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Mobility of Handicapped Persons: Examination of Mobility Levels of Different Groups of Handicap

WERNER BRÖG and KARL RIBBECK

ABSTRACT

A large-scale study of mobility-handicapped persons in the Federal Republic of Germany in 1981 made possible the examination of the mobility of handicapped persons in light of several classifications of handicap. This paper is a report on the mobility of those persons generally defined as handicapped (i.e., with a reduced earning capacity), those defined in the major study as mobility handicapped, and those whose mobility is, officially, considered limited enough to warrant the issue of a free travel pass. The results show the mobility handicap extends well beyond the official definition and that it is particularly evident if movement is possible only with the assistance of a second person. It also appears that free travel passes distributed on the basis of general, not mobility, handicap can result in only those persons who are already most mobile receiving them.

In the Federal Republic of Germany in 1981 a nationwide study of handicapped persons was undertaken under the auspices of three federal ministries: the Ministry for Youth, Family and Health; the Ministry for Employment and Social Order; and the Ministry for Transport (1). Already at the pilot study stage of this project in 1980 (2), however, the question of the definition of handicap had arisen. Up to that time the only data available had been on persons who were officially acknowledged as handicapped. During the course of the 1981 study, five categories of mobility-handicapped persons were identified and included persons other than those with official handicaps.

The levels of mobility of handicapped persons are discussed initially. The mobility of handicapped persons who are not entitled to unlimited free travel on public transport is then addressed. The analysis of the mobility of the latter group centers on a comparison with those persons who, due to a certain level of "official" handicap, actually receive free travel passes.

CLASSIFICATION OF HANDICAPPED PERSONS

Officially Handicapped Persons

To qualify for official recognition as handicapped, a person must meet a standard rating criterion that is used to establish handicap according to various levels of reduction in earning capacity (REC). The REC level is measured by the extent of the functional losses of the body or by the size of the functional impairment that is attributable to the impaired member or part of the body. The young and the elderly are measured in the same way. This definition has several limitations:

- It is impossible to deduce the percentage of the population with comparable handicaps who, for whatever reason, have not been given, or have not sought, official recognition as "handicapped."
- The official statistics include no data suited to describing the living conditions of handicapped persons in such a way that it is possible to comment on the size and composition of the subpopulations whose needs are not being fulfilled.
- The causes of severe handicaps are not well disaggregated; more than three-quarters of all persons who are officially acknowledged as handicapped with an REC of at least 30 percent are summarized under "other causes or several causes" or "other illness (including those resulting from vaccinations)."
- The official statistics are distorted because some deceased persons are included in the files and tens of thousands of persons whose documents are currently being processed are not included.

Mobility-Handicapped Persons

Before the national survey, a pilot survey of 26,700 representative private households (66,000 persons) was conducted. It was intended to collect information on all disabilities--officially recognized or not. The indicators of these disabilities were (in addition to the disabilities and functional impairments) any aids needed in order to travel outside the home; the need for any medical or other basic care; the need for assistance with the care of the household or with communication; and impairments of bodily, spiritual, or mental well-being as defined by the World Health Organization. From this survey, three categories of handicapped persons were obtained: the officially recognized, those persons who were quite probably handicapped even though not officially recognized, and those who were possibly handicapped.

In the main survey it was possible, by the use of proportionate sampling, to verify, confirm, and classify the handicaps of all persons in the study, to gather descriptive data on those persons, and to identify specific needs. This meant that, in addition to the official classification of handicap, handicaps could now be classified in a much more disaggregate manner.

The form of disaggregation to be considered in this paper is based on a classification of handicapped persons according to the degree to which they are handicapped in their ability to move--mobility

handicap. In the German study, mobility-handicapped persons 18 years old and older--11.9 percent of the population--were identified as falling into five categories. The categories included persons who were not officially categorized as handicapped but who had great difficulty with mobility.

Every twentieth person who is mobility handicapped is so limited in his ability to move that he actually needs to be categorized as immobile (I). This does not imply, however, that these people are actually constantly immobile. On the contrary, out-of-house mobility provides such basic necessities of life that, despite the utmost individual difficulties, it cannot, as a general rule, be totally suppressed. This is also valid for two further groups: those persons theoretically dependent on other people and on mechanical aids (P+M) and those theoretically "only" dependent on other people's assistance (P). For these two groups (which total a good third of the handicapped population), this does not mean that such assistance is always available or that out-of-house activities take place only when it is available. About one-third of the mobility handicapped persons use various mechanical aids when they leave the house, and a good half of these can only be mobile with the assistance of another person. This means that there are about 2 million persons who use mechanical aids and about 1.3 million persons who actually need to be accompanied by another person. Although it is possible that a majority of the persons discussed so far also have problems with structural impediments such as steps, the last group (S) has problems "only" with these structural impediments and does not need mechanical aids or another person. This group of 2.38 million persons includes almost half of the mobility-handicapped population (Table 1).

Handicapped Persons with Free Travel Passes

The third classification of handicap is based on eligibility for unlimited free travel on public transport. This is granted to persons who have an REC of more than 80 percent. One of the goals of this preferential treatment can be assumed to be the improved mobility of this group, and it is relevant, therefore, to examine the impact of this policy in this context. (It has to be noted here that the whole project was finished before January 1, 1984, the day when major changes in the policy were introduced.)

INDICATORS OF MOBILITY

One of the most important indicators of mobility is the extent to which persons actually leave the house on a given day--the share of mobile persons. If mobility-handicapped people are broken down into different groups, then the share of mobile persons increases constantly from Group I to Group S. Only one in six of the theoretically immobile are able to leave the house (Table 2). The share of mobile persons in Group M (67.1 percent) is, however, actually quite similar to persons of the same sociodemographic characteristics who are not handicapped (66.5 percent), as is the share of mobile persons in Group S (73.5 percent) to all nonhandicapped persons (75.8 percent) (3) (Table 3).

Neither the frequency distribution of the number of out-of-house activities nor of the average number of trips, however, follows this pattern exactly. This picture, which may seem confusing at first, can be clarified fairly easily. Group S represents most closely the average of all mobility-handicapped

TABLE 1 Categories of Mobility Handicap

MOBILITY HANDICAPPED IN THE CATEGORIE:		Total %	Absolute (Rounded) Millions
I	(Theoretically Immobile)	5,2	0,28
P+M	(Theoretically dependent on other People and Mechanical Aids)	11,6	0,61
P	(Theoretically "only" dependent on other People)	24,8	1,31
M	(Theoretically "only" dependent on Mechanical Aids)	13,5	0,71
S	("Only" difficulties with Structural Impediments)	44,9	2,38
TOTAL		100,0	5,29

Note: Commas should be understood as decimal points.

TABLE 2 Mobility Indicators of the Mobility Handicapped—All Persons

CHARACTERISTICS (MOBILITY HANDICAPPED)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I	P+M	P	M	S
● ALL PERSONS						
Share of Mobiles	60,4%	17,6%	48,4%	48,6%	67,1%	73,5%
Out-of-House Activities	1,16	0,40	0,94	0,76	1,49	1,46
- Work	0,09	-	0,05	0,04	0,18	0,12
- Shopping	0,49	0,07	0,40	0,33	0,56	0,67
- Recreation	0,50	0,18	0,46	0,39	0,66	0,57
- Other	0,07	0,15	0,03	0,00	0,09	0,10
Sojourns	0,92	0,31	0,68	0,67	1,22	1,13
Trips	2,08	0,71	1,45	1,43	2,71	2,59
Trips per Sojourn	-	-	-	-	-	-

Note: Commas should be understood as decimal points.

persons; about 1.5 sojourns per day, just under two out-of-house activities, and about 3.5 trips per mobile person. Those mobility-handicapped persons who have the lowest mobility are combined to Groups P and I. It is apparent that, because of their general problems, persons in Group I, on the rare occasions that they leave the house, try to accomplish as much as possible.

A similar mobility quota is apparent for the mobile members of Group M; on the basis of the correspondingly higher share of mobile persons, the values per person are approximately three times as high as those for Group I. Finally, compared to Group P, Group P+M shows evidence of many more possibilities to travel, presumably due to the assistance afforded by mechanical aids such as crutches or sticks. Even though the share of mobile persons is the same as that for Group P, the other mobility indicators are consistently higher (Tables 2 and 3).

On the basis of the overall longer trip durations for both Groups S and M, the travel times per person correspond to the equivalent values for nonhandicapped persons and are, therefore, much higher than the values for the control persons of similar socio-demographic characteristics. Furthermore, Group P+M lies above Group P, and members of Group I are only out of the house on average for just over 0.5 hour per day and are only traveling for 0.25 hour (Table 4). The total time spent out-of-house parallels the results of the mobility indicators already discussed. Group M spends the longest time away from home, followed by Group S. Group P has the lowest value for mobile persons and lies considerably under Group P+M (Tables 4 and 5).

The discussion of general indicators has already shown that there is a clear difference in mobility behavior between Groups M and S and those groups that need personal assistance. This is confirmed by a comparison of trip purpose. In such a breakdown the absolute number of trips per person in Group M still exceeds the corresponding values for Group P by more than 1.5 times, even though the relative

TABLE 3 Mobility Indicators of the Mobility Handicapped—Mobile Persons

CHARACTERISTICS (MOBILITY HANDICAPPED)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I	P+M	P	M	S
● MOBILE PERSONS						
Share of Mobiles	-	-	-	-	-	-
Out-of-House Activities	1,91	2,29	1,95	1,57	2,21	1,98
- Work	0,15	-	0,09	0,08	0,26	0,16
- Shopping	0,82	0,42	0,84	0,68	0,83	0,91
- Recreation	0,83	1,02	0,95	0,80	0,98	0,78
- Other	0,11	0,85	0,07	0,01	0,14	0,13
Sojourns	1,53	1,78	1,40	1,38	1,82	1,54
Trips	3,44	4,07	3,00	2,95	4,03	3,52
Trips per Sojourn	2,25	2,29	2,14	2,14	2,21	2,29

Note: Commas should be understood as decimal points.

TABLE 4 Travel Characteristics of the Mobility Handicapped—All Persons

CHARACTERISTICS (MOBILITY HANDICAPPED)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I	P+M	P	M	S
● ALL PERSONS						
Duration per Trip*)	-	-	-	-	-	-
Travel Duration*)	55	16	41	36	68	70
Duration per Activity*)	-	-	-	-	-	-
Time Out-of-House*)	169	37	115	101	229	219
Time at Home	21h 11'	23h 23'	22h 5'	22h 19'	20h 11'	20h 20'
Time at Out-of-House Activities	1h 54'	21'	1h 14'	1h 5'	2h 41'	2h 30'
- Work	31'	-	22'	15'	58'	40'
- Shopping	28'	2'	15'	19'	27'	39'
- Recreation	51'	16'	33'	31'	1h 9'	1h 3'
- Other	4'	3'	4'	0'	7'	8'
Travel Time	55'	16'	41'	36'	1h 8'	1h 10'
*) in Minutes						

frequencies in Group P were about a sixth to a seventh higher in each case. Overall, the average trip frequency per person for shopping and recreational activities for Groups M and S well exceeds the comparable values for the rest of the population, and it can be assumed that the mobility-handicapped persons in these groups are fairly frequently persons who keep house (Table 6).

Even for mobility-handicapped persons who were not classified as handicapped, it appears that persons who keep house are predominant; the high proportion of shopping activities and overall above average mobility supports this conclusion (Table 7).

In a breakdown by the officially acknowledged REC, an almost uniform picture of handicap can be seen. Those mobility-handicapped persons who are not officially recognized as handicapped clearly lie at the lowest end of the scale. This tendency, which is limited to trips per person, varies only once: mobility-handicapped people with an REC of less than 50 percent show relatively less shopping and other service trips, primarily because this group is less frequently employed (Table 7).

TABLE 5 Travel Characteristics of the Mobility Handicapped—Mobile Persons

CHARACTERISTICS (MOBILITY HANDICAPPED)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I	P+M	P	M	S
● MOBILE PERSONS						
Duration per Trip*)	26,3	22,7	28,4	25,0	25,1	26,9
Travel Duration*)	91	12	05	74	101	95
Duration per Activity*)	99	53	79	85	109	103
Time Out-of-House*)	280	214	239	208	341	298
Time at Home	19h 20'	20h 26'	20h 2'	20h 32'	18h 11'	19h 3'
Time at Out-of-House Activities	3h 9'	2h 2'	2h 33'	2h 14'	4h 0'	3h 24'
- Work	51'	-	46'	31'	1h 27'	55'
- Shopping	47'	10'	30'	39'	39'	53'
- Recreation	1h 24'	1h 33'	1h 9'	1h 4'	1h 43'	1h 25'
- Other	7'	19'	8'	0'	11'	11'
Travel Time	1h 31'	1h 32'	1h 25'	1h 14'	1h 49'	1h 35'
*) in Minutes						

Note: Commas should be understood as decimal points.

TABLE 6 Trips to Out-of-House Activities—Mobility Handicapped Persons

TRIPS to OUT-OF-HOUSE ACTIVITIES	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I*)	P+M	P	M	S
	- absolute -		- absolute -	- absolute -	- absolute -	- absolute -
All Persons						
- Work	0,23		0,11	0,09	0,47	0,30
- Shopping	0,91		0,62	0,63	1,01	1,22
- Recreation	0,87		0,68	0,70	1,15	0,98
- Other	0,07		0,04	0,01	0,08	0,09
TOTAL	2,08		1,45	1,43	2,71	2,59
Mobile Persons	%		%	%	%	%
- Work	11		8	6	17	11
- Shopping	44		43	44	37	47
- Recreation	42		47	49	43	38
- Other	3		2	1	3	4
TOTAL	100		100	100	100	100

*) Not applicable

Note: Commas should be understood as decimal points.

MODE USE

The dominating role of the mode "walk" applies to all groups of mobility-handicapped people, although it varies significantly among them. Whereas in Group P two out of three trips are made on foot, in Group P+M it is only every third trip; on the other hand Group P+M has the highest public transport usage. Despite the relatively high share of walk trips in Group P, the average trip frequency per person is higher again in Groups M and S. Once again the share of walk trips for the two latter groups is much higher for the corresponding control person (3). In contrast, the frequency of car passenger travel--relative to all persons--is fairly similar for all groups, as it is for public transport (with the only

TABLE 7 Trips to Out-of-House Activities—Officially Acknowledged Handicapped Persons

TRIPS to OUT-OF-HOUSE ACTIVITIES	Total Mobility Handicapped	MOBILITY HANDICAPPED: Handicapped - SOCIALDATA Definition: Yes	No	Officially Acknowledged *): REC of 30-45%	REC of 50-75%	REC of 80% & more	Not Acknowledged
	absolute	absolute	absolute	absolute	absolute	absolute	absolute
All Persons							
- Work	0,23	0,26	0,14	0,63	0,44	0,24	0,10
- Shopping	0,91	0,85	1,14	0,94	1,25	0,89	0,76
- Recreation	0,87	0,84	0,94	1,15	1,03	0,83	0,80
- Other	0,07	0,07	0,08	-	0,06	0,10	0,05
TOTAL	2,08	2,02	2,30	2,72	2,78	2,06	1,71
Mobile Persons	%	%	%	%	%	%	%
- Work	11	13	6	23	16	12	6
- Shopping	44	42	49	35	45	43	44
- Recreation	42	42	41	42	37	40	47
- Other	3	3	4	-	2	5	3
TOTAL	100	100	100	100	100	100	100

*) Handicapped persons with a Reduction in Earning Capacity (REC) of less than 30% were not considered.

Note: Commas should be understood as decimal points.

exception appearing in Group P). However, because car driver travel varies so significantly, the rather constant tendency to travel as a passenger results in variable occupancy rates. To simplify, the higher the occupancy, the less the mobility of the corresponding target person (Table 8).

Using a breakdown according to whether handicap is generally defined or is officially recognized as REC, the expected relationships appear. The use of public transport rises, at least relatively, with an REC increase and reaches its highest point with an 80 percent REC, the level at which people are en-

TABLE 8 Main Mode of Travel by Mobility Handicapped Persons

MAIN MODE	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I *)	P+M	P	M	S
All Persons	- absolute -	- absolute -	- absolute -	- absolute -	- absolute -	- absolute -
Walk	0,94		0,48	0,90	1,20	1,11
Car Driver	0,40		0,16	0,09	0,75	0,54
Car Passenger	0,22		0,24	0,20	0,20	0,26
Transit	0,34		0,41	0,18	0,36	0,40
Other	0,18		0,16	0,06	0,20	0,28
TOTAL	2,08		1,45	1,43	2,71	2,59
Mobile Persons	%		%	%	%	%
Walk	45		33	63	44	43
Car Driver	19		11	6	28	21
Car Passenger	11		17	14	7	10
Transit	16		28	13	14	15
Other	9		11	4	7	11
TOTAL	100		100	100	100	100
Car Occupancy	1,54		2,50	3,12	1,26	1,47

*) Not applicable

Note: Commas should be understood as decimal points.

