can a commuter transportation system be arranged to minimize the undesirable impacts of transporting temporary workers to large-scale construction projects?

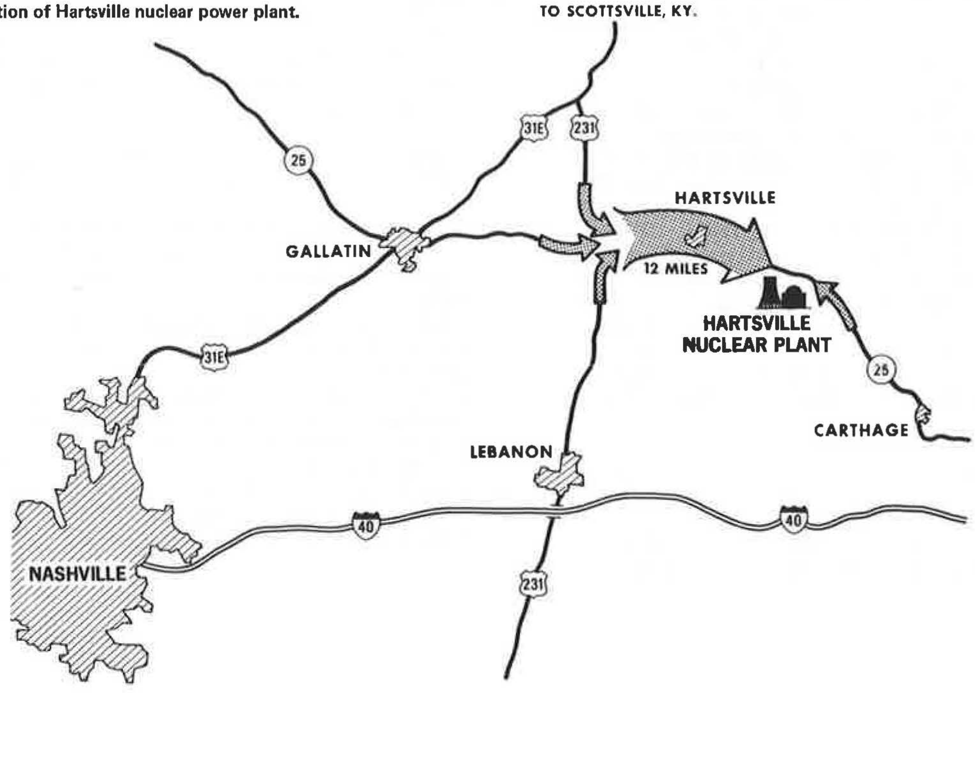
BACKGROUND OF HARTSVILLE PLANT

The Hartsville nuclear plant construction site lies in Trousdale and Smith Counties, about 50 miles northeast of Nashville, Tennessee. The combined population of both counties is less than 20 000. The only towns within a radius of 10 miles are Hartsville (population 2243) and Carthage (population 2491) (see Figure 1).

The critical transportation problem created by the Hartsville construction project is the peak-hour traffic generated by the construction work force. Maximum traffic will occur during the middle 3 years of a 10-year construction period, when more than 6000 employees will be at the site. Approximately 80 percent of the work force will approach the project from the west, which will compound the traffic problem.

During the initial planning to minimize the socioeconomic impacts of the proposed nuclear plant

Figure 1. Location of Hartsville nuclear power plant.



construction project, it became obvious to planners that either an employee commuter transportation program or a road-widening project would be necessary to accommodate construction worker traffic. Initial analysis indicated that 10 miles of two-lane highway approaching the site would need to be widened to four lanes, at an estimated cost of approximately $7 million. This stretch of highway had no developmental potential for the region. In addition, a road-widening project would delay construction for at least one year.

The approach selected by the Tennessee Valley Authority (TVA) was to establish an employee commuter transportation system. TVA's traffic mitigation strategy is to reduce the number of employee cars that approach the site by attracting workers into high-occupancy vehicles (buses and vans). Fortunately, TVA already had experience with ridesharing at its headquarters in Knoxville, Tennessee. However, no bus companies were readily available to provide service in Hartsville. TVA would have to develop and operate its own commuter transportation system.

An agreement was reached with the Tennessee Department of Transportation that the impact of construction worker traffic would be mitigated by the use of a TVA-sponsored commuter transportation system. The state would monitor the traffic and reserve the right to require TVA to take appropriate measures if acceptable traffic volumes were exceeded. In order to maintain an acceptable traffic flow, about half of the day-shift work force at peak employment (6000 employees) would need to be in high-occupancy vehicles, which would take approximately 1300 of the workers' cars off the road.

A voluntary carpool program would not do the job. Such a dramatic shift in commuting behavior requires persuasion by management as well as economic incentives, such as reduced commuting costs. This effort required that the current 1.7 average vehicle occupancy rate experienced at other TVA construction sites be raised to about 5 persons/vehicle--a shift of more than 2000 workers from cars to high-occupancy vehicles. This shift would require the extensive use of buspools and vanpools. As of January 1980, 133 vans and 17 buses were in operation and more than 4000 workers were at the project.

RIDESHARE ORGANIZATION AND ADMINISTRATION

In April 1976, TVA issued the first van at Hartsville. The employee commuter transportation program was established as a cooperative effort between TVA and its employee credit unions. Legal restraints prevent TVA from directly purchasing commuter equipment. Federal law [U.S. Code Section 68(a)(c)(2)] specifically forbids the use of government-owned vehicles for the transporting of government employees between their homes and places of employment. Consequently, the TVA employees credit unions finance and hold title to the vans and buses. They also serve as a depository for fares and provide for insurance coverage.

Administration, operation, and monitoring of the program are handled by TVA's employee transportation branch. The collection of funds, payment of expenses, and other accounting functions are administered by TVA's division of finance. TVA maintains a rideshare office at Hartsville to administer the program, which requires monitoring of ridership, selection of drivers, maintenance of equipment, and collection of fares. The office is staffed by a rideshare coordinator and secretary.

Vanpools and buspools, like any public means of transportation, are subject to state regulation. The TVA vanpool program encountered some initial confusion as to operating, licensing, and authority. These problems were resolved in March 1976 when the Tennessee General Assembly passed a bill (House Bill No. 2184) that exempts vanpools from the regulatory powers of the Tennessee Public Service Commission. Under this bill, it is legal to operate vanpools in Tennessee as long as they meet established criteria.

Bus and van drivers are selected from the applications submitted to the rideshare coordinator according to considerations such as regularity of work hours, driving record, age (over 25), and location in relation to potential riders. The staff introduces drivers to program procedures and helps them form pools. After the pool is established, the driver selects at least one alternate driver.

An underlying policy of the TVA vanpool program is that the driver should take primary responsibility for his or her van and its pool. This not only cuts down on staff demands but also allows the driver to become a significant part of the program and draws on his or her knowledge of the area and fellow workers. The driver arranges the route, pick-up points, and schedule. The informal rules that govern operation of the van are usually set by the driver in conjunction with the riders.

The driver is furnished with a van and a gasoline credit card. Maintenance work is performed at local garages and is charged to the vanpool program. Backup vans are kept at some of these garages for temporary use during the maintenance period. If no backup is available or a van fails to operate, prearranged carpools take the riders to work and their drivers are reimbursed. The driver is responsible for cleaning the van in return for 50 miles of free personal use per week. Drivers are charged 20 cents for each additional mile of personal use above 50.

Buspools operate in a similar manner with drivers and backup drivers drawn primarily from teamsters employed at the site. Drivers are paid $10/day plus 5 percent of fares (fares range from $1.25-$3.50/rider per day for short and long hauls, respectively). Backup drivers receive pay only when they drive. They receive a free ride for collecting fares. If drivers elect, they can receive $20 compensation/week for washing and cleaning the bus. Each vanpool rider is charged a set fare based on the van's daily round trip mileaage. The van riders pay fares weekly and bus riders pay daily (see Figure 2).

The vans are 15-passenger maxivans. The buses are 40-passenger Blue Bird All Americans. All vehicles and drivers are covered by Travelers Insurance Company.

Bus and van insurance coverage includes the following:

Coverage	Limit of Liability ($)
Liability	1 000 000
Comprehensive-collision for buses	1000 deductible
Comprehensive-collision for vans	Self-insured
Medical payments	10 000
Uninsured motorist	250 000
Umbrella	5 000 000

RIDESHARE STATUS

As of January 1980, TVA's commuter pooling program at Hartsville consisted of 132 vans and 17 buses that transport approximately 56 percent of the day shift employees. The average bus ridership is 35 and van ridership is 10.

Figure 2. Employees boarding bus used for ridesharing program.

Figure 3. Quitting time at Hartsville construction site.

Table 1. Benefits of TVA ridesharing program in Hartsville.

Item	Van	Bus
No. of vehicles	132	17
Avg. occupancy	10	35
No. of persons participating	1320	590
Private vehicles not driven to construction site[a]	780	350
Reduction in private automobile annual VMT	13 918 200	8 505 000
Remaining private automobile annual VMT to access rideshare mode	1 687 000	1 026 900
Net difference in private automobile annual VMT	12 231 200	7 476 100
Vehicle miles for rideshare vehicle	2 366 100	413 100

Note: All data are as of January 1980.

[a]Based on a 1.7 occupancy rate for construction workers at other construction sites.

The employee commuter system is only provided for the west corridor to the construction site, where mitigation actions were deemed necessary. No commuter service is provided by TVA on the second shift or to the east. Some limited buspools and vanpools provided by private operators help fill this gap.

Rideshare vehicles carry TVA annual (nonmanual) and hourly (manual) employees from a number of cities and towns in middle Tennessee to the construction site. The 78 vans operated by hourly construction workers have an average one-way trip length of 40.7 miles, and the 55 vans operated by annual employees have an average trip length of 28 miles. The buses primarily haul hourly construction workers and have an average one-way trip length of 48.6 miles (see Figure 3).

Benefits

Although TVA's employee transportation effort at Hartsville is to keep vehicular traffic on TN-25 below its rated capacity, an effective employee transportation system also has provided several spinoff benefits to TVA, the community, and the employees themselves. Perhaps the most significant benefits of the ridesharing program are the reduction of traffic on TN-25 and the conservation of fuel. More than 1100 private vehicles are not being driven each day to the construction site. The rideshare effort then translates into a reduction of 19.7 million annual vehicle miles of travel (VMT), even after consideration that 70 percent of the ridesharers will use their automobile each day to drive to a park-and-ride lot (see Table 1).

One of the direct consequences of a reduction in VMT is the savings in vehicle operating cost. Recent statistics indicate that the average cost of operating a vehicle is 12.4 cents/mile for a standard-size automobile and 6.23 cents/mile for a subcompact. The following analysis, based on a 50-50 mix of standard and subcompact, results in a cost of 10.3 cents/mile. If the vehicles eliminated by commuting are sold, all of the savings in operating cost are passed on to TVA employees, thereby increasing their disposable income. If a TVA employee does not sell his or her second car because of ridesharing but only uses it less, his or her savings would be about those quoted. The figures generated for Hartsville assumed that the present commuting vehicle will not be sold. This is a conservative estimate since a recent survey of 455 vanpoolers indicates that 6 percent of them sold an automobile and 18 percent postponed a decision to buy a new car because of the vanpool system. Savings in vehicle operating costs, however, are offset to some extent by the cost of ridesharing. User cost savings in comparison with private automobile driving are given below:

Item	Savings
Annual reduction in automobile VMT	19 709 300
Cost reduction for less automobile driving at 10.3 cents/mile ($)	2 030 058
Bus fares paid at $2.38/day avg ($)	333 795
Van fares paid at $1.75/day avg ($)	519 750
Annual TVA employee savings ($)	1 176 513

It is estimated that 806 800 gal of fuel are saved annually at the present level of ridesharing as opposed to reliance on the private automobile. A breakdown of changes in fuel consumption by mode is given below.

Changes in Annual VMT

Automobile = Reduction of 19 709 300,
Van = Increase of 2 366 100, and
Bus = Increase of 413 100.

Changes in Annual Fuel Consumption

Automobile (at 18 miles/gal) = Reduction of 1 095 000 gal,
Van (at 10 miles/gal) = Increase of 236 600 gal, and
Bus (at 8 miles/gal) = Increase of 51 600 gal.

Net Change in Annual Fuel Consumption

All modes = Reduction of 806 800 gal (ignoring that buses use diesel fuel, but automobiles and vans use gasoline).

Increase in Convenience

Opinion surveys of TVA vanpoolers indicated additional desirable aspects of the program. As summarized in the table below, vanpoolers are particularly conscious of the reduced costs of commuting and reduced energy consumption. Also significant, but more difficult to quantify, is the perceived relief from the tensions of driving each day. Another important factor noted was the ability to make the vehicle formerly used for commuting available for other family members during the day. Note that 70 percent of the vanpoolers own two or more cars, thus they are riders by choice. Only 1 percent of the riders were without an automobile.

Perceived Benefit	Frequency of Response from 1977 Survey (%)
Conserve gasoline	57
Less-expensive means of travel	30
Safer in case of accident	3
Less damaging to the environment	1
Freedom from tension of driving	7
More comfortable	1
Develop new friends	1

Another benefit of the rideshare effort is the employment opportunities provided to minority employees. This is illustrated in the table below, which gives participation in employee transportation by race in July 1978. More than half of the Hartsville minority employees participate in the TVA employee transportation program, and 97 percent use some form of ridesharing.

Mode of Travel	Minority Employees (%)	White Employees (%)
TVA bus or vanpool	53	36
Private van	9	5
Carpool	35	42
Drive alone	3	17
Percentage of total ridesharing	97	83

Ridesharing at Hartsville has proved to be more economical than building additional highway capacity and constructing and maintaining 1000 additional on-site parking spaces. In addition, valuable space not needed for parking is used for laydown areas (e.g., storage of pipes) needed during construction. The cost savings of deleting temporary gravel parking lots is at least $500 000.

Besides the obvious benefit of reducing traffic congestion on TN-25, a system of ridesharing has also encouraged workers to commute from outside the impact area. This has reduced the overall impact of the project on nearby school systems and local government services. The ratio of commuters to movers is greater than anticipated. Therefore, the cost to the community and to TVA to mitigate the effects of the project on education (i.e., payments to school systems) and other public services has been kept to a minimum.

As a result of the employee transportation program, the Hartsville project can draw its work force from a wide geographic area. TVA's ability to attract large numbers of skilled construction workers has been substantially increased. As a corollary to this, the project should be better able to meet construction schedules.

CONCLUSION

An employer-based transportation program can be shown to benefit the employees and the employer, as well as the community. Rather than the construction project having an adverse impact on a local area through the influx of a large temporary work force, an entire region absorbs the work force. At the TVA Hartsville site, 40 percent of the work force resides outside the immediate five-county area. Transportation is the linkage to relieve pressure on local housing, schools, highway system, and public services.

Employer-based vanpool and buspool programs cannot totally eliminate the impact of heavy traffic loads and inconvenience to the local community, but ridesharing is an alternative to building additional highway capacity and public services that cannot be fully used after construction. Ridesharing will not eliminate all costs but will be more cost effective than wasteful construction of unneeded facilities.

The TVA experiment at Hartsville has been so effective that a similar program has been developed at Yellow Creek, Mississippi. It now has 13 buses and 27 vans that carry more than 29 percent of the day shift. Overall, TVA has developed a transportation system that involves 625 vans and 93 buses at 25 different TVA installations.

Abridgment

Role of the Transportation Broker at Children's Hospital of San Francisco: A Case Study

CLIFF CHAMBERS

Children's Hospital of San Francisco has implemented various ridesharing programs to provide employees with alternatives to the single-occupant vehicle, reduce neighborhood parking congestion, and thereby garner neighborhood support for a major remodeling project. Wilbur Smith and Associates prepared a transportation plan in May 1978. Recommended program elements included ridesharing, transit information, transit improvements, parking management strategies, and the hiring of a transportation broker for implementation purposes. Rotating shifts, a large proportion of part-time employees, a 30 percent annual turnover rate, and shift changes required nontraditional approaches to ridesharing efforts. A carpool and vanpool program offers personalized matching service, the incentive of free parking, and active cooperation with neighboring institutions. Among the 1400 employees, 56 active carpool groups and 5 joint institutional vanpools have been organized. Faced with poor crosstown transit service and poor Bay Area Rapid Transit connections to the south, Children's and two neighboring hospitals are cosponsoring an employee shuttle service. Wilbur Smith and Associates conducted a two-year program evaluation in April 1980. The number of drive-alone employees was reduced from 752 to 574. Key factors included the increase of the ridesharing modal split from 15 to 23 percent and transit from 16 to 20 percent. Three strong influences have aided alternatives programs for commuters. A neighborhood preferential parking program, begun in August 1979, has restricted employee parking in a 24-block area that surrounds the hospital. The two Bay Area ridesharing

agencies have provided tremendous support. Finally, the Joint Institutional Transportation Brokers Association has provided a valuable forum for exchanging ideas, advancing public transit improvements, and cooperating on joint marketing efforts.

Children's Hospital of San Francisco is an acute-care facility located in the northwest quadrant of San Francisco. Across the street is Marshal Hale Hospital, which has one-third the number of Children's 1400 employees. Both hospitals are situated in lovely residential areas; three distinct neighborhood entities and two commercial shopping districts are located within the hospitals' sphere of influence. Active neighborhood associations exist to preserve the integrity of their middle-to-upper-income neighborhoods. Both hospitals are major traffic and parking generators and create problems of on-street parking availability and through traffic in adjoining neighborhoods.

Children's Hospital has been especially concerned about hospital-neighborhood relations. By late 1977, Children's had received its certificate of exemption from the state for a multimillion dollar modernization project. In order to receive city planning commission approval for the project, it had to enlist the support of neighborhood organizations. Neighborhood persons had a platform, and the planning commission and the board of supervisors were ready to listen.

In order to create a constructive relationship with the neighborhood, Children's initiated a hospital-neighborhood steering committee. After one meeting, neighborhood concerns surfaced and were quickly summarized--parking and traffic congestion.

These hospital-neighborhood concerns about parking and trffic are not unique to Children's Hospital. Construction plans at two other major institutions in San Francisco during the mid-1970s prompted the city to approve an institutional master plan ordinance in June 1975. The ordinance established master plan requirements for universities, hospitals, and sanatoriums. Enforcement was ensured by relating such plans to planning commission action on conditional use applications and building permit applications.

The ordinance required institutions to develop a transit action plan as part of the overall institutional master plan. The city Planning Department invited 14 major hospitals, universities, and Fireman's Fund Insurance Company to a meeting to discuss the potential benefits of the institutions working together to solve some common transportation problems. Faced with escalating gasoline prices, a new preferential parking ordinance, and the institutional master plan ordinance, administrators at the institutions agreed to the logic of cooperative action. The joint institutional transportation system management group thus became the parent organization for ridesharing programs at Children's Hospital and Marshal Hale, as well as for other nondowntown institutions in San Francisco.

Taking the cue from a successful University of California at San Francisco program, and seeing the legitimate neighborhood concerns, Children's Hospital retained the services of Wilbur Smith and Associates in December 1977 to develop a transportation system management (TSM) plan.

DEVELOPING A TSM PLAN

The scope of work for the Wilbur Smith study (1) included determination of trip characteristics, documentation of parking and traffic impact generated by the hospital, analysis of candidate mitigation measures, and development of a transportation plan.

The results of an employee survey indicated that a daily work force of 1001 is divided into three shifts: 77 percent day shift, 17 percent evening shift, and 6 percent night shift. Of these, 57 percent were full-time, permanent; 32 percent were part-time; and 11 percent were others. The modal split showed that 59 percent drove alone, 15 percent shared a ride, 16 percent used public transit, and 10 percent walked or bicycled. Two-thirds of all workers lived in San Francisco; 12, 12, and 8 percent lived in the North Bay, Peninsula, and East Bay, respectively. A parking survey revealed a peak on-street parking demand of 390 employee vehicles, 25 percent of the study parking spaces.

The study results generated 31 recommendations that fell into three categories: ridesharing programs, parking management, and public transit improvements. The recommendation to hire a transportation broker was Children's Hospital's first step toward transforming paper recommendations into reality. An agreement was worked out with Marshal Hale Memorial Hospital for them to pay 25 percent of the broker's salary.

RIDESHARING PROGRAMS

Initial ridesharing efforts involved a fairly traditional approach and work with two Bay Area ridesharing agencies: Rides for Bay Area Commuters, Inc., (RIDES) and the Golden Gate Bridge, Highway, and Transportation District's Ridesharing Division. The campaign was launched with a letter sent to all employees from the chief executive officer that extolled the virtues of ridesharing and offered the incentive of free parking for carpool groups or vanpools of three or more. Campaign posters abounded. A large vanpooling display was set up in the cafeteria. A demonstration vanpool from RIDES came out to the hospital to enable employees to experience vanpooling comforts in a relaxed atmosphere. Articles were placed in the hospital newsletter for three consecutive weeks. The initial result was 53 applications from Children's Hospital and 27 from Marshal Hale. Tremendous enthusiasm and interest was generated, but not one vanpool resulted from the initial campaign.

After two months of effort, I began to realize that the hospital work environment had a number of organizational constraints to a successful ridesharing program: rotating shifts, staggered work hours, shift switches, and a large number of part-time employees.

In order to provide employees with feasible transportation alternatives to the single-occupant-vehicle trip, the ridesharing program had to be adapted to accommodate the nature of hospital scheduling. To date, Children's Hospital has 56 active carpool groups registered and five joint institutional vanpools. A recent survey (2) revealed that 296, or 23 percent, of all employees now share a ride to work. The ridesharing program was perhaps the biggest factor in reducing the number of drive-alone Children's Hospital employees from 752 to 574.

An analysis of why the two-year ridesharing modal split goal of 21 percent was exceeded shows eight key factors:

1. Employees were obviously concerned about the on-street preferential parking program. These 2-h restrictions (except vehicles that have residential permits) would affect 510 employees from both Children's and Marshal Hale who were parking on-street all day long. The spring of 1979 also had a large impact on employee commuting habits. Long gasoline lines and escalating gasoline prices sensitized

employees to their daily commute. These two events were drive-alone disincentives that precipitated the urge to look for commuting alternatives.

2. Ridesharing incentives were offered. The incentive of free parking for carpool groups of three or more employees has proved to be the most-effective TSM measure to date. The ability to park close by with no parking hassles proved to be a strong motivating force in both forming and maintaining the carpool group.

3. The rideshare-matching system emphasizes core groups. Thirty-four of 56 existing carpool groups contain at least two members from the same department. If employees are going to make a successful transition from the single-occupant vehicle, they must feel comfortable with the situation. Most employees know of at least one employee who lives in their general area or along their corridor who works their same hours. Once these core groups are given the incentive to share a ride, it is easier to add one or two additional employees to the ridesharing group.

4. Flexipools are encouraged to enable nursing personnel who have rotating shifts to rideshare. A group of 15 employees have a designated park-and-ride location. Because of days off, illness, and vacation, an average of 8 of the 15 work any one day. Whoever shows up before the appointed departure carpools that day. The riders pay the drivers a flat rate. Two such groups exist.

5. Neighboring institutions are used in the matching process. This is accomplished in two ways. The ridesharing applications are forwarded to RIDES. Each employee receives a matchlist that contains names from Children's and neighboring institutions and businesses in our area. In approximately two weeks, I follow up on these ridesharing requests to see if the RIDES matchlist was helpful to the applicant.

Since Fireman's Fund Insurance Company, for example, is located only three blocks from Children's but does not forward ridesharing applications to RIDES, special searches are conducted on their in-house computer matching system to locate potential ridesharing matches. Direct referrals are also made to some of Fireman's Fund's vanpools and club buses.

6. New employees hear of commute alternatives during a 10-min slide show. Each ridesharing application received at orientation sessions is given special attention at a critical time before commuting habits are established.

7. Follow-up is very important. All ridesharing applicants are called approximately 2.5-3 weeks after their original date of application. If an acceptable ridesharing arrangement has not been accomplished, additional efforts are made.

8. Once a carpool group is formed, it is required to complete a carpool registration form. This procedure enables me to keep accurate records of where the carpool originated, how many are in the carpool, and the type of vehicles used. It also serves to verify the existence of the carpool group.

All members of the carpool group are required to attend a 15-min carpool orientation session before receiving their parking card. The purpose of the orientation is to go over carpool parking policies, issue the parking decals, explain the use of the parking card, and explain the monitoring system. It also gives new carpool groups some helpful suggestions in forming their carpool group, such as exchange of home phone numbers, discussion of insurance policy coverages, and promptness guidelines. Most important, it gives the carpool group members an opportunity to check each other out over coffee before they start carpooling.

PARKING MANAGEMENT

There has been a strong correlation between the success of Children's ridesharing efforts and parking management. As is the case with all San Francisco hospitals, demand for parking is greater than the supply. A number of user groups compete for this finite resource: patients, visitors, employees, department heads, attending physicians, interns, volunteers, and students. Combined with two medical office buildings, associated tenant physicians, and their patients, the competition for off-street parking is intense.

In terms of TSM, there are three major facets to a parking management program: prioritization, control, and pricing.

Establishment of a priority among garage users that gives carpools and vanpools of three or more top priority ensures that they will have off-street parking on demand. Top priority also means that they have the right to bump garage users of lower priority should lack of garage space occur. In addition to carpools, patients, visitors, board members, and administrators are in the top-priority category.

The second major initiative for establishing preferential carpool and vanpool parking was for an on-street carpool-permit-parking area. Maple Street separates Children's and Marshal Hale for a one-block duration. Preferential parking for vanpool and carpool vehicles would exempt these vehicles from on-street time restrictions.

The primary reason for advancing this proposal was that Marshal Hale only has a total of 62 off-street parking spaces and cannot provide off-street preferential parking for ridesharing groups. The provision of on-street space would give joint institutional carpool and vanpool groups the priority they deserve. The enabling ordinance to allow carpool permit parking has been approved by the board of supervisors and signed by the mayor. It is awaiting implementation.

The second major parking management element is control. The carpool policy requires carpools to have three or more occupants on entry into the parking structure. Exceptions to this rule are vacation or absence due to illness of one or more carpool members. Experience has shown that carpool groups of four or five experience difficulty in having three members come to work on any one day because of rotating shifts. Although scheduling difficulties are not an exemption from the rule of three, exemptions due to illness or vacation give the ridesharing groups a fighting chance.

In order to monitor this policy, a security guard checks the vehicle's occupancy on garage entry one random day per week for 2 h. If a group has less than three, he asks them which of the carpool members is ill or on vacation. The report comes back to the transportation office, rule-of-three exemptions verified, and appropriate action taken when violations occur. This process has resulted in the suspension of parking privileges for just three carpool groups.

The final control measure is at the time of carpool privilege issuance. All carpool groups are required to fill out a carpool registration form and sign a statement of agreement to adhere to the policies.

The third major parking element is pricing. At Children's, three pricing classifications exist for the off-street parking facilities:

1. Hourly, full daily rate for patients and visitors;
2. Prepaid monthly rate for day-shift employees,

medical office building employees, graduate students, and undergraduate students; and

3. Courtesy parking for evening and night-shift employees, carpools, vanpools, medical staff (physicians), administrative staff, volunteers, and board members.

The garage parking rates were recently raised to $0.85/h with a $4.00 maximum daily rate, $30/month for two-employee occupants per vehicle, and $35/month for one-employee occupant per vehicle. The pricing structure equates the free parking perks that administration has historically received with free carpool and vanpool parking.

TRANSIT INFORMATION AND IMPROVEMENTS

Compared with San Francisco as a whole in 1978, the modal split for transit of Children's Hospital was low; only 16 percent of all work trips were made on public transit. This compares with 23 percent for Pacific Medical Center and 19 percent for St. Mary's Hospital.

