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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 area-wide 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.

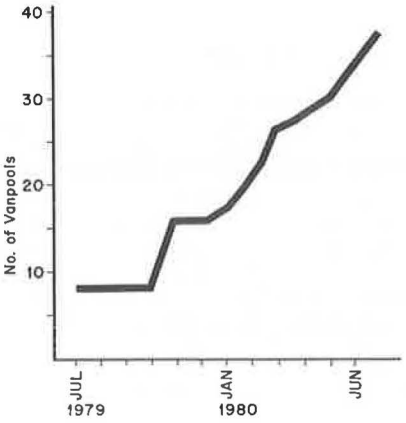


Figure 2. Distance-to-work distribution.

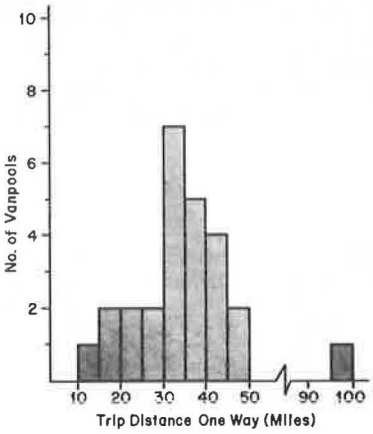
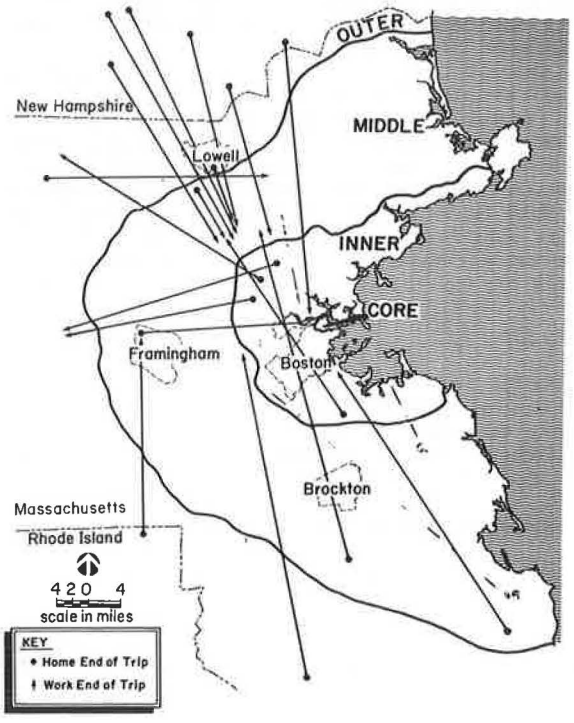


Figure 3. Location of Caravan vanpools: suburb-to-suburb routes.



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.

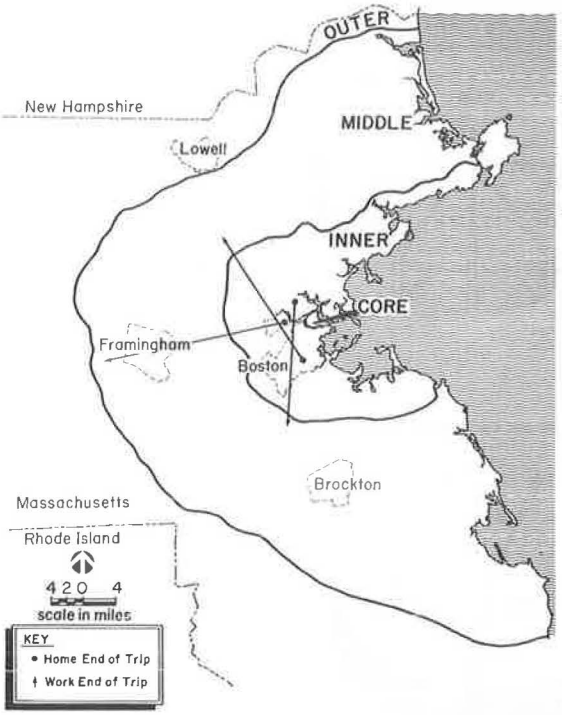


Figure 5. Location of Caravan vanpools: suburb-to-core routes.

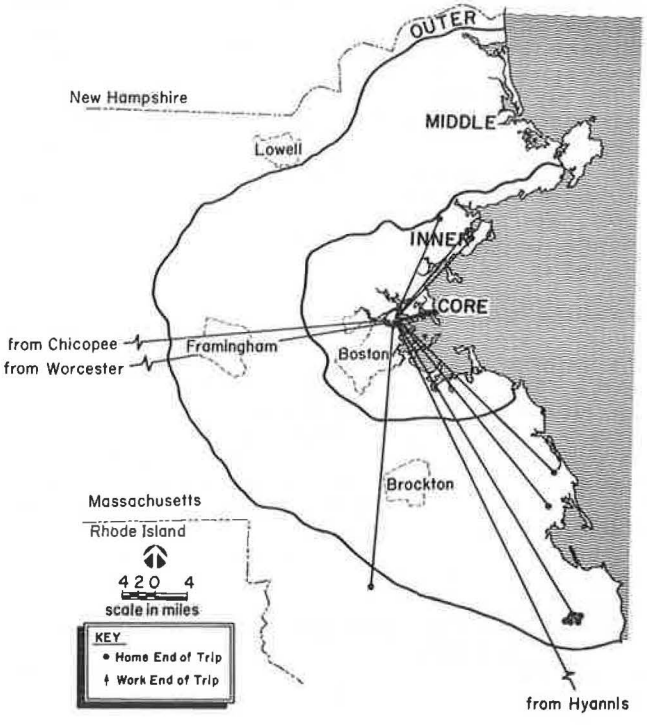


Table 1. Vanpool route characteristics.

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.

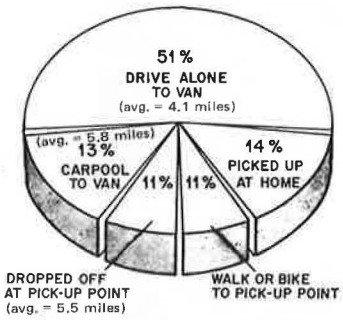
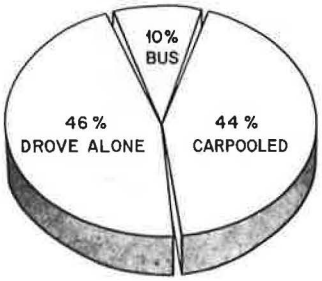


Figure 7. Former commuting modes.



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)		Annual Program Cost per Ton ($)	Percentage of Emissions Reduction Needed to Achieve Standards[b]
		Per Van	Program Total		
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.

Table 5. Current and projected commuter cost savings.

Year	No. of Vans	Commuter Cost Savings[a] ($)		Program Cost[b] ($)	Commuter Cost Savings ÷ Program Cost
		Per Van	Program Total		
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).

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).

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).

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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 evalu-