TABLE 9 Main Mode of Travel—Officially Acknowledged Handicapped Persons

MAIN MODE	Total Mobility Handicapped	MOBILITY HANDICAPPED: Handicapped - SOCIALDATA Definition: Yes	No	Officially Acknowledged *): REC of 30-45%	REC of 50-75%	REC of 80% & more	Not Acknowledged
	absolute	absolute	absolute	absolute	absolute	absolute	absolute
All Persons							
- Walk	0,94	0,92	1,02	0,85	1,24	0,86	0,88
- Car Driver	0,40	0,43	0,28	0,87	0,64	0,52	0,20
- Car Passenger	0,22	0,19	0,30	0,50	0,20	0,16	0,36
- Transit	0,34	0,32	0,36	0,26	0,50	0,40	0,10
- Other	0,18	0,16	0,34	0,24	0,20	0,12	0,17
TOTAL	2,08	2,02	2,30	2,72	2,78	2,06	1,71
Mobile Persons	%	%	%	%	%	%	%
- Walk	45	46	44	31	45	42	51
- Car Driver	19	21	12	32	23	25	12
- Car Passenger	11	10	13	18	7	8	21
- Transit	16	16	16	10	18	19	6
- Other	9	7	15	9	7	6	10
TOTAL	100	100	100	100	100	100	100
Car Occupancy	1,54	1,45	2,01	1,58	1,31	1,31	2,81

*) Handicapped persons with a Reduction in Earning Capacity (REC) of less than 30% were not considered.

Note: Commas should be understood as decimal points.

titled to free travel in this mode. Walk trips are similarly dominant in all groups with a peak for REC levels between 50 and 80 percent; car passengers decline, at least in absolute terms, with increasing REC, but they attain the highest value of all the subgroups observed among mobility-handicapped persons who are not officially acknowledged. This compensates for the overall low use of public transport by this group (Table 9).

ASSISTANCE FROM ANOTHER PERSON

The mobility-handicapped population in general, and particularly Group P+M, theoretically needs the assistance of an accompanying person to engage in out-of-house activities. This accompanying person is available for more than one of every two trips of persons in this group. At the same time four of ten persons in Groups M and S were also accompanied by another person. Generally, in two of three cases these accompanying persons came from the same household as the handicapped person; this relationship corresponds to the division of passengers between household and nonhousehold vehicles. Nevertheless, 46 percent of the trips made by the mobility-handicapped persons in Group P+M and 42 percent of those made by persons in Group P have to be made without assistance; the nonavailability of sufficient assistance does not necessarily mean that the activity can be omitted in every case. The comparatively low mobility of both groups leads to the conclusion, however, that at least again as many trips as are "unaccompanied" are not undertaken at all because of lack of assistance (Table 10).

Although the share of accompanied trips is greater for those persons generally defined as handicapped than for those who are mobility handicapped but are not graded as handicapped, the same correlation for the REC level does not hold. A more or less regular arrangement to be accompanied is obviously only organized if, without it, the need for a "basic level of mobility" cannot be satisfied (Table 11).

Members of the household accompany their mobility-handicapped family members primarily on recreational trips. This holds true for all groups with

TABLE 10 Assistance Needed by Mobility Handicapped Persons

ASSISTANCE	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I*)	P+M	P	M	S
	%		%	%	%	%
Target person was accompanied:						
Yes	44		54	58	38	41
- by a member of the household	31		32	38	26	31
- by another person	13		22	20	12	10
No	56		46	42	62	59
TOTAL	100		100	100	100	100

*) not applicable

TABLE 11 Assistance Needed by Those with Officially Acknowledged Handicap

ASSISTANCE	Total Mobility Handicapped	MOBILITY HANDICAPPED Handicapped - SOCIALDATA Definition Yes	No	Officially Acknowledged *) REC of 30-45%	REC of 50-75%	REC of 80% & more	Not Acknowledged
	%	%	%	%	%	%	%
Target Person was accompanied:							
Yes	44	46	40	50	40	42	43
- by a member of the household	31	32	28	38	27	31	30
- by another person	13	14	12	12	13	11	13
No	56	54	60	50	60	58	57
TOTAL	100	100	100	100	100	100	100

*) Handicapped persons with a Reduction in Earning Capacity (REC) of less than 30% were not considered.

the exception of the P+M group. In addition, in every third case, a family member is the accompanying person on a shopping trip; these two trip purposes encompass more than nine-tenths of this type of accompanied trip. When mode is considered, the share of walk and public transport trips declines in favor of car use (either as driver or passenger). Being accompanied by a family member implies increased car use (Table 12).

Even when the accompanying person is not a member of the household, recreation is the most important purpose of trips. Assistance by nonhousehold members occurs more frequently for work trips and less frequently for shopping trips compared with household assistance. When persons are accompanied by a nonhousehold member, walk trips retain their share of the mode split but the use of public transport increases significantly; this is most obvious in the groups that require mechanical aids (Table 13).

In contrast to the trips made with an accompanying person, most of the trips that mobility-handicapped persons make alone are for shopping activities. This applies to all groups with the exception of the P+M group (Table 14). Walk is clearly the dominant mode for unaccompanied trips. Public transport is also important, however, reaching almost the same level as car driver.

At this point the importance of public transport modes for the mobility-handicapped population can be summarized more precisely. These modes always gain importance when there is no other household member available. This is true even when a person from outside acts as the accompanying person.

This can be confirmed by a more detailed breakdown of public transport usage. The most intensive users of public transport belong to Group P+M, but many belong to Group M. A good third of the mobility-handicapped persons in Group P+M use at least one form of public transport on an average day. Relative to all mobility-handicapped persons in the P+M group, and despite significantly less mobility, there is a proportion of daily public transport users who use the service almost as frequently as the much more mobile groups, M and S. In this group (P+M) the intensity of public transport usage is particularly high: 42 percent of all modes used are public transport modes and for each public transport trip almost 1.5 public transport modes are used. On the basis of these usage criteria, there are some definite divisions between groups. At the apex are Groups P+M and M, mobility-handicapped people who need mechanical aids; they are followed by persons in Group S whose handicap still allows a certain level of movement. At the bottom, Group P is singled out--the group of people who need, above all, the assistance of a second person. This type of assistance is apparently insufficient for the use of public transport in many cases (Table 15).

It is noteworthy that the generally dominant role of buses, at least as main mode, does not apply to the most intensive public transport users, Group P+M, although the important feeder function of the bus cannot be overlooked. It can be surmised, therefore, that the availability of above-ground fixed-track modes makes travel significantly easier even for severely affected mobility-handicapped persons.

ELIGIBILITY FOR FREE TRAVEL

In the Federal Republic of Germany (until December 31, 1983), persons with an REC of more than 80 percent had unlimited free use of the public transport system. An earlier structural comparison (3) had shown that, overall, mobility-handicapped persons eligible for free travel have less mobility restriction than those who do not share this entitlement. This is confirmed by a comparison of the share of mobile persons and trip frequency (per mobile person and per person). Despite this, when they leave the house, those people without free travel entitlement accomplish the same activity (1.96 out-of-house activities per mobile person compared with 1.95 for those with free travel). Shopping activities show

TABLE 12 Assistance from a Household Member—Mobility Handicapped Persons

ASSISTANCE (MOBILES)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I*)	P+M	P	M	S
	%		%	%	%	%
● Accompanied by a Household Member						
Activity						
- Work	6		7	7	6	6
- Shopping	34		51	30	27	35
- Recreation	59		42	63	65	58
- Other	1		-	-	2	1
TOTAL	100		100	100	100	100
Main Mode						
- Walk	35		18	48	29	35
- Car Driver	25		9	11	42	26
- Car Passenger	25		42	24	24	24
- Transit	12		26	14	4	12
- Other	3		5	3	1	3
TOTAL	100		100	100	100	100

*) not applicable

TABLE 13 Assistance from a Non-Household Member—Mobility Handicapped Persons

ASSISTANCE (MOBILES)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I*)	P+M	P	M	S
	%		%	%	%	%
● Accompanied by Another Person						
Activity						
- Work	12		5	7	12	18
- Shopping	26		39	60	9	8
- Recreation	55		42	33	76	63
- Other	7		14	-	3	11
TOTAL	100		100	100	100	100
Main Mode						
- Walk	34		20	67	28	22
- Car Driver	15		9	2	20	24
- Car Passenger	21		18	18	15	28
- Transit	21		42	10	31	13
- Other	9		11	3	6	13
TOTAL	100		100	100	100	100
*) not applicable						

the most noticeable difference between the two groups. Considering their low number of sojourns, this implies that those without entitlement combine more activities into a trip chain (i.e., they organize their out-of-house activities more than their counterparts) (Table 16).

Average trip durations are longer for those who cannot travel free. Their overall travel times, however, are the same as those for the free travelers because of lower trip frequencies. Those with free passes spend more time at out-of-house activities--although the differences are not great and are largely explicable by the differing proportions of persons employed (19 to 15 percent for those not entitled to free travel). As a consequence of these relationships, relative to all persons, those entitled to free travel spend just under half an hour longer away from home each day (Table 17).

TABLE 14 Unaccompanied Travel—Mobility Handicapped Persons

ASSISTANCE (MOBILES)	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL	I*)	P+M	P	M	S
	%		%	%	%	%
● Unaccompanied						
Activity						
- Work	17		14	11	24	16
- Shopping	54		40	50	46	61
- Recreation	25		46	37	26	20
- Other	4		-	2	4	3
TOTAL	100		100	100	100	100
Main Mode						
- Walk	49		41	76	46	46
- Car Driver	21		15	9	28	20
- Car Passenger	-		-	-	-	-
- Transit	20		32	13	18	20
- Other	10		12	2	8	14
TOTAL	100		100	100	100	100
*) Not applicable						

TABLE 15 Public Transport Usage—Mobility Handicapped Persons

TRANSIT USE	MOBILITY HANDICAPPED IN THE CATEGORY: TOTAL		I*)	P+M		P		M		S	
	%			%		%		%		%	
All Persons											
- Transit Users per day	15			17		9		19		18	
- Transit as Main Mode	10			14		6		9		11	
- All transit used	13			20		7		13		16	
Mobile Persons											
- Transit Users per day	25			36		19		29		24	
- Transit as Main Mode	16			28		13		14		15	
- All transit used	22			42		15		19		21	
Transit Distribution (in %)	Main Mode	All		Main Mode	All	Main Mode	All	Main Mode	All	Main Mode	All
- Bus	51	82		41	90	72	80	46	85	48	80
- Tram	35	36		59	59	15	20	27	27	36	39
- U-Bahn/Train (Urban)	10	12		-	-	4	4	21	23	12	13
- S-Bahn	4	5		-	-	9	9	6	6	4	5
Average number of Transit Modes used per Transit Trip	1,35			1,49		1,13		1,40		1,37	

*) Not applicable

Note: Commas should be understood as decimal points.

If the difference in work travel mentioned previously is disregarded, there are only quite small differences between the purpose of travel for the two groups. The availability of free travel, therefore, does not lead to a change in existing activity patterns (Table 18).

The situation is quite different for mode use. Persons entitled to free travel use public transport much more frequently but, corresponding to higher car and license ownership (1), are also car drivers much more frequently. If it is considered that when compared with the total, the mobility-handicapped people who can travel free have a higher trip frequency, it means that, per person, they use public transport twice as frequently. This value of 0.44 trips per person per day is almost twice as high as that for the non-mobility handicapped (0.23). In contrast, those without free travel compensate for their lower public transport usage (0.20 trips per person per day; 0.28 for the control group) by a higher percentage of walk trips and an even higher share of car passenger trips. Car passenger trips

TABLE 16 Mobility Indicators—Persons with Free Travel

CHARACTERISTICS (FREE TRAVEL)	All Persons: Total	With Free Travel Pass *)	Without Pass *)	Mobile Persons: Total	With Free Travel Pass *)	Without Pass *)
Share of Mobiles	60,4%	62,1%	57,2%	-	-	-
Out-of-House Activities	1,16	1,20	1,13	1,91	1,95	1,96
- Work	0,09	0,11	0,08	0,15	0,18	0,14
- Shopping	0,49	0,49	0,51	0,82	0,80	0,88
- Recreation	0,50	0,51	0,49	0,83	0,82	0,85
- Other	0,07	0,09	0,05	0,11	0,15	0,09
Sojourns	0,92	0,99	0,86	1,53	1,59	1,51
Trips	2,08	2,19	1,99	3,44	3,54	3,47
Trips per Sojourn	-	-	-	2,25	2,23	2,30

*) The two groups do not always equal the total since persons who did not respond were excluded from the analysis.

Note: Commas should be understood as decimal points.

TABLE 17 Travel Characteristics—Persons with Free Travel

CHARACTERISTICS (FREE TRAVEL)	All Persons			Mobile Persons		
	Total	With Free Travel	Without Pass *)	Total	With Free Travel	Without Pass *)
Duration per Trip **)	-	-	-	26,3	25,9	26,8
Travel Duration **)	55	57	53	91	92	93
Duration per Activity **)	-	-	-	99	103	93
Time Out-of-House **)	169	182	157	280	292	275
Time at Home	21h 11'	20h 58'	21h 23'	19h 20'	19h 8'	19h 25'
Time at Out-of-House Activities	1h 54'	2h 5'	1h 44'	3h 9'	3h 20'	3h 2'
- Work	31'	41'	29'	51'	1h 5'	50'
- Shopping	28'	30'	25'	47'	48'	44'
- Recreation	51'	49'	48'	1h 24'	1h 19'	1h 24'
- Other	4'	5'	2'	7'	8'	4'
Travel Time	55'	57'	53'	1h 31'	1h 32'	1h 33'

*) The two groups do not always equal the total since persons who did not respond were excluded from the analysis.

**) In Minutes

Note: Commas should be understood as decimal points.

are almost twice as high (0.29 to 0.16 for those who can travel free) and are above the benchmark of 0.26 for the non-mobility handicapped. Car occupancy per trip is also comparatively high (Table 19).

From this it might be concluded that, in the first instance, free travel allows more freedom for family members. This conclusion can only be justified to a limited extent. If greater car availability is considered a factor for those with free travel and the two values of car driver and passenger are added, it results in identical values per mobile person. Assuming that the generally higher mobility of those entitled to free travel can be attributed to other factors, it would mean that the public transport trips from free travel can be attributed less to newly generated mobility than to replaced walk trips (Table 19).

The hypothesis is supported by the insignificant level of accompanying persons for those who cannot travel free. A relief effect for family members is, therefore, only weakly proven (Table 20).

Persons entitled to free travel not only travel more frequently with public transport but also use the system more intensely. Relative to all modes

TABLE 18 Trips to Out-of-House Activities—Comparison

TRIPS to OUT-OF-HOUSE ACTIVITIES	Total	Mobility Handicapped With Free Travel Pass *)	Mobility Handicapped Without Free Travel Pass *)
	absolute	absolute	absolute
All Persons			
- Work	0,23	0,30	0,19
- Shopping	0,91	0,91	0,90
- Recreation	0,87	0,89	0,84
- Other	0,07	0,09	0,06
TOTAL	2,08	2,19	1,99
Mobile Persons	%	%	%
- Work	11	14	10
- Shopping	44	42	45
- Recreation	42	41	42
- Other	3	3	3
TOTAL	100	100	100

*) The two groups do not always equal the total since persons who did not respond were excluded from the analysis.

Note: Commas should be understood as decimal points.

TABLE 19 Main Mode of Travel—Comparison

MAIN MODE	Total	Mobility Handicapped With Free Travel Pass *)	Mobility Handicapped Without Free Travel Pass *)
	absolute	absolute	absolute
All Persons			
- Walk	0,94	0,91	0,97
- Car Driver	0,40	0,52	0,33
- Car Passenger	0,22	0,16	0,29
- Transit	0,34	0,44	0,20
- Other	0,18	0,16	0,20
TOTAL	2,08	2,19	1,99
Mobile Persons	%	%	%
- Walk	45	41	48
- Car Driver	19	24	16
- Car Passenger	11	7	15
- Transit	16	20	10
- Other	9	8	11
TOTAL	100	100	100
Car Occupancy	1,54	1,31	1,88

*) The two groups do not always equal the total since persons who did not respond were excluded from the analysis.

Note: Commas should be understood as decimal points.

TABLE 20 Assistance Obtained—Comparison

ASSISTANCE	Total	Mobility Handicapped With Free Travel Pass *)	Mobility Handicapped Without Free Travel Pass *)
	%	%	%
Target Person was accompanied:			
Yes	44	44	44
- by a household member	31	31	33
- by another person	13	13	14
No	56	56	53
TOTAL	100	100	100

*) The two groups do not always equal the total since persons who did not respond were excluded from the analysis.

used, the mobile persons use 28 percent public transport compared to those who cannot travel free who use 13 percent public transport (1.39 public transport modes per trip compared to 1.30). Here it can be observed that the fixed-track modes are used relatively more frequently. It can be concluded, therefore, that free travel will be most effective if the available public transport supply has a certain attraction.