Because of San Francisco's radial transit system, no direct crosstown transit line is within easy walking distance of the hospital for the approximately 470 employees at Children's who live in the southern portion of San Francisco. For the majority of these employees, existing transit service involves either two transfers or a time-consuming journey downtown before transferring. This involves extensive backtracking and is unacceptable to most employees.

Wilbur Smith and Associates established a goal of 33 percent transit modal split for Children's Hospital in 3-5 years. To accomplish this goal, the most-important actions are route and service improvements for crosstown travel. To this end, the consultant recommended that Children's vigorously support the up-coming San Francisco Municipal Railway (MUNI) five-year plan, which would vastly improve crosstown transit travel. The second suggestion was to sell "fast passes", MUNI's monthly transit pass. The third area of action was to provide transit information at the three main hospital entrances. Finally, the recommendation was made to improve security at bus stops and to build bus stop shelters and benches.

The MUNI route improvements were projected to reduce on-street parking by 14 percent. The other transit support actions combined might reduce on-street parking by 1 percent. Obviously, efforts needed to be concentrated on providing route improvements.

Children's Hospital is fortunate that San Francisco has been developing a five-year plan since 1974. Most of MUNI's routes were inherited from previous private owners; the five-year plan tends to develop transit into a more equitable and cost-effective system. Phase 1A was implemented in August 1979.

The transportation broker can play an important advocacy role in promoting transit improvements. In working with MUNI services, there have been a number of levels where this input has been provided. These range from giving public testimony at a city public utilities commission meeting to working with MUNI planning staff to develop acceptable scheduling. Input has been provided on a number of opportunities. During critical hearings on the five-year plan, the support of a major institution can counterbalance the "I do not want that bus on my street" testimony. From time-to-time, MUNI staff have asked me, as the transportation broker, to attend public utility commission meetings to give support to a transit improvement item.

The major crosstown transit improvement to Children's and Marshal Hale is the proposed 33-Stanyan route. Because it is a trolley coach line that needs overhead wiring before implementation, MUNI service is not scheduled until sometime beyond 1982. Because the Wilbur Smith study identified a market for this service of at least 65 employees from Children's alone, ways were explored to capture this market on an interim basis.

A proposal was submitted and accepted by administrations at both Children's and Marshal Hale for an interim employee shuttle service. The shuttle provides an alternative to those 470 employees who live in the southern portion of San Francisco and Daly City.

By providing a crosstown link to Children's and Marshal Hale, substantial reductions in transit travel times and transfers are realized. The shuttle route connects with Bay Area Rapid Transit (BART), MUNI's new MUNI metro, and key MUNI transfer locations. The route also dissects zip codes that have high concentrations of employees and provides access to a park-and-ride location.

Service frequencies of an average of 20 min are accomplished with the use of two shuttle vehicles. The shuttle schedule is coordinated with the beginning and ending of shifts from 6:30 to 8:30 a.m. and 3:00 to 5:00 p.m.

Revenue analysis projected that an 81 percent subsidy would be required for shuttle operation. The subsidy monies would be generated through new parking revenues at both institutions. At Childrens' this would be accomplished through adjustments in parking garage rates. At Marshal Hale, a new coin-operated system was proposed for an uncontrolled 25-space surface lot.

A bid packet was prepared and sent to various charter operations and the San Francisco jitney operators association. The bids were reviewed and references checked. The charter operator selected has a mixed fleet of 14-passenger Dodge vans and 17-21-passenger minibuses, which would provide some flexibility in ridership fluctuations. The most time-consuming part of the shuttle service development was the preparation of the necessary contracts. I worked closely with lawyers from both institutions to negotiate an acceptable trilateral agreement among Children's, Marshal Hale, and the contractor. Liability and contract organization issues worked its way through a five-month review process.

The shuttle service has been in operation since February 1980. St. Mary's Hospital joined a few months later. Ridership has grown steadily to an average 94 passenger trip/day. The transit support measures have also been implemented. The selling of monthly fast passes at the hospital has proved to be a popular benefit for employees. It is also a nice neighborhood service. MUNI produced some very attractive schedule and route racks. Located at convenient locations, they are an excellent transit information center. The racks have also helped to market the services of public transit.

MARKETING

In order to achieve a successful transportation program at Children's Hospital, various strategies had to be devised to get the message across. Marketing has played a vital role in my daily activities as transportation broker. The transportation programs not only had to be sold to the average employee but also to the hospital administration, the neighborhood organizations, and to governmental agencies responsible for implementation of elements of the transportation action plan.

The normal marketing effort at most institutions is a ridesharing campaign. This effort is normally the equivalent of a United Way campaign: precampaign publicity, a letter from the administrator, a collection period, and the campaign is over until next year. Working with people's commuting habits, however, is a process over time. The campaign can plant the seed, but nurturing is required for the ridesharing concept to be accepted within an institution.

The nurturing process at Children's Hospital and Marshal Hale has involved frequent articles in the hospital newsletter, active participation in new employee orientations, making departmental presentations, and newspaper coverage. One of my most-valuable contacts within the hospital has been the director of public information. Children's Hospital has a weekly newsletter that is distributed to all employees. Copy is frequently provided to her and her assistant on a wide variety of transportation programs and issues of interest to employees. In trying to gain media coverage to give programs some community visibility, the director of public information has been a valuable asset.

Finally, the more management support and participation during promotional campaigns, the better. In August 1979, when preferential parking was about to begin, the chief executive officer held a series of three employee meetings to announce the new transportation programs that were being implemented immediately or in the near future. He combined this topic and information on the building program (which was his main reason for holding the meetings).

JOINT INSTITUTIONAL TRANSPORTATION BROKERS ASSOCIATION

Reference has previously been made regarding joint institutional efforts for ridesharing programs, proposals to transit and governmental agencies, the employee shuttle service, and marketing. Without the forum of the Joint Institutional Transportation Brokers Association (JITBA), progress in many TSM areas would not only be more difficult and time consuming but also more costly with fewer results.

A good portion of the joint institutional efforts are handled through the JITBA. The association is actually an outgrowth from the original hospital administrator parent group discussed earlier. The original program called for an institution to hire or designate a transportation broker. Part of this original program was a 10-week transportation broker training course held at Golden Gate University. Throughout the sessions, the logic for working together on various programs became obvious. The need to keep channels of communication open, share ideas, and discuss successes and failures spawned the idea to have regular monthly meetings.

Because TSM plans at each of the 13 participating institutions were being prepared by De Leuw Cather and Company (3) during the same time period, the transportation broker became involved with the plan development, was familiar with its goals, and was committed to seeing the paper recommendations become reality. Of course, the degree of commitment was dependent on the transportation problems encountered at the institution, management support, and the interests of the individual transportation broker.

During the initial organizational meetings, it was decided to establish bylaws for the association. The necessity of having the president spend at least 25 percent of his or her time devoted to coordinating activities of the association was also discussed and eventually approved. Since I was elected president in August 1979, my time has been divided in three ways: 25 percent to JITBA, 25 percent to Marshal Hale, and 50 percent to Children's Hospital.

JITBA was fortunate to have a budget of $14 000 available from an Urban Mass Transportation Act of 1964, as amended, Section 9 grant. It was decided to have $5000 allocated to the association's president's institution for time spent on association activities, with the remaining $9000 earmarked for JITBA projects.

The monthly meetings are rotated among member institutions. An agenda is established for each meeting but serves more as a focus than as a rigorous schedule. The meetings have served as a support group, information exchange, action catalyst, and as a useful forum for interface between the brokers and transportation entities.

Transportation brokers, by their very nature, are generally the only individuals within the institution who work on transportation issues. The exception is the University of California at San Francisco, which has a transportation staff of three. It has been useful for the borkers to share their successes and disappointments in a somewhat informal environment. Sharing experiences is a catharsis for the work frustrations one encounters in trying to motivate employees to give up driving alone to work.

The broker meetings are also a time for exchange of information. Whether it be a new transit map, an interesting newspaper article, or an upcoming meeting on a crucial transportation issue, there always seems to be something of current interest to exchange. Because the transportation broker is in business to disseminate information, information garnered at the meeting is passed on at an exponential rate.

For most meetings, we invite an outside guest. They are normally action-oriented sessions with much dialogue between the guest and the brokers. At one meeting, for example, we invited the senior planner for the Golden Gate Bridge, Highway, and Transportation District. We asked him to briefly review the district's long-range plans adopted in 1975. More specifically, we asked him to review an element of the plan that would disperse the civic center route to Park Presidio and Geary Boulevard. This route change would provide direct service to seven of our member institutions who currently have cumbersome backtracking service from Marin County. He was also able to outline the history of the original proposal, why the Geary Boulevard element has not been implemented, and the prospect for future implementation. After much discussion, the brokers decided to have a letter written to the bridge district that asks to make a formal presentation on this proposal. JITBA received a quick response to appear before the transportation committee. JITBA members are currently following the proposal through the approval process.

Many of the specific projects JITBA undertakes are handled through committees. When it was decided, for example, to produce a professional slide show for use at new employee orientations, a committee was formed to select the consultant, develop the content for the script, and review the script produced by the consultant. The product is an excellent presentation on alternatives available to the single-occupant vehicle. The slide show has been duplicated and is now in use at new employee orientations at eight of the JITBA institutions.

Marketing efforts have been a special interest of JITBA. Aside from the slide show, a portable display is being developed for use during promotional campaigns. Since the display will be rotated among 13 institutions, the purchase cost of the displays and the cost for the graphic artist to develop the display materials can be justified.

Table 1. Transportation plan objective fulfillment.

	Fulfillment of Objectives[a] (%)		
Measure of Effectiveness	1978 Condition	1980 Condition	Objective
Percentage of automobile trip reduction	0	-16	-10
Percentage of long-term on-street parking reduction	0	-42	-40
Modal split			
Employee trips by transit and shuttle	16	20	+25
Employee trips by ridesharing	15	23	+21
Percentage of off-street physician parking	100	100	+100
Percentage of available short-term parking	100	100	+100

[a]Short term from January 1978-April 1980, after neighborhood preferential parking district has been formed.

Table 2. Comparison of employee mode of travel: January 1978 versus April 1980.

	Day Shift				Night Shift				Combined Shifts			
	1978		1980		1978		1980		1978		1980	
Mode	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Drive alone	596	57	429	41	156	66	145	61	752	59	574	45
Shared ride[a]	167	16	261	25	26	11	35	15	193	15	296	23
Transit[b]	167	16	230	22	36	15	26	11	203	16	256	20
Other[c]	115	11	125	12	19	8	31	13	134	10	156	12
Total	1045		1045		237		237		1282		1282	

[a]Includes automobiles that have a driver and one passenger, carpool, and vanpool passengers and drivers.
[b]1980 figures include shuttle, public transit trips, combinations of transit-shuttle and transit-other.
[c]1980 figures include walking, taxi, kiss-and-ride, and motorcycle trips.

The final main function of JITBA is personnel development. Most transportation brokers have had little or no prior transportation experience. JITBA sponsored a series of five training sessions for three new transportation brokers. In addition to these official sessions, the JITBA meetings tend to provide state-of-the-art information to the brokers. Special sessions are also conducted. For example, when RIDES implemented a new computer interactive matching system, the brokers were given a demonstration on how the new system works.

EVALUATION

On numerous occasions, progress reports on the transportation programs have been called for, whether it be a report to the hospital-neighborhood steering committee or to an administrative advisory group meeting. Records have been kept on ridesharing requests, carpool registrations, carpool occupancy checks, garage use, number of transit passes sold, and weekly ridership figures on the employee shuttle.

Children's was fortunate, however, to have the opportunity to complete a comprehensive evaluation of the effectiveness of the hospital's transportation program. The evaluation was actually at the request of the neighborhood organizations. Children's administration began to question the need for a 45-space parking structure (a 1978 Wilbur Smith study recommendation) when the construction bid came in at more than $800 000. In order to judge the effectiveness of the transportation program and thus reassess the need for the new parking garage, Wilbur Smith and Associates were retained to conduct an evaluation study (2). Table 1 lists the measures of effectiveness used to judge short-term (two years until 1980) objective fulfillment by evaluating the various transportation measures developed in the transportation plan.

Daily employee automobile trips were reduced by 16 percent since 1978; the 1980 reduction objective was 10 percent. Long-term, on-street parking was reduced by 42 percent; the objective was 40 percent.

The 23 percent of employee trips by ridesharing exceeded the 21 percent short-term objective. The percentage of physician parking off-street and availability of short-term parking were not decreased in the short run. The percentage of employee trips by transit, including trips on the shuttle, did not fulfill the short-term objective of 25 percent. The modal split for transit only increased from 16 to 20 percent.

The evaluation study revealed a large decrease in the percentage of hospital employees who drive alone during the most important shifts, day and night, since 1978. As shown in Table 2, 59 percent or 752 employees traveled alone in 1978; in 1980, 45 percent or 574 employees drove alone.

In terms of fulfilling neighborhood parking objectives, employee long-term, on-street parking during the peak hours of a typical weekday in the surrounding neighborhood zones was reduced from approximately 390 vehicles to 121 vehicles.

CONCLUSION

For the average employee, the transition from the single-occupant vehicle to an alternative is a difficult decision. There have been six major reasons why 178 employees at Children's Hospital have chosen to make that transition during the past two years:

1. The implementation of preferential parking has been a disincentive that has encouraged employees to look for a solution to parking problems;
2. Off-street parking-management policies, including free carpool and vanpool parking, have created an incentive to form ridesharing groups;
3. The core concept in forming and maintaining carpool groups has been strongly promoted to overcome employees' reluctance to share a ride; coupled with a personalized matching system and flexipools, ridesharing has become an acceptable alternative;
4. RIDES has provided a strong support network; aside from providing ridesharing applicants with a computerized matchlist, their promotional assistance during initial ridesharing campaigns was invaluable;
5. The employee shuttle service has provided some employees with crosstown transit service until

MUNI service is implemented; and

6. The forum of JITBA has proved to be an extremely valuable medium for exchanging ideas, advancing public transit improvements, and cooperating on joint marketing efforts.

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Impacts and Effectiveness of Third-Party Vanpooling: Synthesis and Comparison of Findings from Four Demonstration Projects

CARLA HEATON, MARK ABKOWITZ, DAVID DAMM, AND JESSE JACOBSON

This paper presents findings from four federally sponsored experiments designed to test the concept of third-party vanpooling. Under this vanpool provider mechanism, some entity other than the employer or individual is responsible for promoting and organizing vanpools. The four projects, implemented in Knoxville, Tennessee; Norfolk, Virginia; San Francisco, California; and Minneapolis, Minnesota, experimented with a variety of organizational, operational, and financial approaches. Accordingly, the comparative findings regarding implementation issues, vanpool level-of-service characteristics, traveler response, and vanpool economics are widely applicable to other locales. Given the available evidence, third-party vanpooling appears both workable and effective in a range of settings and markets. For a sizable number of commuters, vanpooling is a feasible and attractive mode. Vanpoolers in the four projects are predominantly riders by choice who do not need a car during the day, rarely work overtime, and commute relatively long distances. For these individuals, the benefits of vanpooling, such as lower commuting costs, less hassle, and the possibility of eliminating a household automobile, more than compensate for the added time spent in collecting and discharging other passengers. Vanpool drivers exhibit considerable entrepreneurship in terms of adapting vanpool operating policies and amenity levels to passenger preferences and setting fares to reflect individual passenger circuitry and van occupancy levels. The concept of using third-party vans as seeds appears to be effective in encouraging privately operated vanpools to use purchased or leased vehicles. Finally, third-party vanpooling offers considerable flexibility in terms of how, where, and at what rate vanpool services are introduced within an urban area. For some transit operators, this mechanism represents a feasible alternative to the expansion of peak-period fixed-route transit service in low-density markets.

Between 1975 and 1977 the Urban Mass Transportation Administration's (UMTA) Service and Methods Demonstration (SMD) program sponsored four vanpool projects in Knoxville, Tennessee; Norfolk, Virginia; San Francisco (Golden Gate Corridor), California; and Minneapolis, Minnesota. At that time, vanpooling was still a novel commuting mode. Although employer-sponsored vanpool programs were expanding rapidly (accounting for several hundred operating vanpools), significant institutional obstacles and market barriers inhibited the formation of vanpools. These included restrictive state regulations, limited availability of financing and insurance for vanpools, and general uncertainties about the operational and economic feasibility of large ridesharing units, particularly those comprised of employees of different firms. With national interest in high-occupancy modes mounting in response to energy and environmental concerns, there was a need for an innovative vanpool provider mechanism under which some entity other than the employer or individual (that is, a third party) would be responsible for promoting and organizing vanpools. Accordingly, the SMD program embarked on a multiproject research and demonstration effort to test the feasibility and costs of a third-party-provider mechanism and to ascertain the effectiveness of this organizational approach for serving the multiemployer commuter market.

As can be seen from Table 1, the projects differed in terms of the type of organizations that performed the third-party function, geographic and target-group focus, marketing approaches, van acquisition and deployment strategies, user charge and passenger fare structures, and driver incentives. The Knoxville and Minneapolis vanpool programs were part of broader brokerage operations that encompassed other computer ridesharing modes and (in Knoxville) social-service agency transportation. The demonstrations in Norfolk and San Francisco's Golden Gate Corridor, however, were primarily oriented toward vanpooling. Collectively, then, the

Table 1. Comparison of demonstration characteristics.

Item	Knoxville	Norfolk	Golden Gate Corridor	Minneapolis
Grantee	City of Knoxville	Tidewater Transportation District Commission[a]	Golden Gate Bridge, Highway, and Transportation District[b]	Metropolitan Transit Commission[a]
Project services	Vanpools, carpools, social service agency transportation	Vanpools, private-hauler buses	Vanpools	Vanpools, carpools, subscription bus, fixed-route bus
Site data[c]				
Population	400 300 for SMSA	733 000 for SMSA	411 000 for two counties	1 965 000 for SMSA
Population density per mile^2	282	1004	226	861
Median income ($)	8200	8700	10 500	11 700
Percentage using public transit to work	3.9	9.7	1.8	9.1
Vanpool target group	146 000 commuters areawide	108 000 commuters to five U.S. Navy bases	140 000 commuters in corridor north of Golden Gate Bridge	70 000 commuters to 11 multi-employer sites
Automobile drivers in target group (%)	75	62	74	76
Marketing orientation	Areawide	Employer-based with active employer participation	Commuter-focused	Employer-based
Vanpool coverage	Restricted to areas not served by fixed-route transit	Restricted to employees at navy bases and areas not served by fixed-route transit	Restricted to residents of Marin and Sonoma Counties	Restricted to employees at targeted sites
Van fleet	51 purchased with demonstration funds	50 purchased with demonstration funds	43 purchased with demonstration funds	Vans leased as needed from local dealer
Pricing policy	User charges cover all costs except administration, promotion, and backup and trial vans; driver has full discretion over passenger fares	User charges cover all costs except promotion, administration, and backup and trial vans; driver has full discretion over passenger fares	User charges cover all costs except promotion, administration, backup and trial vans, and seat vacancies; fares set by transportation district	User charges cover all costs except promotion, administration, trial vans, idle fleet capacity, and insurance; driver has full discretion over passenger fares
Driver incentives	Potential for free commute and for retention of excess fares; personal use of van at $0.09/mile	Potential for free commute and for retention of excess fares; personal use of van at $0.07/mile	Free commute; personal use of van at $0.11/mile, including gasoline with a 350-mile/month limit	Potential for free commute and for retention of one-half of excess fares; personal use of van free for first 200 miles and $0.08/mile thereafter

[a]Tranist operator. [b]Multimodal operator. [c]Data are from 1970.

projects provided an opportunity to examine the third-party vanpooling concept across four distinct urban settings and across a variety of organizational, operational, and financial approaches. Moreover, these demonstrations afforded a unique opportunity to expand knowledge about the operational characteristics and users of this relatively new form of ridersharing.

This paper synthesizes findings from the four projects regarding the implementation, operations, and impacts of third-party vanpooling. The comparative information presented is based on published evaluation reports for each project (1-5), a comparative report that describes the four projects (6), project records and reports [for example, Beeson and others (7-9)], and a variety of data sets assembled specifically for the evaluations. These include (a) project records on the vanpooler applicant pool, vanpool fleet use, and third-party program costs; (b) surveys of vanpoolers, ex-vanpoolers, and nonvanpoolers that provide information on demographic, work-related, behavioral, and attitudinal characteristics; and (c) van logs that provide information on van operations, level of service, and occupancy levels.

IMPLEMENTATION AND OPERATION OF THIRD-PARTY VANPOOLING

The four projects collectively broke considerable new ground by overcoming institutional barriers to vanpooling and by testing different approaches to third-party vanpooling. Although the institutional accomplishments and operational features of each project reflect site-specific conditions, the breadth of project designs permits us to draw some transferable conclusions about the feasibility of the basic third-party concept and the relative effectiveness of alternative approaches.

Institutional Efforts

When these projects were starting, significant obstacles to vanpooling included the following:

1. Restrictive state regulations that treated vanpools as public carriers that require certification;
2. Limited availability of insurance for vanpools because of insufficient operational experience on which to base actuarial tables;
3. Limited availability of financing for vans, which is a reflection of uncertainties about the economic feasibility of this new mode; and
4. Ambiguity as to whether the driver of a third-party van would be considered an employee of the third-party provider and hence subject to minimum-wage provisions of the Fair Labor Standards Act of 1938, as amended.

An additional implementation barrier that confronted these projects was the need to negotiate Section 13(c) of the Urban Mass Transportation Act of 1964, as amended, labor agreements as a prerequisite to receiving UMTA funding. The Knoxville and Norfolk agreements stipulated that major van maintenance be performed by transit employees and project vans not be allowed to operate in areas served by conventional transit. The Minneapolis and Golden Gate Section 13(c) agreements contained no such restrictions, primarily because overcrowding was common on the transit routes in the vanpool program target areas.

The project staff had to address and successfully resolve these problems before their programs could become fully operational. On the regulatory front, the active research and lobbying efforts of the Knoxville and Minneapolis project staffs resulted in major legislative changes in 1976 that exempted vanpools from the purview of the Tennessee and Minnesota state regulatory commissions. Largely due to efforts in Knoxville, the Insurance Services Office, in 1977, issued a new classification and rating scheme for various types of vanpools. To overcome financial barriers, the Knoxville, Norfolk, and Golden Gate Corridor projects negotiated with selected local financial institutions to provide (under an abort agreement) 100 percent financing to project-affiliated van purchasers. The Minneapolis project provided the impetus for obtaining an interpretation from the U.S. Department of Labor that specifically exempted the vanpool program from the minimum-wage provisions of the Fair Labor Standards Act of 1938, as amended.

Organization and Management

One of the most significant differences among the projects was the type of organization responsible for performing the third-party function. In Knoxville, the city government took on this responsibility, largely because it was thought that an organization without any vested modal biases would be more effective at accomplishing regionwide multimodal transportation brokerage. In the other three sites, the third-party function was performed by the local transit operator. The direct involvement of the transit operator in the promotion and organization of vanpools represented a significant institutional innovation, given the then-prevailing fear on the part of many transit operators that ridesharing programs might be detrimental to transit. Note that the particular transit operators involved in these demonstrations shared a rather unique perspective regarding the role of ridesharing: Faced with constraints on the size of their bus fleets and increasing service demands, especially in lower-density areas, they viewed vanpooling as a potentially cost-effective alternative to the expansion of peak-period fixed-route service. This attitude might not be found among larger transit operators that service predominantly higher-density markets.

Experience with these alternative approaches to third-party vanpooling revealed that both are workable and that there is no clear advantage in having a transit operator versus a local governmental agency perform the third-party function. The major advantages of a transit property are its ability to conduct certain activities such as marketing, maintenance, and accounting cost effectively within the existing organization and in conjunction with transit-related activities. The major disadvantages in having a transit operator in this role are possible restrictions on operations that stem from labor negotiations and possible increases in insurance costs to cover contingent liability on operator assets.

Another organizational variant across projects was the management structure and use of outside contractors. In the Golden Gate and Norfolk projects, one organization, the transit operator, handled all functions, including start-up activities, marketing, fleet operations, and liaison with pool groups. In Knoxville, during certain periods the city contracted with the University of Tennessee's Transportation Center to operate the vanpool program as well as carry out broader brokerage functions. In Minneapolis, the Metropolitan Transit Commission performed a management and coordination role and contracted with two other organizations for front-end planning and marketing (Public Service Options, Inc.) and for vanpool program operations (Van Pool Services, Inc., a subsidiary of Chrysler Corporation). The use of outside contractors to perform certain third-party functions minimizes staff requirements for the sponsoring organization (often a constraint in governmental agencies) and may provide more specialized skills than would otherwise be available. This approach was found to be susceptible to coordination problems, which suggests the need for a well-defined yet flexible allocation of roles among participating organizations and clear lines of authority and communications. The overall staff size requirements were larger in the projects where more than one organization was involved, but this difference appears to be related to the scope of staff activities (e.g., multimodal focus with significantly more front-end planning and institutional effort in the first two projects) and does not reflect or suggest inherent inefficiencies in the contract approach.

Marketing

Marketing techniques were tailored to the target groups being served and involved varying degrees of marketing to and participation by employers. The Knoxville project, whose target market consisted of areawide commuters, used a combination of mass media advertising (e.g., newspaper ads, billboards, and radio and television spots) and employer-based promotion and surveying (over the course of the three-year demonstration 829 employers were contacted, which represents nearly half of the areawide work force). In the Golden Gate project, whose target market consisted of commuters who live in the corridor north of the bridge, there was minimal outreach to or through employers (32 large employers were contacted). Rather, the emphasis was on techniques aimed directly at commuters; for instance, brochures distributed at toll booths and on buses and direct mailings to corridor residents. In Minneapolis, where the target areas were 11 suburban work sites comprised of more than 700 different firms, marketing efforts were directed at employers (direct contact and literature to solicit the cooperation of top management) and employees (multimedia presentations, information booths, and newsletters). Because of the selected geographic coverage of the program, no mass media advertising was used. In Norfolk, where the target market consisted of five U.S. Navy bases, similar employer- and employee-directed techniques were used, but the commanding staff of the bases played a far-more-active role than did Minneapolis employers in distributing marketing material and encouraging employees to pool.

On the basis of project records and survey data that indicate the sources of applications for rideshare matching, passive techniques, such as billboards, newsletters, and information booths, appear to be far less effective in generating interested applicants than are more focused and personalized approaches, such as employee presentations and handouts of promotional literature. Another noteworthy finding is the importance of top-level management support in both facilitating and improving response to employee-focused marketing efforts. Finally, the Minneapolis experience with multiemployer work sites revealed significant difficulties in eliciting the cooperation of small firms and the consequent need to focus outreach efforts on the larger firms (especially those that have more than 1000 employees, who could generate a critical mass of rideshare applicants). Since the smaller firms tended to be sales or service businesses, their managers were difficult to contact and skeptical that the program could benefit their employees, many of whom had irregular work schedules and needed a vehicle during the day.

Fleet Operations

The projects differed in terms of van fleet size and composition, the method of acquiring vans, and van deployment strategies. Three of the projects had fleets comprised entirely of bench-seat vans (typically 12-passenger); however, the Golden Gate Cor-

Table 2. Basis for determining vanpool user charges.

