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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REFERENCES

1. Wilbur Smith and Associates. Transportation Element of the Children's Hospital Master Plan. Children's Hospital of San Francisco, San Francisco, May 1978.
2. Wilbur Smith and Associates. Transportation Improvement Program Evaluation. Children's Hospital of San Francisco, San Francisco, June 1980.
3. DeLeuw, Cather and Company. Transportation Management Plan--Summary Report. City and County of San Francisco, San Francisco, Oct. 1979.

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

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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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REFERENCES

1. E. Dorosin, P. Fitzgerald, and B. Richard; Crain and Associates. Golden Gate Vanpool Demonstration Project. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, Interim Rept. UMTA-CA-06-0095-79-1, July 1979.
2. E. Dorosin; Crain and Associates. Golden Gate Vanpool Demonstration Project. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, draft final rept., Dec. 1980.
3. R.E. Furniss; CACI, Inc. An Evaluation of the Norfolk Van Pool and Contract Hauler Demonstration. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, draft final rept., Aug. 1979.
4. R.D. Juster, J.A. Kruger, and G.F. Ruprecht; Multisystems, Inc. The Knoxville Tennessee Transportation Brokerage Demonstration: An Evaluation. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, Rept. UMTA-TN-06-0006-80-1, Aug. 1979.
5. G.E. Weisbrod and E.S. Eder; Cambridge Systematics, Inc. Evaluation of the Minneapolis Ridesharing Commuter Services Demonstration. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, Rept. UMTA-MN-06-0008-80-1, June, 1980.
6. C. Heaton, J. Jacobson, and J. Poage. Comparison of Organizational and Operational Aspects of Four Vanpool Demonstration Projects. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, Rept. UMTA-MA-06-0049-79-6, April 1979.
7. J.D. Beeson, F.W. Davis, and F.J. Wegmann; University of Tennessee. The Knoxville Transportation Brokerage Project, Vol. II: Operations and Management. UMTA, Rept. UMTA-TN-06-0006-77-2, Oct. 1977.
8. F.W. Davis, J.D. Beeson, and F.J. Wegmann; University of Tennessee. The Knoxville Transpor-

tation Brokerage Project; Vol. I: Philosophy and Institutional Issues. UMTA, Rept. UMTA-TN-06-0006-78-3, Nov. 1978.

9. F.J. Wegmann and others; University of Tennessee. The Knoxville Transportation Brokerage Project: An Eighteen-Month Evaluation. UMTA, Rept. UMTA-TN-06-0006-78-1, Feb. 1978.

10. C. Johnson and A.K. Sen; University of Illinois at Chicago Circle. Ridesharing and Park-and-Ride: An Assessment of Past Experience and Planning Methods for the Future; Vol. II, The Van Pool Planning Manual. Research and Special Programs Administration, U.S. Department of Transportation, Rept. DOT-RSPA-DPB-50-78-10, Nov. 1977.

11. D. Fong. The Effects of the Energy Crisis on Four Vanpooling Demonstration Projects. Transportation Systems Center, U.S. Department of Transportation, Cambridge, MA, staff study SS-24-U.3-184, Sept. 1979.

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.

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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