CONCLUDING COMMENTS

The examination of the mobility levels of handicapped persons as defined by three different measures shows evidence that significant levels of mobility handicap occur outside the current definition, which relates to reduced earning capacity. Although the case study reported is based on experience in the Federal Republic of Germany, it is likely that similar relationships exist in other countries. The importance of elements such as the need for aids and assistance by other persons has been shown to be significant in affecting the levels of mobility possible for traveling by both public and private modes of transport.

REFERENCES

1. W. Brög and K. Ribbeck. Number and Status of Mobility-Handicapped Persons in the Federal Re-

public of Germany. In Transportation Research Record 973, TRB, National Research Council, Washington, D.C., 1984, pp. 27-39.
2. W. Brög, G.F. Häberle and K. Ribbeck. The Mobility of Persons Needing Nursing and Who Live at Home. In Transportation Research Record 830, TRB, National Research Council, Washington, D.C., 1981, pp. 1-7.
3. W. Brög and K. Ribbeck. The Mobility of the Handicapped in the Federal Republic of Germany. Presented at the Third International Conference on Mobility and Transport for Elderly and Handicapped Persons, Orlando, Florida, Oct. 1984.

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Travel Behavior of Residents of Retirement Communities

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ABSTRACT

Urban travel estimation is reviewed in the context of a growing elderly population and the trend of development of retirement communities. The life-style characteristics of retirement communities are uniquely different from those of virtually all elderly groups previously studied, and the mobility of the inhabitants appears to be reflected in this life style. Traditional, and newly developed, travel demand models fail to incorporate parameters that account for the significant variation in travel demand of elderly people that exists as a function of life style. An alternative trip generation model is proposed that would estimate travel demand of elderly people on the basis of life style using measures of age, dwelling unit type, employment status, and discretionary or obligatory travel.

An important transportation planning objective is to provide accurate travel estimates that simulate current travel and reasonably approximate future target-year conditions. This product is considered an essential element in the timely delivery of effective, efficient transportation facilities and service to the users. Many key decisions that involve enormous expenditures of time, money, and resources hinge on accurate forecasts.

In the early 1940s it was recognized (and confirmed by subsequent population census) that elderly people comprise an increasingly larger proportion of the total population of the United States. Ascertaining the needs and desires of this segment of the population has already effected changes in the housing, health care, leisure industries, and related government programs, but travel demand forecasting has been slow to fully assess and consequently adjust to the travel behavior that is unique to the elderly population.

Although the transportation planner generally knows that individual trip rates are affected by age, only a limited amount of research has been devoted to comprehensively study the travel behavior of elderly people and seldom has this knowledge substantially affected the practice of forecasting travel. Urban transportation planning agencies in general do not incorporate an age parameter in the trip generation, distribution, and assignment-modeling procedures (1). Typically, travel demand forecasts for the elderly population and the delivery of facilities and service have come under the heading of "Transportation for the Elderly and the Handicapped," which insinuates the needs of elderly people are similar to those of handicapped people or that elderly people, who are not disabled by age, behave like any other trip maker. In reality, travel by elderly people is not so insignificant that it can be ignored and it is not so readily separable into "disabled" and "ordinary other" travel.

THE ELDERLY POPULATION IN PERSPECTIVE

Figures 1 and 2 (based on 1980 Census of Population, Characteristics of Population, U.S. Summary and Arizona, respectively) show the proportion of the population made up of each cohort for 1940 through 1980 as reported by the U.S. Census. For this discussion, a cohort is defined as all persons born within a common 10-year period. That is:

Cohort	Age (years)
1	0-9
2	10-19
3	20-29
4	30-39
5	40-49
6	50-59
7	60-69
8	70-79+

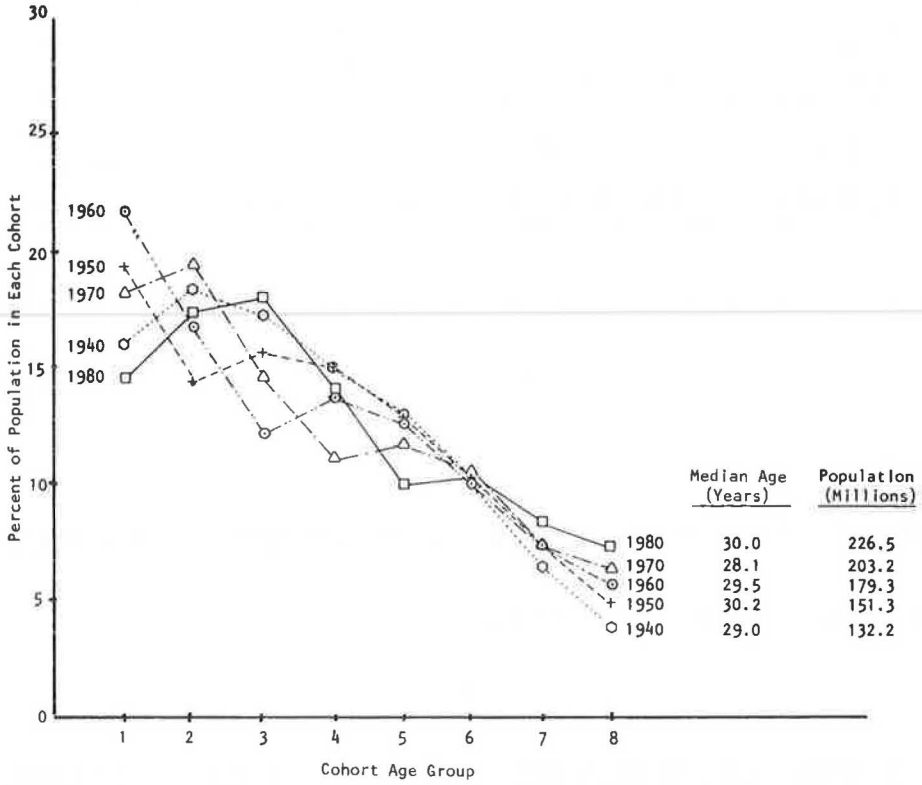

FIGURE 1 Percentage of population of each cohort for the United States, median age, and population—1940-1980.

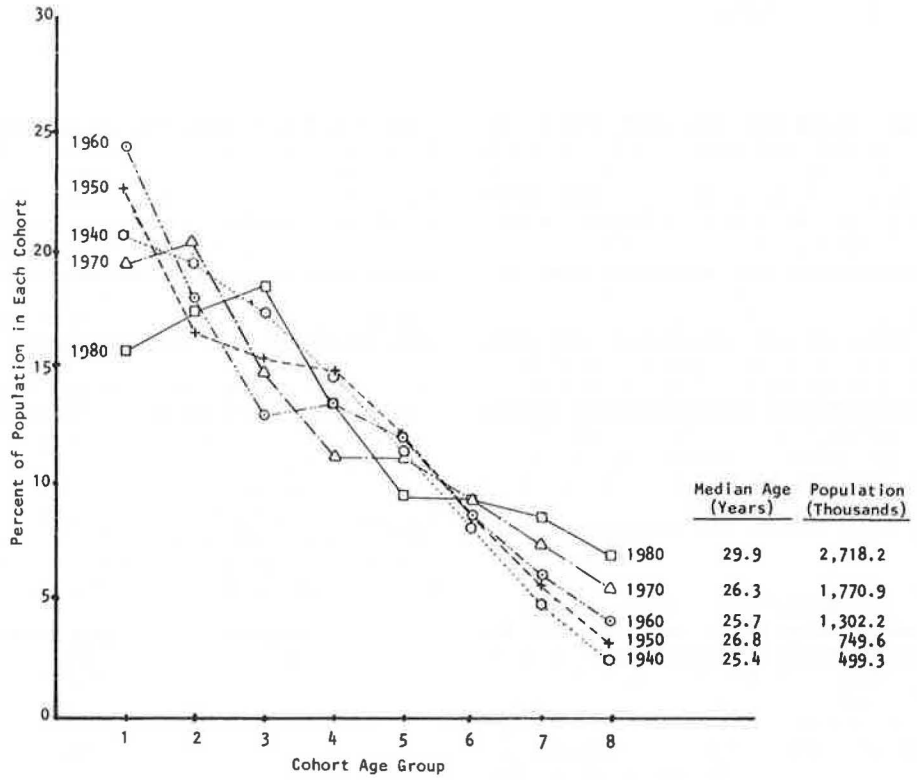

FIGURE 2 Percentage of population in each cohort for Arizona, median age, and population—1940-1980.

Note that all persons 80 years of age or older were assigned to Cohort 8. As is shown in Figures 1 and 2, from 1940 through 1980 there was a continual increase in the proportion of the population in Cohorts 7 and 8. As the population has increased, the number of persons 60 years of age or older has increased significantly from 13.7 million in 1940 to 35.8 million in 1980 nationwide--a threefold increase. In Arizona, the change has been from 38,000 in 1940 to 431,000 in 1980--an 11-fold increase.

From 1940 through 1960 the proportion of the population, nationwide and in Arizona, in Cohort 1 steadily increased. This represents the post-World War II baby boom. Just before 1970 the proportion of the population in Cohort 1 reached its peak and began a decline. However, the population wave created by the baby boom is moving forward in time as the baby boomers age. Its amplitude is diminishing, but it will continue to increase the proportion of the population in each successive cohort.

Since 1970 the population has been growing older because of the long-term downward trend of the birth rate and increasing life expectancies. In Arizona, these trends have been overwhelmed by the net immigration of people including the elderly. As Masnick and Bane (2) indicate, the baby boom will begin to have its most significant impact on the ranks of the elderly around the year 2010. Therefore, the proportion of the population that is elderly should continue to increase for at least the next 60 years. Census forecasts reported by Bell and Revis (3) indicate that the proportion of the population 65 years old and older will reach approximately 18 percent by 2040. They also indicate that by the year 2000, 40 percent of the population 65 years old and older will be over 75, increasing the ranks of what they term the "frail elderly."

This shift in age distribution to an older population has been accompanied by changes in housing and travel patterns. Retirement aged individuals often select unique living quarters and exhibit distinctly different travel behavior as indicated by trip purposes, trip rates, trip-length frequencies, and travel modes. The issues and problems of providing transportation for the elderly population are only beginning to be clarified.

Of particular interest from a transportation planning viewpoint is the current trend in Arizona of the development of retirement communities. Green Valley, Sun City, and Sun City West are examples of residential community developments primarily designed for and marketed to retirees. Green Valley is in the Tucson metropolitan planning area approximately 25 miles south of the Central Business District (CBD) adjacent to Interstate 19. Sun City and Sun City West are in the Phoenix planning area approximately 15 and 20 miles northwest, respectively, of the Phoenix CBD near US-89.

Figures 3-5 and Tables 1-3 provide an illustration of the character of these communities in relation to the cities of Tucson and Phoenix. The data were extracted from the 1980 Census (Figure 3 is based on 1980 Census of Population, General Population Characteristics, Arizona, Chapter B; Figure 4 is based on 1980 Census of Housing, General Housings Characteristics, Arizona; and Figure 5 is based on 1980 Census of Housing, Detailed Housing Characteristics, Arizona.) For Tucson and Phoenix, the data represent information for the incorporated cities. Green Valley, Sun City, and Sun City West are Census Designated Places (CDPs). [The Standard Metropolitan Statistical Area (SMSA) statistics were not used because they contain the data for the retirement communities and would, therefore, cloud the comparison.]

The residents of Sun City, Sun City West, and

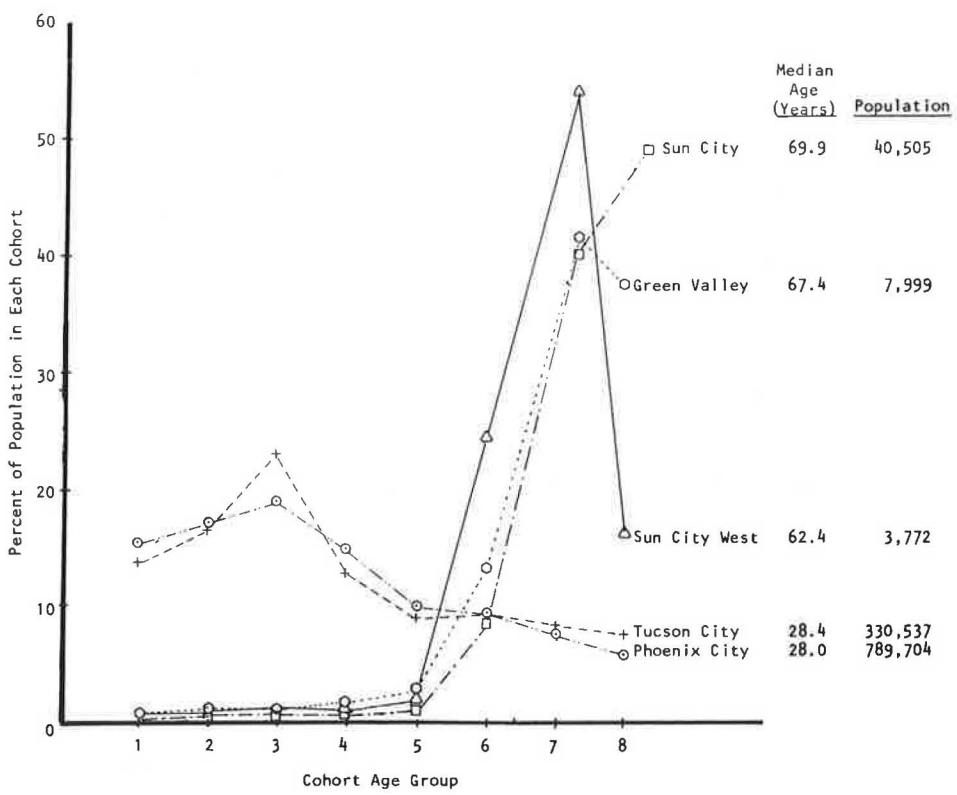

FIGURE 3 Percentage of city population in each cohort age group, median age, and population from 1980 Census.

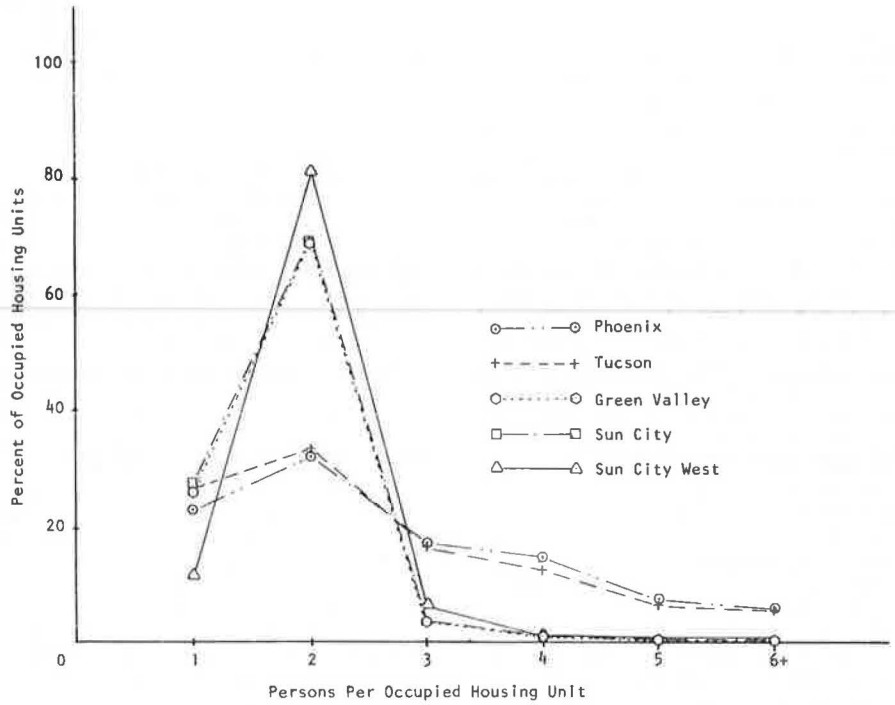

FIGURE 4 Persons per household for each community.

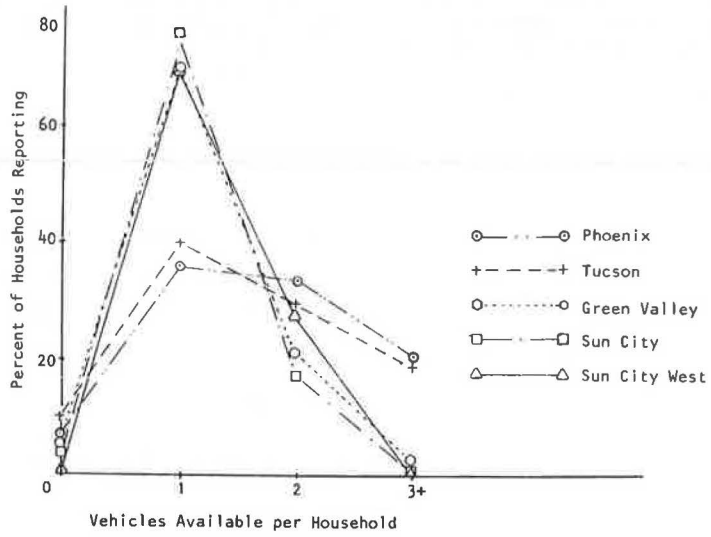

FIGURE 5 Percentage of households by vehicles available.