Item	Knoxville, 12-Passenger Van[a]	Norfolk, 12-Passenger Van	Golden Gate Corridor 11-Passenger Van	Golden Gate Corridor 10-Passenger Van	Minneapolis, 12-Passenger Van
Van model	Plymouth Voyager	Dodge B-300	Plymouth Voyager	Plymouth Voyager	Dodge B-300
Seat type	Bench	Bench	Bench	Reclining	Bench
Purchase price ($)	6035	6553	7800	9300	NA
Fixed component per month ($)					
Depreciation	83.79[b]	83.00[c]	108.00[d]	129.00[d]	NA
Insurance	63.50	72.00[e]	102.00[f]	114.00[f]	-[g]
Sales tax allowance	5.76				NA
Title and other taxes	2.08				NA
Total	155.13	155.00	210.00[h]	243.00[h]	205.00[i]
Mileage-based component ($)					
Maintenance	0.015	0.025	0.015	0.015	0.015[j]
Tires	0.015	0.01	0.01	0.01	-[j]
Oil	0.003		0.015	0.015	0.01
Accessories		0.005			
Gasoline	0.06	0.07	0.07	0.07	0.065
Total	0.093	0.11[k]	0.11	0.11	0.09

Note: All costs are as of December 1978. Van purchase prices span a two-year period from September 1975 (Knoxville) to August 1977 (Golden Gate).

[a]Five of the 51 vans are 15-passenger vehicles that cost $6654.

[b]Depreciation is calculated by assuming a resale value of $2000 after a 4-year period or 90 000 miles and does not include interest on capital. The amount shown is for vans that travel less than 90 miles round trip. For vans that travel farther, depreciation is figured at $0.045/mile.

[c]Depreciation is calculated by assuming a resale value of $2500 after a 4-year period or 75 600 miles and does not include interest on capital. Vans that travel more than 75 miles round trip pay an additional mileage charge, which ranges from $0.005 (75 miles) to $0.017 (100 miles) to cover the faster rate of wear-and-tear. Prior to April 1978 the marginal charge was applied to trips of 60 miles or more and ranged from $0.02 to $0.024/mile.

[d]Depreciation is calculated by assuming a zero residual after 6 years or 120 000 miles and does not include interest on capital. The amount shown is for vans that travel less than 79 miles round trip.

[e]The Tidewater Transportation District Commission pays $63.58/vehicle for insurance but charges $72 in order to cover insurance for three backup vans and to provide a fund to cover the $500 deductible on collision.

[f]Insurance costs include the bridge district's contingent liability coverage and a fee of $0.25/vanpooler to cover the deductibility exposure for collision and comprehensive coverage. Cost shown is for Marin County. Sonoma County rates are slightly lower for the 12-passenger van and higher for the 10-passenger luxury van.

[g]Between November 1977 and October 1978, a monthly insurance cost of $65/vehicle was included in computing the fixed user-charge component. Effective November 1978, Van Pool Services began to self-insure for collision and comprehensive, which reduced the monthly insurance policy premium to about $35. In addition, a decision was made at that time to subsidize insurance costs out of demonstration funds.

[h]The monthly user charge also includes, as applicable, a fixed amount ($10, not included in table) for parking in lots in downtown San Francisco subsidized by the California Department of Transportation.

[i]This represents the lease fee paid to a local Chrysler dealer and includes depreciation, interest, sales tax, title, and dealer profit.

[j]Because of the short-term nature of the closed-end lease (3 years), maintenance costs were expected to be lower and tire wear was not included in the mileage cost.

[k]The amount does not include the surcharge for faster wear-and-tear (see footnote c).

ridor project, which served a relatively affluent market, used a mix of 12-passenger bench-seat vans and 10-passenger, luxury reclining-seat vehicles. In three projects, vans were purchased outright by using demonstration funds; in Minneapolis, on the other hand, vans were leased from a local automobile dealer. The leasing arrangement reduced the need for a large initial capital outlay and, because of the short-term lease duration, reduced the amount and cost of maintenance work. However, the other potential advantage of leasing (i.e., flexibility in adjusting fleet size to changing levels of demand) did not materialize. The initial supply of leased vans proved to be far in excess of needs for the first year, and the second order for vehicles, which coincided with the fuel shortage in the spring 1979, took several months to arrive due to production delays. The three projects that purchased their vehicles differed with respect to their fleet size objectives. All three had originally planned to use their accumulating depreciation funds to purchase additional or replacement vans. In Knoxville, however, a decision was made to liquidate the van fleet (except for two vehicles retained for backup and promotional purposes) and to use the resulting funds for program operations.

Project vans were made available to pool groups on a lease arrangement. As with most vanpooling programs, drivers performed many of the functions associated with organization and operation of the vanpools, in exchange for which they were offered financial incentives such as a free commute and personal use of the van at nominal charge. The total monthly user charge for each van was designed to cover all costs of van operations, except for certain overhead items such as administration and marketing. As can be seen from Table 2, there were significant differences across projects in the fixed and variable (mileage-based) components of the monthly user charge, which reflect factors such as vehicle type, vehicle acquisition method, depreciation schedule, insurance coverage, and geographic location. Note that the Minneapolis fixed component included interest charges (borne by the dealer) on the funds used to acquire the vans. Since the other three projects purchased their vehicles outright, no interest expenses were incurred, nor was imputed interest included in the monthly user charge. At an assumed interest rate of 10 percent, the monthly amortization charge for the Knoxville vans would have been approximately $119 (in comparison, the $84 amount shown in Table 2 under depreciation reflects only the decline in value of the van over the holding period). The Golden Gate vans incurred the highest insurance costs, primarily due to the bridge district's additional contingent liability coverage of $1 million/vanpool, which cost $41/month per van. From time to time each of the projects revised the variable cost per mile in accordance with actual cost experience. Maintenance expenses, in particular, proved to be significantly at variance with original estimates, due to longer-than-anticipated commuting distances and higher-than-expected post-warranty expenses. In Knoxville, for example, the maintenance cost averaged $14/month per operating van while the vehicles were still under warranty but rose to approximately $160/month per van by the close of the demonstration two years later.

Vehicle deployment practices were aimed at encouraging vanpool formation by underwriting some of the start-up risks associated with vanpooling. All four projects allowed vanpools that had fewer than the recommended number of passengers to operate over a trial period of up to 3 months. During this period, passengers paid the recommended (break-even) fares, and deficits were subsidized from project funds. The trial van policy proved to be an effective strategy for overcoming market barriers to vanpooling. In Knoxville, for example, more than 60 percent of the trial pools initiated during the first year and a half reached operational status.

Another innovative vehicle-deployment practice tested in the Knoxville and Golden Gate projects was the seed-van concept, under which project vans would be used by newly formed pool groups while they worked out operating policies and reached a stable size. After this break-in period, the pool group was expected to transfer into a purchased or leased van, so that the project van could be reassigned to another new group. Project staff actively assisted the transition process by identifying sources of insurance and financing, providing assistance in filling vacancies, and arranging for discounts on new vans, parts, and maintenance. In the Golden Gate project, where a 12-month time limit was strictly enforced, 41 percent of project vanpools made the transition. In Knoxville, where this policy was pursued less vigorously, there were no instances of a project vanpool transferring into a new purchased or leased vehicle; however, the project was able to sell off its fleet of used vehicles to existing operators.

VANPOOL LEVEL OF SERVICE

In order to understand why individuals decided to participate in the four vanpooling programs as drivers or passengers, we must examine the potential level of service and user benefits embodied in vanpooling. Within the spectrum of urban travel modes, vanpooling and carpooling are unique in that modal availability and service attributes, such as travel time, cost, and reliability, are highly dependent on the volume and distribution (in time and space) of demand. The existence of a unit of capacity to serve a particular individual's travel needs depends entirely on there being one or more other individuals who have similar origin, destination, and schedule requirements. Unlike conventional transit, where fare and service policies are determined by the operator, ridesharing characteristics such as schedule adherence, vehicle amenities, and social interaction policies are defined by the pool unit, and the addition of each new pool member may significantly affect the cost and travel time incurred by other members. Vanpooling stands apart from carpooling by virtue of having a regular driver who exerts considerable influence over fare and service policies and the financial feasibility of the vanpool.

Travel Time

To the prospective vanpooler, one of the major drawbacks of vanpooling is the additional travel time (over and above alternative modes) that is incurred in picking up and dropping off other passengers. Since travelers' willingness to accept longer travel times in exchange for cost savings and other benefits is a primary determinant of the potential market demand for vanpooling, it is of interest to glean evidence from these demonstrations regarding the actual level of circuity experienced by project vanpoolers. Although travel time circuity is probably the most relevant circuity concept for explaining behavioral response, note that mileage circuity is important for computing fuel-consumption and operating costs of vanpooling relative to other modes.

Analysis of survey data and van logs from three of the projects reveals circuity levels (as measured by the ratio of an individual's travel time or distance by vanpool to his or her drive-alone time or distance) that range from 1.25 to 1.5. On the basis of Minneapolis data, travel time circuity was examined separately for drivers and passengers. As would be expected, the average increment over drive-alone time was found to be much higher for drivers--22 min added to a 34-min drive-alone time (a 64 percent increase)--versus a 35 percent increase for passengers. These circuity levels reflect not only size of the pool group (which in all three projects averaged eight persons, after accounting for observed daily attendance rates of 80 percent) but also specific operational arrangements such as pick-up location and waiting time policies. Well over half of the surveyed vanpoolers walked or drove to a pick-up point (in some cases, a common meeting area). This practice clearly minimized the collection time for the pool as a whole but may have increased the circuity experienced by the individual passenger.

Minneapolis data were also used to analyze circuity as a function of trip length. The finding that the absolute time increment is roughly constant regardless of commute distance is consistent with recent empirical evidence from Australia on carpool spatial structure (see paper by Richardson and Young in this Record) but contrary to the Johnson-Sen postulation (10) that vanpoolers are willing to accept greater circuity on longer trips. Further investigation of this issue by using data from other projects is warranted to ascertain how vanpoolers trade off travel characteristics such as time and cost and whether there is some sort of threshold circuity level beyond which vanpooling is considered an infeasible travel option.

Travel Cost

Vanpool passenger fares varied considerably across projects, which reflects not only differences in monthly vanpool user charges but also different policies regarding how these charges should be shared by vanpool members. All of the projects recommended passenger-fare schedules based on dividing the monthly user charge by a break-even number of passengers (excluding the driver). In the Golden Gate project, the recommended fare schedules assumed full vans. In the other three projects, the break-even number of passengers used to compute recommended fares was lower than the maximum passenger capacity of the van, the intent being to provide a cushion against low load factors and surplus revenue in the case of higher than break-even load factors. In practice, however, drivers in Knoxville, Norfolk, and Minneapolis were allowed considerable latitude in establishing the level and structure of passenger fares. Evidence from two of the three projects indicates that drivers opted for charging fares below the recommended fare schedules and not only forfeited the incentive of excess passenger revenues from higher than break-even loads but also, in some instances, forfeited their free ride or voluntarily contributed a fare.

In Minneapolis, only one driver charged the break-even fare, and 38 percent of the drivers actually paid a fare. Of the 46 Norfolk vans for which actual fare information is available, 41 charged fares below the recommended level, including 4 vans that operated with fewer than the break-even number of passengers. Of these 41, 16 charged fares below the actual prorated amount per passenger excluding the driver (which implies that the driver was contributing all or a portion of his or her prorated share and forfeiting the free ride), and 6 of the 16 actually charged fares below the actual prorated amount including the driver (meaning that the driver was contributing more than any passenger).

This finding regarding driver-determined fare

Table 3. Comparative user costs for vanpooling as a function of commute trip length.

	Cost ($)				
			Golden Gate Corridor		
Vanpool Fare[a]	Knoxville	Norfolk	11-Passenger Van	10-Passenger Van	Minneapolis
20-mile round-trip daily	24.88	25.25	26.00	33.00	27.00
50-mile round-trip daily	32.88	34.00	33.00	40.00	33.30
90-mile round-trip daily	44.38	48.50	44.00	52.00	41.70

Note: For Knoxville and Norfolk, the break-even load, excluding the driver, is 8 passengers; for the Golden Gate Corridor 10-passenger van and Minneapolis, it is 9 passengers; and for the Golden Gate corridor 11-passenger van, it is 10 passengers.
[a]Vanpool fares are based on December 1978 costs and calculated according to the following formula: Recommended monthly fare = [monthly fixed cost + (variable cost per mile x round-trip distance in miles x 21 days/month)] ÷ break-even passenger load. See Table 2 for fixed and variable costs for each project.

policies suggests one or more of the following: (a) drivers are motivated by incentives other than the heavily touted free ride plus excess fares and by actual or perceived competition from other providers, (b) drivers are strongly committed to keeping their pools in operation and not raising passenger fares when vacancies arise, or (c) drivers live considerably further from work than do their fellow passengers and wish to keep fares competitive with potential shorter-distance vans. Another possible explanation is that pool groups agree to set fares that correspond to the level of service experienced by each individual. A multivariate regression analysis of fares of Minneapolis vanpool passengers reveals that the fare-setting mechanism is in accord with rational economic behavior. In particular, fares for individuals in vans that carry more passengers are significantly lower, and fares for individuals who live farther from work are higher, everything else being equal. Also, fares for individuals who do not commute by van every day of the week are slightly lower. Order of pick-up also appears to have an impact--fares are higher for passengers picked up later in the collection portion of the trip.

For purposes of intermodal cost comparisons, Table 3 shows each project's recommended monthly vanpool passenger fares for three different trip lengths. The comparative monthly cost to the user of driving alone and carpooling is given below:

Length of Comparable Vanpool Trip	Mode	Comparative Cost ($)
20-mile round-trip daily	Drive alone	46.83
	Two-person carpool	24.37
	Four-person carpool	12.18
50-mile round-trip daily	Drive alone	112.98
	Two-person carpool	60.91
	Four-person carpool	30.46
90-mile round-trip daily	Drive alone	201.39
	Two-person carpool	109.64
	Four-person carpool	54.82

Drive alone and carpool costs are based on cost data, assumptions, and methodology presented in Juster and others (4, p. 5-5). The cost figure of $0.131/mile includes all fixed costs of automobile ownership that can be attributed to the commute trip (for simplicity, the attributed portion is assumed to be constant for all automobile submodes) and all variable operating expenses except for parking, which typically is free at the four sites. Automobile costs are computed for shorter trip lengths than the vanpool daily round-trip mileage to account for circuity. The circuity values used are 1.26 for vanpool versus drive alone and 1.11 for carpool versus drive alone. For carpooling alternatives, the total vehicular cost is divided by the number of occupants, which reflects the assumption that all members share expenses equally.

It can be seen that the recommended monthly vanpool fare is, for the three commute distances selected, well below the drive-alone user cost, and that the cost differential between automobile submodes and vanpooling increases with distance and decreases as automobile occupancy increases. The project vanpools are cost-competitive with two-person and four-person carpools at round-trip commute distances in excess of 20 and 60 miles, respectively. Note, however, that these threshold distances are based on user cost comparisons only; factors such as added travel time and reduced schedule flexibility offset the user cost savings associated with vanpooling and, in effect, increase the commute distance at which vanpooling is an attractive alternative to other travel modes.

Reliability

Evidence from the four projects indicates high levels of vehicle reliability, which reflects the newness of the vans and the diligent preventive maintenance practices. The availability of service on a day-to-day basis was also very high, due to the availability of backup vans from the third-party provider (one to three vehicles were reserved for this purpose) and designated backup drivers. In part, as a result of the care taken by project staff in driver selection and training, the drivers turned out to be responsible and interested in maintaining high-quality service. Most vanpool drivers established rules regarding pickup times and procedures and were rated favorably by passengers as to their adherence to agreed on schedules.

TRAVELER RESPONSE AND IMPACTS

This section examines the target market response to the four third-party projects, including vanpool formation and termination rates, vanpooler characteristics, and user benefits. Even though the findings presented reflect site-specific conditions and the timing and relatively short duration of the demonstrations (2-3 years), they provide a useful indication of the nature of the traveler market for whom vanpooling is most appealing.

Vanpool Formation

All of the projects were reasonably successful in attracting prospective poolers and placing them in vanpools (see Table 4). Although in most cases vanpool growth was slow during the initial stages of the project, all third-party vans were assigned to operating pool groups within 6-18 months of demonstration start-up and stayed in service until or beyond the close of the demonstration period. Vanpool occupancy levels were high in all four projects and averaged approximately 10 persons/vehicle (including the driver) once demonstration operations were in full swing. The project vanpools transported a very small percentage of target area commuters; nonetheless, the fleet utilization and vanpool occupancy levels experienced in the four sites matched or exceeded local expectations.

Table 4. Vanpool formation and vanpooler characteristics.

Item	Knoxville	Norfolk	Golden Gate Corridor	Minneapolis
Operational vanpools at close of demonstration	51[a]	46	86[b]	62[c]
Vanpool occupancy				
Year 1	10	6-8	9.4	8
Year 2	11	8-10	10.2	10.2
Vanpool mode split (%)	2.1	3.4	0.5-1	0.3-0.7
Vanpooler characteristics				
Avg age	NA	37	40	40
Male (%)	64	71	63 in year 1; 52 in year 2	56
Avg household income ($)	13 680	NA	24 000	25 200
Automobile availability	7 percent have no automobile available	1.87 vehicles/household	1.83 vehicles/household	2.09 vehicles/household
Percentage in managerial professional category	20	NA	71	47
Former commute mode (%)				
Drive alone	36	52[d]	15 in year 1; 31 in year 2	27
Carpool	54	33[e]	35 in year 1; 30 in year 2	65
Transit	10	3	50 in year 1; 32 in year 2	8
Private hauler	-	12		
Job requirements	NA	80 percent have regular work hours	93 percent rarely work overtime; 95 percent rarely need car for work	86 percent rarely work overtime; 86 percent rarely need car for work
Avg round-trip distance (miles)	61	54	80 in year 1; 56 in year 2	54

[a]This number excludes six privately formed vanpools that were assisted by the project but did not use project vans.
[b]This number is comprised of 35 vanpools in project vans and 51 transitioned vanpools; it excludes 25 vanpools that were assisted by the project but did not use project vans.
[c]This number is comprised of 36 vanpools that operated at the 11 targeted work sites and another 26 vanpools that operated at other sites where no marketing was performed.
[d]This percentage includes automobile drivers who were in two-person carpools.
[e]This percentage excludes automobile drivers who were in two-person carpools.

Note that the Norfolk, Minneapolis, and Golden Gate projects experienced sharp increases during the spring 1979 in the number of applicants interested in joining vanpools, the number of vans in operation, and average vanpool occupancy levels. However, the extent to which these increases in vanpool activity resulted from changes in gasoline price and availability (either actual local shortfalls or perceptions of impending shortfalls) cannot be ascertained, primarily because the projects were still in an active marketing and growth phase (11). An additional exogenous factor that may have affected response to the Norfolk project was the implementation of stricter parking policies in March 1979 coupled with the announcement of impending reductions in parking capacity and federally mandated parking charges.

Vanpool termination rates ranged from approximately 15 percent of all project vanpools formed in Norfolk and Minneapolis to 30 percent in Golden Gate. The median life of vanpools that disbanded was quite short (approximately 4 months), which is consistent with the finding that the major reason for vanpool dissolution was the inability of trial vans to reach a minimum size. In most cases of vanpool termination during the second year of operations, the backlog of interested pool groups was sufficient that vans were only temporarily unassigned.

Driver and passenger turnover rates were also quite low. Of the 46 vanpools in operation in Norfolk at the close of the project, only 7 had experienced a change of drivers. The predominant reasons for driver turnover were changes in job location and work schedule. The average driver turnover rate in Knoxville during the last 6 months of the project was 2.6 drivers/month, which represents 7 percent of the operating vans. As of the middle of the Golden Gate demonstration, 32 drivers had been used to operate 30 vans. Although lack of a willing driver was sometimes a barrier to vanpool formation in the Golden Gate Corridor, driver resignations or job transfers accounted for only 19 percent of vanpool terminations. Passenger drop-out rates averaged well under one rider per month per van in Norfolk and Minneapolis and less than 5 percent of all registered vanpoolers during the course of the Golden Gate demonstration. On the basis of Minneapolis and Golden Gate survey data, the principal reasons for leaving a vanpool appear to be higher-than-anticipated vanpool fares (and, for low-income passengers, difficulties in paying a monthly fare), insufficient flexibility and convenience, and changes in commuting needs.

Vanpooler Characteristics

Analysis of vanpooler survey data reveals remarkable similarity across projects in demographic characteristics and employment-related attributes. The typical vanpooler is around 40 years old, comes from a household of 3-4 persons that has higher than average annual income and automobile ownership. Vanpoolers are predominantly male, married, and college-educated. The percentage in managerial-professional job categories ranges from 20 percent in Knoxville to 71 percent in the Golden Gate Corridor. Drivers tend to be slightly older, better educated, and from higher-income households than passengers, and nearly all of them are married males. Limited information is available from which to assess differences in characteristics of vanpoolers and those of commuters and metropolitan households in general. In Golden Gate, it was found that vanpoolers more often come from households that own automobiles, have college educations, and are employed in a professional or managerial occupation. In Minneapolis, comparisons of vanpoolers with solo drivers and carpoolers in the targeted work sites reveals little difference in automobile ownership or income levels; however, vanpoolers tend to be older than users of these other modes.

A finding consistent with prior empirical evidence is that project vanpoolers tend to have long commute distances relative to the average target market or metropolitan area resident. Average vanpooler round-trip commute distance ranges from 54 miles in Minneapolis and Norfolk to 61 miles in Knoxville. Analysis of Minneapolis data reveals that the trip lengths of former transit users and solo drivers are considerably shorter than those of former carpoolers. Because the cost advantage of vanpooling over automobile submodes increases with distance, this finding suggests rational economic behavior on the part of vanpoolers in deciding to switch modes.

The former commuting mode of vanpoolers varies significantly across projects, which reflects differences in target area characteristics, explicit marketing priorities, and Section 13(c) service restrictions. The Golden Gate Corridor project had the largest percentage diversion from transit (50 percent during the first year), which is not surprising given the active marketing of vanpools on corridor buses. Note the rather extensive diversion from carpooling, which ranges from 30 percent in the Golden Gate Corridor to 65 percent in Minneapolis. This finding may be the result of a higher incidence of carpooling among long-distance commuters before the projects began (this possibility is suggested by the Minneapolis data on trip length by former mode). Another possible explanation, which merits further examination, is that carpoolers trade off modal attributes differently from users of other modes and are a more receptive market for vanpooling. For instance, carpoolers might be willing to accept greater circuity in exchange for the opportunity to be fully relieved of the driving responsibility. Whatever the explanation, the user cost and fuel savings achieved through vanpooling can be considerably overestimated if the diversion from prior ridesharing modes is not accounted for, particularly because vanpoolers diverted from carpooling were found to have longer commute distances than the average vanpooler.

Examination of vanpooler employment characteristics reveals that the type of commuter most likely to vanpool is a worker who does not usually need a car for work and rarely works overtime. As can be seen from Table 4, an extremely high percentage of surveyed vanpoolers work overtime less than once per week and need a car less than once a week. Over three-quarters of the vanpoolers in Minneapolis neither work overtime nor need a car at work more than once per week. Vanpoolers in Minneapolis also reported flexibility in shifting daily work schedules (33.2 percent) and permanently changing work hours (46.9 percent). In contrast, the reported prevalence of overtime requirements and need for a car during the day is significantly higher among nonvanpoolers, especially those who drive to work alone.

As noted earlier, an important objective of these demonstrations was to determine the applicability and effectiveness of the third-party mechanism for serving multiemployer markets, since single employers cannot be expected to provide vanpools to any but their own employees. The projects differed in terms of how extensively they tested this question: in Norfolk, there was only one employer but multiple work sites; in Knoxville and Golden Gate, the focus was on areawide and corridor commuters from numerous employers, but there was no special attempt to create multiemployer pools; in Minneapolis, on the other hand, the concept was put to the hardest test, since the focus was on suburban work sites with firms of varying sizes. Based on limited data on vanpool composition and operations, the majority of project vanpools in Knoxville and Golden Gate were single-employer pools, and the employers represented by these vanpools tended to be large. (For instance, 44 percent of Golden Gate vanpoolers work at firms that employed more than 1000 persons.) In Minneapolis, the percentage of multiemployer pools was higher than in other sites (55 percent); however, varying work schedules and dispersed company locations within a work site constituted major barriers to multiemployer pools. The finding that dispersed work locations (up to 1 mile apart) inhibited the formation of multiemployer vanpooling suggests that commuters may perceive circuity at the work end of the vanpool trip to be more onerous than circuity at the residence end or, alternatively, that commuters may be unwilling to endure the travel time increases due to circuity at both ends of the work trip.

User Benefits

Project vanpoolers experienced many benefits as a result of shifting their commuting mode. These included the following:

1. Out-of-pocket cost savings of several hundred dollars a year, in part a reflection of fuel savings of 300-400 gal/year (the precise amounts of course depended on their former mode);
2. Reduced driving hassle (for passengers who formerly drove alone or carpooled); and
3. Decreased travel time (for former transit users).

Another important source of cost savings for vanpoolers was the ability to sell a household vehicle or defer purchase of a new vehicle. In the Golden Gate Corridor, 1 percent of vanpoolers sold a vehicle and 15 percent claimed they deferred purchase of a new vehicle; in Norfolk, 5 percent of vanpool passengers sold a vehicle and 28 percent claimed to have deferred purchase of a vehicle. The percentage of Knoxville and Norfolk drivers who sold a vehicle was 13 and 21 percent, respectively, with another 3 percent in Knoxville and another 29 percent in Norfolk reportedly deferring purchase of a new vehicle. Drivers were in a relatively better position than were passengers to decrease automobile ownership because of the availability of the van for personal use at reduced rates. Based on data from Knoxville and Minneapolis, drivers logged approximately 150-200 miles/month on nights and weekends. In Golden Gate, several vanpoolers reported savings on their automobile insurance premiums of up to $300/year.

THIRD-PARTY PROVIDER IMPACTS

The cost of operating these third-party programs varied considerably across sites, which reflects differences in the nature and scope of staff activities, demonstration duration, and explicit subsidy policies. The demonstration operating budgets exclusive of vehicle capital costs ranged from $162 000 over a 20-month period in Norfolk to $895 000 over a 24-month period in Minneapolis. In the Golden Gate Corridor project, $614 000 was expended over a 33-month period, and in Knoxville a total of $783 000 was spent over 30 months. These operating budgets covered project administration, marketing, matching, and data collection conducted for evaluation purposes. The cost of acquisition and maintenance of a van fleet was almost entirely offset by revenues from vanpool user charges, as explained previously. The low cost of the Norfolk project relative to the other three demonstrations can be explained by the focused target market and the extensive in-kind support provided by the Navy. The considerably higher cost of the other three projects reflects their more diverse and geographically dispersed target markets (especially Minneapolis, where there was extensive outreach to small firms), their more elaborate marketing efforts, and their greater emphasis on institutional and multimodal brokerage activities.

By using available cost and demand data and cost-allocation assumptions to obtain the net cost of vanpool-related activities, the unit cost of these four third-party programs is estimated to have ranged from $300 to $500/operational van-month.

These unit cost figures are not, however, considered indicative of the cost of operating such a program at the present time. For one thing, they cover many institutional and planning activities that were necessary several years ago because of the prevalent barriers to vanpooling and the novelty of the third-party provider mechanism. Second, these costs reflect only 2-3 years of operating experience and are thus heavily influenced by start-up costs and low initial levels of van utilization, which necessitated subsidies for low-occupancy vans and (in Minneapolis) carrying costs for idle vans. Evidence from three of the projects suggests substantial declines in unit costs over time as the number of applicants and operational vanpools increases and the emphasis shifts from forming new vanpools (a function largely performed by the third-party provider) to maintaining existing vanpools (primarily a driver responsibility). In the Golden Gate project, for example, the cost per operational van-month averaged $1440 during the first year and a half and $240 during the subsequent year. The Minneapolis project experienced a similar reduction, with the cost per operational van-month declining from $1300 during the first year to $350 during the second year. In Norfolk, the average cost per operational van-month declined from approximately $125 during the last year of the demonstration to $27 two years later.