TABLE 1 Education, Race, and Labor Force Characteristics[a]

	Location				
Characteristic	Phoenix	Tucson	Sun City	Sun City West	Green Valley
Education					
High school grads (%)[b]	73.3	72.7	79.2	79.7	82.9
Completed 4+ years college (%)[b]	16.5	19.2	24.5	20.1	27.2
Percentage white race	84.3	81.7	99.9	99.4	99.3
Labor Force					
Families with no workers (%)	10.5	14.6	74.2	53.1	69.7
Nonworkers per 1,000 workers	102	113	920	520	694
Persons 16+ years old (%)	66.2	60.3	9.8	16.3	12.7

[a] Based on 1980 Census of Population, Volume 1, Chapter C, Part 4, Arizona, June 1983.
[b] For persons 25 years old and older.

TABLE 2 Socioeconomic Characteristics[a]

Characteristic	Location				
	Phoenix	Tucson	Sun City	Sun City West	Green Valley
Housing					
Number of units	308,302	137,249	25,347	3,558	6,160
Persons/occupied unit	2.74	2.57	1.77	1.97	1.81
One unit at address (%)	70.0	70.9	98.4	99.4	83.1
Median value of house ($)[b]	54,100	50,300	62,400	72,400	65,000
Median value of condo ($)[b]	56,000	49,000	55,900	67,700	45,800
Median rent ($)[b]	246	213	317	337	246
Built since 1974 (%)	19	14	24	99	47
Income					
Median/head of household ($)[b]	17,419	14,086	16,026	21,425	17,160
Mean/head of household ($)	20,784	16,849	19,370	24,747	20,499
Per capita ($)	7,551	6,473	10,943	12,658	11,182
Median of families with no workers ($)	8,655	9,411	17,480	19,189	18,070
Families below poverty level (%)	8.1	10.2	2.4	3.9	1.3

[a]Based on 1980 Census of Population, Volume 1, Chapters B and C, Part 4, Arizona, June 1983.
[b]All values in 1979 dollars; income is an annual amount.

TABLE 3 Family Structure[a]

Characteristic	Location				
	Phoenix	Tucson	Sun City	Sun City West	Green Valley
Persons 60+ years old living alone (%)	24.2	26.2	16.4	6.9	15.7
Households family occupied (%)	70.2	63.4	71.3	87.6	72.2
Married couple families (%)	81.5	80.0	95.7	96.9	96.1
Female householder, no husband present (%)	14.2	15.7	3.6	2.4	3.0

[a]Based on 1980 Census of Population, Volume 1, Chapters B and C, Part 4, Arizona, June 1983.

Green Valley have similar characteristics. Figure 3 clearly shows that the population of these communities is predominately 60 or more years of age. The labor force statistics given in Table 1 verify that the residents are generally retirees. They are white, affluent, married couples, well educated and living in detached single-family homes that average fewer than two persons per household (Figure 4 and Tables 2 and 3). Dwelling unit densities are low at 3.3 dwelling units per acre for Sun City, which is typical for this type of development (4). These developments are relatively new with a large percentage of housing units constructed after 1974. A relatively small percentage of the residents 60 years old or older live alone, and they appear to rely predominantly on private vehicles for transportation. Figure 5 shows that more than 95 percent of the households in these communities have at least one vehicle available.

A closer look at these retirement communities comes from an in-depth reader survey by the Green Valley News, which boasts 7,279 paid subscriptions out of 7,748 households and a 77.3 percent return of their two-page questionnaire survey of 300 households. (Note that these data were taken from a study conducted in January 1984 and, therefore, differ from the 1980 Census. Also, Green Valley has grown beyond the limits of the CDP indicated in the census.) According to the survey, 90.1 percent owned their home, 25.4 percent had bought a new car, and 70.7 percent opened a new checking or savings account during the 1983 calendar year. Shopping purposes, which account for 75 percent of the external trips to Tucson, occurred at least once a week for 28.9 percent of the Green Valley residents. It can be inferred from the data that a nearly equal percentage of Tucson trips were for dining out (72.8 percent), and medical and entertainment purposes were indicated by 34.5 and 24.1 percent of the respondents, respectively. The answers to these and 14 other questions confirm personal observations of Green Valley as a vibrant, mobile community that does not fit the sterotypic image of reticent elderly people (5).

These retirement communities also contain many of the activity centers generally associated with home-based travel. Shopping centers, financial institutions, medical facilities, golf courses, and other recreational facilities are typically designed into planned unit developments. They have proven to be attractive living arrangements and the development of retirement communities with these characteristics appears to be a growing trend. Since 1970 Sun City has increased in population 300 percent while the population in Cohorts 7 and 8 in Arizona has shown a 45 percent increase overall. Green Valley and Sun City West were developed after 1970 as were other similar communities in Arizona. Florida and California are experiencing a similar phenomenon.

The inhabitants can be expected to travel less than the typical urban dweller; however, not enough is known to accurately quantify their demand and, thereby, resolve the important issues of facility and service design. On the basis of travel forecasts using models that may be inappropriately calibrated, new bridge crossings and highway interchanges are contemplated in the Green Valley area and major upgrading of state routes near Sun City and Sun City West is being considered.

Reviewing the characteristics of the retirement communities indicates that the trip rates of these areas may be declining as the communities and the residents grow older. Sun City represents the oldest of the three communities with some of the development having taken place before 1970. Green Valley is

next chronologically, with extensive development having taken place between 1970 and 1975. Sun City West is the youngest with nearly all of the development having taken place since 1974. The population age, persons per household, income, and family structure data for the residents are rank-ordered precisely with the age of the communities. The possibility that the age of the residents will increase on average, and that household size will decrease with time, is supported by the 1970 Census statistics for Sun City. Between the 1970 and 1980 Census, the median age of Sun City residents increased from 67.5 to 69.9 years, and the average number of persons per household declined from 1.85 to 1.77.

The implication is that as the communities and residents age and the number of persons per dwelling unit declines as a result of the death of a spouse, trip making per dwelling unit will also decline. Hence, even within this particular life style and community, trip making per dwelling unit may vary significantly over time. Traditional modeling efforts have not taken this possibility into consideration. What is needed is a model that will forecast individual trip rates as a function of age and lifestyle variables.

TRAVEL BEHAVIOR OF RESIDENTS OF RETIREMENT COMMUNITIES

Current knowledge of travel of elderly persons has come primarily from studies of urban or suburban dwellers. These studies generally characterize the urban elderly population as relatively poor, transportation disadvantaged, and often dependent on public transportation (6-10). The daily person trip rates reported in these studies range from a low of 0.3 (10) to 2.68 (6) trips per person per day for elderly population subgroups stratified by income, automobile ownership, and the existence of a transportation disadvantage.

A significantly higher trip rate would be anticipated for the inhabitants of the retirement communities that are the focus of this paper. Previous studies (6,7) indicate increased trip making for elderly people with more affluent life styles. People with a "financially secure" life style described by Wachs (7) had the highest average trip rate of the elderly life styles studies in the Los Angeles area at 2.04 trips per person per day. The financially secure were described as similar to the residents of the retirement communities discussed earlier. However, the financially secure households were indicated as having significantly lower automobile ownership (28.4 percent with no automobile) and home ownership (approximately 40 percent renters). The implication is that retirement community dwellers would have an even higher propensity for trip making.

Retirement communities are defined by the Institute of Transportation Engineers (ITE) (11, Section 200) as follows:

> Retirement Communities--restricted to adults or senior citizens--contain residential units similar to apartments or condominiums and are usually self-contained villages. They may also contain special services such as medical services, dining facilities, and some limited supporting retail facilities.

The ITE reports an average weekday vehicle trip generation rate of 3.3 vehicle trip ends per dwelling unit for retirement communities. This figure is based on only five studies conducted in the San Francisco Bay area (12,13). One of the study sites was an apartment development. Three of the study sites were multibuilding complexes that had relatively large staffs that supplied extensive services and recreational activities. This type of facility was designed not only as a place to live, but also to satisfy the health care and recreational needs of the residents and thus reduce the need for travel. This type of facility will henceforth be referred to as an extended care facility. The fifth study site was a low-density, single-family, detached housing development with a golf course, service station, and grocery store--similar to the Green Valley, Sun City, and Sun City West areas.

Similar data for four other locations were also made available from the Maricopa Association of Governments, Phoenix, Arizona (4) and from the Florida Department of Transportation (14). The relevant statistics for these sites are given in Table 4. The data in this table were collected using cordon counts of vehicle traffic entering and leaving these sites, which were isolated and had minimal through traffic. These counts are not directly comparable to the statistics cited earlier, which were based on data collected for person trips at the household level. However, these data suggest that the type of dwelling unit is indicative of travel behavior of elderly residents and that the aggregation of trips per dwelling unit, irrespective of dwelling unit type, is improper.

At least two, and possibly three, stratifications by dwelling unit type are indicated. The mean vehicle trip rate per dwelling unit for extended

TABLE 4 Vehicle Travel Demand of Residents of Retirement Communities[a]

	California					Arizona			Florida
		Extended Care Facilities				Single-Family Homes			Single-Family Homes with Apartments (1,500 homes + 800 apts)
	Apartments	1	2	3	Single-Family Homes	1	2	3	
Dwelling units	108	300	46	3,122	460	125	60	176	2,300
Residents	150	347	90	5,463	835				4,500
Residents per dwelling unit	1.4	1.2	1.2	1.8	1.8				2.0
Staff persons		42	50	350	75				500[b]
Dwelling units per acre	18.6	34.5	10.8	5.6	1.5	3.3	3.9	3.3	
Weekday trips per[c]									
Dwelling unit	2.9	2.8	3.4	3.1	4.9	7.8	4.8	4.9	3.0
Resident	2.1	2.4	2.9	1.8	2.7				1.5
Person	2.1	2.1	1.9	1.7	2.5				1.4

[a]Based on Maricopa (*4*), California (*12-13*), and Florida (*14*) data.
[b]Includes 200 permanent employees and 300 new construction workers on-site at the time the data were collected.
[c]Total one-way vehicle trips.

care facilities is 3.1, whereas that for the single-family home communities is 5.6 (this does not include the Florida data that contain two dwelling unit types). Using the statistical T-test, these mean values were found to be significantly different at the 95th percentile level. It should be noted that travel demand for the extended care facilities is inflated by the inclusion of staff travel, which would indicate an even lower travel rate for the elderly residents. A third stratification may exist for apartment dwellers, although this could not be tested. Although this analysis is not definitive because of the small data sample, it does reinforce the idea that type of dwelling unit could be used as an indicator of both life style and travel demand for retirement communities.

Trip purpose stratification for the elderly population has been fairly well documented (6-8,15). Although the trip purpose categories vary between studies, there is general agreement that work travel decreases significantly after retirement and that social, recreational, and leisure travel becomes more prominent. However, Wachs (7) indicated a significant variation in trip rates with life style for discretionary trip purposes. The proportion of travel for work did not vary significantly between life-style groups.

Trip generation rates are not the only variables of interest for forecasting travel demand for retirement communities. Trip distribution has traditionally been an important element in the modeling chain. The calibration of the Gravity Model for trip distribution requires a distribution of travel by trip length or travel time. The effect of distance on travel of elderly people is not well documented. Ashford and Holloway (15) indicate that trip length remains relatively constant for adults regardless of age.

The conversion of person trips to vehicle trips using automobile occupancy rates is also necessary for quantifying highway volumes. However, little information is available describing the effect of age on automobile occupancy.

Although the potential for a uniquely different travel behavior pattern for retirement communities has been recognized, adjustments to the regional travel demand models are often hypothetical in nature and are not substantiated by empirical data. The conventional regional models are limited in the variables that are available for adjustment.

In Arizona the forecasts made from the regional travel demand models are refined by lowering the trip rates of the elderly population (sometimes by one-half) in order to assess particular sites or special generators. This practice begins to improve the accuracy of travel forecasts but it does not necessarily reflect the actual travel behavior of the elderly population or represent the self-contained nature of a retirement community separated by some distance from the urbanized portion of a metropolitan area.

LIFE-STYLE CONCEPT

The life-style concept of behavioral modeling suggests that different segments of the population can be clearly identified on the basis of specific characteristics of the individual or household and that these characteristics can be used to predict behavior. Definitions of life style primarily revolve around the theme of the allocation of an individual's time and resources to the activities of life (16,17). Life style is assumed to identify homogeneous groups that participate in the activities of life in a similar fashion.

Traditional travel estimation techniques have segmented the urban travel market on the basis of geographic location and, ultimately, of aggregate zonal demand characteristics. It is often assumed that the demand estimation error, caused by the variation of demand by individual households from the aggregate value, will be reduced if the zonal characteristics are homogeneous. Homogeneity for residential zones is typically defined by a similarity in the travel predictors of household size, income, and automobiles available. It is obvious from this discussion of retirement communities that similarity of household size, income, and automobiles available does not necessarily constitute a homogeneous population. Clearly, an elderly couple with an automobile and a $20,000 annual income will have significantly different travel behavior than a younger couple with the same characteristics.

Life-style market segmentation is an effort to further refine the composition of a homogeneous group. This approach is well known as a marketing tool for business (18,19); however, its application to transportation demand estimation is relatively new.

The use of life-style segmentation has been shown to improve trip generation forecasting through the inclusion of measures of household structure and residential location in existing travel forecasting procedures (16). It has been used successfully to discriminate between market segments in a joint mode and destination choice model (20), and it has been used to identify variations in travel demand for urban population subgroups (21). The parameters used to describe life style vary considerably among studies, and they are generally tailored to meet specific research needs. In each case the researchers developed an expanded list of measurable socioeconomic and demographic variables that demonstrated the segmentation of life style for the purpose of modeling transportation demand. They have explicitly recognized age as an important indicator of life style and predictor of travel behavior. However, they have each grouped the elderly population into a single 65-and-older life style and hence failed to account for the diversity of life styles and travel needs that exists within this group.

Wachs (7) has demonstrated that the variation in life styles of elderly people can be related to a significant difference in travel demand. The cross-classification presented by Wachs (7) assumes that the trip generation rate within a life style remains stable over time. This technique does not account for the potential impact of a new cohort entering a particular life-style category and bringing with it mobility standards different from those of the previous cohort. Nor does it account for the potential change in travel demand within a life style resulting from continued aging.

The application of any of these existing techniques appears inappropriate for the retirement communities discussed. The residents of these communities appear to have a unique life style that has yet to be fully evaluated and comprehended relative to its travel needs. Also, efforts to develop a transportation demand model should recognize the diverse life styles of the elderly population.

DISAGGREGATE LIFE-STYLE MODEL

Estimating travel, including that of elderly persons, should be based on reliable, easily obtained parameters that accurately simulate present conditions and prove to be suitable for future-year forecasts. Compared to the aggregate models, the disaggregate models are ideal for accounting for the

unique differences in travel patterns of various life styles. The disaggregate approach also offers the advantages of reduced data costs, improved accuracy in predicting travel responses to public policy, more relevant and timely output information, and a model structure more readily transferred from one geographic area to another (22). In view of the current status of transportation planning for elderly persons in Arizona (further primary data collection is about to start, public policies are beginning to emerge, and burgeoning retirement communities are being located throughout the state), a disaggregate model seems most appropriate. Because both the Phoenix and the Tucson regional transportation offices use disaggregate, cross-classification trip generation models, a similar model structure for the elderly population would facilitate its integration into the regional modeling chain.

The traditional methods of transportation planning need to adapt in theory and application to the emerging reality of a traveling elderly population. Research suggests that conventional methods and theory need to be more strongly focused on behavioral life styles of elderly persons for quantifying their travel demand (7). Supernak's (21) categorization of travel into obligatory and discretionary trips facilitates the modeling of travel by elderly persons and the subsequent planning of facilities and service:

1. Trip rates for elderly persons are rationally explicable, especially relative to the diverse trip-making behavior within the aged population and in comparison to the typical trip generators of the more generalized regional models.
2. Travel measures such as trip length frequencies, peaking characteristics, and special distribution of trips are ascertained more precisely by this stratification.
3. Assessment of the effectiveness of plans and programs such as carpooling, flexible work hours, and suppression of peak-period discretionary travel is made clearer under this modeling approach.

Beyond this categorization into obligatory and discretionary travel, a cross-classification matrix of trip purposes and life-style parameters, which will meet the test of reliability, efficiency, and temporal stability, is needed.

The most difficult aspect of formulating a model for forecasting travel by elderly people is the selection of the independent trip generation variables. Research has shown (7) that the activities and mobility to which a person has become accustomed are likely to continue into the elderly and retirement years. In the future the retirement communities in Arizona are likely to see cohorts with a larger portion of licensed drivers primarily reflecting today's increase in licensed females. This phenomenon is not easily represented by surrogate parameters like automobile availability, age, household type, employment status, or residential zone descriptors as suggested by Allaman et al. (16).