All four vanpool programs have continued beyond the demonstration period by using other sources of funding to cover administrative expenses. Knoxville no longer operates its own fleet of vans but has continued to provide assistance to pool groups in the areas of matching and brokering, arranging for insurance and financing, and organization of a driver association. The other three projects have continued to provide a full range of third-party services, including project vans. The Golden Gate project has held its fleet size to approximately 40 vehicles and has continued its policies of seeding project vanpoolers into nonproject vans and assisting in the formation and maintenance of privately operated vanpools. The Norfolk and Minneapolis projects have expanded their scale of operations to 100 vans, and Norfolk's pricing policy has been altered so that vanpool user charges cover a portion of the program's administrative costs. Although there have been few instances to date of vanpools being used to replace fixed-route service, the organizations that sponsor these programs continue to see vanpooling as a cost-effective alternative to the expansion of peak-period transit capacity. The Golden Gate Bridge, Highway, and Transportation District, for example, has estimated that the per person subsidy costs for the vanpool program are less than one-fourth of the bus subsidy costs.

In recent years there has been a noticeable increase in the number of third-party vanpool programs in operation across the country. These newer programs have benefited considerably from the institutional accomplishments and operational experiences of the four demonstrations. Given the prospect of rising energy costs and increasingly severe fiscal constraints that threaten to force the curtailment of transit service in many metropolitan areas, there appears to be a continuing if not growing role for third-party vanpooling programs in order to attract commuters into this high-occupancy mode. In particular, the third-party mechanism offers considerable flexibility in terms of how, where, and at what rate vanpool services are introduced within an urban area. Moreover, this mechanism represents an effective avenue for promoting greater participation by the private sector in the provision of urban transportation services and for encouraging more entrepreneurship on the part of individuals to organize and operate transportation services for other commuters. Note, however, that many of the policies and operational procedures developed in the four demonstrations may not be applicable or necessary at this time. For instance, seed vans may not be required in all settings now that there is greater public familiarity with vanpooling. Similarly, marketing efforts and policies such as trial van subsidies may not be needed to such a degreee. Finally, as the cost of competing modes rises and pressures to contain public costs become even stronger, there may be increasing impetus to find other sources of funding (vanpool user charges and employer contributions) to cover third-party program administrative expenses.

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Analysis of Transportation Impacts of Massachusetts' Third-Party Vanpool Program

HOWARD J. MORRIS

Massachusetts' third-party vanpool program, Caravan, launched 34 vanpools in the year that ended June 30, 1980. This paper describes the vanpool trip characteristics and changes in travel behavior and analyzes the current and projected impacts on energy consumption, air quality, cost of commuting, and subsidies. The analysis shows that the benefits of the third-party program, as measured by user cost savings, far outweigh the portion of the program costs that is publicly funded. The cost savings to the user are more than six times as great as the public subsidy in 1980 and are projected to be more than 22 times as great for the 1985 program. The user fees cover 81 percent of the total program cost in 1980 and are projected to cover 94 percent for a mature 500-van program in 1985. The program is relatively cost effective for achieving reduction in fuel consumption and vehicle emissions compared with other transportation measures. For example, each vanpool currently saves more than 6500 gal/year, which represents a fuel savings of 66 percent for one vanpool group, at a cost of $0.29/gal. However, because of natural market limits to potential vanpool growth, the total contribution toward achieving areawide energy and air quality goals is small. For instance, the 500-vanpool program anticipated for 1985 will save about 0.12 percent of statewide motor fuel consumption. The funding and other policy implications of these findings are discussed.

Massachusetts' third-party vanpool program, Caravan, launched 34 vanpools in the year that ended June 30, 1980. This paper describes the vanpool trip characteristics and changes in travel behavior and analyzes current and projected impacts on energy consumption, air quality, cost of commuting, and subsidies.

The vanpool trip characteristics and changes in travel behavior are based on program records and a user survey. Surveys were distributed to vanpoolers at the start of operation of each vanpool and were returned within two months. The response rate for the vanpoolers was 77 percent, which represents 27 of the 34 vanpools. The survey provided information for marketing purposes as well as for planning and evaluation. This analysis will be updated as additional vanpools are formed and surveyed.

PROGRAM DEVELOPMENT

Caravan evolved from the efforts since 1975 of Masspool, the state's ridesharing program, to promote vanpooling through assistance to large employers. By 1978, the decision was made that the third-party mechanism was needed to effectively implement vanpooling in Massachusetts, given the concerns of many companies regarding liability, administrative burden, and financial risk. In mid-1978, the Executive Office of Transportation and Construction (EOTC) began detailed program development, based heavily on the design and experience of Baltimore's Van-Go program and San Francisco's Rides program. This resulted in the formation, in November 1978, of Masspool, Inc., a private, nonprofit corporation that had an eight-member board of directors. The corporation was funded with federal transportation and energy monies for 1979, and an executive director was hired in April 1979. The program, marketed as Caravan, put its first 15-passenger vanpool on the road in July 1979. By July 1980, it had 34 vans on the road and served nearly 500 commuters. Of these 34, 11 are multicompany vanpools, and 23 are single-company vanpools that serve 12 employers. Figure 1 shows the vanpool growth rate.

VANPOOL TRIP CHARACTERISTICS

The average one-way distance to work for the group of commuters is 33 miles. The median distance is 32 miles. Figure 2 shows the work-trip length distribution, which ranges from 13 to 95 miles. The average one-way van mileage is 40 miles.

Trip Locations

Figures 3-5 show the vanpool locations, according to suburb-to-suburb, reverse-commute, and suburb-to-core types of routes. For the purpose of summarizing locational characteristics, eastern Massachusetts has been divided into four zones:

1. The outer area, roughly, beyond Interstate 495;
2. The middle ring, between MA-128 and I-495;
3. The inner ring, within MA-128 but not including downtown Boston; and
4. The core area, downtown Boston.

Radial routes to downtown Boston are well served by transit, and circumferential transit service is weak or nonexistent. Figures 3-5 show that most of the vanpools serve trips that cannot be served well or at all by transit.

Eighteen of the 34 vanpools are suburb-to-suburb commutes: trips between the outer, middle, and inner rings. Three vanpools are reverse commutes and take commuters from their homes in or just outside the core to their work sites in the middle or outer

Figure 1. Vanpool growth.

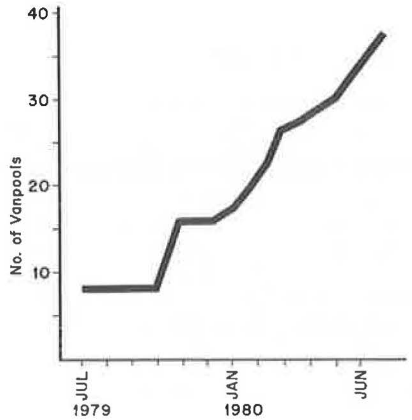


Figure 2. Distance-to-work distribution.

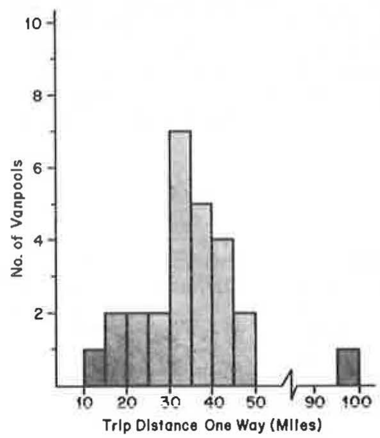
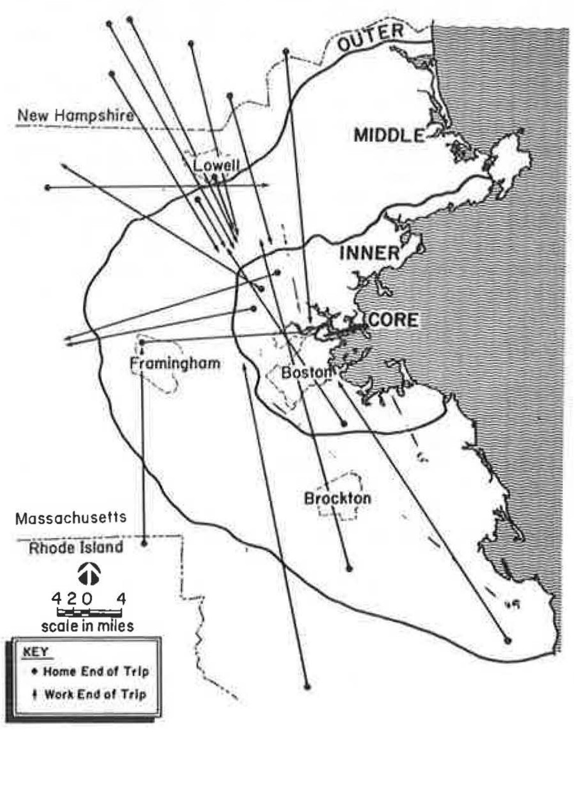


Figure 3. Location of Caravan vanpools: suburb-to-suburb routes.



ring. Thirteen of the vanpools terminate in the core. These route characteristics are summarized in Table 1.

Collection and Distribution Characteristics

Directness of the vanpool routing and how the vanpoolers access the vanpool affect the calculation of

Figure 4. Location of Caravan vanpools: reverse-commute routes.

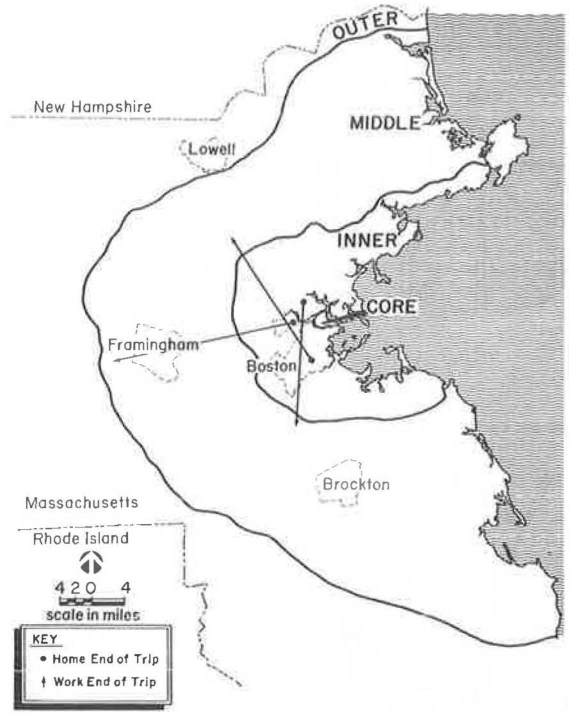


Figure 5. Location of Caravan vanpools: suburb-to-core routes.

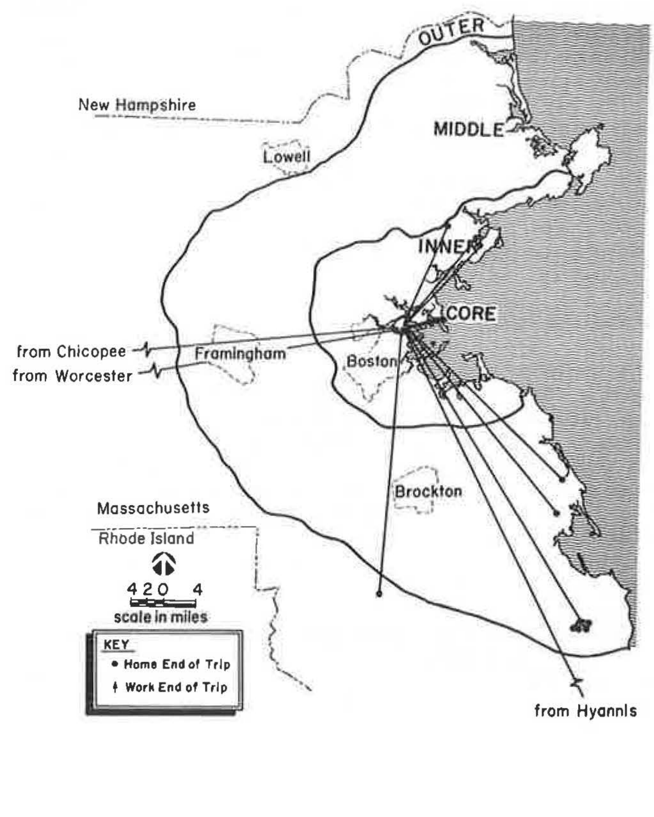


Table 1. Vanpool route characteristics.

Home End of Vanpool Route	Work End of Vanpool Route			
	Core Area	Inner Ring	Middle Ring	Outer Area
Core area				
Inner ring			3	4
Middle ring	8	1	2	
Outer area	5	2	9	

Figure 6. Access to vanpool.

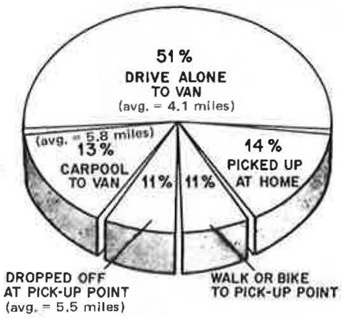
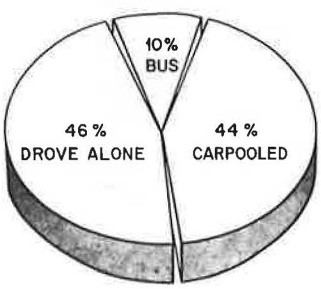


Figure 7. Former commuting modes.



societal and individual benefits through total vehicle miles of travel and total number of trips. Although the average one-way commute length served is 33 miles, the one-way van mileage is 40 miles.

As may be seen in Figure 6, slightly more than half (51 percent) of the new vanpoolers access the vanpool by driving alone to the pick-up point, where they park their cars. Approximately equal numbers of vanpoolers carpool to the pick-up point (13 percent), are picked up at home (14 percent), walk or bicycle to the pick-up point (11 percent), or are dropped off at the pick-up point (11 percent).

VANPOOLER CHARACTERISTICS

The majority of the vanpoolers are male (65 percent). There is no significant relationship with age (30 percent in the 20-30 age bracket, 28 percent between 30 and 40, 23 percent between 40 and 50, and 19 percent older than 50 years). Vanpoolers are predominately professional, technical, and administrative workers (74 percent). Only 26 percent are clerical or labor workers.

The majority of the drivers and backup drivers (74 percent) is male. There is no significant relationship with age.

Almost all the commuters check "conserve gasoline" (78 percent) and "ability to save on travel costs" (74 percent) as among the reasons why they joined a vanpool. Significant numbers check "ability to relax while traveling" (46 percent), "freedom from driving" (46 percent), and "convenience" (41 percent).

Former Commuting Methods of Vanpoolers

As may be seen in Figure 7, approximately equal percentages of the new vanpoolers formerly drove alone to work (46 percent) or carpooled (44 percent). This corresponds to the experience of similar programs in other states. Ten percent of the vanpoolers were drawn from transit. Disaggregating the data by vanpool group, six of the vanpool groups reporting were predominately (more than 75 percent) drawn from drive aloners and four from carpoolers. Although more than one-third (38.2 percent) of the vanpool groups have one or more persons who were previous transit users, only 9 percent of the vanpools have four or more previous transit users.

Impact on Work Schedules

Thirty-two percent of the vanpoolers reported that they changed their work hours to accommodate to the service. However, this result is not as significant as it first appears, given the respondents' written comments in many cases, that these changes were generally discretionary decisions by professional staff rather than changes from employer-set schedules.

Automobile Ownership

Vanpooling also affects travel habits and impacts in the medium range. More than one-third of the new vanpoolers (34 percent) say that the availability of the service will affect their decision to buy another vehicle. Furthermore, 8 percent of the vanpoolers reported their intention to sell a vehicle as a result of the vanpool service.

CURRENT-YEAR BENEFITS

The reduction in number of trips and vehicle miles of travel (VMT) that results from commuters switching to vanpooling leads to reduced fuel consumption, automotive emissions, and commuting costs. These benefits are calculated by using the vanpooler and trip characteristics from the survey.

The calculations take into account the previous modes of the vanpoolers and the access modes to the vanpool route. Although the daily round-trip VMT per person decreases by 76 percent (from 43.1 miles to 10.5 miles), the percentage reductions in fuel consumption and vehicle emissions are somewhat less. This is because the fuel-consumption rate and pollutant-emission rate for both the van trips and the shorter automobile-access trips are greater than the rates for the longer automobile line-haul trips.

Gasoline Savings

Each vanpool saves an average of 26.2 gal of gasoline daily, or 6548 gal/year. The average fuel consumed per commuter was reduced from 2.9 gal/day to 1.0 gal/day. This represents a 66 percent fuel savings for the vanpool group. These figures mean that the annual fuel savings achieved by Caravan's first 34 vanpools is 222 615 gal/year.

Reductions in Automotive Emissions

Hydrocarbon emissions are calculated by applying an emissions factor to VMT. The effects of cold trip starts are accounted for in the calculation through the choice of emission factor. The emission factor

Table 2. Annual commuter cost savings.

Access Mode to Vanpool	Cost of Van and Access Mode[a] ($)	Savings Based on Prior Mode and Its Cost ($): Drive Alone, $2398	Carpool: Shared Driving, Two Persons, $1315	Carpool: Shared Driving, Three Persons, $878	Bus, $1110[b]
Drive alone to pick up	950	1448	365	-72	305
Carpool to pick up	788	1610	528	90	305
Pick up at home	600	1803	720	283	305

Note: Annual per person savings are shown. All calculations are for 33-mile one-way commute. Automobile operating costs are based on FHWA data (1) updated for 1980 costs, $1.25/gal gasoline, 15 miles/gal automobile, 10 miles/gal van. Automobile costs are adjusted to account for higher per mile costs for shorter access trips. Carpool trips include 10 percent collection mileage, automobile occupancy of 2.5.

[a]Vanpool fare is $50/month (van operating costs of $0.17/mile).
[b]Average bus cost is based on typical one-way (commuter discounted) fare of $1.80 and assuming access to bus was the same as current access to vanpool.

Table 3. Current and projected energy conservation benefits.

Year	No. of Vans	Gasoline Savings[a] (gal/year): Per Van	Gasoline Savings[a] (gal/year): Program Total	Annual Program Cost per Gallon Saved ($)	Percentage of Statewide Target Reduction[b]
1980	34	6548	222 615	0.29	0.12
1982	100	5980	598 000	0.25	0.36
1985	500	4963	2 481 250	0.10	1.60

[a]Based on the following fuel efficiencies for 1980, 1982, and 1985 (2): 15.0, 16.5, and 19.0 miles/gal for automobile; 10.0, 11.0, and 12.0 miles/gal for van. Fuel efficiencies for the 4.1 and 5.8 mile access trips are 74.3 and 79.4 percent, respectively, of the warmed-up fuel efficiency (3).
[b]Based on total motor fuel consumption of about 2.3, 2.2, and 2.0 billion gal in 1980, 1982, and 1985, respectively. This reflects a 2.3 percent annual growth in VMT and average fuel efficiencies as noted above. U.S. Department of Energy target reduction percentage is assumed to be 7.4 percent for each year.

is greater for the shorter trip segments.

The reduction in nonmethane hydrocarbon (NMHC) emissions that results from the operation of one vanpool is 2.62 lb/day or 0.33 tons/year. This represents a reduction of 55 percent from the 4.79 lb/day NMHC produced by the vanpoolers in their previous modes to 2.17 lb/day currently produced by one vanpool group. The reduction in NMHC emissions for 34 vanpools is 11.22 tons/year.

Commuter Cost Savings

Commuter cost savings are calculated for the average vanpool commute and the average automobile fuel efficiency (15 miles/gal). The savings are based on automobile operating costs only; vanpoolers who can eliminate a household automobile save more.

The amount of savings depends on the commuter's previous mode and current mode of access to the vanpool as shown in Table 2. The average commuting cost per vanpooler is reduced by 52 percent, from $1677/year to $802/year. The average vanpool saves $12 247 annually. The annual commuter cost savings for 34 vanpools is $416 398.

PROJECTED PROGRAM BENEFITS AND COST-EFFECTIVENESS

The significance of the vanpool program's contribution to areawide transportation goals (e.g., energy conservation) depends on the benefits from each vanpool, the number of vanpools, the magnitude of the impacts (e.g., reduction in fuel consumption) needed to achieve the goals, and the cost of the program. The travel characteristics (prior mode, access mode, and trip lengths) used to calculate benefits are assumed to remain constant.

The potential number of vanpools depends on user costs, costs of alternative modes, trip lengths, and densities of home and employment locations. The maximum potential for third-party vanpools is estimated at 500, based on a 10 percent market share of commuters who work at facilities where 500 or more are employed and who commute more than 15 miles one way (employer-sponsored vanpools are expected to grow from the current 190 to 225-250). The analyses in this section are for three points in the growth of the program: (a) the current (mid-1980) 34 vanpools, (b) a 100-vanpool program expected to be attained in 1982, and (c) the projected maximum potential of 500 vanpools, which could be attained in 1985.

The cost of the program for the first year is about $65 000. The program cost is projected to be $150 000 in 1982 and $250 000 in 1985 (in 1980 dollars).

Areawide goals for energy conservation and air quality are expressed as target reductions in fuel consumption and vehicle emissions. Cost-effectiveness for an objective is defined as total program costs divided by the reduction amount. Although this understates cost-effectiveness in absolute terms, it is considered to be more useful than the allocation of total program cost across multiple impacts: The measure can be used in a consistent manner to compare projects that have the same range of impacts.

This analysis does not consider other impacts that cannot be readily estimated. Such impacts include labor market access, parking requirements, local congestion, and effect on peak transit service.

Energy Conservation

The U.S. Department of Energy sets voluntary state gasoline conservation targets semiannually, based on a national target that is adjusted for each state. For the second half of 1980, the Massachusetts target reduction is 7.4 percent (based on a nationwide target reduction of 5.5 percent). This represents an annual target reduction of 183 298 000 gal for 1980 from the 1979 gasoline consumption of 2 465 769 400 gal.

As may be seen in Table 3, the 34-van program (1980) achieves 0.12 percent of this target reduction, at a cost of $0.29/gal.

Projected values for fuel consumption and vehicle fuel efficiencies are used to determine the cost-effectiveness for program levels in future years. The reduction target is based on the 1980 percentage target.

As Table 3 shows, the gasoline savings increase less than proportionally to the number of vans because of the impact of the increases in average automobile fuel efficiency. The annual savings per van decreases to 5980 gal in 1982 and 4960 gal in 1985. The cost per gallon saved decreases to $0.10 in 1985 because of the expected economies of scale of the program. The percentage of the statewide target reduction in motor fuel consumption increases to 1.6 percent for the 500-van program in 1985. The 2.5 million gal saved by the 500 vans is 0.12 percent of the roughly 2.0 billion gal of motor fuel consumed statewide for all trip purposes, or about 0.4 percent of the fuel consumed for work trips.

Air Quality

Pollutant standards are established in accordance with the Clean Air Act Amendments of 1977. The entire state has been designated as being in violation of the air quality standard for ozone. Transportation-related ozone results primarily from NMHC emissions. The air quality analysis is performed for NMHC emissions only, since it is the only pollutant for which Massachusetts will have difficulty in attaining the standard by 1987, as required.

The emissions reduction targets are calculated by the state air quality agency and documented in the state implementation plan. The 1980 emissions reduction target for transportation sources is 103 400 tons of NMHC, or about 48 percent of the total transportation NMHC emissions (after federal motor vehicle emission controls). As may be seen in Table 4, the 34-van program achieves 11.2 tons/year, or 0.011 percent of the statewide emissions target, at a cost of $5804/ton.

The Federal Motor Vehicle Emission Control Program will lower vehicle emission rates significantly in coming years. As a result, the annual NMHC emissions reduction per vanpool decreases to 0.22 tons in 1982 and to 0.11 tons in 1985. The cost per ton NMHC reduction increases for the 100-van program in 1982 but then decreases to $4545 for the 1985 program due to the effect of economies of scale. The percentage of the statewide target reduction NMHC emissions increases to 0.14 percent for the 500-vanpool program. The 55 tons/year reduction that results from the 500 vanpools is 0.05 percent of the approximately 120 966 tons NMHC emitted by transportation sources, or about 0.13 percent of the work trip NMHC emissions.

Table 4. Current and projected air quality benefits.

Year	No. of Vans	NMHC Emissions Reductions[a] (tons/year) Per Van	Program Total	Annual Program Cost per Ton ($)	Percentage of Emissions Reduction Needed to Achieve Standards[b]
1980	34	0.33	11.2	5804	0.011
1982	100	0.22	22.0	6818	0.029
1985	500	0.11	55.0	4545	0.140

[a]Emission factors (4) include the effect of the shorter-distance access trips through the percentage cold-start factor.
[b]Emissions reductions targets (5) are 103 439 tons/year, 76 403 tons/year, and 39 361 tons/year for 1980, 1982, and 1985, respectively. Total transportation NMHC emissions (after FMVECP controls) are 213 176 tons/year, 176 307 tons/year, and 120 966 tons/year for these years.

Commuter Cost Savings

Projected values for vehicle operating costs are used to estimate the commuter cost savings for program levels in future years, given in Table 5. Members of the typical vanpool save $12 247 in 1980 and $11 397 in 1985. These savings are more than 6 times as great as the program cost in 1980, and 22 times as great in 1985, in large part due to the expected economies of scale in the program. These factors may be thought of as benefit-cost ratios for the third-party program, if benefits are narrowly defined as user cost savings (note, however, that travel time costs are not considered here).

Table 5. Current and projected commuter cost savings.

Year	No. of Vans	Commuter Cost Savings[a] ($) Per Van	Program Total	Program Cost[b] ($)	Commuter Cost Savings ÷ Program Cost
1980	34	12 247	416 398	65 000	6.4
1982	100	12 258	1 225 800	150 000	8.2
1985	500	11 397	5 698 500	250 000	22.8

Note: All costs are annual amounts and are shown in 1980 dollars by using a projected inflation rate of 10 percent.
[a]Costs are based on operating costs only. Projected fuel costs are based on 15 percent annual price increase and fuel efficiencies, as in Table 3; all other projected costs are based on 10 percent annual inflation rate. See notes to Table 2.
[b]Program cost refers to funding from state agencies (i.e., it does not include program expenses recovered through vanpool fares).

Subsidy Levels

The total program cost consists of the administrative program cost (the program cost of the third-party operation funded by federal and state monies) and the user fees (the vanpoolers' fares, which cover capital and operating expenses). This administrative program cost (which includes certain contingency expenses as well as strictly administrative and marketing expenses) is, in effect, a subsidy to the vanpool operation. Table 6 shows that this subsidy is quite low. The vanpool fares cover 81 percent of the total cost for the operations in 1980 and 94 percent in 1985.

The subsidy per trip is $0.27 in 1980 and $0.07 in 1985. The annual subsidy per vanpooler is $137 in 1980 and $36 in 1985.

CONCLUSIONS

The first year of experience with the program has shown the effectiveness of a third-party vanpool program that is operated by a private, nonprofit corporation. Caravan served as a catalyst for van-

Table 6. Current and projected subsidy levels.

Year	No. of Vans	Administrative Program Cost or Subsidy[a] ($)	Percentage of Total Program Cost[b]	User Fees[c] ($)	Percentage of Total Program Cost	Total Program Cost ($)	Subsidy per Person-Trip, One-Way ($)	Annual Subsidy per Vanpooler ($)
1980	34	65 000	19	285 600	81	350 600	0.27	137
1982	100	150 000	15	833 058	85	983 058	0.21	107
1985	500	250 000	6	4 173 913	94	4 423 913	0.07	36

Note: All costs are annual amounts in 1980 dollars by using projected inflation rate of 10 percent.
[a]Administrative program cost refers to funding provided by state agencies for third-party administrative and marketing expenses.
[b]Total program cost is the sum of the administrative program cost and the user fees.
[c]User fees are vanpool fares (estimated as described in notes to Table 5) of $50, $60, and $80 for the three program years, respectively (current dollars).

pool formation in companies that had shown an interest in vanpooling but had not implemented a company-operated program. Caravan also succeeded in establishing multicompany vanpools.

This analysis provides benefit and cost data for determining the role of vanpooling in a comprehensive transportation policy. The benefits of the third-party program, as measured by user cost savings, far outweigh the portion of the program costs that is publicly funded. The program is relatively cost effective for achieving reductions in fuel consumption and vehicle emissions, compared with other transportation measures. However, because of natural market limits to potential vanpool growth, the total contribution toward achieving areawide energy and air quality goals is small (though, again, comparable to many other measures).

Third-party vanpooling is a relatively inexpensive program for government to support. Based on the findings of this analysis, policymakers could follow two different paths in deciding future government funding and involvement.

One line of reasoning is that, since the financial benefits of the program accrue to the users, government should discontinue subsidy after the program is nurtured to maturity. Since the anticipated subsidy is low (6 percent), its removal might not significantly decrease van ridership (depending on the demand sensitivity to price).

The second line of reasoning is that government should continue or increase its subsidy to the program so as to increase the potential for vanpools (again, depending on the demand sensitivity to price) and hence maximize the societal benefits. In this case, the interrelation of such a policy with transit policy should be analyzed carefully.

The policy determination should consider the full range of impacts of vanpooling and the cost-effectiveness, compared with other programs, toward achieving a wider range of areawide and corridor-specific goals. In either case, other actions could be taken that increase the potential for vanpooling. Government could implement automobile management actions that would make vanpooling more desirable. The program can continue to pursue cost-reduction strategies, stress other factors in promotional activities in addition to cost savings, and market through a variety of channels (e.g., office parks, communities, and the general public, in addition to large employers).

ACKNOWLEDGMENT

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Abridgment

Can Employer-Based Carpool Coordinators Increase Ridesharing?

JOANNA M. BRUNSO AND DAVID T. HARTGEN

The carpool coordinator is a company employee who forms carpools among employees by using personal, manual techniques. He or she is available to resolve ridesharing problems as well as to promote carpooling. This paper evaluates the carpool coordinator demonstration project undertaken by the New York State Department of Transportation in 1979 under contract to the New York State Energy Office. Six state agencies in the Albany, New York, area were used to set up a quasi-experimental design to test the effectiveness of the concept and to control for carpool formation that would normally occur because of rising gasoline prices and restrictions of supply. Before and after surveys in the six agencies were conducted in October 1978 and again in October 1979. The results show that in test agencies the carpool coordinators increased ridesharing substantially (10 percentage points), but ridesharing among control agencies rose only 3.5 percentage points during the same period of time. Thus, the coordinator project was able to effect an increase of 6.5 percentage points because of its activities. Approximately 195 000 gal of gasoline were conserved by new carpoolers in all six agencies, an average of 283 gal of gasoline per year per carpooler. Of this, 101 000 gal is attributable to the carpool coordinator program. The direct cost of the project in the three agencies was $26 000. This produces an overall benefit/cost ratio of 3.9; however, the benefit/cost ratio for employees who commute long distances was 9.0.

The 1973-1974 and 1979 oil crises provided the impetus for carpool demonstration programs across most of the country. These programs consisted primarily of computer-matching procedures and a wide range of publicity measures. These programs did not result in a great increase in carpooling (less than one percentage point) and, once the restriction on the gasoline supply was lifted, many of these new carpools fell apart and many programs were abandoned (1,2). Some projects, however, continued to expand in scope and enlisted the support of major employers in their area. Most programs were unable to evaluate their effectiveness in terms of new carpoolers induced to rideshare by the program itself. In the fall of 1978, estimates were that these programs had increased ridesharing to the extent of 1.1 percent of the areawide population (1).

Simultaneously, research into the motivations and attitudes of commuters toward carpooling (2-5) showed that carpooling is not basically an economic phenomenon but rather a complex social and psychological one. Most carpools are formed among acquaintances and friends, both at home and in the work place. Most people are not easily motivated to contact nonacquaintances provided by computer-matching lists and may shy away from doing so because of perceived difficulty in easily resolving problems that can arise in ridesharing situations. This research suggests that carpool coordinators who work within employer sites and use manual and personalized techniques to match employees and resolve ridesharing problems can have a more positive influence on the incidence of ridesharing than will conventional computer-matching techniques.

In recognition of the energy-saving potential in ridesharing, the New York State Energy Office (SEO) contracted with the New York State Department of Transportation (DOT) in mid-1978 to test the concept of the employment-site-based carpool coordinator. This demonstration was intended to be promoted by SEO and DOT throughout New York State as one of many actions to reduce the state's dependence on foreign energy resources. This paper describes the results of that study.

STUDY DESIGN

The purpose of the carpool coordinator demonstration project was two-fold:

1. By using state agencies as a test, evaluate the impact of carpool coordinators on the incidence and stability of carpooling in a white-collar working environment.
2. Evaluate the amount of energy that can be saved by this approach.

Approximately 36 000 state workers are employed at two major sites in the Albany area. One is the state campus on the Albany city outskirts, which is characterized by good access to urban expressways and arterials, infrequent transit service, and unlimited parking. The other is the downtown Albany Rockefeller Plaza, where transit is good, traffic more congested, and parking severely restricted. Within each site numerous state agencies operate, each as a separate entity that has a separate management structure. Thus the demonstration could be confined within specific agencies at each location. The participating state agencies were the DOT, Department of Labor (DOL), Department of Motor Vehicles (DMV), Office of General Services (OGS), Department of Health (DH), and the Department of Public Service (DPS). A quasi-experimental design that uses test and control agencies was developed. The test agencies appointed carpool coordinators; the control agencies did not. The design may be represented as follows, with the before and after observations taken from an employer survey.

Location	Agency	Oct. 1978	Carpool Coordinator Demonstration	Oct. 1979
State campus	DOT	X	X	X
	DOL	X		X
Rockefeller Plaza	DMV	X	X	X
	OGS	X	X	X
	DH	X		X
	DPS	X		X

A random sample of 200 employees was selected from each agency in the fall of 1978 and again in 1979. The observations at each agency serve to uncover significant changes in carpool formation or mode shift. Changes that occurred in the control agencies allow measurement of the effects of changes in the energy supply or price, political changes, or changes in the work environment (e.g., flex time) that have occurred in the period October 1978-October 1979.

PROGRAM DEVELOPMENT

Initially the concept of a carpool coordinator was that of an agency employee who works within each agency who would publicize and promote carpooling, hold small group meetings, relate on a personal level to those who desire help with carpool matchings, perform introductions, and resolve ridesharing problems. Within each test agency a current employee who has some other duties as well was appointed as carpool coordinator.

In February 1979, two employees hired with funds from the Comprehensive Employment and Training Act (CETA) of 1973 joined the project in DOT. The coordinating activities, under close supervision, were largely turned over to them. They engaged in a canvass of all DOT employees, beginning with a well-defined neighborhood approximately 15 miles from work. Their job was to promote carpooling, determine interest in carpools, match individuals, distribute lists of employees interested in carpooling, arrange introductions, and resolve problems. The most effective techniques in forming carpools were personal introductions and matching based on routes to work. All new carpoolers were called on a monthly basis to encourage communication with the program to offer assistance in problem solving and to keep records current.

SURVEY RESULTS

The results of the 1978 and 1979 surveys of the employees of the six agencies are presented in Table 1. Carpooling (the percentage of employees who drive with other employees) clearly increased during the past year, with the exception of the DH; however, the percentage of family members who ride to work together decreased or rose less significantly (DOT). The much greater increase in ridesharing in the test agencies (10 percent) as opposed to the control agencies (3.5 percent) shows the positive impact of the carpool coordinators and the existence of ridesharing promotional programs.

The percentage of employees who drive alone was greater on the state office campus, where parking is virtually unlimited. The higher incidence of transit use in the downtown agencies seems to suggest that, in the case of limited parking and energy constraints, transit will be used when it is available.

Energy Savings

Analysis of the survey results indicates that, over the course of the demonstration project, there have been no significant changes in the length of the one-way commuting trip, the one-way door-to-door commuting time, or the carpool automobile occupancy (6). If the one-way commuting distances and increases in carpoolers associated with each agency are combined, the result is an implied savings of 196 000 gal of gasoline or about 283 gal of gasoline for each new carpooler per year.

Effect of the Energy Crisis on Carpooling

The energy events of 1979 had a definite negative impact on the percentage of solo drivers among

Table 1. Mode to work.

Agency	Drive Alone (%)			Drive with Another Employee (%)			Drive with Family Member (%)			Transit (%)			Walk (%)			Other (%)		
	1978	1979	Δ	1978	1979	Δ	1978	1979	Δ	1978	1979	Δ	1978	1979	Δ	1978	1979	Δ
Campus																		
DOT[a]	54	42	-12	27	39	12	11	16	5	5	2	-3	3	0	-3	1	1	0
DOL	50	45	-5	25	32	7	18	18	0	6	4	-2	0	0	0	2	2	0
Plaza																		
DMV[a]	43	33	-10	27	41	14	13	8	-3	12	11	-1	3	4	1	3	4	1
OGS[a]	43	40	-3	28	32	4	14	11	-5	9	11	2	6	4	-2	0	2	-1
DH	41	37	6	26	23	-3	16	16	0	11	18	7	5	4	-1	1	3	2
DPS	42	39	-3	34	35	1	10	5	-5	10	15	5	5	3	0	2	2	0
Percentage of entire survey	46	40	-6	27	33	5	14	13	-1	9	10	1	3	2	-1	1	2	1
Avg. test			-8			10			-1			-2			-2			0
Avg. control			-3			3.5			-2			3			0			1

[a]Test site.

agency employees (the one exception is the DH; here, the inclusion of an additional group, formerly located in an area where parking was less restricted and transit less available, is shown to have increased both the percentage of solo drivers and the percentage of transit users).

The increase that occurs in the control agencies represents the increase that would have occurred due to the energy crisis had no carpool program been in effect. The table below indicates the effect of the energy crisis on the incidence of carpooling:

Agency	Change in Driving with Another Employee (%)		
	Campus	Plaza	Overall
Test	12	9	10
Control	7	-2	3.5
Increase attributable to carpool coordinator project	5	11	6.5

The difference between the incidence of carpooling in the test agencies and the control agencies, as shown in the table, represents the true effect that the carpool coordinators were able to realize--an increase of 5 percent on the campus and 6.5 percent overall. In view of the initial high incidence of ridesharing, this is a substantial effect.

MARKET SEGMENT ANALYSIS

In an attempt to determine which factors influence ridesharing, a computerized data analysis scheme known as AID (7,8) was used on the 1978 survey data. This analysis showed that, in general, demographic data are poor predictors of ridesharing. Nevertheless, four market segments based on distance and travel time to work were identified. The incidence of ridesharing was greatest among those who travel over long distances (>10 miles) and slower routes (≥40 min) ("far slow"), and decreased among those who travel greater than 10 miles but take less than 40 min ("far fast"), those who travel between 3 and 10 miles ("medium"), and was least among those who commute 3 miles or less to work ("near"). This segmentation is useful in targeting the activities of the carpool coordinators as well as in interpreting the results of the attitudinal and cost/benefit analyses.

ATTITUDINAL ANALYSIS

In order to understand the underlying attitudes of carpoolers and solo drivers, the survey respondents were asked to describe their feeling toward 11 attributes of carpooling and driving alone: convenience, gasoline cost, travel time, safety, crowding, waiting for others, relaxing, parking costs, arriving for work on time, independence, and conversation during the commute to work. The employee indicated agreement with each statement on a five-position categorical judgment scale, where 1 means convenient and 5 means not convenient. For example, "Carpooling is ...", "Driving alone is ...".

The responses were divided into solo drivers and ridesharers and into test agencies and control agencies. An average score for each group was computed for each attribute. The 1979 response was then compared with that of 1978. In all instances the shift in attitude is small. The most consistent shift is found in the test agencies where the attitudes of the solo drivers and ridesharers toward the opposite mode have shifted to a more extreme value.

A second measure of attitude known as an overall carpool rating (CPRAT) was constructed for each respondent by summing the positive (i.e., 1 or 2) responses to each carpooling attribute. The average CPRAT was then calculated for each market segment for the test and the control agencies. Figure 1 displays the result in the change of the CPRAT with respect to the proportion of ridesharing. It is clear that the carpool coordinator activities have produced a positive shift in both attitude and the proportion of ridesharing. The similar slopes of these lines indicate that this effect has been uniform across all segments of the population. What is not clear is whether the change in attitude influenced an increase in carpooling behavior, vice versa, or both.

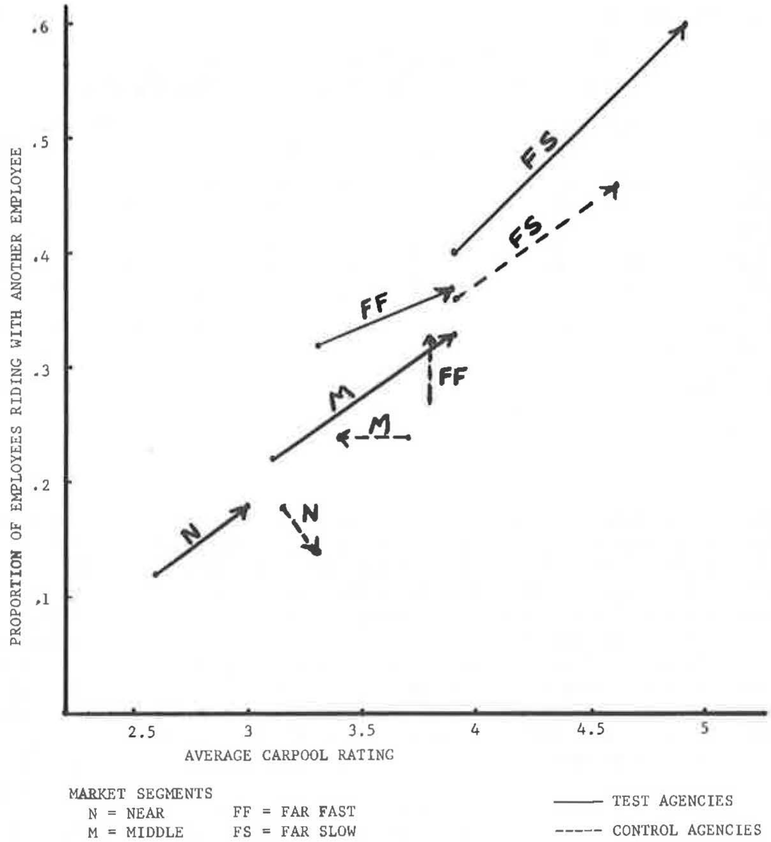
The inconsistent pattern in the control agencies contrasts with the effectiveness of the coordinators' action in the test agencies with the exception of the far fast segment. This again points out the need for additional research into this market segment to develop appropriate ridesharing strategies.

CARPOOL DROPOUTS

The 1979 survey asked the respondents to identify their usual modes to work in the fall of 1979 and in the fall of 1978. Tabulation of those who commuted to work in automobiles during both years indicates that the majority (86 percent) of employees did not change their modes of either ridesharing or solo driving. However, of those employees who switched, 60 percent converted from solo driving to ridesharing, but 40 percent reverted from ridesharing to solo driving.

Cross-tabulations of these four groups indicate that there is little correlation between socio-

Figure 1. Change in proportion of carpoolers versus carpool rating from 1978 to 1979 for each market segment.



economic variables and the decisions to join or leave carpooling. The key to carpooling longevity is found in attitudinal analysis.

When the attitude of each group toward carpooling is contrasted with the attitude toward driving alone, it becomes clear that the difference for the carpool dropout is more extreme than for even the confirmed solo driver. Although he or she recognizes the money savings aspect of carpooling, the carpool dropout is concerned about convenience, independence, crowding, and waiting for others. He or she puts less value on conversation during the work trip. Clearly, carpooling was an unpleasant experience.

COST/BENEFIT ANALYSIS

The cost of the demonstration project represents all salaries paid to DOT employees, including fringe benefits and overhead, additional costs for computer analysis, telephone installation, printing, supplies, and travel ($38 578) plus additional funds ($12 432) donated to the project by the test agencies through the services of the carpool coordinators and CETA employees. In total, the project cost $51 010. The nature of a research project, which will lead eventually to implementation, is such that costs include literature research and analytical analysis to investigate hypotheses that lead to improvements of the program. As such, they would not normally be repeated if others chose to undertake the service. When these costs are subtracted from the program, which will leave salary costs for supervision and carpool coordinators, telephone, supplies, and tabulation of the preliminary and final surveys, the direct operational non-research-and-development cost of the study is $26 092.

The benefits of the carpool coordinator project can be measured directly by the benefits to the employees in the gallons of gasoline saved and the resultant dollar savings. Although many additional benefits result to the employee, employer, and the community, such as improvement in traffic flow, freeing up of parking spaces, and improvement in air quality, our survey did not address these issues. To determine the employee benefits, the average distance to work for the test agency employee who drives to work with another employee was calculated by market segments.

The direct operational costs of the program (total costs - research and development cost = $26 092) were distributed across the market segment proportionally to the distribution of the 1978 employment population, as displayed in Table 2. The gasoline savings (computed by using a midsummer 1979 cost of $1.00/gal of gasoline in the Albany area) were then reduced to 65 percent (6.5/10), the amount previously calculated as the direct effect of the carpool coordinator. Overall, within the test agencies the program resulted in a benefit/cost ratio of 3.9; the far slow market segment showed an extremely high payoff of 9.9.

The results of this analysis indicate that, even with the existence of a high degree of carpooling at an employee site, the investment of a vigorous ridesharing promotion campaign can result in savings for employees that are significantly greater than the costs of the program. Furthermore, when the attention of the coordinator is initially directed to those employees who have the greatest commuting distances and times, the program can return the investment rapidly.

CONCLUSIONS AND POLICY IMPLICATIONS

This study presents an evaluation of the carpool

Table 2. Cost/benefit of carpool coordinator demonstration by market segments.

Market Segment	1978 Population of Test Agencies	Direct Cost[a] ($)	Avg One-Way Trip[b] (miles)	New Carpoolers	Gasoline Savings per New Carpooler[c] (gal)	Total Savings ($)	Savings Attributable to Carpool Coordinator[d] ($)	Benefit/Cost at 1.00/gal
Near	707	4 383	2.3	50	40	2 000	1 300	0.30
Middle	1470	9 112	7.8	167	136	22 712	14 763	1.6
Far fast	1075	6 664	17.1	118	298	35 164	22 857	3.4
Far slow	957	5 933	32.4	160	566	90 560	58 864	9.9
Total	4209	26 092	18.0	495	314	155 430	101 030	3.9

[a] Direct costs are distributed proportional to population.
[b] Average one-way-trip distance for employees who drive with another employee.
[c] Assumes 14.5 miles/gal, 220 days/year, 2 trips/day, 10 percent excess circuity, factor to account for shared driving is (2.75 - 1)/2.75 = 64.
[d] Amount is 65 percent of savings.

coordination project undertaken in six state agencies located in the Albany, New York, area. The study was undertaken under contract to the SEO and was evaluated to determine the effect of carpool coordinator activities on the incidence of ridesharing in a white-collar working environment and the resulting energy saving that can be attributed to such a project.

A quasi-experimental study design was developed by using three state agencies as test sites and three state agencies as control groups. Random sample surveys taken at the beginning and end of the project indicate that the incidence of ridesharing directly attributable to the carpool coordinators is 6.5 percent. The study concluded that a trained carpool coordinator, working actively within an employment site and using manual and personalized methods, can increase the incidence of carpooling significantly, even though the level of ridesharing was comparatively high at the beginning of the project.

Energy savings can be substantial. Approximately 195 000 gal of gasoline were saved by the increase in ridesharing in all agencies. Overall, each new carpooler attracted to the program can be expected to save an average of 283 gal of gasoline/year.

Cost-Effectiveness

The carpool coordinator method is extremely cost effective. The direct cost of the project within three agencies was $26 092; the overall cost/benefit ratio was 3.9. Relative savings to employees are greatest among those in the market segment that commutes more than 10 miles and 40 min. Since benefits to employees can approach project costs rapidly among employees who have the greatest vehicle miles of travel, carpool coordinators are urged to concentrate initially on this market.

Interpretation of the shifts in attitudes of solo drivers and carpoolers in both test and control agencies demonstrate that the coordinator activities resulted in a positive shift in attitude as well as ridesharing in the test agencies. Although previous research suggests that ridesharing behavior is both influenced by and influences attitude, the extent to which this is true remains to be tested. Such an evaluation can serve to refine carpool coordinator techniques, company policies toward ridesharing, and marketing strategies by government to promote ridesharing programs among employers within its jurisdiction.

Policy Implications

The following policy implications can be immediately drawn from this study:

1. Since ridesharing is basically a social phenomenon, appeals based on pure economics are not likely to be successful. Government should emphasize that noncomputer informal approaches are more sensitive to personal concerns and more effective than mechanistic privacy-invading techniques.
2. Money for the carpool project is not really necessary: What is needed is a strong commitment by employers to provide the service to their employees. Federal programs that emphasize the capital needs of ridesharing (e.g., park-and-ride lots) have their place but should not be pushed ahead of noncapital approaches.
3. The inability of ridesharing agencies to isolate the effectiveness of their programs has probably hurt the course of ridesharing by providing unrealistic goals that cannot be achieved. More care should be taken in program design such that various impacts can be isolated.
4. For greater cost-effectiveness, ridesharing programs should probably not be based on areawide campaigns but rather should focus on selected markets characterized by long commutes to major work sites.
5. Research into the social and psychological aspects of carpool formation and retention should be continued. Although much is known, much more can be learned from such research, particularly if coupled with carefully constructed demonstrations.

Although the carpool coordinator project has proved successful in its initial stages, three immediate effects remain to be tested. The project was undertaken during a period of rapid gasoline price increases and intermittent restriction of supply. These facts served to highlight the efforts of the coordinators. The project is being continued to determine the stability of the carpooling behavior of these new carpoolers. Can the program sustain its effectiveness and rate of growth through continued awareness and promotion and more-effective techniques? The program remains to be tested in other business environments under various combinations of white- and blue-collar workers.

Finally, since carpooling has been shown to be a psychosocial phenomenon rather than an economic one and long-term ridesharing behavior is formed most successfully among friends and acquaintances, the carpool coordinator concept should be tested at the residential level. Coordinator techniques must be developed and refined for this market. Evaluation designs must include tests to control for external economic and political forces as well as to contrast with existing employer-based carpooling programs. These efforts are now on-going and will be reported on in the future.

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Abridgment

Texas Vanpool Program

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The U.S. Department of Energy's annual report on state energy conservation programs for 1979 cites the Texas vanpool program as one of the most innovative programs in the nation. This report ranked Texas first nationwide in the number of official programs in existence (54) and first in the number of vans on the road (910). Between January 1978 and January 1981, the number of vans on the road increased by more than 900 percent. Vanpooling continues to grow in Texas, but not at the furious pace of 1000/year set during the last half of 1979. According to the January 1981 edition of the Texas vanpool census, there are 2008 vans on the road (with 34 more on order) at 122 sites as part of 103 individual programs. These 2008 vans carry 22 100 passengers, eliminate 16 000 cars from the road, and save 8.12 million gal of fuel each year. These vans represent an investment of $20 million in private capital. This paper attempts to explain how and why the Texas vanpool program grew from 14 vans in 1974 to the present totals.

The Texas vanpool program is best defined as a cooperative effort involving the Texas Energy and Natural Resources Advisory Council (TENRAC) and the Texas Transportation Institute (TTI), about 100 vanpool program coordinators (almost all in the private sector), and various other state agencies. The roles of TENRAC and TTI have been to provide a focal point for technical assistance and information exchange and to persuade other organizations to initiate programs. The Texas Railroad Commission, Department of Public Safety, Department of Highways and Public Transportation, and State Board of Insurance all support the program.

The key to the success of the program, however, has been the willingness of farsighted employers to accept that they have a stake in how their employees get to work. These employers established programs at their own facilities, and many of the early vanpoolers have played a significant role in promoting the vanpool concept. Under the leadership of the Houston National Association of Vanpool Operators (NAVPO), Houston is now the "vanpool capital of the world" and has 1511 vans at 60 sites.

The basic strategy of the program has been to create a vanpooling community that embraces all active participants without creating a vanpooling bureaucracy to get in the way. The idea is to enlist as many salespersons as possible to market vanpooling at every opportunity--not to set up a tsar of vanpooling to market a specific house brand.

The remainder of this paper describes how the Texas vanpool community emerged and gained the position of prominence it now enjoys. Included is a short review of the history of Texas vanpooling (1974-1977), the recent period of rapid growth (1978-1980), and a description of how we attempt to coordinate a statewide effort.

BEGINNINGS: 1974-1977

Contrary to some published reports, the first Texas vanpool program was implemented in Dallas, not Houston. Texas Instruments initiated their first program with 9 vans in March 1974 at their main facility. By the end of 1977, this program had grown to 14 vans. The next program in Dallas was a one-van pilot program initiated by Crum and Forester Insurance Company in 1977.

Although Dallas had Texas' first program, the focus of vanpooling quickly moved from Dallas to Houston. The primary reason for this shift was the missionary zeal with which CONOCO promoted the concept in Houston. CONOCO put 10 vans on the road in 1975 and has steadily added to that number. Following CONOCO's example, other companies in Houston began their own programs. Soon, 10 programs that had 160 vans were operating in the city. In addition to CONOCO, this early group consisted of ARAMCO, ARMCO, Brown and Root, Comet-Rice, Gulf Oil, Hughes Tool, Mitchell Energy, Mobil Oil, and Prudential Insurance. [Brown and Root, one of the early programs expanded to 265 vans by 1980, the largest program in the state (1).] This early group of dedicated vanpoolers formed the first local chapter of NAVPO in 1979.

Two other significant programs began during this period. United Services Automobile Association (USAA) in San Antonio initiated a pilot program late in 1978 with 6 vans. In spite of a four-day workweek and the use of 15-passenger vans, this program grew rapidly to become one of the largest in the state. The Mason and Hanger, Silas Mason Company, Inc., program at the PANTEX plant outside of Amarillo started in 1977 with 30 vans. This is the largest and most successful owner-operator program in the state and remains the only significant program at a federal agency. In addition to the vans that operate in Houston, CONOCO and Gulf began operating six vans to and from remote sites.

During this early period, numerous promotional efforts were sponsored by various government agencies. A national conference on areawide carpooling was held in Houston in 1975. The Federal Energy Administration (FEA) conducted a series of vanpool workshops in Houston, San Antonio, Dallas, Fort Worth, Beaumont, Corpus Christi, and Lubbock in 1977. The U.S. Environmental Protection Agency (EPA) sponsored three workshops in Houston, Dallas, and San Antonio early in 1978. It is difficult to assess the effect of this effort, but at least two of the major programs (USAA and PANTAX) began as a result of the FEA workshop series.

During this period, no attempt was made to alter the regulatory climate of the state to make it more favorable for the growth of vanpooling. Although the current situation was far from ideal, employers found that, as long as their programs were not open to the public-at-large and as long as they operated on a share-the-expense basis, they could operate within the existing regulations. In exploring the possibility of creating legislation more favorable to vanpools, we were advised more than once to "leave well enough alone." In retrospect, we are still convinced it was good advice.