Even if all of Allaman's parametric values were the same for the elderly traveler in the year 1980, that person in all probability will have behaved differently from the elderly traveler of the year 2000 or from the elderly traveler from the 1960 era. Thus the formulation of a model, if pursued to an academically satisfying conclusion, could entail postulating all of the correct parametric descriptors of life style, the collection and analysis of further data, and the arrangement of these parameters into a temporally stable model. This would be an expensive undertaking, beyond the scope of this research, and likely to produce a model the data input requirements of which would be beyond the limit of practicability.

After a review of what primary data have been collected on travel by elderly people, it is apparent that retirement community travelers are primarily distinguished from other elderly travelers by the era of their birth (and consequent formation of life styles and mobility predilections) and their cultural, economic, and health tendencies. Thus "date of birth" and the "type of dwelling unit" (including some measure of value) are suggested here as the preferred surrogate parameters for many of the significant influences on travel of elderly persons. Trip rate data used in the ITE studies affirm the existence of distinctly different travel patterns according to the type of housing occupied. It appears that extended care nursing homes and in-city apartments for the elderly have uniquely lower trip rates than does the single-family detached house of a planned retirement community (9,23). This is probably because distinctly different people with different activities, mobility patterns, and tendencies inhabit these dwelling units. The "date of birth" or age and the "type of dwelling unit" parameters have the added feature of being readily available and commonly forecast with confidence about the temporal stability of the data. The resultant trip rates for a given cohort age group and a potentially quantifiable relationship between preretirement and postretirement travel in the obligatory and discretionary categories can also be estimated with confidence.

The disaggregate life-style model for travel by elderly people is thus formulated as

$$T = f(B,C,D,E)$$

where

- T = a particular cell of obligatory or discretionary travel within the cross-classification matrix;
- B = birth date, which identifies cohort mobility tendencies;
- C = category of travel, obligatory or discretionary and further subdivided by trip purpose;
- D = dwelling unit type (including some measure of value and categorized as extended care facility, apartments for the elderly, or single-family detached); and
- E = employment status, employed or not employed.

CONCLUSIONS

On the basis of the preceding evaluation, the following conclusions can be drawn:

1. As the proportion of elderly people in the population is growing, the attractiveness of retirement communities, as described here, appears to be an increasing trend.
2. On the basis of the life-style characteristics of the inhabitants of retirement communities, their travel behavior would appear to be uniquely different from that of the elderly groups previously described in the literature. Their propensity to travel would appear to be much higher, with a large portion of trips having destinations within the community. However, this hypothesis requires data collection for further testing.

3. The sorting of housing into categories such as apartments, extended care facilities, nursing homes, and single-family detached housing appears appropriate for improving travel demand estimation for the elderly population.

4. Birth date and descriptions of dwelling unit type appear to have a high potential for use as independent variables in a life-style-based travel demand estimation model.

5. Existing travel demand models generally fail to incorporate the effect of aging beyond 65 years of age on travel demand and fail to recognize the diversity of life styles of elderly persons.

RECOMMENDATIONS

On the basis of this study, the following recommendations for further research are made:

1. Observations of the retirement community life style suggest a travel behavior substantially different from that of other elderly populations or from the urban traveler in general. High automobile occupancy rates, licensed golf cart transporters, frugal use of time and money resources, and remarkably unique external and local travel behavior are begging to be measured, analyzed, and synthesized into a calibrated model. Such work must begin with a well thought out, comprehensive collection of primary data.

2. Although life-style models have considerable conceptual appeal, one needs to be formulated and tested against the conventional models that have generally proven to be quite accurate and useful in the planning and implementation process.

3. Cohort mobility tendencies have been recognized, but a method to systematically monitor and appraise them over time and then integrate them into the forecasting of travel by elderly people should be developed.

4. The self-containment objectives of the retirement community hinge on providing the land uses that support the desired activities of the elderly residents. External local travel patterns and sitings of businesses and public facilities within or nearby indicate the extent to which this objective has been accomplished. A time series analysis of land-use development and external travel is needed.

5. Developers of retirement communities aim to provide the amenities that will attract elderly residents. The efficient arrangement of land use along with an integrated transportation system designed for the particular mobility needs of this life style would further the communities' goals and those of the developers. An assessment of these land-use and transportation attributes and their congruence with resident needs ought to be undertaken and the direction of planning for these attributes revised or reinforced accordingly.

6. The modeling of travel by elderly people suggested in this paper is an attempt simply to address the wide variation in travel for that segment of the population. However, this model needs to be tested.

7. With similar differences in life styles for the young and middle aged, further research and model formulation (perhaps in the disaggregate form of cohort age group, obligatory and discretionary activities, dwelling unit type, and employment status) is recommended. The proposed model need not apply just to the elderly population.

REFERENCES

1. H.S. Levinson. Urban Travel Characteristics. In Transportation and Traffic Engineering Handbook. Institute of Transportation Engineers; Prentice-Hall Inc., Englewood Cliffs, N.J., 1982, pp. 255-307.
2. G. Masnick and M.J. Bane. The Nation's Families: 1960-1990. Auburn House Publishing Company, Boston, Mass., 1980.
3. W.G. Bell and J.S. Revis. Transportation for Older Americans: Issues and Options for the Decade of the 1980's. Final Report DOT-I-83-41. U.S. Department of Transportation, April 1983.
4. Trip Generation by Land Use, Part II: Valley Area Studies. Transportation Planning Office, Maricopa Association of Governments, Phoenix, Ariz., Nov. 1974.
5. 1984 Demographic Survey of Green Valley, Arizona. Green Valley News, Green Valley, Ariz., 1984.
6. J.K. Markovitz. Transportation Needs of the Elderly. Traffic Quarterly, Vol. 25, No. 2, April 1971, pp. 341-358.
7. M. Wachs. Transportation for the Elderly: Changing Lifestyles, Changing Needs. University of California Press, Los Angeles, 1979.
8. F.M. Carp. The Mobility of Retired People. In Transportation and Aging: Selected Issues. U.S. Government Printing Office, 1970, pp. 23-41.
9. R.E. Paaswell, E. Weinstein, and M. Nalopa. Housing Location and Transport for the Elderly. Proc., National Conference on Transportation for the Elderly, Florida State University, Orlando, 1981, pp. 57-63.
10. R.E. Paaswell. Estimation of Demand for Transit Service Among the Transportation Disadvantaged. In Transportation Research Record 660, TRB, National Research Council, Washington, D.C., 1977, pp. 38-49.
11. Trip Generation, 3rd ed. Institute of Transportation Engineers, Washington, D.C., 1982.
12. Fifth Progress Report on Trip Ends Generation Research Counts. State of California, Business and Transportation Agency, Department of Public Works, Division of Highways, Sacramento, Dec. 1969.
13. Sixth Progress Report on Trip Ends Generation Research Counts. State of California, Business and Transportation Agency, Department of Public Works, Division of Highways, Sacramento, Dec. 1970.
14. Trip Generation Survey Report. Highway Planning Office, Florida Department of Transportation, Tallahassee, April 1975.
15. N. Ashford and F.M. Holloway. The Effect of Age on Urban Travel Behavior. Traffic Engineering, Vol. 41, No. 7, April 1971, pp. 46-49.
16. P.M. Allaman, T.J. Tardiff, and F.C. Dunbar. New Approaches to Understanding Travel Behavior. NCHRP Report 250. TRB, National Research Council, Washington, D.C., 1982.
17. V.L. Bengaton. The Social Psychology of Aging. Bobbs-Merrill, Indianapolis, Ind., 1973.
18. M. Hanan. Life-Styled Marketing. AMACOM, New York, 1980.
19. W.D. Wells, ed. Life Style and Psychographics. American Marketing Association, Inc., New York, 1974.
20. I. Salomon and M. Ben-Akiva. Life-Style Segmentation in Travel Demand Analysis. In Transportation Research Record 879, TRB, National Research Council, Washington, D.C., 1982, pp. 37-44.

21. J. Supernak. Travel-Time Budget: A Critique. In Transportation Research Record 879, TRB, National Research Council, Washington, D.C., 1982, pp. 15-28.
22. W.B. Tye, L. Sherman, M. Kinnucan, D. Nelson, and T. Tardiff. Application of Disaggregate Travel Demand Models. NCHRP Report 253. TRB, National Research Council, Washington, D.C., Dec. 1982.
23. W. Brög, F. Häberle, and K. Ribbeck. Mobility of Persons Who Need Nursing and Who Live at Home. In Transportation Research Record 830, TRB, National Research Council, Washington, D.C., 1981, pp. 1-7.

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Estimating the Cost of Providing Transportation Services to Elderly Clients

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ABSTRACT

The purpose of this paper is to help individuals and organizations engaged in the provision of transportation services to the transportation disadvantaged better understand and control the cost of those services. Presented is the "parametric cost estimation methodology," which resulted from a study conducted by the Institute for Economics and Social Measurement, Inc., and Ecosometrics, Inc., for the U.S. Department of Health and Human Services, Administration on Aging. In this study methodologies were developed for assessing the costs of both transportation and in-home services provided to elderly clients under Title III of the Older Americans Act. The study produced (a) a research report summarizing the application of the resource-based cost methodology that was developed for these two studies and (b) a cost assessment manual for use by local service providers. Data used to develop the cost methodology were collected from in-depth interviews with all transportation service providers in 16 randomly selected planning and service areas across the United States (a total of 49 providers were included in the sample). Providers were contacted in person for information on factors such as the basic costs of resources, the amount of resources required to produce services, service specifications, and consumption patterns and rates. From the data, parametric cost formulas were developed that relate resources used with services produced and consumed. A brief overview of the results of the research and of how to use the methodology to construct and analyze the true cost of operating transportation services is presented.

The issue of how to achieve the greatest level of program effectiveness within available resources has always been of paramount concern for service providers who find themselves operating within limited budgets. In recent years this issue has become even more critical for providers of transportation services to the disadvantaged as budgets have been cut and the cost of services has been rising. Complicating the challenge of providing cost-efficient services is the severe lack of knowledge about the actual cost of providing services and the specific factors that create substantial differences in cost from area to area or organization to organization.

Selected results of a 3-year research project, conducted by Ecosometrics, Inc., and the Institute for Economic and Social Measurements, Inc., for the U.S. Department of Health and Human Services, Administration on Aging, are presented. Although the primary purpose of these studies was to examine the difference in the cost of services to elderly clients in urban and rural areas, one of the major products of the studies is a cost estimation methodology that can be used by local service providers to estimate current or future service costs. A simpler version of the methodology applied to secondary data on transportation services was applied to secondary data in a previous phase of the study (1). The development of this new approach to cost measurement was precipitated by the realization that generally available cost estimation methodologies and previous

studies of costs have severe limitations resulting from problems of inadequate or nonuniform record keeping, lack of uniformity across service providers in terms of service and accounting definitions, failure to include all relevant costs, and lack of control for service quality (2). The limitations of this previous work, coupled with the recent reductions in governmental spending on social services, highlight the need for more complete, accurate, and simple ways to calculate the cost of services. The methodology presented here is intended to fill this gap.

The research project referred to previously resulted in both a research report describing the results of applying this resource-based cost methodology to transportation and in-home services (3) and a cost assessment manual that enables service providers to apply this methodology (4). A brief overview of both the research results and the manual is presented here. It is intended that a service provider be able to use the information in this paper to roughly estimate costs. First, cost models, which can be applied by local agencies to their situations, are presented. Second, instructions for applying the models are presented, and, finally, results of the analysis of unit costs are included. In the event that an agency is missing information on a particular cost element (e.g., administrative rates, fuel costs), average or "default" values are presented. Note that "default" cost figures presented in the tables were developed by (a) computing the average value for data on all applicable providers, (b) eliminating providers with unusually high or low values (more than one standard deviation away), and (c) recalculating to get a new "average." If more in-depth costs or more detailed instructions are required, the reader should refer directly to the manual for step-by-step instructions on calculating disaggregated costs.

DATA USED TO DEVELOP COST MODELS

The data used to develop the parametric cost models were collected in in-depth personal interviews with 49 transportation service providers nationwide. In conjunction with the University of Michigan, a sample of 16 planning and service areas (PSAs) was prepared (a number sufficient to provide data on site characteristics and to apply the cost analysis methodology). The sample was stratified to represent those characteristics of the service setting or provider that were anticipated to affect costs. Providers in the sample varied by the urban or rural nature of their service area, geographic location, agency base, type of organization, and quality of service provided (3). [Quality of service was defined by a set of performance measures and program attributes. Service provided by each provider was rated relative to the sample as a whole by using standardized scores (z scores).]

All transportation service providers derived some portion of their funds from Title III of the Older American Act of 1965, as amended. The transportation services typically were provided by human service organizations, usually private nonprofit or public social service agencies. The scale of operation was rather modest, with a median vehicle fleet size of three vehicles. The service generally was provided on an advanced reservation basis, either through telephone reservations or by signing up at meal sites or other service centers. Passengers were either picked up at their homes and taken to destinations (door-to-door service) or transported in groups. A list of trip priorities was often employed to provide some controls on the demand for trips.

BASIC FEATURES OF A COMPLETE RESOURCE-BASED COST METHODOLOGY

The comprehensive cost analysis framework used in this paper examines transportation service costs in terms of three dimensions: the service being costed in terms of requisite activities and functions, the resources necessary to provide the service, and the costs of the resources. This approach develops service costs in terms of the actual amount of resources needed to deliver a service unit and the costs of those resources as determined by a particular setting. Because this approach works by combining detailed individual cost elements, called parameters, the overall costing methodology is known as "parametric cost modeling." It can be used to estimate the unit cost of a service using simple equations.

To perform a complete resource-based cost analysis, it is necessary to

1. Specify the services in their most basic components (e.g., as institutional arrangements, client characteristics, service characteristics, developmental phase of the service) to ensure that like services are being analyzed;
2. Specify the functions or activities (e.g., administration or direct service provision) that lead to the expenditure and use of resources such as personnel, equipment, buildings, and materials;
3. Specify the amount of each type of resource that is required (e.g., the number of gallons of fuel needed per mile of service); and
4. Assign costs or values to all resources used on the basis of current resource prices, contractual or other agreements including estimated costs of volunteer or donated labor and donated or in-kind equipment, materials, and buildings.

The approach also allows an agency to track the effect on service costs of current resource prices and to study the effect of assuming different prices for each type of resource used.

TRANSPORTATION COST MODELS

The parametric cost models that were developed in this research are tools with which to estimate transportation unit costs. The relatively simple equations that follow were used to estimate and compare the cost of providing transportation services in a variety of situations by a variety of types of organization. These equations can be used along with the data presented in the tables to make such estimates and comparisons of transportation costs. The subsequent section presents instructions for using the equations.

USE OF COST MODELS

The total cost of transportation services is computed by first adding service operating costs to the cost of administering the transportation program. Transportation-specific capital costs are then added in, as is the cost of general agency administration that is allocated to the service. Both administrative cost categories are expressed as ratios of administrative costs to program or operating costs. Separate equations are specified in subsequent sections for each of the variables. This relationship can be written as the following equation:

Total transportation costs = [(Transportation operating cost) (Transportation administrative expense rate + 1) + (Transportation capital costs)] (Agency administrative expense rate + 1).

The cost elements have been grouped in three major cost categories: (a) operating costs, (b) capital costs, and (c) administrative costs. Operating costs are those expenses incurred in actual transportation operations. Capital costs represent expenses for office equipment and vehicle depreciation and interest (it has been assumed that all other capital equipment or facilities are rented). Administrative costs are those expenses incurred to administer the overall agency function and, more specifically, to administer transportation services.

Administrative Costs

Two categories of administrative expense rates were developed: a general agency administrative expense rate and a transportation administrative expense rate. The general administrative expense rate includes the cost of general agency functions such as accounting, agency management, and grant proposal writing. The transportation administrative expense rate includes the cost of transportation management functions. Both rates are expressed as ratios of the administrative costs in each category to program costs. Both rates include labor (wages and fringe benefits), office space (rent and other space costs), office equipment costs, and other administrative expenses (telephone, postage, supplies, and other). All costs are included as actual dollar values. Discussions of the two administrative rate categories follow (explanations of how to compute the four cost components included in each rate are included in the complete manual and research report).

General Administrative Expense Rate

The general agency administrative expense rate is computed as the ratio of the total general agency administrative costs divided by the total of all agency program costs:

General administrative expense rate = General administrative costs/All agency program costs.

The denominator of the ratio can either be taken directly from agency records or can be computed by taking the total agency budget minus the general administrative costs in the numerator. The numerator of the ratio includes all cost elements cited previously. Cost formulas are presented in the manual for each of the four administrative cost elements (labor, space, office equipment, other costs) and can be used in a building-block (additive) format; that is, the results of the four formulas can be added to calculate total general administrative costs.