By the end of this early period the commitment to vanpooling varied considerably in different parts of the state. The greatest public awareness was in Houston, where the early vanpoolers actively promoted the concept. Otherwise, most of the interest in vanpooling at this time was along the Interstate 35 corridor between San Antonio and Dallas.

In summary, by the end of 1977 the vanpooling concept was well established. A total of 15 vanpool-related workshops had been held. Fourteen programs were under way, and 196 vans were on the road. The Houston vanpool group actively promoted the concept to all who would listen. In short, significant progress had been made toward establishing a base from which to build a strong statewide effort.

RAPID GROWTH: 1978-1980

Late in 1977 the Governor's Office of Energy Resources (which became a part of TENRAC in 1979) received a grant from the U.S. Department of Energy (DOE) to promote vanpooling as one of the mandatory programs in the state energy conservation plan (SECP). The Governor's Office of Energy Resources entered into an interagency agreement for technical assistance with TTI in January 1978, and the Texas vanpool program got under way. To date, the combined effort has cost less than $250 000.

The ridesharing goal in the SECP was set at 1500 vans on the road by the end of 1980, with an increase of 0.2 percent in carpooling (2). In addition, vanpooling is one of three specific actions cited by the governor to meet interim voluntary gasoline conservation targets released quarterly by DOE. Although TENRAC is not a part of the state's traditional transportation establishment, the governor looks to TENRAC to provide the focal point for vanpooling because of its importance in meeting energy conservation goals.

The original SECP called for a rather specific promotional process to be carried out by TENRAC. The steps, which were to be carried out in chronological order, were as follows:

1. Conduct 24 (series 1) workshops and meetings with the 24 metropolitan planning organizations (MPOs) in the state and establish a local plan to promote ridesharing,
2. Cohost with the MPOs 24 (series 2) workshops for the major employers in each urban area to persuade them to initiate vanpool programs, and
3. Conduct at least 24 (series 3) followup meetings with employers who attended the workshops and expressed an interest in gaining more information.

The first eight months of 1978 were spent in developing materials, attempting to set up series 1 workshops, and in meeting with local ridesharing agencies and existing vanpool program coordinators. The reaction of vanpool coordinators was favorable but guarded. The reaction of ridesharing agencies and the State Department of Highways and Public Transportation ranged from mild interest to outright hostility. The San Antonio Energy Conservation Office was the only experienced ridesharing agency that actually cohosted a workshop. With few exceptions, the MPOs were generally convinced that employers in their area would not be interested in vanpooling and that a workshop would be a waste of time.

These early experiences suggested that we had misread the situation. It became clear that the process as outlined in the SECP was unworkable for several reasons:

1. Local ridesharing agencies seemed afraid that we might upset the local operation and impose statewide policies,
2. Ridesharing was not very high on the priority list of the transportation establishment,
3. A number of MPOs had experienced disappointing results in their 1973 venture into ridesharing and were not eager to try again, and
4. The level of awareness of vanpooling in the state varied widely from one area to another; therefore, different strategies had to be developed for different areas.

We began to realize that working through customary channels was not the best procedure when we learned that the employers whom we contacted on our own initiative were more receptive than the transportation agencies that were supposed to be leading the local effort. Based on experience, we decided to veer away from the original SECP. With approval from the regional DOE office, we laid out a new strategy that called for the following steps:

1. Visit chambers of commerce to obtain lists of employers that might be receptive to vanpooling;
2. Use the lists provided by chambers of commerce to telephone interested employers to set up on-site visits (series 3) to sell vanpooling; the approach would emphasize financial incentives for employers instead of energy conservation (3); and
3. Hold large meetings (series 2) on request.

A new slide show and hand-out materials emphasizing financial rewards were developed for this new approach. After establishing an informal goal of 60 employer visits, we got under way with the new strategy in November 1978. With the help of the Austin and Dallas Chambers of Commerce, the San Antonio Energy Office, and the State Department of Highways and Public Transportation, a total of 80 workshops and meetings had been held by the fall of 1979.

During the summer 1979, a period of fuel shortages for many Texans, interest in vanpooling accelerated greatly. Vanpooling was seen by some as a way of avoiding the long gasoline lines or a way of being assured of a ride to work in times of very tight supplies. TENRAC assisted companies that had their own fuel storage tanks in obtaining gasoline for their vanpools.

By the end of 1979, the situation had changed: there was no shortage of fuel, prices were rising steadily but slowly, and growth began to slow. However, more than 95 employer programs were already in existence and inertia carried the program forward. San Antonio and Dallas were actively marketing vanpooling. A concentrated effort by the city ridesharing office in Dallas resulted in the initiation of 30 new programs in late 1979 and early 1980. By comparison, growth in Houston slowed because the existing programs were reaching maturity and the newer programs were still small.

In summary, the period of most-rapid growth occurred during summer and fall 1979. It occurred in locations where fuel was scarcest and most expensive. Growth occurred because a large number of small pilot projects were already under way and because vanpool material was in the hands of receptive employers before the crisis occurred. In other words, the mechanism was in place before the crisis occurred.

STATEWIDE COORDINATION

In 1978 no other state agency was interested in promoting vanpooling, and TENRAC fell heir to the leadership of the statewide vanpool program by default. TENRAC's main problem was how best to conduct the program. There are two basic approaches to conducting such a program. The safe option is to play a numbers game and simply conduct the required workshops and meetings according to plan. The more risky option is to attack targets of opportunity and concentrate on them until the vans are on the road, regardless of workshop goals. Our basic approach turned out to be a combination of these two options (we also hit both targets--1500 vans and the required 72 workshops). The significant deviation from the original plan was that we attacked the targets of opportunity and paid little attention to the sequence of workshops. On-site meetings with employers were often held before meetings with (or without) the local MPO. The lack of competition from other state agencies allowed us to structure the program without regard to who got credit for each program and grant.

The next issue was how to coordinate a statewide program that had no real authority or responsibility to do so--our grant from DOE specified the conduct of a series of workshops but not the coordination of a statewide program. We have not forced the issue on this problem and do not, in any event, wish to see the creation of a vanpool hierarchy. We use three indirect techniques that provide the ridesharing effort with a sense of direction:

1. The vanpool census serves as a vehicle to communicate with the entire vanpool community at least four times a year;
2. The fuel-allocation office, which is housed in TENRAC, is sensitive to the gasoline needs of the vanpool programs and assists them as much as possible; and
3. The state ridesharing committee, which was finally established (on an unofficial basis) in July 1980, tackles regulatory and legal problems faced by the vanpool community.

The final problem is, How do two part-timers conduct a statewide promotional effort? (We work for the project on a half-time basis, aided by two half-time administrative assistants and graduate research assistants as available.) The answer is: You train as many vanpool salespersons as you can, provide them with some incentive to sell, and give all the technical and moral support you can. We have also tried to see that the sales force received the bulk of the publicity and credit for their efforts.

The first group of salespeople we assisted in this way were staff from the existing ridesharing projects in Houston, Dallas, Fort Worth, and San Antonio. San Antonio was the first to market vanpooling; however, their market is primarily public agencies, and results are hard to achieve. Dallas Rideshare, in cooperation with the Dallas Chamber of Commerce, began to market vanpooling, in addition to their carpool effort, in July 1979. The results during the following year were outstanding--25 new programs. Houston and Fort Worth have been kept busy handling the many responses to their outstanding carpool efforts. In addition, Houston has assisted in initiating third-party operations at Greenway Plaza and the City Post Oak Center.

In the spring 1979, TENRAC and the State Department of Highways and Public Transportation developed a good working relationship to promote vanpooling. (This was all accomplished at the working level through long-time professional relationships.) The State Department of Highways and Public Transportation district offices have arranged and cohosted 12 workshops and meetings in their respective areas. This effort has netted six possible new programs in areas of the state not usually on the workshop circuit (i.e., the small towns). We consider this a very important effort because of the potential for breaking the one-car-one-passenger syndrome in the rural areas.

Another very important source of contacts is the network of equipment providers: primary manufacturers, van conversion firms, fleet managers, and leasing companies. Their motivation, of course, is to sell or lease vans. We feel that it is necessary to educate this group so that they do not oversell vanpooling or distribute misinformation. These people generally know the large employers on a business basis, and they are skilled salespeople; therefore, they should not be overlooked.

Probably the most effective force for the expansion of vanpooling has been the vanpool coordinators themselves. Many of these people have very unselfishly shared their experiences with others in starting programs or considering doing so. The Houston chapter of NAVPO has been an especially effective advocate. In order to avoid duplicating their efforts, we have not pursued opportunities that have occurred in Houston as aggressively as we might have.

CONCLUSIONS

The result of this effort over a two-year period has been the development of a large number (90 percent of the vans) of employer vanpools. Employers have come to realize that they have a stake in how their employees get to work. Although this is expressed differently by various employers, the principal concerns are expansion and protection of the labor market, reduction of parking costs, and public relations. The employer's enlightened self-interest, which is evidenced by those concerns, is the key to the success of vanpooling in Texas. This is the main reason the period of rapid growth occurred during the past two years.

If the employer is appealed to on the basis of this self-interest and reasonable tax shelters are provided for the purchase of vans, employers will put the vans on the road. The point to remember is that people will not put vans on the road merely to capture the tax break (or to reduce pollution or to save energy); they must have a stronger reason, such as saving money. The tax breaks only make the program more attractive by reducing the fares to the riders to a reasonable $30-45/month for an average 50-mile daily trip.

Our experience in Texas makes clear that a tsar of vanpooling is not a requirement for a successful statewide program. The key is to build a vanpool (or ridesharing) community and guide its development. Otherwise, there is a real danger that the tzar will market his or her own brand of vanpooling to the exclusion of others and, by doing so, will miss major targets of opportunity.

When the vanpool community in Texas consisted of 15-30 employers, four regional coordinators, Houston NAVPO, and TENRAC, coordination was easy. Now, however, TENRAC must coordinate 105 employers as well as newly interested state agencies. The danger is that too much time will be required in the coordination effort, and too little time left for contacting employers and assisting with technical problems.

Finally, the job of putting vanpools on the road is a selling job that requires an adequate budget (say, 20 percent of the total cost) for travel, conference expenses, and materials. The vanpool promoter must know the territory, know how to interest prospects in the product, and be available to answer questions and give assistance after the sale.

ACKNOWLEDGMENT

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Multiemployer Ridesharing Brokerage: Findings from Minneapolis Commuter Services Demonstration

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This paper presents findings from the evaluation of the Minneapolis ridesharing commuter services demonstration, a prototype transportation brokerage program designed to arrange alternatives to driving alone for commuters. The program promoted and coordinated services for carpooling, vanpooling, and bus commuting at selected employment sites in the Minneapolis-St. Paul area. A unique aspect of this demonstration was its focus on multiemployer work sites in nondowntown locations. The demonstration showed that these sites represent a potentially important market for ridesharing; however, program success can be dependent on a variety of critical site characteristics. A number of new program features were also tested, including a variety of marketing strategies, a telephone brokerage technique to assist carpool applicants, and the use of a private, third-party contractor for vanpool services. Findings from this demonstration can serve as a reference for other interested agencies to aid in indicating the type and range of issues they may confront in establishing a ridesharing program.

The Minneapolis ridesharing commuter services demonstration, popularly known as the Share-A-Ride program, was a prototype transportation brokerage program designed to arrange alternatives to driving alone for commuters. It coordinated services for carpooling, vanpooling, and bus commuting to workers at selected employment sites in the Minneapolis-St. Paul area. Initiated by the Metropolitan Transit Commission (MTC) in 1977, the project was part of the Urban Mass Transportation Administration's (UMTA) Service and Methods Demonstration (SMD) program. The Share-A-Ride program has been designed to be a permanent, ongoing program, characterized by

1. Intensive marketing efforts aimed at employers and employees at selected sites;
2. Matching services for carpool, vanpool, and bus information applicants;
3. Follow-up assistance with carpool and vanpool formation; and
4. Administration of a fleet of leased vans.

The primary purpose of the program was to increase work-trip vehicle occupancy.

Key elements of this demonstration that differentiate it from previous ridesharing promotion efforts are the following:

1. Simultaneous promotion of a wide range of ridesharing services, including carpools, vanpools, and buses;
2. Focus on multiemployer, nondowntown sites as the market for the program;
3. Reliance on intensive, small group employee presentation meetings for program marketing;
4. Use of telephone brokerage as a personal follow-up for all matched carpool applicants;
5. Sponsorship by a regional transit agency that also serves as the program coordinator and broker of carpools;
6. Use of a private, nonprofit organization for program design, implementation, and marketing activities; and
7. Use of a private, third-party vanpool provider to operate the multiemployer vanpool program.

The demonstration, which ended in 1979, involved 11 multiemployer sites outside the central business districts of Minneapolis and St. Paul, each with from 3700 to 14 000 employees (see Table 1). The Share-A-Ride program has since expanded to downtown St. Paul and additional sites throughout the metropolitan area.

The SMD evaluation report on the Minneapolis Share-A-Ride program discusses a wide variety of topics, including travel behavior characteristics, perceptions of ridesharing, program costs, and organizational issues (1). This paper focuses on three issues related to aspects of program operations and delivery of services that differentiate the Minneapolis program from that of other ridesharing programs: (a) the feasibility of marketing ridesharing to multiemployer, nondowntown sites; (b) the design of a telephone brokerage technique to assist with carpool formation; and (c) the delivery of vanpool services by a third-party provider.

OVERVIEW OF KEY PROGRAM FEATURES

A unique aspect of this demonstration has been its focus on multiemployer work sites in nondowntown locations. This is in contrast to previous public ridesharing programs that have concentrated on large employers and central city areas. The multiemployer orientation of the program is important in overcoming the problem that only a limited number of large firms have sufficient scale for effective rideshare matching. The extent to which employees of small- and medium-sized firms can be successfully incorporated into a ridesharing program is a major issue addressed in the demonstration. Although the focus on multiemployer sites has the advantage of increasing the size of the potential poolable population, it also raises the problems of conflicting shifts, varying overtime requirements, and intrasite pickup and dropoff distances. Marketing the ridesharing service is operationally much more difficult in a highly fragmented multiemployer context.

The focus on nondowntown locations is important because nondowntown work sites are generally less conducive to ridesharing than downtown work sites, yet they account for a large (and growing) proportion of employment in many metropolitan areas. The Twin Cities area is typical of many urban areas in the United States in which the majority of the employment is widely dispersed throughout the metropolitan area outside of downtown. Only 17 percent of the 800 000 jobs in the Twin Cities are in the downtowns of Minneapolis and St. Paul; 50 percent are in the suburbs and the remainder are located in the central cities outside the downtowns. This dispersed employment pattern cannot be cost effectively or easily served by the traditional set of transit routes that radiate from employment centers. With few (if any) centers comparable in size to the downtowns, many routes cannot be operated with full buses to serve the wide array of working hours. Thus, nondowntown work locations frequently have a low level of transit service. In addition, suburban work sites are typically characterized by a variety of conditions favorable to solo driving: plentiful free parking, proximity to major freeways, and little traffic congestion.

The site-based marketing strategy was characterized by an intensive effort that initially involved attempts to contact all employers personally and arrange small group presentations for all employees. The presentations were 30-40 min meetings held during work hours and involved a speaker, a slide-and-tape show, and a question-and-answer period. The typical audience was 30-50 persons, although audiences occasionally were as small as 2 or as large as 500. Most of the participating firms had multiple presentation meetings; one firm had 46 meetings. Other marketing approaches, used when employee presentations were not possible, included employee surveys with attached applications and a variety of passive marketing strategies, including information booths, posters, newsletters, and brochures.

Telephone brokerage was designed to encourage and assist matched carpool applicants to make contact with other persons on their match list. This was the first program to use this technique as a response to the problem (faced by other ridesharing programs as well) that relatively few persons ever follow through to form carpools after they receive a match list of potential carpoolers. Initially, lunch-time carpool formation meetings were employed as the principal technique for organizing carpools among matched individuals. These meetings were characterized by high staff costs and low turnouts

Table 1. Summary of site characteristics.

Site	Total Employment	Number of Firms by Employment Size: >1000	100-1000	<100	Type of Activity
Pentagon Park	7 572	1	10	291	Manufacturing, office park
South Central Minneapolis	8 677	3	7	6	Hospital, sales, office
Central Bloomington	4 463	0	12	138	Manufacturing, warehouse
East Bloomington	5 869	1	6	14[a]	Sales, office
Arden Hills	4 900	2	2	1	Manufacturing
Northeast Minneapolis	14 027	3	20	45	Manufacturing, warehouse
Golden Valley	5 816	2	5	5	Manufacturing offices
Eagan	4 858	2	3	6	Office
Plymouth	5 685	1	11	58	Warehouse, office park
St. Louis Park	3 729	1	2	60	Manufacturing, office park
Fort Snelling	4 289	1	4	14	Government offices
Total	69 885	17	82	638	

[a]In addition, approximately 200 small firms in the adjacent Metro Office Park were invited to participate.

Table 2. Applications, carpoolers placed, and current vanpools by site.

	Total Applications			
Site	No.	As Percentage of Total Employment	Verified New Carpoolers	Total Vanpoolers
Pentagon Park	2 497	33	287	26
South Central Minneapolis	1 717	20	175	63
Central Bloomington	434	10	64	0
East Bloomington	1 477	26	196	44
Arden Hills	911	19	70	22
Northeast Minneapolis	1 780	13	137	102
Golden Valley	1 083	19	69	47
Eagan	1 473	30	-[a]	46
Plymouth	1 389	24	129	42
St. Louis Park	1 521	41	70	0
Fort Snelling	1 134	26	37	0
Off site	-[a]	NA	NA	281
Total	16 530	24	1234	673

[a]Not available.

Table 3. Employee restrictions by mode.

	Pentagon Park (%)			Northeast Mineapolis (%)			
Employee Restrictions	Drive Alone	Carpool	Bus	Drive Alone	Carpool	Bus	Vanpoolers (%)
Overtime							
Less than 1 day/week	41.5	58.8	70.0	52.2	76.8	63.3	85.9
1-2 days/week	28.5	21.6	20.0	22.9	9.1	30.6	11.6
3 or more days/week	30.0	19.6	10.0	24.9	15.2	6.1	2.5
Need for a car							
Less than 1 day/week	59.0	80.4	88.0	71.1	75.8	91.8	85.5
1-2 days/week	15.5	10.8	6.0	13.9	15.2	8.2	13.7
3 or more days/week	25.5	8.8	6.0	14.9	9.1	0.0	0.8
Rotating shift							
Yes	8.5	4.5	0.0	11.9	2.0	4.1	0.8
No	91.5	95.1	100.0	88.1	98.0	95.9	99.2
Overtime or need car							
Less than 1 day/week	30.5	49.0	66.0	39.8	62.6	61.2	76.3
1-2 days/week	24.0	24.5	22.0	23.9	18.2	32.7	20.3
3 or more days/week	45.5	26.5	12.0	36.3	19.2	6.1	3.3

and were replaced by the telephone brokerage technique early in the program. In addition to its function as a marketing tool that encourages and assists carpool formation among matched applicants, telephone brokerage also served as a data collection technique for measuring carpool formation and updating application information.

When initiated in 1977, the organizational and operational structure of the Share-A-Ride vanpool program differed from that of most other vanpool programs in operation across the country because it was managed by a private third-party provider rather than by an employer or a public agency. Also, the vans were neither leased nor sold to the vanpool drivers nor were they purchased by the vanpool agency. Rather, the vehicles were leased by the vanpool provider and supplied directly to vanpool groups in exchange for passenger fares.

This paper describes program results for the first two years of program operation, ending in October 1979. During that period, 16 530 applications that expressed carpool, vanpool, or bus interest had been received from an employment base of 70 000 at 11 sites. A total of 1234 former drive-alone applicants became verified carpoolers as a result of the Share-A-Ride program. There were 62 Share-A-Ride vanpools in operation, including 26 based outside of the multiemployer demonstration sites (see Table 2). A total of 903 persons participated in vanpools, including 344 from off-site vanpools. (As of April 30, 1980, the program continued to process applications from the 11 sites and added downtown St. Paul as a 12th site. The number of drive-alone applicants that became verified carpoolers increased to 2269, and 104 vanpools were operating.)

MARKET FOR MULTIEMPLOYER RIDESHARING

The Share-A-Ride experience has demonstrated that multiemployer sites do represent a significant market for ridesharing, but a difficult and expensive one to organize. The limited communication between smaller firms poses a major challenge to the effective penetration of this market, and efforts to obtain permission from each individual employer to solicit applications from their employees are costly. Varying work hours and other work-related constraints are additional barriers to multiemployer ridesharing. Work-related constraints consistently emerge as important factors in limiting the extent of multiemployer pooling (and pooling within some large single firms) at all 11 employment sites. A multiplicity of different working times, overtime, part-time employment, and employees who need their cars during work hours often reduces the potential for carpooling and vanpooling more than initially anticipated. These work-related conditions are typical of many multiemployer sites and were found to occur more frequently at retail stores, hospitals, warehouses, and sales and service firms than at manufacturing facilities and offices. Surveys conducted at three of the sites indicated that more than half of the employees either worked overtime or required the use of a car for work at least once a week. Although these conditions did not preclude ridesharing, they did consistently reduce the likelihood of ridesharing (see Table 3). The extent of dispersed working hours is illustrated by the fact that the largest work shift at any of the surveyed sites (with 30-min intervals each for start and end times) accounted for just 31 percent of the employment at that site. Restrictive work conditions,

Table 4. Role of largest employers at each site.

Site	Large Employer	No. of Employees at Large Employer	Total Site Employment at Large Employer (%)	Total Site Applications from Large Employer (%)
Pentagon Park	Magnetic Peripherals branch of Control Data Corporation	2500	33	79[a]
South Central Minneapolis	Honeywell	2000	23	80[a]
Central Bloomington	Donaldson Warehouse	600	13	39
East Bloomington	Control Data Corporation	3467	59	71
Arden Hills	Control Data Corporation	2200	45	55
	Honeywell	1600	33	33
Northeast Minneapolis	Honeywell	2500	18	24
	Univac	4200	30	45
Golden Valley	Honeywell	3100	53	64
Eagan	Univac	3000	62	81
	Blue Cross-Blue Shield	1150	23	28
Plymouth	Litton	1200	21	18
	Control Data Corporation	820	14	25
St. Louis Park	Honeywell	2000	54	68
Fort Snelling	Veterans Administration Center	1236	28	NA

[a]Increased by new-hire marketing at Magnetic Peripherals in Pentagon Park and resurvey at Honeywell in South Central Minneapolis.

widely varying working hours, and the geographic dispersion of residences are major reasons why no subscription bus groups were formed and only a small number of vanpool groups were formed at any given site.

In an assessment of the importance of work-related constraints to ridesharing, the characteristics of existing commuting conditions and the perceived need for ridesharing services must be taken into account. The Share-A-Ride staff conducted discussions with employers about changes in employee schedules to facilitate or encourage ridesharing. Many employers were not receptive to the idea, but we thought that they would have been more willing to consider changes in work shifts if commuting conditions had been less favorable for driving alone. In addition, employee surveys indicated that some persons who had rotating shifts, occasional overtime, or the need for a car at work did nevertheless commute by carpool or bus, but most commuters preferred the convenience and flexibility of driving alone over the cost savings they recognized from ridesharing. Future changes in fuel prices and availability could shift these values and encourage more commuters to work out ridesharing arrangements that overcome the current work-related constraints. A variety of backup services such as taxi vouchers or employer-provided loaner cars might also help overcome some of these work-related barriers to ridesharing, although this concept was not tested in the Minneapolis program.

Short commute distances were another factor that particularly limited the potential for vanpooling. Although the median home-to-work distance for vanpoolers was 23 miles, less than 12 percent of the employers at the survey sites had commute distances in excess of 20 miles.

From the marketing experience at the initial two sites, it became clear that small firms (i.e., under 100 employees) seldom cooperated with the ridesharing promotion and were the source of very few applications. Managers of small firms (particularly those that had less than 25 employees) were often not office-bound and were difficult to reach, and they were usually reluctant to allow company time (or resources) for presentations or literature distribution. To some extent, this occurred because small firms were typically sales or service businesses, and many of their employees were office-bound or did not work regular shifts.

On a more fundamental basis, many of the program's selling points to employers (e.g., reduction in parking congestion, improved labor force access, employee relations and productivity, and community image) are not relevant for small firms. For almost all of these small firms, employee commuting was not considered an urgent concern, and there was no perceived need to reduce employee parking requirements. Program participation would have little impact on employee relations (since they know all of their employees on a first-name basis), and small firms are seldom concerned with enhancing their community image.

In response to the difficulties of effectively reaching employees of small firms, marketing efforts in the second year were redirected to concentrate employee presentations and surveys on firms that have 100 or more employees; only passive marketing (brochure distribution) was used for the smaller firms. This streamlining of the marketing effort substantially shortened the time (and cost) required for marketing to each new site. As a result, the Share-A-Ride program was able to expand from 3 to 11 sites in the second year, generate more than twice as many applications, and place twice as many persons into carpools and vanpools as in the first 12 months. This accelerated program expansion was achieved with no budget increase over the program's first year's budget. It was only made possible by limiting the effort to reach smaller firms.

Very large firms (i.e., those that have more than 1000 employees) played a crucial role in the success of the ridesharing program. One or two major employers accounted for the majority of the ridesharing applications at most of the sites, regardless of the level of marketing effort aimed at smaller firms (see Table 4). A large proportion of the carpools had all members working at a single firm, despite the multiemployer nature of the matching service (see table below). Similarly, nearly half of the vanpools at the multiemployer demonstration sites were single-employer pools.

	Carpoolers in Employee Follow-Up Survey (%)	
Carpool Composition	Pentagon Park	Northeast Minneapolis
Family members only	36.0	32.4
Includes nonfamily members, but all from same employer	48.3	62.6
Includes nonfamily members who work at a different employer, but all at the same work site	10.8	5.0
Includes nonfamily members who work at a different work site	4.9	0.0

These findings do not undermine the value of multiemployer matching, but rather, they indicate the importance of large anchor firms at the employment sites and the challenge for marketing to smaller firms.

Another finding from the experience at 11 sites is that the size and geographic definition of site boundaries can also affect the extent of multiemployer pooling. Inaccessibility among firms within a site emerged as a major factor to discourage the formation or continuation of multiemployer carpools and vanpools at some of the sites. Distances of more than one mile between firms or the existence of railroad tracks, expressways, other physical barriers, or a nondirect road network all may isolate some firms from others and make circuity for dropping off and picking up riders an additional problem for multiemployer pools. Thus, a successful multiemployer site must encompass a well-defined and reasonably compact area while still including a sufficient number of employees who are potentially eligible for rideshare matching. The minimum employment base for a successful site appeared to be around 4000 persons.

The variation in program success among various sites indicates several lessons for identifying the most-appropriate multiemployer sites for a ridesharing program:

1. The successful multiemployer site had more than 4000 total employees among firms with 100 or more employees each and had at least one anchor firm that employs more than 1000 employees.
2. Work conditions at manufacturing facilities and office building complexes generally made them more suitable for rideshare marketing than retail stores, sales companies, or warehouse districts.
3. Multiemployer work sites must have carefully defined boundaries within which there is an easily identifiable and reasonably compact cluster of firms. This requires that intrasite travel distances and the existence of barriers to intrasite access be taken into account.
4. Current travel conditions, including commuting distances, the extent of current ridesharing and bus use, and the existence of road congestion, parking scarcity, and parking fees all should be considered in order to evaluate the market potential for additional ridesharing.

TELEPHONE BROKERAGE

Telephone brokerage was one of the more unique aspects of this ridesharing demonstration. Under this system, the Share-A-Ride carpool coordinator made a follow-up telephone call to each matched carpool applicant. These telephone calls, made from two to eight weeks after the mailing of match lists, revealed that fewer than 15 percent of the people had contacted others on their match lists. Reasons for the failure of most matched applicants to make carpool arrangements were as follows:

1. Loss of interest in forming a carpool,
2. Reluctance to contact strangers,
3. Change in address or work hours from that given on the application, or
4. Matches considered unacceptable by the applicant.

For those who had lost interest or were reluctant to contact strangers, the telephone call served to remarket the program and encourage subsequent contact with others on their match lists. Three-way conference calls between the carpool coordinator and potential carpoolers were sometimes made to assist with the arrangement of carpools at the first few sites. (Lack of sufficient staff time prevented the continuation of conference calls as well as second and third follow-up calls at the later sites.)

In addition to its function as a marketing tool, telephone brokerage functioned as an application-updating and data-collection tool. For those who had changes in work schedule, workplace location, or residence location, telephone brokerage calls updated their applications so they could be rematched. Applicant claims that none of their matches were appropriate could be due to differences in schedule times, work locations, or residence locations that were beyond the applicant's tolerance, or they could be due to the existence of carpool preferences that were not asked on the application. The latter problem could sometimes be resolved by noting additional preference information on the application and returning it to the file to be rematched. The telephone brokerage calls made it possible to verify the number of applicants placed into carpools as a result of Share-A-Ride matching. They also served an important function of feedback on problems at some of the sites. These problems ranged from complaints of unacceptably long travel distances between firms to restrictions for some employees on receiving telephone calls at work (particularly brokerage calls and calls between matched applicants to arrange carpools).

The telephone brokerage technique helped the carpool program achieve a level of placement in which 20 percent of the matched drive-alone applicants (14 percent of all drive-alone applicants) became verified carpoolers. This is higher than the 2-10 percent placement rate typically achieved by carpool matching programs (2,3). Further analysis is still necessary to measure the unit costs of telephone brokerage and the marginal increase in carpool placement that is directly attributable to the technique. In addition, several issues remain concerning the design and implementation of a telephone brokerage effort. These are as follows:

1. The optimal number of follow-up telephone calls to be made to each applicant,
2. Selectivity criteria for concentrating the telephone calls on those market segments most likely to form carpools,
3. The extent of use of conference calls, and
4. The time delay between mailing match lists and conducting telephone brokerage.

STRUCTURE OF VANPOOL SERVICE DELIVERY

The Share-A-Ride demonstration program had a decentralized organization, with the MTC as the grant recipient and program coordinator and several private firms contracted to perform specific project tasks. Since the end of the demonstration period, MTC has centralized all but one program function within its own organization. Van Pool Services, Inc., has been retained to coordinate vanpool matching and brokerage and to administer the fleet of leased vans.

The issue of contracting for services versus providing them in-house arises repeatedly for public agencies such as MTC. The Norfolk, Virginia, the Golden Gate (San Francisco), and the Minneapolis vanpool demonstration programs were all funded directly to a local transit agency; however, only in Minneapolis did the transit agency choose not to operate the vanpool program directly (4). Direct operation of the vanpool program by the MTC was never seriously considered for two key reasons. First, direct operation by the transit agency would require an additional investment in staff and offices plus significant administrative effort involved in acquiring and maintaining a van fleet. An equally important concern was that the ownership or leasing of vans by MTC for use by volunteer drivers would represent a visible competition to the services performed by union-driven buses. As such, it would be likely to encounter greater objections from the transit union and could make the vans more directly liable to negotiations with the union relative to their maintenance, driver arrangements, and areas served.

Instead of contracting to a third-party provider to administer vanpool operations, some programs have avoided the administrative work of maintaining a growing van fleet by either encouraging the transition of drivers to become independent owner-operators (e.g., Knoxville Commuter Pool) or by shifting drivers to lease the vans from another organization (e.g., Golden Gate Vanpool). Still other vanpool programs (e.g., Baltimore's VANGO) lease the vans to the drivers from the outset. These approaches have a variety of potential disadvantages, however. They require a sufficient number of persons who are willing to lease or buy the vans and assume the financial responsibility of obtaining insurance and operating the pools. As the drivers become independent contractors, the vanpool program office is limited in its control over the quality of service provided. There is also a tax advantage for a corporation rather than individuals or a public agency to purchase or lease the vans. In particular, a corporation can amortize a purchased or leased van just as it would any item of plant or equipment and can also claim an investment tax credit (5,6). (With the 1981 tax laws, public agencies may also be able to take advantage of depreciation through sale leaseback arrangements. The interpretation of the law, however, is still being debated.)

The third-party-provider model used in Minneapolis was considered to have several implementation and operational advantages over other options for program management. Since it operates independently of employers, it presents no additional liabilities or costs to employers nor does it necessarily even require cooperation of all employers in order to establish multiemployer vanpools. As the program grows, one vanpool provider can maintain control over vanpool pricing and service quality that is consistent among employment sites and can realize the potential savings in administrative and insurance cost from a large-scale operation.

As a private organization, the third-party provider can have the flexibility to make independent decisions regarding staffing, office operations, vehicle acquisition, and maintenance agreements. It is not clear whether a private third-party provider offers staffing allocation or administrative cost advantages over a direct transit agency operation, but it clearly gives the vanpool program some element of independence from political and bureaucratic decision making concerning vehicle fleet acquisition and operations. The concept of a multiemployer vanpool program operated by a third party organization is now becoming increasingly popular, and third-party vanpool programs now operate in several states.

CONCLUSION

As vanpool and ridesharing brokerage programs are becoming more common, the critical issues that confront many local programs are shifting from the area of legal and regulatory barriers to the area of program design and operation. For example, the legal environment for initiation of the Share-A-Ride program in 1977 was already conducive to vanpooling, due in part to the prior existence of the pioneering vanpool program at the 3M Company of St. Paul and the existence of 10 other employer-based vanpool programs in the area. Commuter van legislation passed by the Minnesota legislature in 1976 had exempted commuter vanpools from Public Service Commission regulations and modified the regulatory, insurance, liability, and tax structures to facilitate van operation.

Multiemployer, site-oriented carpool, and vanpool marketing programs are now arising as alternatives to reliance on single-employer initiatives and regionwide promotions. The concept of telephone follow-up is gaining recognition as a means of assisting carpool formation among applicants and as a tool for record updating. Organizational alternatives, including third-party providers and contracts to private agencies for other marketing services, are also worthy of further attention.

Note that the setting for the Minneapolis ridesharing demonstration was unique in several ways. The employment base in the Twin Cities area is dominated by the offices and manufacturing facilities of several high-technology, computer-oriented firms. The attitudes and cooperation of these major employers were systematically more conducive to ridesharing than those exhibited by some other types of employers, such as retail and warehousing firms. Thus, the mix of firms and employmemt types in a metropolitan area may affect employer attitudes toward ridesharing as well as the poolability of the employment base.

The extent of employer cooperation and assistance with the promotion of ridesharing can also be sensitive to the level of concern about gasoline supplies and the perceived need for ridesharing services. There were measurable increases in both the proportion of firms that allow employee presentation meetings and the number of requests for vanpool services from off-site firms, starting in the spring and summer of 1979, when dramatic gasoline price increases and supply shortages occurred.

Despite a few caveats to transferability of results, the Minneapolis ridesharing demonstration has yielded a number of major findings that should be applicable elsewhere. In particular, the demonstration program showed that a comprehensive package of ridesharing services aimed at multiemployer, non-downtown sites can be feasible and can tap an important market for ridesharing. At the same time, the demonstration has helped to identify the existence of difficulties in engaging participation from small firms and the existence of various site characteristics critical to program success. Lessons learned from experimentation with several different marketing strategies, the development of the telephone brokerage approach, and the use of contractors to perform certain ridesharing services are all applicable for the design and implementation of ridesharing programs elsewhere.

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Abridgment

Personalized Approach for Ridesharing Projects: Experience of Share-A-Ride in Silver Spring, Maryland

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Recent research suggests that ridesharing programs could increase their effectiveness if the assistance process were humanized and the behavioral factors that influence ridesharing were taken into account. To test this premise, the Maryland-National Capital Park and Planning Commission has developed a project called Share-A-Ride that uses a personalized approach to overcome the traditional barriers to ridesharing. Initiated in September 1979, this project has experimented with personalized marketing, matching, and follow-ups in the central business district of Silver Spring, Maryland. Early results indicate that Share-A-Ride has (a) provided 93 percent of the applicants with the ridesharing information they seek, (b) influenced 72 percent of matched applicants to telephone other prospective poolers, and (c) helped 43 percent of all applicants to enter new ridesharing arrangements. Share-A-Ride is currently implementing the personalized approach at a cost of about $130/person who enters a new ridesharing arrangement. Planned personnel adjustments and increases in pool-formation rates could drop this cost below $100/person in upcoming years. Important considerations for applying the personalized approach in other locations include the following: (a) personalized programs should be implemented in moderate-size employment centers and also in special segments of large metropolitan areas; (b) employers and employees should be encouraged to participate actively in planning and operating the project; (c) the computer should be used to perform routine chores so staff will be free to concentrate on personalized marketing, matching, and follow-ups; and (d) staff should be highly qualified and able to assume a wide range of responsibilities.

Many metropolitan areas in the United States currently have computerized carpool matching systems. Although these systems were established to create new pooling arrangements, they have typically helped only small percentages of the commuting population.

In recent years, researchers such as Margolin and Misch (1), Levin and Gray (2), Hartgen (3), Horowitz and Sheth (4), Kurth and Hood (5), Brunso, Kocis, and Ugolik (6), Shea and Tischer (7), and Wagner (8) have investigated the performance of these systems in order to understand the factors that may hinder their effectiveness and to point to new directions for rideshare-assistance programs. This research suggests that the key to increased effectiveness lies in humanizing the rideshare-assistance process and in taking into account the behavioral factors that help or impede ridesharing.

In response to this research, the Montgomery County Planning Department of the Maryland-National Capital Park and Planning Commission (M-NCPPC) has initiated a project called Share-A-Ride in the central business district (CBD) of Silver Spring, Maryland. This project, which began operations on September 10, 1979, is testing the ability of the personalized approach to blend behavioral considerations into the rideshare-assistance process. At the same time, it is demonstrating how rideshare assistance can be made more effective, particularly in moderate-size employment centers, such as downtown areas of small-medium size cities, suburban CBDs, and other clusters of commercial development. Share-A-Ride has been developed with primary technical assistance from the project consultant, Sverdrup and Parcel and Associates, Inc.

PERSONALIZED APPROACH

The guiding principle behind the Share-A-Ride project has been the personalized approach. This approach recognizes that sharing a ride involves a personal, social, and business relation that many people find difficult to enter and maintain. The premise of the approach is that personalized assistance can help people overcome certain behavioral barriers, such as reluctance to ride with strangers, perceived loss of independence, or resistance to rigid and confining commuting arrangements.

Project Location and Staff

The Silver Spring CBD was selected for Share-A-Ride because the market is identifiable, manageable, and comprised of commuters from a wide area. Silver Spring is an unincorporated suburb of Washington, D.C., that has a compact CBD where approximately 1150 employers and 17 750 employees work (9). The CBD has a broad mix of employer types; the three largest categories are professional and technical services, government, and wholesale and retail (10). Many of these are small businesses; employers who have fewer than 100 employees account for approximately 58 percent of all employees in Silver Spring.

Although the Washington region's computerized carpool matching program has attempted to serve Silver Spring, the program has historically been ineffective in increasing ridesharing there. Cases in point were two carpooling campaigns conducted by the regionwide program, which together produced an estimated total of only 48 new carpoolers (11)

The Share-A-Ride staff consists of two field representatives and a secretary. Policy direction and supervision are provided by a staff member of the Transportation Planning Division of M-NCPPC. This has proved to be a sufficient level of staffing to provide personalized marketing, matching, and follow-ups.

Rather then treating rideshare assistance as simply a mechanical process, Share-A-Ride is structured to provide continuous, personal service, from initial contacts with the employers all the way to assistance for their employees. The field representatives have responsibility not only for marketing and promotion but also for matching applicants and making follow-up telephone calls as well. This wide spectrum of tasks adds variety to the job, lets the field representatives manage their time to achieve the proper balance among all activities, and promotes accountability. A field representative recognizes that the ability to make good, prompt matches and follow-ups will affect the receptiveness of employers and employees when he or she attempts to market the project further. Moreover, when the field representative matches applicants and makes follow-up telephone calls, he or she is able to explain to applicants the reasoning behind the match-ups.

Share-A-Ride's field representatives are experienced and educated in marketing and public relations and have good record-keeping skills. Their backgrounds enable them to show sensitivity and develop rapport with both employers and employees and to provide perceptive feedback on marketing strategy and applicant-assistance procedures.

Marketing

Most carpool matching programs attract primarily self-starters--those people who are highly motivated to share a ride with a bare minimum of assistance. Share-A-Ride's personalized marketing program, on the other hand, has been designed also to attract the undecided--those people who are marginally interested in ridesharing, yet who can be convinced to give it a try if personalized assistance is made available.

Much of the marketing strategy has been based on findings from interviews of focus groups, which were held before the project's services were made available to the public. A trained moderator guided seven discussion sessions; each contained 8-10 employers or employees (12). The purpose of these sessions was to obtain qualitative information on local attitudes toward ridesharing modes, incentives that would be most effective in inducing pooling and transit use, and options for designing a ridesharing program that has the most appeal and chance of success in Silver Spring.

Two important marketing objectives have been as follows:

1. To make Share-A-Ride a common workplace term and
2. To make a positive impact as early as possible in order to instill public confidence in the project.

The field representatives personally contacted the local Chamber of Commerce and key officials of the 140 largest firms to familiarize them with Share-A-Ride. The field representatives were aware of the business community's natural hesitancy to get deeply involved until the project has proven itself. They initially sought only a modest level of assistance. Employers were asked to distribute to all employees Share-A-Ride brochures that contain tear-off application cards and to permit audiovisual slide presentations to groups of employees.

Six months later, after considerable newspaper publicity concerning the early success of the project, Share-A-Ride invited company representatives to attend one of a series of two-hour luncheon workshops. The staff briefed them on the status of the project, gave them a tour of the office, and also took the opportunity to request higher levels of assistance from businesses in the upcoming phase of the project. Some of the newer commitments included designation of a coordinator within the company, briefings to new employees about Share-A-Ride during company orientations, posters on company bulletin boards, endorsement of Share-A-Ride via letters to employees, and articles about the project in company newsletters.

The employees of approximately 1100 smaller businesses in Silver Spring could not readily be approached through their employers. Share-A-Ride staff reached them through other marketing techniques, such as posters in building lobbies and public garages; displays or brochures in banks, post offices, restaurants, and other public places; and radio public service announcements and newspaper articles. One local company made personnel available to help the staff distribute these posters and brochures.

Important to any marketing effort are word-of-mouth endorsements from satisfied clients. By improving the quality of the rideshare-assistance process and thereby bringing greater satisfaction to its clients, Share-A-Ride staff expects that word-of-mouth endorsements will increasingly reinforce the marketing efforts of the project.

Hybrid Processing System

An important objective during the creation of Share-A-Ride was to keep track of potentially thousands of applicants with as few errors and as little paperwork as possible and at the same time to give personal attention to each applicant. Accordingly, the project's hybrid manual-automated system combines the personal touch of Share-A-Ride personnel with the efficiency and speed of the computer. A fundamental decision was made to reserve to the computer the objective tasks and to reserve to human judgment the subjective tasks. As a result, the staff uses a printing terminal connected to a minicomputer to handle routine record-keeping, card and letter generation, and information retrieval functions, complemented by personal, manual methods for the matching and follow-up functions.

Share-A-Ride's limited market area produces trip patterns that are essentially many to few (many home locations to few work locations). This type of trip distribution is advantageous because it has permitted the start-up of effective matching at a threshold of 300 applicants. It has also been very adaptable to personalized manual techniques, thus the need for computerized matching is removed.

Share-A-Ride's commuter locator map, a key element of the matching process, is a manual tool that permits quick, visual, and subjective matching. Since this map encompasses the entire Washington-Baltimore region and would be difficult to place flat on a wall, it has been mounted on a scroll-like device that allows the user to pull the map up and down to bring any area into easy view. The map also has a specially designed movable template for finding an applicant's home location.

Share-A-Ride's printing terminal produces coded information that gives each applicant's identifying number, work arrival and departure times, and work subarea. This information is photocopied onto a small gum-backed label that is then affixed to the applicant's home location on the map. When ready to match, the field representative scans the map's labels to select applicants who appear to be good matches, according to home proximity and information on the labels. The field representative then checks the potential matches more closely by referring to the applicant records for additional characteristics, such as driving preference, occupation, work affiliation, or certain personal requirements that may have a bearing on the suitability of the match. The field representative ranks the matches on the basis of expected compatibility. After the match information is transmitted to the computer, the printing terminal produces a variable-paragraph match letter that is sent to the applicant. The terminal's high-quality print wheel types the letter on regular Share-A-Ride letterhead, in normal letter format and typeface. The letter lists potential poolers in order of presumed compatibility and also suggests public transit routes, where applicable.

Two more examples of how the computer assists the personalized process are Share-A-Ride's courtesy cards and rematch cards. Immediately after a person enrolls in the project, the printing terminal automatically produces a courtesy postcard that acknowledges that the application has been received and that assistance will follow shortly. At the same time that a new applicant receives a match letter, the printing terminal automatically produces rematch postcards that are sent to the potential poolers on the new applicant's match list to let them know that the new applicant may be a good match for them. In this way, all parties to a match know about each other, and old applicants, whose files are still active, continue to receive potential matches until their needs are met.

Along with every match letter, each new applicant receives a concise carpool, vanpool, or transit information booklet, according to his or her ridesharing preferences. The carpool booklet emphasizes the flexibility of carpooling and points out additional benefits such as reserved carpool spaces and reduced automobile insurance premiums. The vanpool booklet explains how vanpooling works and describes how a person gets a van and qualifies as a vanpool driver. The transit information booklet serves as a handy reference on all the public transit services available to the applicant. Additional features that are common to all booklets are tips for successful ridesharing, endorsements of ridesharing from both employees and employers, and a brief explanation of Share-A-Ride's personalized services.

Telephone Follow-Ups

About two to three weeks after an applicant receives the matches, the staff makes the first follow-up telephone call. This follow-up provides information on early actions taken by the applicant or serves as a reminder to the applicant to make contact with other potential poolers. This call also serves to inform the applicant that Share-A-Ride staff is ready to assist personally if necessary.

A second follow-up telephone call normally occurs two to three weeks later. At this stage, the field representative can take an active role in assisting an applicant who has not yet made new ridesharing arrangements. A skilled field representative can ferret out the reasons for the applicant's inaction and suggest ways to remove barriers that may exist. A hesitant applicant soon realizes that if a ridesharing arrangement does not work out, the field representative is prepared to give advice or supply names of additional prospects on a continuing basis.

As time permits, the field representative may make additional follow-up calls to verify the effectiveness of the assistance or to supply additional information or assistance. An important side benefit of these periodic calls is the opportunity to find out if applicants have moved or otherwise changed their status. The currency of data, a perennial problem for most ridesharing programs, is therefore much less of a problem for Share-A-Ride.

EARLY RESULTS

To obtain an early indication of the effectiveness and efficiency of the personalized approach, preliminary results were compiled in June and November 1980. These compilations relied primarily on three sources of information:

1. Postcard questionnaires that were mailed back by 30 percent of the 4600 Silver Spring employees receiving cards at random sampling points near building entrances during June 2-4, 1980;
2. Questionnaire forms that were mailed back by 38 percent of the 858 applicants in the Share-A-Ride project as of June 4, 1980; and
3. The Share-A-Ride data inventory system, which contains information from 1220 application cards and from an intensive series of follow-up telephone calls as of November 10, 1980.

Effectiveness

The 1220 people who applied to Share-A-Ride during the first 14 months of the project represent 6.9 percent of the work force of 17 750. About 50 percent of Share-A-Ride's applicants have been from employers who employ fewer than 100 persons, about 30 percent from employers who employ 100-500 persons, and about 20 percent from employers who employ more than 500 employees.

Although Share-A-Ride's roster of applicants is not large by ordinary standards, effective matching has still been possible. This has been due primarily to the many-to-few trip distributions of the applicants. The field representatives have been successful in providing match list or transit information to more than 93 percent of all applicants who requested assistance.

An especially important accomplishment of the personal approach has been the ability to overcome a formidable barrier for most ridesharing programs--the reluctance of applicants to call persons on their match lists. Approximately 72 percent of the applicants who received lists of prospective poolers have actually contacted each other.

A key measure of the project's effectiveness is its ability to create new or expanded pools and transit passengers. By February 1980, Share-A-Ride was able to get 25 percent of all its applicants into new ridesharing arrangements; by July 1980, the rate had increased to 29 percent; and by November 1980, the rate rose to 43 percent. Since the project is young and the full potential of the personal approach has yet to be met, this formation rate can be expected to go even higher. Of the applicants who started new pools or expanded old ones, 62 percent drove alone before applying to Share-A-Ride, and 30 percent applied in order to expand existing pools. The remaining 8 percent, who switched from transit to pooling, were more than offset by the number of people who switched from driving alone to transit, to produce a net gain for transit.

About 46 percent of the persons who entered new ridesharing arrangements did so soon after being exposed to the initial promotion at or near their work location and receiving a personalized match list through the mail. About 39 percent entered new arrangements as a result of personal contacts by the field representatives. The remaining 15 percent entered new arrangements only after receiving additional assistance and new matches from the field representatives. About 70 percent of those who entered or expanded their pools actually pooled with people on their match lists. The remaining 30 percent pooled with persons who had not applied to Share-A-Ride.

A major objective in tapping the Silver Spring CBD market was to influence employees from different companies to pool with each other, particularly those who work for small businesses. Results show that this objective is being met. Approximately 72 percent of all pools created via the match lists are composed of employees of different companies, and 47 percent of Share-A-Ride poolers work for companies that have fewer than 100 employees.

Calculation of benefits that accrue to the average applicant who has entered new ridesharing arrangements through Share-A-Ride shows an annual savings of 7177 km (4460 miles) of travel and 935 L (247 gal) of gasoline per person. At an assumed automobile operating cost of $0.11/kilometer ($0.17/mile), the average dollar saving amounts to $760/person annually.

Efficiency

The cost of providing service in comparison with the number of persons influenced to share a ride is an efficiency measure typically used by ridesharing programs. The ongoing cost of Share-A-Ride is now $55 000/year, which covers staff salaries, fringe benefits, equipment and supplies, postage, and telephone service. This figure is based on the project's budget for the second year and thus does not include the start-up costs incurred in the first year. Because Share-A-Ride, like many other ridesharing programs, has been provided free office space and computer time, these items are not reflected in the $55 000 figure. Share-A-Ride's partnership with the business community has also resulted in substantial donations of printing services by local firms, thus operating costs are decreased further. In the future, Share-A-Ride plans to have enough company coordinators and employee volunteers to assist in marketing so that the project can operate effectively with a reduced staff of two persons. Such a reduction would lower net operating costs to approximately $45 000/year.

At the rideshare success rate of 43 percent and the annual cost of $55 000, Share-A-Ride's current cost per new ridesharer is approximately $130. If we assume that the success rate continues its upward trend and approaches 50 percent and that staff reductions lower the annual cost to $45 000, the cost per new ridesharer for the following year could drop below $100. This cost is based on a continuing application rate of 1000 new applications per year.

Share-A-Ride's cost per new ridesharer, not surprisingly, is somewhat higher than costs reported by most regional computerized programs. The additional resources were necessary to serve a difficult market area effectively and to reach beyond the self-starters to attract and retain people who initially are undecided about ridesharing. When compared with the much higher public expense of funding the alternatives to carpooling, such as providing additional parking spaces or new transit capacity, personal assistance to potential poolers stands as a very efficient and worthwhile service. The addition of new parking garage capacity in Silver Spring, for example, currently costs $8000-10 000/space.

IMPLICATIONS FOR RIDESHARING PROJECTS

Share-A-Ride continues to refine the specific methods for implementing the personalized approach. Its fundamental philosophy--humanizing and raising the quality of the rideshare-assistance process--has been the key to the success of the project and can be important to the future of other ridesharing programs. Important considerations for projects that plan to use the personal approach include the following.

Personalization of ridesharing services has the best chance of succeeding in limited market areas. Although the personal approach is especially feasible for moderate-size employment centers, it is also adaptable to large metropolitan areas where centralized ridesharing projects may already exist. In such cases, satellite offices could be established in certain subareas that deserve special treatment.

The staff of a personalized project must encourage its clients to participate actively in implementing the program. Group discussion sessions with employers and employees during the planning phase and the involvement of coordinators and volunteers during the operating phase of the project increase awareness and acceptance of the ridesharing services. A partnership with the community can also result in important side benefits, such as donations of services to the project.

Although the matching process is important, it only requires about 10 percent of the staff's time in limited, employer-based market areas such as Silver Spring. In such areas, matching by complex computer programs would be inappropriate because the computer would save little time and would limit the flexibility required for personalized matching. The computer, nevertheless, should be used to perform routine, mechanical record-keeping chores so that the staff can devote the bulk of its time to people-oriented components of the project, such as marketing and follow-ups.

Assignment of the field representatives to the entire range of marketing, matching, and follow-up responsibilities avoids an assembly line situation whereby each function is performed with little regard or knowledge of the others. Since personalization requires extensive outreach and interaction with the public, selection of project staff should be performed carefully. Highly qualified professionals are not a luxury, but a necessity for achieving a reputation of competence and credibility.

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Business Plan for a Commercial, Third-Party Vanpool Operation

LEONARD F. HERK, JR.

Vanpool rate schedules that are based primarily on meeting costs in a break-even operation discourage participation by the greater number of short-distance riders. As a result, this business plan is based on the supposition that, if vanpool rate schedules were directly related to the gasoline cost of travel by automobile, vanpooling would have much broader appeal, and might even be profitable. Of course, profit is not a necessity. This plan would also be useful in an unsubsidized, nonprofit operation. The plan itself is based on a computer-optimized model, created largely from 3M vanpool data. This model uses a pricing strategy that is indexed directly to the cost of gasoline. Other important features and assumptions are shown as well as profitability, cash flow, and internal rate of return over a seven-year time period.

3M is generally regarded as a pioneer in development of employer-supported vanpools. The 3M program started with 6 vans in 1973. Now, the 3M program has 145 vans that serve more than 1500 employees. Average occupancy per van is 11.5 riders. In addition to reducing gasoline consumption by 300 000 gal/year, this program has reduced demand for parking space at the 3M Center by about 940 spaces. The estimated capital savings for these parking facilities is about $3.4 million. This, of course, if offset in part by the capital investment in the 3M van fleet, which at this time is in the neighborhood of $1 million.

The 3M fare schedule for employees is based on the cost of operating and maintaining the fleet plus amortized van cost. The costs of administering the program, providing maintenance facilities, collecting fares, and purchasing are borne by 3M.

This practice of vanpool subsidization by employers or government is quite common. Public Service Options, Inc., managed 50 vans in the Twin Cities of St. Paul and Minneapolis in 1979. About half of their costs were borne by state and federal government. Subsidization, in fact, seems to be common to most forms of multirider transportation, except carpooling. In October 1979, in a radio interview, one of the commissioners of the Twin Cities Metropolitan Transit Commission (MTC) stated that revenues for meeting the cost of operating the MTC come from the following sources:

Source	Share of Operating Cost (%)
Fares	33
Property taxes	22
State subsidy	25
Federal subsidy	18

Bus fare at that time was $0.40/ride; senior citizens rode for $0.10. Thus, subsidization for operating cost was between $0.70 and $0.80/passenger trip. This operating cost did not include amortization of the purchase price of the buses. Eighty percent of the cost of purchasing a new bus was borne by the federal government. If this capital investment cost is added to operating cost, the total subsidization of public transportation in the Twin Cities was in excess of $1/passenger trip. The business plan that follows will show that commercial vanpooling may be a more cost-effective means of multiple-rider transportation.