General administrative expense rates average about 21.5 percent and do not vary considerably between urban and rural areas, even with higher labor costs and rent per square feet in urban areas. Table 1 gives a summary of general administrative rates for each area. General administrative expense rates do vary by the type of agency. General administrative expense rates for public agencies were 43 percent greater than rates for private nonprofit organizations. Single-purpose agencies and independent units with a central planning unit have higher general administrative expense rates than do agencies in which transportation services are part of a consolidated multipurpose agency. Aging services agencies have higher rates than community action agencies, governmental agencies, or senior centers. (Aging service organizations include some Area Agencies on Aging but are primarily private nonprofit agencies that exclusively serve the elderly population.) Table 2 gives a summary of administrative rates by agency type.

TABLE 1 General Administrative Expense Rates in Urban and Rural Areas

Area	General Administrative Expense Rates (%)	
Rural		
Average-cost areas (n = 14)	22.1	21.9
High-cost areas (n = 7)	21.3	
Urban		
Average-cost areas (n = 9)	22.2	21.2
High-cost areas (n = 5)	11.9	

TABLE 2 Summary of Administrative Expense Rates by Agency Type

	General Administrative Expense Rate (%)	Transportation Administration Expense Rate (%)
Organization		
Private nonprofit (n = 35)	19.0	35.6
Public (n = 11)	27.1	31.3
Management		
Single-purpose agency (n = 11)	25.3	33.8
Independent unit with central planning unit (n = 6)	29.0	30.0
Part of consolidated multipurpose agency (n = 29)	17.4	33.3
Agency		
Aging services (n = 13)	31.0	31.1
Community action (n = 9)	25.7	28.3
Government (n = 6)	18.5	45.2
Senior center (n = 12)	13.0	37.8
Average	21.5	35.1

Transportation Administrative Expense Rate

The transportation administrative expense rate is computed as the ratio of transportation administrative costs divided by transportation operating costs:

Transportation administrative expense rate = Transportation administrative costs/Transportation operating costs.

The denominator of the ratio is computed on the basis of the operating cost equation and the parameters established in the next section. The numerator of the ratio includes the same administrative cost elements that are included in the general administrative expense rate, with the exception that these particular costs are directly attributable to the administration of the transportation program. As with the general administrative costs, simple formulas were developed for each of the four cost elements (labor, space, office equipment, other costs) and the results of these four formulas can be added to arrive at total transportation administrative costs.

Transportation administrative expense rates average around 35.2 percent. Although they are not highly correlated with the urban or rural nature of

an area, transportation administrative expense rates are slightly higher in urban areas. Even though both wages and rents per square foot are higher in urban areas, transportation administrative expense rates are greater in high-cost rural areas and average-cost urban areas. Table 3 gives a summary of transportation administrative expense rates.

TABLE 3 Transportation Administrative Rates in Urban and Rural Areas

Area	Transportation Administrative Expense Rate (%)	
Rural		
Average-cost areas (n = 14)	25.4	31.1
High-cost areas (n = 8)	41.0	
Urban		
Average-cost areas (n = 15)	43.5	39.4
High-cost areas (n = 6)	29.2	

Transportation administrative expense rates do vary depending on the type of agency operating the service. Table 2 gave a summary of administrative expense rates by agency type. Transportation administrative expense rates are comparable for private nonprofit and public agencies and for various management types. Governmental agencies and senior centers have higher transportation administrative expense rates than do aging services or community action agencies. Because the reverse is true for general administrative expense rates, it may be that a trade-off is made in agencies between what is called transportation administration and what is called general administration.

Space does not permit the presentation of results and information with which to calculate the general administrative rate and transportation administrative rate for the reader's individual agency. Both the manual and the research report produced through this study contain detailed step-by-step instructions (and default values if information is missing on a system) for computing both these rates and the following individual components that are included in the rates:

- Administrative labor costs (wages and fringe benefits);
- Administrative office space costs (space, utilities, and so forth);
- Administrative office equipment (desks, photocopies, and so forth); and
- Other administrative costs (telephone, supplies, postage, printing, and so forth).

Transportation Operating Costs

Transportation operating costs are separated into three categories depending on the output measure that affects the cost:

- Operating costs dependent on vehicle-miles,
- Operating costs dependent on vehicle-hours of available service, and
- Operating costs dependent on number of vehicles.

Cost formulas have been developed for each of these categories. The results of each formula can be added to calculate total operating costs.

Operating Costs Dependent on Vehicle-Miles

There are two main cost elements that are dependent on vehicle-miles: (a) fuel and oil and (b) vehicle maintenance and repairs. Fuel and oil costs per mile do not vary by urban or rural area, but they do vary considerably by vehicle type. This means that agencies that operate larger vehicles have greater fuel and oil costs per mile. The average fuel and oil cost was $0.165 per mile. Table 4 gives default values developed for average fuel and oil costs per mile based on the survey data.

TABLE 4 Fuel and Oil Costs—1982

Vehicle Type	Approximate Miles per Gallon[a]	Fuel and Oil Cost per Mile ($)
Sedan or station wagon	10.0	0.13
Van	8.1	0.16
Small bus	6.5	0.20

[a]Assumes a 1982 price per gallon of fuel of $1.30 (leaded, $1.20; unleaded, $1.28; and leaded premium, $1.40).

Vehicle maintenance costs include all contract or in-house maintenance, or both, of vehicles. As with fuel and oil costs, vehicle maintenance costs per mile are also more dependent on the type of vehicle. However, vehicle maintenance costs per mile also vary by urban or rural areas with urban areas generally higher in cost than rural areas. Table 5 gives vehicle maintenance costs per mile by vehicle type and urban or rural areas.

TABLE 5 Vehicle Maintenance Cost per Mile—1982

Vehicle Type	Rural ($)	Urban ($)	Average ($)
Sedan or station wagon	0.0377	0.0900[a]	0.0638[a]
Van	0.0542	0.0903	0.0801
Small bus	0.1201	0.0949	0.1083

[a]Imputed on basis of urban or rural area and vehicle variables.

Operating Costs Dependent on Vehicle-Hours of Service Availability

Some categories of operating costs are dependent on the hours that service is available. Typically, the number of vehicle-hours was used as the influential output variable to explain these costs. However, data on vehicle-hours were kept by only a few agencies in the sample. As a surrogate for vehicle-hours, the number of vehicles operated times the number of hours per month that service is offered (referred to as the vehicle-hours available service) is used.

The cost elements in this category include driver and dispatch wages. Driver and dispatcher wages are the product of (a) the number of hours spent by each category of personnel, (b) the wage rate for each category, and (c) the fringe benefit rate plus one. Because information on volunteer labor was so sparse and appeared inconsistent, all labor is assumed to be paid. (Agencies that anticipate volunteer labor can account for this by either assuming a wage rate of $0.00 or by assuming a certain percentage of hours will be volunteered.)

Driver Wages

Driver wages are the product of driver-hours, driver wage rates, and driver fringe benefit rates plus one. The number of driver-hours required to provide the service is dependent on the total number of vehicle-hours available. Overall, the number of driver-hours per month is 0.78 times the number of vehicle-hours of service available per month. The ratio of driver-hours to available vehicle-hours is greater in rural areas, indicating that in rural areas there is probably more service being provided within the hours service is offered or that there may be fewer idle vehicles or vehicles not fully utilized, or both. The average number of driver-hours per month is 586 with more driver-hours per agency in rural areas than in urban. Table 6 gives driver-hours per month.

TABLE 6 Operating Hours per Month

Labor Category	Rural	Urban	Average
Drivers			
Monthly hours	608	559	586
Driver-hours per vehicle-hours available	0.811	0.736	0.776
Dispatchers			
Monthly hours	70	171	122
Dispatcher-hours per driver-hours	0.179	0.278	0.237
Other personnel		275	275
Average operating hours	650	700	683

Driver wage rates vary by the urban or rural nature of the area and by whether drivers are full time or part time. Unionization did not play a part in differences in wage rates because few of the systems were unionized. Table 7 gives driver wages found in the study. In general, driver wages are higher in urban areas and wages for full-time employees are greater than wages for part-time employees.

TABLE 7 Operator Wage Rates—1982

	Rural ($)		Urban ($)			
	Average-Cost Areas	High-Cost Areas	Average-Cost Areas	High-Cost Areas	Average	
Driver						
Full time	3.70	4.99	3.92	6.45	4.59	4.22
Part time	3.54	4.51	3.98	5.41	4.18	
Dispatcher						
Full time	4.34	4.85	5.11	8.38	5.48	4.82
Part time	3.35	4.75	3.93	5.09	4.19	

Fringe benefit rates for drivers also vary for urban or rural areas and by the full-time or part-time status of the driver. The overall fringe benefit rate for operating personnel is 25.6 percent with full-time personnel at 22.7 percent and part-time personal at 21.7 percent. The fringe benefit rate for full-time drivers is 28.1 percent and that for part-time drivers is 22.2 percent. Fringe benefit rates for operating personnel are greater in rural areas than in urban. Tables 8 and 9 give fringe benefit rates for drivers.

TABLE 8 Operator Fringe Benefit Rates by Personnel Category

Labor Category	Full Time (%)	Part Time (%)
Driver	28.1	22.2
Dispatcher	28.4	22.0
Other	22.9	17.7
Average[a]	27.7	21.7

[a]Average for all categories is 25.6.

TABLE 9 Operator Fringe Benefits as Percentage of Wages by Urban or Rural Classification

Area	Average-Cost Area	High-Cost Area	Average
Rural	26.5	28.3	27.2
Urban	23.7	25.0	24.0

Dispatcher Wages

Total dispatcher wages are the product of dispatcher-hours times dispatcher wage rates times the dispatcher fringe benefit rate plus one. The number of dispatcher-hours is dependent on the number of driver-hours required to provide the service. Overall, the number of dispatcher-hours is 24 percent of the number of driver-hours. However, the ratio of dispatcher-hours to driver-hours is much greater in urban areas than in rural areas. The average number of dispatcher-hours per month per system is 122 with considerably more hours in urban areas than in rural areas. Table 6 gives a summary of dispatcher-hours and ratios of dispatcher-hours to driver-hours for urban and rural areas.

As do driver wage rates, dispatcher wage rates vary for urban and rural areas and by the full-time or part-time status of the employee (Table 7). Dispatcher wages are generally higher than driver wages, which makes sense because dispatchers are often drivers with more seniority or persons who began as drivers and were promoted. Dispatcher wages are higher in urban areas, and full-time employee wages are higher than part-time wages.

Fringe benefit rates for dispatchers also vary by the full-time or part-time status of the dispatcher and for urban or rural areas. The fringe benefit rate for full-time dispatchers is 28.4 percent whereas the fringe benefit rate for part-time dispatchers is 22.0 percent. Tables 8 and 9 give fringe benefit rates for dispatchers and other operating personnel.

Operating Costs Dependent on Number of Vehicles

There are three categories of operating costs that are influenced by the number of vehicles an agency operates: (a) insurance costs, (b) license and registration costs, and (c) vehicle storage costs.

Insurance costs per vehicle vary by the type of vehicle and for urban or rural areas. The data in Table 10 indicate that in urban areas the average per vehicle monthly insurance cost is $51.36 and this does not appear to vary by type of vehicle. In rural areas, monthly insurance costs per vehicle vary from $52.28 for automobiles to $74.16 for small buses, with an average of $63.27.

Average cost of vehicle license and registration fees was $2.61 per month per vehicle. As the data in

TABLE 10 Monthly Insurance Costs per Vehicle--1982

Vehicle Type	Urban ($)	Rural ($)
Station wagon or sedan	51.49	52.28
Van	51.47	63.22
Small bus	50.50	74.16
Average	51.36	63.22

Table 11 indicate, vehicle license and registration fees averaged $2.00 per vehicle per month in rural areas and $3.05 per vehicle per month in urban areas.

Vehicle storage costs were only reported by three agencies and ranged from $1.50 per month per vehicle to $33.00 per month per vehicle, with an average of $32.70. Vehicle storage costs were included when they were reported but they were not added for agencies not reporting such costs because it appeared that most agencies either parked their vehicles in the agency parking lot or, in some cases, drivers took them home overnight. In the former case, vehicle storage space would be included in building rent.

TABLE 11 Vehicle License and Registration Costs per Month--1982

Area	License and Registration Cost per Vehicle ($)
Rural	2.00
Urban	3.05
Average	2.61

Transportation Capital Costs

Capital costs associated with transportation include the cost of vehicles, office equipment associated with the actual operation of those vehicles, and dispatch equipment. The following sections explain how each of these costs was treated in the study.

Vehicle Capital Costs

As were other capital costs in the study, vehicle capital costs were estimated as the cost of replacing vehicles and are expressed as the cost of depreciation on the vehicle plus interest over the useful life of the vehicle (the length of time it was estimated that the vehicle would be operational). Capital recovery factors were used to convert one-time vehicle purchases to equivalent annual or monthly costs. The capital recovery factors assumed a 12 percent interest rate and a useful life that varied by the size of vehicle. A 10 percent salvage value on vehicles was also assumed.

Thus the vehicle capital costs were estimated as

$$\text{Vehicle capital costs} = \sum^{i} (\text{Capital acquisition or replacement cost for vehicle type } i)\ (1 - \text{Percent residual salvage value})\ (\text{Capital recovery factor for vehicle type } i).$$

Table 12 gives the monthly capital costs for various vehicle types as well as the assumed useful life, replacement costs, and monthly capital recovery factors.

TABLE 12 Vehicle Capital Costs--1982

Vehicle Type	Useful Life[a] (yr)	Replacement Acquisition ($)	Replacement Cost Minus Salvage Value ($)	Monthly Capital Recovery Factor[b]	Monthly Vehicle Cost per Vehicle ($)
Sedan	5	10,000	9,000	0.0231175	208.06
Station wagon	5	12,000	10,800	0.0231175	249.67
Van	5	18,000[c]	16,200	0.0231175	374.50
Small bus	7	40,000[c]	36,000	0.0182598	657.35
Large bus	12	150,000[c]	135,000	0.0134531	1,817.17

[a] From consumer guides and transit industry reports.
[b] Assumes 12 percent interest rate.
[c] Price includes the cost of a wheelchair lift and tiedowns.

Transportation Operating Office Equipment Costs

The cost of office equipment that was associated with the actual operation of the transportation service was treated exactly as other capital expenditures. As for vehicle capital costs, replacement values were used for items including depreciation and interest. Capital recovery factors were used to convert one-time costs to monthly expenditures (assuming 12 percent interest and a useful life of 5 years). Table 13 gives a list of common items and computed monthly expenditures for each.

These costs vary with the number of operating hours expended by an agency. The typical agency spent $40.08 per month on this cost element representing $0.066 per operating hour per month.

TABLE 13 Office Equipment Capital Costs--1982

Item	Monthly Capital Cost per Unit ($)
Desk	6.24
Chair	2.08
Table	4.16
Adding machine or printing calculator	2.70
Calculator (nonprinting)	1.04
Typewriter	20.81
File cabinet	4.16
Bookshelf	2.08

Dispatch Equipment Costs

Only two of the providers in the sample actually had radio-dispatched vehicles. For this reason, good information was not obtained on the cost of such equipment--and it was not included in the study. Almost all providers included cost for a dispatcher or scheduler and the labor cost for those employees is included in operating costs. It appears that a dispatcher labor cost is incurred regardless of whether or not the dispatcher uses a radio. If an agency is anticipating radio-dispatching of vehicles, additional capital costs for dispatch equipment and maintenance costs for that dispatch equipment can be included.

USE OF THE COST MODELS

The cost estimation methodology presented in the previous section can be applied to existing services or used to forecast expenses that will be incurred

if services are initiated. The manual describes and gives detailed instructions for following the four basic steps required to compute and analyze monthly costs and unit costs of service:

1. Gather information on resource and service specifications;
2. Using the information gathered, compute monthly costs for each cost category and add them together to arrive at total monthly costs;
3. Compute unit costs and efficiency measures; and
4. Compare unit costs, efficiency measures, and production parameters with those of similar providers.

This section is chiefly concerned with the second step--the computation of total monthly costs. This computation is performed in the following substeps:

1. Compute transportation operating costs,
2. Compute transportation capital costs,
3. Transfer administrative rate, and
4. Compute total monthly transportation costs.

Step 1: Compute Transportation Operating Costs

Transportation operating costs are separated into three categories depending on the output measure that affects the cost:

1. Operating costs dependent on vehicle-miles,
2. Operating costs dependent on vehicle-hours of available service, and
3. Operating costs dependent on vehicles.

Cost formulas have been developed for each of these categories. The results of each formula can be added to calculate total operating costs. Costs should be recorded on the worksheet for calculating monthly transportation operating costs (Figure 1). If monthly costs are known, these can be recorded. If any costs are unknown, they can be estimated using the formulas given hereafter.

Calculate Operating Costs Dependent on Vehicle-Miles

The two main cost elements dependent on vehicle-miles are fuel and oil and vehicle maintenance and repairs. Thus,

Monthly operating costs dependent on vehicle-miles = (Monthly fuel and oil costs) + (Monthly maintenance and repair costs).

As mentioned previously, if information on monthly fuel and oil costs and monthly maintenance and repair costs is available, it should be recorded on the transportation operating cost worksheet (Figure 1, Lines 1 and 2). If fuel and oil costs are not

I. CALCULATE COSTS DEPENDENT ON VEHICLE MILES

		MONTHLY COSTS	
monthly vehicle miles _____ x fuel + oil cost per mile _____	=	fuel + oil costs	$_____ (1)
monthly vehicle miles _____ x maintenance cost per mile _____	=	maintenance costs	$_____ (2)

II. CALCULATE COSTS DEPENDENT ON AVAILABLE VEHICLE HOURS

no. vehicles _____ x hours/week service _____ x 4.22 = monthly available veh. hours

monthly available vehicle hours _____ x $\frac{\text{driver hours}}{\text{available vehicle hours}}$ _____ = monthly driver hours _____

monthly driver hours _____ x $\frac{\text{dispatcher hours}}{\text{driver hours}}$ _____ = monthly dispatcher hours _____

monthly driver hours _____ x driver hourly rate _____ x 1 + driver fringe benefit rate _____	=	monthly driver wages & fringes	$_____ (3)
monthly dispatch hours _____ x dispatcher hourly rate _____ x 1 + dispatcher fringe benefit rate _____	=	monthly dispatcher wages & fringes	$_____ (4)
other operating hours _____ x other hourly rate _____ x 1 + other fringe benefit rate _____	=	monthly other operating wages & fringes	$_____ (5)

III. CALCULATE COSTS DEPENDENT ON NUMBER OF VEHICLES

number of vehicles _____ x monthly insurance costs per vehicle _____	=	monthly insurance costs	$_____ (6)
number of vehicles _____ x monthly license and registration cost per vehicle _____	=	monthly license & registration cost	$_____ (7)
	=	monthly vehicle storage cost	$_____ (8)
		TOTAL MONTHLY OPERATING COSTS	$_____ (9)

IV. ADD ALL OPERATING COSTS TOGETHER (Add Lines 1 through Line 8)

FIGURE 1 Worksheet for calculating monthly transportation operating costs.

available they can be estimated by taking the number of vehicle-miles times an appropriate value for fuel and oil costs per mile.

Vehicle maintenance costs include all contract or in-house maintenance, or both, of vehicles. If actual monthly maintenance costs are known, they should be recorded on the worksheet. If this information is unavailable it can be estimated on the basis of vehicle-miles by taking total monthly vehicle-miles times an appropriate maintenance cost per vehicle-mile (see Table 5 for default maintenance cost per mile).

Calculate Operating Costs Dependent on Vehicle-Hours of Service Availability

Some categories of operating costs are dependent on the hours that service is available. Typically, the number of vehicle-hours was used as the influential output variable to explain these costs. However, data on vehicle-hours are not commonly keep by most agencies. As a surrogate for vehicle-hours, it is possible to use the number of vehicles operated times the number of hours per month that service is offered. The cost elements in this category include driver and dispatcher wages:

Transportation operating costs dependent on vehicle-hours of service available = [(Available vehicle service hours) (Driver-hours/Available vehicle service hours) (Driver hourly wage rate) (1 + Driver fringe benefit rate)] + [(Driver-hours/Dispatcher-hours) (Monthly driver-hours) (Dispatcher hourly wage rate) (1 + Dispatcher fringe benefit rate)].

Although this equation is fairly complex, the operating cost worksheet (Figure 1) can be used to systematically sort data and work through the equation. The boxed areas of the worksheet can be used to estimate both monthly driver-hours and dispatcher-hours. (This section needs to be filled out only if the number of driver- or dispatcher-hours used or needed is not known.)

As was seen previously, driver and dispatcher wages are the product of (a) the number of hours spent by each category of personnel, (b) the wage rate for each category, and (c) the fringe benefit rate plus one. Again, when agency-specific information is known, it should be recorded, when unavailable, default values from the table should be used.

Calculate Operating Costs Dependent on Number of Vehicles

There are three categories of operating costs that are influenced by the number of vehicles an agency operates: (a) insurance costs, (b) license and registration costs, and (c) vehicle storage costs. These costs can be computed as follows:

Transportation operating costs dependent on number of vehicles = $\sum_{i,j}^{n}$ (Number of vehicles of type i)
(Insurance cost/Vehicle for type i in area j)
(License and registration cost/vehicle in area j)
(Vehicle storage cost/Vehicle).

As with other operating costs, if the actual monthly costs of these items are known, this amount should be recorded on the worksheet. If, however, this information is not available, any or all of the appropriate default values can be substituted.

Calculate Total Monthly Operating Costs

When the monthly costs for all operating cost categories, (Figure 1, Lines 1-8) have been calculated, these costs should be added to arrive at total monthly operating cost (record on Line 9). This total should also be transferred to the worksheet for calculating total transportation costs (Figure 2) under (a).

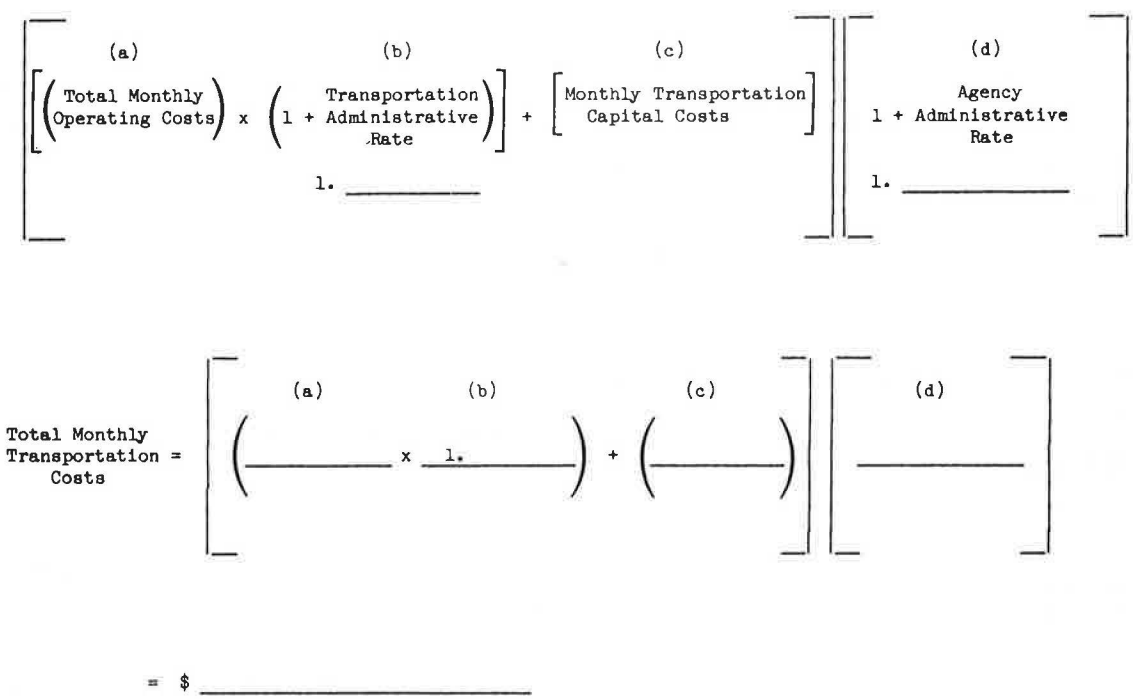

FIGURE 2 Worksheet for calculating total monthly transportation costs.

Step 2: Compute Transportation Capital Costs

Capital costs associated with transportation include the cost of vehicles, office equipment associated with the actual operation of those vehicles, and dispatch equipment. Transportation capital costs can be calculated as:

$$\text{Transportation capital cost} = \sum_{i}^{n} (\text{Number of items of type } i)\ [(\text{Total replacement cost or total actual purchase price of item } i) - (\text{Residual or salvage value of item})]\ (\text{Monthly capital recovery factor for useful life of item } i \text{ and interest rate}).$$

The worksheet for computing monthly transportation capital costs (Figure 3) is used to compute monthly transportation capital costs. As shown on the form there are two ways to treat transportation capital costs depending on whether it is assumed that the item will be replaced when it is no longer functional. Both ways include the cost of depreciation plus interest over the useful life of the item. However, only one way includes a provision for the replacement of capital purchases. Either method can be used here so that readers may select the most appropriate for their agency and circumstances.

Capital costs are expressed as the cost of depreciation on the item plus interest over the useful life of the vehicle (the estimated length of time that the vehicle should be operational). Capital recovery factors are used to convert one-time vehicle purchases to equivalent annual or monthly costs. The capital recovery factors can be calculated assuming various interest rates and different useful lives, which vary by size of vehicle. A 10 percent salvage value on vehicles is also assumed.

The first step in calculating capital costs is to record the number and age of each item by type on the form. If a provision is being made for replacement, the next step is to record the total replacement costs for all items in Column c. If provision

Transportation	(a) Number	(b) Age	(c) Total Replacement or Cost	(d) Purchase Cost on Items With Useful Life	(e) Total Replacement or Purchase Cost-Salvage Value (c or d x .90)	(f) Monthly Capital Recovery Factor	(g) Monthly Cost (e)x(f)
1. Office Equipment							
a. photocopies							
b. desk							
c. chair							
d. table							
e. adding machine							
f. typewriter							
h. file cabinet							
i. bookshelf							
j. other _____							
_____							
_____							
2. Vehicles							
a. Sedan							
b. Station wagon							
c. Van							
d. Small Bus							
e. Large Bus							
3. Dispatch Equipment							
f. Base Station							
g. Mobile Units							
h. Dispatch Maintenance Equipment							

Total Capital Cost $ _____

FIGURE 3 Worksheet for computing monthly transportation capital costs.

is not being made for replacement, the next step is to record the total actual purchase price for all items with remaining useful life in Column d. Because it is recommended that a 10 percent salvage values be assumed, the next step is to multiply the replacement cost/purchase price by 0.90 and record the product in Column e. This total purchase/replacement value is then converted to monthly costs by multiplying it by the capital recovery factors described previously and recorded in Column f. The monthly cost by item is the product of Column e and Column f. (Tables 12 and 13 give monthly capital costs per item for vehicles and office equipment.)

Calculate Total Capital Costs

Total capital costs should be computed (by adding all values in Column g of Figure 3) and recorded on the bottom of line of Column g. This total should also be transferred to the worksheet for computing total monthly transportation costs (Figure 2) under (c).

Step 3: Transfer General Agency Administrative Rate and Transportation Administrative Rate

If the general agency administrative rate and transportation rates for the agency are known, it will be possible to use these agency-specific values in the next step. However, if these values are not available, the most appropriate rate from Tables 1-3 should be selected for inclusion in the final calculation.

Step 4: Compute Total Monthly Transportation Cost

The final step in computing monthly transportation costs is to use the results of the calculation in each of the four cost categories to arrive at the total monthly transportation costs. A worksheet for calculating total monthly transportation costs (Figure 2) is included for this purpose.

COSTS PER UNIT OF TRANSPORTATION SERVICE

A significant deficiency of previous studies of transportation costs has been the failure to specify exactly what is being costed in specific units. This has led to confusion between costs of transportation services produced and costs of transportation services consumed. The precise identification of unit costs is crucial to the identification of costs in particular regions or areas. In particular, to make it possible to address questions about cost differentials with respect to transportation for the elderly population, both production and consumption must be fully understood, particularly because it is suspected that production costs are higher in urban areas but consumption rates are lower in rural areas, providing no a priori indication of which type of area has the highest overall costs.

Unit Costs of Transportation Services Produced

Unit costs for transportation services produced include (a) cost per vehicle-mile and (b) cost per vehicle-hour of service available. An examination was made to determine whether these overall unit production costs varied by (a) urban or rural areas, (b) quality of service, and (c) type of agency operating the service. One of the major findings was that quality of service does not affect the unit cost of producing the service. This may be because the services in the sample did not vary enough in quality and were basically the same service types. As mentioned previously, this made comparison of the cost of services in rural areas easier. (The cost for each hour of vehicle availability does vary by quality of service but these variations are erratic. There is no correlation between the two factors.) Tables 14 and 15 give unit production costs.

TABLE 14 Transportation Production Unit Costs by Quality of Service—1982

Service Quality	Cost per Mile ($)	Cost per Hour of Vehicle Availability ($)
Low (n = 25)	2.30	16.64
High (n = 24)	2.23	15.43

TABLE 15 Transportation Production Unit Costs by Urban or Rural Location—1982

Area	Cost per Mile ($)	Cost per Hour of Vehicle Availability ($)
Rural		
Low quality (n = 12)	1.87	13.75
High quality (n = 13)	1.75	16.28
Average	1.81	15.07
Urban		
Low quality (n = 13)	2.71	20.11
High quality (n = 11)	2.80	14.42
Average	2.75	17.13
Average	2.27	16.01

The cost of producing a mile or an hour of transportation service does vary by urban or rural designation with rural areas averaging about a 52 percent lower cost per vehicle-mile ($1.81 in rural areas and $2.75 in urban areas) and an almost 14 percent lower cost per available vehicle-hour ($15.07 in rural areas and $17.13 in urban areas).

The type of agency operating the service also affects the cost per mile and hour with public agencies having higher costs than private nonprofit agencies and aging services organizations having slightly lower rates than other agencies. Table 16 gives transportation unit production costs by agency type.

TABLE 16 Unit Costs for Transportation Produced by Agency Type—1982

	Cost per Mile ($)	Cost per Hour ($)
Organization		
Private nonprofit (n = 35)	2.19	15.64
Public (n = 11)	2.77	17.21
Management		
Single-purpose agency (n = 11)	2.31	16.42
Independent unit with central planning unit (n = 6)	2.15	17.13
Part of consolidated multipurpose agency (n = 29)	2.27	15.62
Agency		
Aging services (n = 13)	1.85	14.87
Community action (n = 9)	2.41	13.52
Government (n = 6)	2.05	17.13
Senior center (n = 12)	2.22	17.37
Average	2.27	16.01

Transportation Production Rates

Three transportation production rates were considered in the study: (a) trips per vehicle-mile, (b) trips per hour of vehicle availability, and (c) miles per hour of vehicle availability. Trips per mile averaged 0.437, and trips per available vehicle-hour and miles per available vehicle-hour averaged 3.88 and 9.80, respectively. Table 17 gives a summary of these production measures.

TABLE 17 Transportation Production Efficiency

Area	Trips per Mile	Trips per Available Vehicle-Hour	Miles per Available Vehicle-Hour
Rural			
Low quality (n = 12)	0.356	2.62	7.62
High quality (n = 13)	0.401	3.78	9.67
Average	0.379	3.23	8.68
Urban			
Low quality (n = 13)	0.544	6.33	14.73
High quality (n = 11)	0.411	2.45	6.51
Average	0.497	4.55	10.96
Average	0.437	3.88	9.80

As expected, trips per vehicle-mile are greater in urban areas than in rural areas (31.1 percent greater, at 0.379 in rural areas and 0.497 in urban areas). The trips per available vehicle-hour are 41 percent greater in urban areas, and miles per available vehicle-hour are 26 percent greater in urban areas.

In general, it appears that the lower the service quality, the greater the number of trips per mile, trips per hour, and miles per hour. This makes sense because higher quality trips may be more specialized. Table 18 gives production measures by service quality.

TABLE 18 Transportation Production Efficiency Service Quality

Service Quality	Trips per Mile	Trips per Available Vehicle-Hour	Miles per Available Vehicle-Hour
Low quality (n = 25)	0.454	4.55	11.31
High quality (n = 24)	0.419	3.17	8.22
Average	0.437	3.88	9.80

Unit Costs of Transportation Services Consumed

The most important measure of service costs is cost per trip because this measures what it costs to actually provide one unit of service to an elderly client. In previous research, it was suspected that, if quality were taken into account, the cost per trip would be higher in rural areas or at least comparable. The data from this study indicate that, for low-quality services, the cost per trip is 12 percent higher in rural areas. For high-quality services, the cost per trip is 51 percent higher in urban areas. Overall, the cost per trip is 14 percent higher in urban areas. Even though production rates (e.g., trips per mile) are higher in urban areas, this does not totally offset the higher unit production costs (e.g., cost per mile). Table 19 gives unit costs for transportation consumed by urban and rural areas.

The cost per trip for transportation services also varies by agency type (Table 20). Trips by public agencies cost approximately 19 percent more than trips by private nonprofit agencies. Trips by single-purpose agencies cost more than those by agencies with other management types, and trips by community action agencies and government-based agencies cost more than those by aging organizations or senior centers.