MARKET PLACE PERSPECTIVE

In 1979 about 6000 (1) employer- or government-sponsored vanpools were in operation in the United States. A like number of private owner-operated vans are also estimated to be functioning in the United States. At an average of 10 riders/van, about 120 000 U.S. workers out of a total labor pool of 90 million are currently vanpooling. This is 0.13 percent of the total labor population. At the 3M Center in St. Paul, Minnesota, participation is 14 percent and there is a waiting list of applicants.

From the above figures one might project that the total potential for pooling in the United States may be about 100 times greater than its present level. This projection equals 12 million riders. The ensuing analysis will show average annual revenues

Table 1. Comparison of monthly vanpool rates.

Daily Round Trip Car Miles	Cost of Driving a Car[a] ($)	Daily Vanpool Miles	Commercial Vanpool Price Factor[b]	Rate Schedule ($)		
				Commercial Vanpool	3M Internal[c]	Vanpool Services[c]
9.1	13.49	15	1.750	23.60	27.50	NA
13.3	19.71	20	1.268	25.00	29.25	29.22
17.5	25.94	25	1.000	25.90	31.00	30.90
21.7	32.17	30	0.977	31.40	32.75	32.58
30.1	44.62	40	0.930	41.50	36.25	35.94
38.5	57.07	50	0.883	50.40	39.00	39.30
46.9	69.52	60	0.837	58.20	42.50	42.66
55.3	81.97	70	0.790	64.80	46.00	46.02
63.7	94.37	80	0.743	70.10	49.50	49.38
72.1	106.88	90	0.697	74.50	53.00	52.74
80.5	119.33	100	0.650	77.60	55.75	56.10
88.9	131.78	110	0.603	79.50	59.25	59.46
97.3	144.23	120	0.557	80.30	NA	62.82

[a]Gasoline cost only, figured at $1.20/gal. The average automobile fuel efficiency is 17 miles/gal.
[b]See text for explanation.
[c]Figures are for March 1, 1980.

of $4500 per 11-rider van or about $410.00/rider per year (at $1.50/gal gasoline). Thus, a total market potential of $4.9 billion may be estimated:

(120 000 riders) x (100) x [($4500/van-year)/
(11 riders/van)] = $4.9 billion/year

PRICING

When a driver decides that no serious obstacles, such as scheduling, will hinder participation in a vanpool, the decision on whether to pool or not will depend on what is perceived as the cost of driving versus the cost of vanpooling.

With gasoline priced at $1.20/gal and average car fuel efficiency of 17 miles/gal, the perceived cost of driving a car is about $0.071/mile. The full cost of operating an automobile is actually much higher. The Wall Street Journal (2) states that the national average is $0.319/mile. Depreciation and insurance are major contributors to this cost. However, unless the potential vanpooler is ready to dispose of a car, he or she bears the burden of these costs whether or not the car is driven to work. Thus, at most times, the driver is quite correct in using only gasoline cost as the marginal cost for driving to and from work. Nevertheless, at least one time each year he or she will pay significant insurance premiums, and about every five to eight years he or she will face the expensive prospect of buying a new car. These are times when the driver will surely consider pooling if he or she had not done so to date. We estimate that 15-20 percent of individual worker-drivers will face this decision once each year.

In general, this simple comparison of gasoline cost versus fare makes vanpooling look unattractive for short distances and very attractive for longer commuting distances of 20 miles/day or more (see Table 1). Unfortunately, only 30-50 percent of a typical company's employees commute over these longer distances (i.e., 50-70 percent of the nation's traveling work force are not attracted by organized vanpools).

Vanpool rate schedules based primarily on meeting costs in a break-even type of operation discourage participation by the greater number of short-distance riders. As a result, this business plan is based on the supposition that, if rate schedules were directly related to the gasoline cost of travel by automobile, vanpooling would have much broader appeal and might even be profitable.

Our pricing strategy calls for vanpool rate schedules that are indexed directly to the cost of gasoline for an automobile that makes trips of the same distance. Thus, if gasoline prices increase by 50 percent, then the entire vanpool rate schedule would also increase by 50 percent, regardless of the rate of inflationary increases on other operating costs. If the rate of inflation of gasoline pricing continues to outstrip the overall rate of inflation, the profitability of this operation will continue to improve and the rider should be indifferent to these increases. The increase in profitability is because the cost of gasoline accounts for 20-45 percent of the direct cost of operating a vanpool over the period of study; however, 84-88 percent of total sales revenue will be directly indexed to gasoline pricing over that same period.

In this business plan vanpool fares are not always exactly equal to the equivalent gasoline cost for automobile travel. Instead, the rate for each distance is attenuated by a special price factor that either raises the vanpool fare above the equivalent gasoline cost or reduces it. The algebraic expression for the relationship is as follows:

$$V = pK \quad (1)$$

where

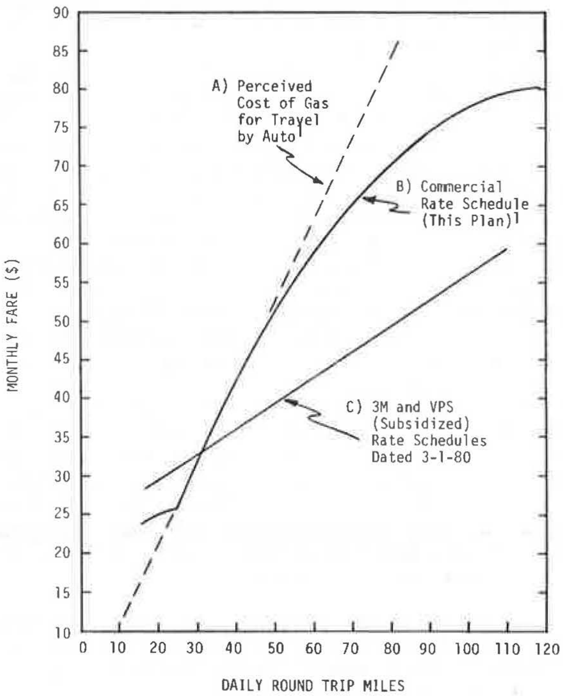
V = vanpool rate,
p = price factor, and
K = cost of gasoline for an automobile for the distance.

The purpose of the price factor (p) is to make adjustments to the rate schedule for marketing reasons. Our proposed p-values for various distances are given in column 4 of Table 1.

For daily vanpool distances of 25 miles (17.5 miles actual travel), a price factor of 1.00 was chosen. In this case the vanpool fare should closely approximate actual gasoline cost for the automobile trip. For distances that are less, the price factor is greater than 1.00 because the conscious cost of traveling only short distances must include a sharper realization that more than the cost of gasoline is involved. (The car owner should be more aware of the cost of the rapidly depreciating asset when he or she uses it for only brief periods of time.) For travel distances greater than 25 miles/day, the pricing factor drops below 1.00 because carpooling, as an alternative to vanpooling, will become more attractive with increasing travel distances.

For many U.S. vanpools, pricing is based on the cost of operation (i.e., the direct cost of opera-

Figure 1. Comparison of monthly vanpool rates with gasoline cost.



[1]Gas is $1.20 per gal.
Auto Mileage is 17 MPG.

tion is divided by the number of riders to determine monthly fare). Since many of the major costs of operation, such as depreciation, are fairly independent of distances traveled, these fare versus distance curves tend to be flat. The fare for traveling 80 miles each day to and from work is not much higher than the fare for traveling 30 miles each day. Thus, to the individual driver who sees his or her gasoline cost doubling with a doubling of distance, vanpooling becomes more attractive for the longer distances. (Compare lines A and C in Figure 1.) At the 3M Center, only 20 percent of the personnel travel more than 25 miles each day, but approximately 92 percent of 3M's vanpools serve this select population.

The foregoing price strategy relates more closely to the rider's perceived cost of driving alone or carpooling and, as such, comes closer to market pricing. (See lines A and B in Figure 1.) This market pricing strategy is expected to have two effects: (a) it will make short-range vanpools more attractive, and (b) it will increase the profitability of longer-range vanpools.

FINANCIAL ANALYSIS

A great deal is known about vanpooling in general. But, because the common approach to most vanpool operations is to run them on a partly subsidized basis, very little is published about how to make them profitable.

Late in 1979, 3M began to investigate third-party vanpooling as a potential business opportunity. The idea of indexing fare schedules directly to the price of gasoline seemed to provide the leverage needed to make commercial vanpooling feasible. In the face of rapidly escalating gasoline prices, it soon became apparent that, in time, commercial vanpooling could be made profitable if this strategy were adopted. As a result, definition of the important conditions for a profitable operation soon

Figure 2. Annual P & L for 15-passenger van for 15-mile round trip.

PAYLOAD	12.5 (DRIVER EXCL.)	
LINE HAUL MILES	2.8	ONE WAY
PICK-UP/DROP-OFF MILES	4.7	ONE WAY
TOTAL DAILY POOL MILES	17.4	
ANNUAL POOL MILES		4402
ANNUAL PERSONAL MILES		2400
GROSS ANNUAL MILES		6802

PURCHASE PRICE	9300
SALES TAX	372
TOTAL PURCH. COST	9672
IMMED. DEPREC'N	200
NET VALUE (NEW)	9472
VALUE AFTER 7 YRS.	900
VALUE FOR DEPREC'N	8572
ANNUAL DEPREC'N	1225

	Year One		Year Two		Year Three		Year Four		Year Five	
ODOMETER @ YEAR END		6802		13,604		20,406		27,208		34,010
BOOK VALUE @ MID YEAR		8860		7635		6410		5185		3960
DIRECT VAN COSTS:										
VAN DEPREC'N	1225									
LIABILITY INS.	252									
LICENSE TABS	43		-4		-4		-4		-4	
OPERATING COST LESS TIRES & GAS @ $.084 PER MI	571									
TIRES @ $.015 PER MI	302		-200							
GASOLINE @ 1.25 PER GAL	1088									
TOTAL DIRECT VAN COST		3481		-204		-4		-4		-4
PAYMENT FOR PERSONAL MILES .160 x 2400		384								
NET DIRECT VAN COST		3097		-204		-4		-4		-4
MARKETING/SALES COST		250								
OPERATIONAL ADMIN. @ $35/MO.		420								
GEN'L ADMIN. @ 1.5% PASS. REV.		42								
TOTAL OPERATING COST		3809		-204		-4		-4		-4
EMPLOYER SUBSIDY @ $ .10 PER PASS.-TRIP 2 x .10 x 253 x 14.5	734									
GOVERNMENT SUBSIDY @ $ .10 PER PASS.-TRIP	734									
TOTAL SUBSIDIES		1468								
NET OPERATING EXPENSE		2341		2137		2133		2129		2125
REVENUE @ $18.25 PER PASS.-MO. 12 x 12.5 x 18.25		2738		2738		2738		2738		2738
ANNUAL PROFIT	Lifetime avg 580	397		601		605		609		613
AS A % OF REVENUE	21.2%	14.5%		21.9%		22.1%		22.2%		22.4%
RET. ON CAP. EMPLOYED	16.1%	4.5%		7.9%		9.4%		11.7%		15.5%

Note: Distance from home to work is approximately 2.8 miles.

became the major thrust of our study. The results of this analysis follow.

Any broad-scale vanpool operation may be viewed as a conglomerate of several individual vanpools. Thus, our business model began with the detailed analysis of a single van that operates over a regular distance of travel each day for its entire life. An example of this unit analysis is shown in Figure 2.

Figure 2 is the lifetime profit and loss statement (P&L) for a 15-passenger van that travels 15 miles/day with a fixed gasoline price of $1.25/gal. Similar P&Ls were created for longer-distance vans (25, 40, and 80 miles/day), for 12-passenger vans, for other gasoline prices, and for other levels of outside support fees. The bottom line of this P&L not only shows profit or loss but also shows the return on capital employed (ROCE) that would accrue from such a single-unit operation. By using this simple analysis, some understanding was developed regarding the relative importance of cost and revenue factors on investment criteria. Figure 2 is a preliminary hand calculation that includes some features, such as a government subsidy, that are not a part of the final model. These hand calculations helped in the design of our computer program that contains most of the elements shown in this figure.

A model fleet P&L was synthesized by combining unit P&Ls, like Figure 2, in a way that would simulate a typical fleet mix. Ordinarily, any fleet of 100 vans would have individual vehicles that travel a variety of at least 15 different distances each day. For the sake of simplifying the calculations, only four distances were chosen in the following mix:

50 fifteen-passenger vans that travel 15 miles/day,

30 twelve-passenger vans that travel 25 miles/day,
15 twelve-passenger vans that travel 40 miles/day, and
5 twelve-passenger vans that travel 80 miles/day, for a total of 100 vans.

This mix of travel distances was chosen to simulate the distribution of distances traveled by most workers in the United States. Any deviations from this simplified mix will not have any significant effect on the final results of our analysis.

Our model calls for a one-city fleet to grow at the rate of 200 vans/year until it reaches a level of 1000 vans, at which point fleet size remains constant. For simplicity, no continuing growth in fleet size is projected beyond the 1000-van level. At this point, we assume that total demand for vanpools in this one-city market has been satisfied.

Expansion of the model to include more than one urban center may be achieved by taking multiples of this one-city model. In this respect, note that, for this type of business, economies of scale can only occur within a single compact area of operation. One hundred vans in each of 10 cities will not operate as efficiently as will 1000 vans in 1 city. Thus, a national business is seen as a conglomerate of single urban area operations, such as the one described by our model.

In our fully developed one-city model, consideration is given to depreciation (linear and accelerated), special tax benefits, resale values of mature vans, and computer-based administration of fleet operations. Our seven-year model also takes inflation into consideration.

A general rate of inflation of 12 percent/year was used for all cost factors that are not directly related to the price of gasoline. All gasoline-dependent costs and revenue factors (such as fares and personal use charges) are inflated at the rate of 35 percent/year for the first three years and at 12 percent/year thereafter. Figure 3 is a graphical representation of this inflation schedule. The top line of Table 2 shows our projections of the average annual price of gasoline that results from this inflation rate, with a starting point of $1.50/gal.

An unusual source of revenue that appears in this model is the employer's fee. This is the fee paid by the employer of the vanpool rider to the third-party vanpool operator for organizing and maintaining the vanpool for employees. In our model, this fee is set at $0.15/passenger trip or $0.30/day for the rider who travels to work (one trip) and back (second trip). This fee is analogous to 3M's contribution to the administration of its internal vanpool. In our model this fee is also inflated at 12 percent/year and is treated as revenue in the model.

At the present time, wherever vanpools flourish, employer support is an important part of the operation. Usually, this support takes the form of fleet administration and financing when vans are purchased. The employer's fee is a substitute for these costs.

These and other considerations were programmed into a special vanpool model for computer analysis. Because the entire model was programmed into the computer, we could test several variables and their impact on the various investment criteria. In this fashion, the following financial model evolved. Although the model was refined repeatedly, the pool's size, its growth rate, sources of revenues, inflation rate, and basic pricing strategy remained as described in the foregoing discussion.

Figures 4, 5, and 6 are copies of computer printouts that show fleet P&L, sources and uses of funds, and ROCE, respectively, for a seven-year period. Figure 6 shows ROCE figures that are quite high in the later years of the study period. This is due, in large measure, to the 12 percent inflation rate and to the fact that 80 percent of the van fleet has a life expectancy of seven years. The purchase of new replacement vans in the eighth year will cause fleet ROCE to drop sharply for that year. Because of the irregularity in rate of van replacement in

Figure 3. Projected annual inflation rates.

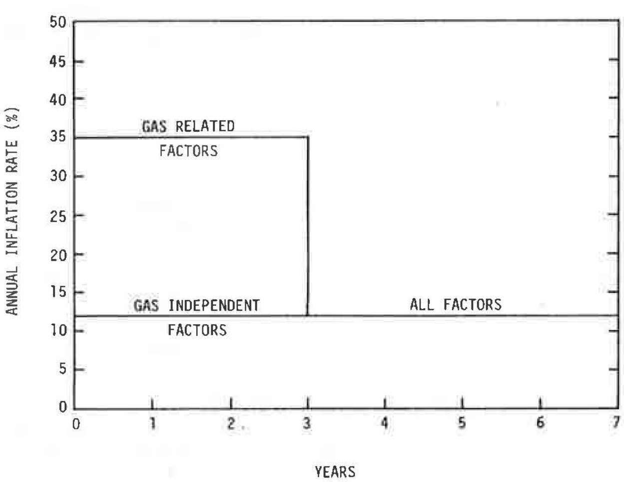


Table 2. Summary of average annual gasoline cost, investment, and revenue levels for seven-year, 1000-van commercial pool.

	Year						
Factor	1	2	3	4	5	6	7
Projected avg. annual gasoline price ($)	1.50	2.03	2.73	3.06	3.43	3.84	4.30
Total revenue ($000s)	586	2309	5074	7956	11 456	14 256	15 967
Profit ($000s)	-206	371	1449	2550	3839	5169	5901
Profit as percentage of revenues	-35.2	16.1	29.5	32.0	33.5	36.3	37.0
Net permanent investment ($000s)	1679	3263	4738	6225	7581	6330	5284
Return on capital employed (%)	-12.0	10.8	29.1	37.1	45.1	69.1	89.7
Cash flow ($000s)	-1664	-1303	-608	26	887	4099	4434
Cumulative cash flow ($000s)	-1664	-2967	-3575	-3549	-2662	1437	5871

Note: The internal rate of return for the seven-year period is 33.5 percent. A 12 percent annual inflation rate is assumed.

general, wide fluctuations in ROCE can be expected from year to year. More gradual fleet growth in developed areas and expansion into new market areas will tend to dampen these fluctuations. Nevertheless, if an overall inflation rate of 12 percent/year is maintained, a long-term-average ROCE in the range of 60-90 percent may be expected.

Profit and the various operating costs as a part of total revenue are shown in Figure 7. The rapid growth of profit and gasoline cost over the years as a result of inflation are more obvious in this graph. It should not be assumed that these are recommended levels of profitability. The quoted levels are simply those that can be projected for this model under the stated conditions. Note, however, that there is sufficient profitability in

Figure 4. Seven-year vanpool P & L.

$ THOUSANDS

1. Gas pricing starts at $1.50 per gallon.
2. Employer fee starts @ 15¢ per passenger trip.
3. All gas dependent factors inflate @ 35% (first 3 years), then at 12%.
4. All gas independent factors inflate @ 12% per year.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
TOTAL EMPLOYER FEES	$ 94	$ 316	$ 589	$ 924	$ 1,330	$ 1,655	$ 1,854
TOTAL PERSONAL MILEAGE REV	$ 41	$ 166	$ 374	$ 587	$ 845	$ 1,051	$ 1,177
TOTAL SERVICE REVENUES	$ 451	$ 1,827	$ 4,110	$ 6,445	$ 9,281	$11,550	$12,936
NET SALES	$ 586	$ 2,309	$ 5,074	$ 7,956	$11,456	$14,256	$15,967
DIRECT COST							
GAS EXPENSE	$ 160	$ 649	$ 1,461	$ 2,291	$ 3,299	$ 4,106	$ 4,599
TIRE EXPENSE	$ 13	$ 45	$ 83	$ 131	$ 188	$ 234	$ 262
INSURANCE EXPENSE	$ 24	$ 80	$ 150	$ 235	$ 339	$ 422	$ 473
LICENSE EXPENSE	$ 3	$ 10	$ 19	$ 30	$ 44	$ 55	$ 61
DEPRECIATION EXPENSE	$ 290	$ 631	$ 1,004	$ 1,435	$ 1,918	$ 1,977	$ 2,062
OTHER DIRECT EXPENSE	$ 74	$ 250	$ 466	$ 731	$ 1,053	$ 1,310	$ 1,467
TOTAL DIRECT EXPENSE	$ 573	$ 1,666	$ 3,185	$ 4,854	$ 6,841	$ 8,104	$ 8,924
DISCRETIONARY COSTS							
SALES COST	$ 150	$ 168	$ 220	$ 290	$ 384	$ 463	$ 518
ADMINISTRATIVE COST	$ 70	$ 104	$ 171	$ 262	$ 392	$ 521	$ 624
TOTAL DISCRETIONARY COST	$ 220	$ 272	$ 390	$ 552	$ 776	$ 903	$ 1,142
GRAND TOTAL COST	$ 792	$ 1,937	$ 3,575	$ 5,406	$ 7,617	$ 9,087	$10,066
NET PROFIT	$ (206)	$ 371	$ 1,499	$ 2,550	$ 3,839	$ 5,169	$ 5,901
PERCENT PROFIT	(35.2%)	16.1%	29.5%	32.0%	33.5%	36.3%	37.0%

This computer program calculates in whole dollars and then rounds the result to the nearest thousand.

Figure 5. Sources and uses of funds over seven years.

$ THOUSANDS

1. Gas pricing starts at $1.50 per gallon.
2. Employer fee starts @ 15¢ per passenger trip.
3. All gas dependent factors inflate @ 35% (first 3 years), then at 12%.
4. All gas independent factors inflate @ 12% per year.

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
OPERATING PROFIT	$ (206)	$ 371	$ 1,499	$ 2,550	$ 3,839	$ 5,169	$ 5,901
INCOME TAX	$ (87)	$ 156	$ 629	$ 1,071	$ 1,613	$ 2,171	$ 2,479
INVESTMENT CREDIT	$ 181	$ 202	$ 227	$ 259	$ 290	$ 42	$ 54
NET INCOME AFTER TAX	$ 61	$ 418	$ 1,096	$ 1,737	$ 2,516	$ 3,041	$ 3,477
VALUE OF DISPOSAL				$ 9	$ 10	$ 34	$ 51
DEPRECIATION EXPENSE S	$ 298	$ 631	$ 1,004	$ 1,435	$ 1,918	$ 1,977	$ 2,062
TOTAL CASH GENERATED	$ 359	$ 1,049	$ 2,100	$ 3,181	$ 4,444	$ 5,052	$ 5,589
WORKING CAPITOL	$ 45	$ 138	$ 228	$ 233	$ 284	$ 227	$ 139
FIXED ASSAT PUR	$ 1,977	$ 2,214	$ 2,480	$ 2,922	$ 3,273	$ 726	$ 1,017
TOTAL USE OF FUNDS	$ 2,022	$ 2,352	$ 2,708	$ 3,156	$ 3,557	$ 953	$ 1,155
CONTRIBUTION TO CORP CASH	$(1,664)	$(1,303)	$ (608)	$ 26	$ 887	$ 4,099	$ 4,434
CUMULATIVE CASH FLOW	(1,664)	(2,967)	(3,575)	(3,549)	(2,662)	1,437	5,871

This computer program calculates in whole dollars and then rounds the result to the nearest thousand.

Figure 6. Return on capital employed over seven years.

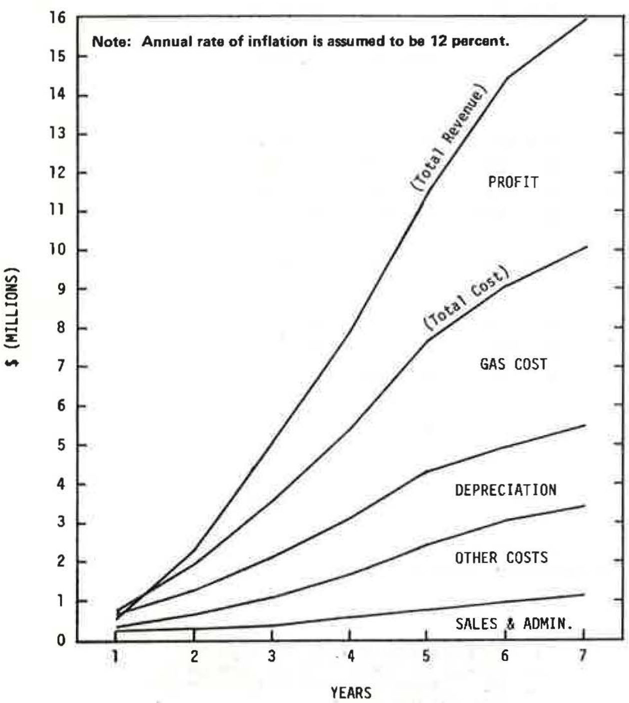
1. Gas pricing starts at $1.50 per gallon.
2. Employer fee starts @ 15¢ per passenger trip.
3. All gas dependent factors inflate @ 35% (first 3 years), then at 12%.
4. All gas independent factors inflate @ 12% per year.

$ THOUSANDS

	YEAR 1	YEAR 2	YEAR 3	YEAR 4	YEAR 5	YEAR 6	YEAR 7
TOTAL SALES	$ 586	$ 2,309	$ 5,074	$ 7,956	$11,456	$14,256	$15,967
WORKING CAPITAL	$ 45	$ 183	$ 411	$ 645	$ 928	$ 1,155	$ 1,294
NET PERMANENT INVESTMENT	$ 1,679	$ 3,263	$ 4,738	$ 6,225	$ 7,581	$ 6,330	$ 5,284
TOTAL CAPITAL EMPLOYED	$ 1,724	$ 3,445	$ 5,149	$ 6,870	$ 8,509	$ 7,484	$ 6,578
OPERATING PROFIT	$ (206)	$ 371	$ 1,499	$ 2,550	$ 3,839	$ 5,169	$ 5,901
RETURN ON CAPITAL	(12.0%)	10.8%	29.1%	37.1%	45.1%	69.1%	89.7%

This computer program calculates in whole dollars and then rounds the result to the nearest thousand.

Figure 7. Seven-year comparison of costs and profit.



this model to allow for a variety of plan adjustments, such as going to an unsubsidized, nonprofit operation.

By using the appropriate investment parameters that were developed by this model, an overall internal rate of return of 33.5 percent is computed for the seven years under study. This and other investment criteria are summarized in Table 2. The assumptions that were used in constructing this model for analysis are summarized below.

1. Employers of vanpool riders will pay a small per trip fee to support the program.
2. Purchase price of a 12-passenger van is $10 300; for a 15-passenger van, it is $10 500. Resale occurs after 70 000 miles or seven years of use, whichever comes first. Resale value is $675-$900, depending on age. (Recently 3M has found retrofitting to be more practical than resale for older vans.)
3. Fifteen-passenger vans are used for all round trips of 20 miles/day or less. Twelve-passenger vans are used for all round trips of 25 miles/day or more.
4. All vans operate, on the average, at one-half seat under full capacity.
5. Driver rides free and also receives the fare from the last seat in the van. Driver keeps van overnight and keeps van clean.
6. All personal mileage is repaid at a rate equal to the cost of gasoline up to 200 miles/month. A surcharge of 30 percent is placed on personal mileage over the 200-mile monthly maximum.
7. Fifty miles/month, on the average, are allowed for maintenance.
8. Van depreciation is linear for P&L purposes and accelerated for taxes.
9. Liability insurance is $250/year per van. Collision is self-insured by the operator.
10. Cost of license tags, maintenance, and tires are based on 3M internal vanpool fleet averages. Mileage varies with distance traveled from 7.5-10.0 miles/gal, based on 3M fleet averages.
11. Pick-up and drop-off distances will vary according to total distance traveled, as per 3M internal vanpool averages.
12. Payment by riders is by the month in advance. Accounts receivable should show net payment in advance instead of in arrears. Model does allow for some receivables and inventory (e.g., gasoline). Payments are made to the employer, by payroll deduction, for example. The employer is then billed by the third-party operator.
13. Taxes are paid on operating profit at a consolidated rate of 42 percent.
14. Vans that are retired for reasons of age or mileage are immediately replaced with new vans.

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