TABLE 19 Unit Costs for Transportation Consumed by Urban or Rural Classification—1982

Area	Cost per Trip ($)
Rural	
Low quality (n = 12)	6.57
High quality (n = 13)	4.60
Average	5.55
Urban	
Low quality (n = 13)	5.86
High quality (n = 11)	6.94
Average	6.35
Average	5.92

TABLE 20 Transportation Consumption Unit Costs by Agency Type—1982

	Cost per Trip ($)
Organization	
Private nonprofit (n = 35)	5.67
Public (n = 11)	6.75
Management	
Single-purpose agency (n = 11)	6.44
Independent unit with central planning unit (n = 6)	5.17
Part of consolidated multipurpose agency (n = 29)	5.89
Agency	
Aging service (n = 13)	5.43
Community action (n = 9)	6.88
Government (n = 6)	6.29
Senior center (n = 12)	4.84
Average	5.92

REFERENCES

1. S.F. Knapp and A.M. Lago. Results of a Parametric Cost Analysis of the Differences Between Urban and Rural Transportation Services for Transportation-Disadvantaged Persons. In Transportation Research Record 934, TRB, National Research Council, Washington, D.C., 1983, pp. 1-8.
2. M. Wozny et al. Review of the Reported Differences Between the Rural and Urban Elderly: Status, Needs, Service and Service Costs. Ecosometrics, Inc., Bethesda, Md.; Administration on Aging, U.S. Department of Health and Human Services, March 1981.

3. M. Wozny, S. Knapp, and M. Ramsdell. The Cost of Services to the Elderly: A Resource-Based Approach to Cost Analysis. Institute of Economic and Social Measurement, Inc.; Administration on Aging, U.S. Department of Health and Human Services, 1984.
4. M. Wozny, S. Knapp, J. Burkhardt, and A. Lago. The Cost of Services to the Elderly: A Manual for the Aging Network. Institute of Economic and Social Measurement, Inc.; Administration on Aging, U.S. Department of Health and Human Services, 1984.

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Analysis of Commuter Ridesharing Behavior at Five Urban Sites

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ABSTRACT

This paper is based on an evaluation of the National Ridesharing Demonstration Program (NRDP) established by the Department of Transportation in 1979 as a 2-year effort to develop comprehensive and innovative approaches to ridesharing. The findings presented are based on results of a workplace survey administered at five NRDP sites: Atlanta, Georgia; Cincinnati, Ohio; Houston, Texas; Portland, Oregon; and Seattle, Washington. The focus is on the characteristics of ridesharers, the workings of carpool arrangements, the relationship between firms and ridesharing, and the impact of ridesharing programs. Survey results showed that ridesharers were more likely than other commuters to have a long journey to work and to have more than zero and less than one automobile per employed worker in their households. An overwhelming majority of carpools were formed by household members or by informal work contact. Most carpools were two-person arrangements, more than half of which consisted of persons from the same household. Fifty-eight percent of those ridesharing 2 years before the survey were still ridesharing at the time of the demonstration, and about the same proportion of persons ridesharing at the time of the survey had been ridesharers 2 years earlier. Most of the movement into and out of carpools was from the drive-alone mode. Ridesharing mode split and carpool size were both positively associated with firm size. Large firms were more apt to provide ridesharing assistance to their employees, and assistance was associated with a higher ridesharing mode split. No association was found between flextime and the amount of ridesharing. Firm contact with a ridesharing program was associated with increased employee ridesharing at firms offering ridesharing assistance. Implications for ridesharing program design are briefly explored.

The market for ridesharing, both in terms of individual ridesharers and in terms of employers who are potential participants in ridesharing programs, is described. [Ridesharing is defined as motor vehicle travel in which the driver is accompanied by at least one passenger, the driving function is uncompensated or compensated in only minimal fashion, and the vehicle is owned or leased by an individual for his personal use or by an institution for the use of its employees (1,p.4). "Ridesharing" and "carpooling" are used interchangeably in the text because of survey definitions. Vanpooling is considered a subset of carpooling involving seven or more passengers.] The discussion of ridesharing arrangements and participants relies mainly on analysis of data from uniform workplace surveys of employers and employees administered in 1982 at five National Ridesharing Demonstration Program (NRDP) sites: Atlanta, Cincinnati, Houston, Portland, and Seattle. The NRDP surveys generated usable responses from more than 200 firms and 2,000 employees at each of the five sites.

Responses from the employer survey were merged with those from the employee survey for analysis of

individual ridesharing behavior. The merged data set not only describes employee characteristics but also connects them with an employee's work environment. Sample sizes for the subset of ridesharing employees whose characteristics were examined in detail ranged from 348 in Cincinnati to 462 in Houston. Responses were weighted to correct both for the effects of stratification (i.e., sampling different population segments at different rates) and for the effects of differential response rates among population segments.

The measures of association used for the analysis were a chi-square test applied to two- and three-way cross-tabulations of data and a difference of proportions test applied to particular data cells in the cross-tabulated data. The principal findings refer to associations between independent variables that were found to be significant at the 95 percent level or higher.

EMPLOYEE RIDESHARING

Ridesharing Commute Mode Choice

The workplace survey asked respondents to identify their primary current (1982) means of transportation to work as well as the mode they used 2 years before the survey. Results of the survey questions showed no significant change in the mode split for commuters from 1980 to 1982, as the data in Table 1 indicate. The level of employee ridesharing in 1980 was similar at most of the five sites to the national average for ridesharing to work that year, 19.7 percent (2,p.18). An exception was Houston, which had the highest ridesharing mode split, 26 percent. This disparity is probably explained by the relatively thin public transit service density and the dramatic increase in population and employment in Houston during recent years.

Factors Associated with Ridesharing

Sociodemographic, motivational, and employment characteristics of ridesharers were examined by cross-tabulating responses to the employee workplace survey at five sites. Some of the results confirm previous findings, whereas others are at variance with earlier ridesharing research. Results of the survey analysis confirm studies such as that by Bonsall, Spencer, and Tang (3,pp.20-22), which show a relationship between sex and propensity to rideshare. At all five sites the ridesharing mode split was higher for women workers than for men. On the other hand, survey results showed no consistent relationship between age and propensity to rideshare, a finding at odds with other research suggesting that ridesharers are disproportionately represented within certain age groups.

Evidence associating income with ridesharing was less clear-cut. At all sites except Portland, employees with (1982) household incomes below $15,000 were more likely to rideshare than employees in most other income groups. In Portland, workers in this lowest income bracket were least likely to carpool. It was hypothesized that automobile ownership may be a better variable than income to explain mode choice.

Results of the workplace survey showed a correlation between ridesharing and car ownership patterns. As the data in Table 2 indicate, ridesharing employees at all sites were more likely than the average employee to have more than zero and less than one car in their household. At the same time, ridesharing employees were less likely than the average employee to have two or more automobiles per employed household member. This is logical for several reasons. First, as will be discussed later, most ridesharers drive some of the time, which necessitates at least partial access to a car. Second, as will also be seen, a large proportion of carpools involves two family members commuting together, which would require household access to a car. Finally, the availability of two or more cars per employed household member eliminates much of the need to carpool.

Many studies have suggested that cost savings are more important for ridesharers than for other commuters. Responses to the workplace survey question asking riders to give the reasons for their choice of mode confirmed this finding. Ridesharers mentioned cost as the most important consideration more often than all commuters did--25 versus 15 percent of the time. However, ridesharers were also motivated by considerations similar to those of other commuters; namely, convenience, travel time, schedule requirements, and unavailability of transit, as Weisbrod and Eder (4,p.11-4) have noted.

Among the job-related factors shown by the workplace survey to be associated with employee propensity to rideshare were firm size, distance to work, full- versus part-time work, and work schedule. Survey results showed firm size to be highly correlated with employee ridesharing behavior. For all sites the ridesharing mode split was higher at firms with more than 100 employees than it was at smaller firms, as shown in Figure 1. This finding is consistent with earlier research and also with recent work such as that done by Wiley-Jones et al. in

TABLE 1 1980 and 1982 Commute Mode Split (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
1980						
Ridesharing	19	20	26	21	17	21
Single-occupant automobile	72	68	61	61	58	64
Public transit[b]	8	10	11	13	20	12
Other[c]	2	3	1	5	5	3
Total	100	100	100	100	100	100
1982						
Ridesharing	19	20	28	19	16	20
Single-occupant automobile	72	70	63	63	60	66
Public transit[b]	7	8	8	14	21	12
Other[c]	2	2	1	4	3	2
Total	100	100	100	100	100	100

[a]From NRDP workplace survey.
[b]Includes subscription bus.
[c]Includes walk, cycle, taxi, and "other" responses.

TABLE 2 Distribution of Automobiles per Employed Household Member for Ridesharing (RS) Employees and All Employees (%)[a]

No. of Automobiles	Atlanta		Cincinnati		Houston		Portland		Seattle		Five-Site Average	
	RS	All	RS	All	RS	All	RS	All	RS	All	RS	All
None	5	5	3	3	5	3	0	3	1	3	3	3
0.01-0.99	13	8	25	16	27	16	25	18	25	17	23	15
1	51	47	49	54	53	59	59	55	48	50	52	53
1.01-1.99	21	20	13	11	5	8	6	7	13	12	11	12
2	8	15	8	12	9	13	9	14	11	14	9	14
>2	2	5	2	3	1	1	2	2	2	4	2	3
Total	100	100	100	100	100	100	100	100	100	100	100	100

[a]From NRDP workplace survey.

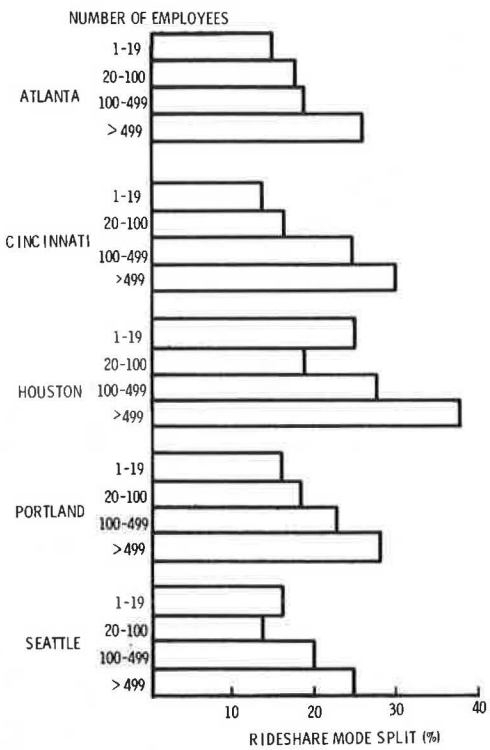

FIGURE 1 1982 employee rideshare mode split by firm size category.

Wisconsin (5,p.IV-6). The positive association between firm size and level of ridesharing can be explained at least partly by firm size alone. The larger the firm, the greater the number and density of potential poolers at one location and thus the greater a worker's chances of being exposed to ridesharing requests and of finding a suitable co-rider.

Mean distance to work at the five sites was 12.0 miles, ranging from under 10 miles to more than 14 miles (Table 3). Ridesharing was found to be a more likely mode choice as distance to work increased. Mean distance to work was significantly higher for ridesharing employees than for those who drove alone at all five sites, and significantly higher than for bus users at all sites except Houston. The research of Brunso and Hartgen (6); Kulp, Tsao, and Webber (7,p.86); Heaton et al. (8); and others has also related ridesharing to increased distance to work. The higher cost of individual automobile trips over longer distances and the decreased availability of public transit presumably make ridesharing more attractive for longer journeys to work.

Full-time workers at all sites were more likely than part-timers to rideshare, a finding consistent with the positive association also found between fixed work hours and propensity to rideshare. At all sites, survey results showed no significant differences in ridesharing mode split for employees on fixed-hour schedules versus those who set their own schedules, which are thereafter fixed (Table 4). Compared with those on fixed-hour schedules, however, employees with flexible-start schedules presented a mixed picture. (Flexible-start schedules were understood to mean those requiring a fixed number of work hours per day but allowing the worker to choose a start time, usually from within a range of hours.) On the basis of this finding, the introduction of flexible work hours (i.e., employee-set fixed schedule or flexible start) could not be associated with increased or decreased ridesharing.

To see whether there was a difference in carpool formation patterns between carpoolers working fixed hours and those with some flexibility in their schedules, carpooler responses to the question of how they formed their carpool were cross-tabulated with responses to a question about type of work schedule. Carpools formed with household members or through informal work contact accounted for 82 percent of all carpoolers at the five sites. At four of the five sites, carpoolers with some flexibility in

TABLE 3 Average Employee Commute Distance by Mode (miles)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Ridesharing	18.2	12.8	15.6	13.0	14.3	14.8
Single-occupant automobile	12.4	10.9	13.5	9.5	10.9	11.4
Public transit[b]	12.8	9.2	15.4	8.7	11.8	11.6
Other[c]	2.6	1.3	8.5	1.8	9.8	4.8
All modes	13.3	11.0	14.2	9.8	11.7	12.0

[a]From NRDP workplace survey.
[b]Includes subscription bus.
[c]Includes walk, cycle, taxi, ferry, and "other" responses.

TABLE 4 1982 Employee Ridesharing Mode Split by Type of Work Schedule (%)[a]

Schedule Type	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Fixed hours	21	20	31	20	19	22
Employee-set fixed schedule[b]	23	18	29	24	19	23
Flexible start[c]	14	26	22	22	11	19
Rotating shift	13	13	24	10	8	14
Irregular	7	13	12	11	6	10
All schedule types	19	20	28	19	16	20

[a] From NRDP workplace survey.
[b] Employee selects work schedule that is thereafter fixed.
[c] Employee can vary start time each day.

work hours were more likely than carpoolers on fixed schedules to have formed their carpools with household members. A significantly lower percentage of the flexible-schedule carpoolers had formed their carpools through informal work contact. At the fifth site, Cincinnati, no statistically significant difference in carpool formation patterns between those on fixed schedules and those with some flexibility in schedules could be observed.

These results suggest that flexible working hours facilitate carpool formation among family members. This same flexibility hinders carpool formation through informal work contact because it encourages schedule diversity among employees. Carrying this hypothesis further, the increase in carpooling among household members working flexible hours may tend to cancel out the decrease in carpooling through informal work contact in the same flexible work hour environment. This would confirm the previous observation that flexible working hours have little net effect on rideshare mode split.

Earlier research on the relationship between ridesharing and flextime is mixed, with Kulp et al. (7,p.86) showing a positive association between ridesharing and regular hours and other studies suggesting that the relationship is more ambiguous. It is possible that flextime may have positive or negative effects on ridesharing, depending on whether it is promoted as part of a more comprehensive ridesharing program.

Carpool Arrangements

Analysis of survey questions about carpool size and composition at most sites showed more than half of all carpoolers to be in two-person carpools, as shown in Figure 2. A high proportion of the members of two-person carpools lived in the same household, which is not surprising because of the ease of making and changing arrangements and the absence of circuity at the home end. Between 47 and 61 percent of those ridesharing in two-person carpools shared the ride with a family member. In contrast, fewer than one-third of the members of three- or four-person carpools shared the ride with one or more family members.

The proportion of carpoolers in carpools whose members all worked for the same employer was found to increase with carpool size at most sites. Although women were more likely than men to carpool, as already seen, men were more likely to drive in a carpool than women. On average, 37 percent of men and 21 percent of women employees always served as the driver of their carpool and 51 percent of men and 59 percent of women sometimes served as the driver. These findings are consistent with other research (3).

Although the workplace survey did not distinguish between kinds of carpools on the basis of size,

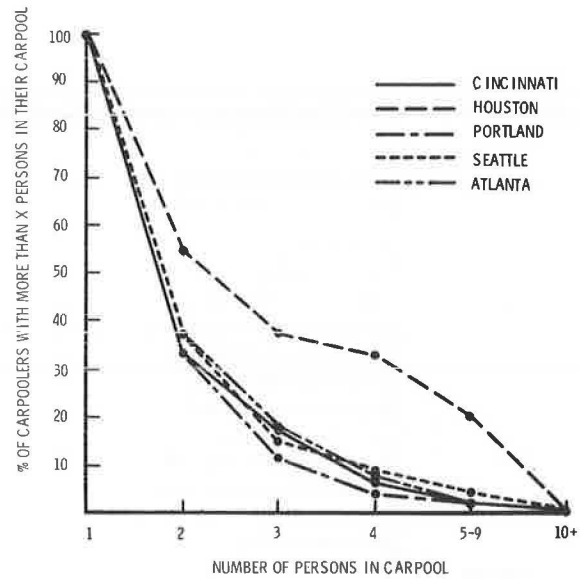

FIGURE 2 Cumulative distribution of carpoolers by carpool size.

carpools with seven or more members were here termed "vanpools" and described separately because results indicated that they were distinctly different from smaller carpools. Survey responses related to carpool formation patterns showed that the overwhelming majority of ridesharing arrangements resulted from informal contact at work or from household members' deciding to commute together, as discussed previously. However, the method of formation varied by carpool size, with the largest and smallest carpools demonstrating quite different formation characteristics, as the data in Table 5 indicate. Most two-person carpools were formed by household members, whereas most carpools with seven or more persons were formed at work. Formal mechanisms such as company newsletters and matching lists were used more widely by members of the largest carpools than by those in the smallest ones.

Evidence on the dynamics of ridesharing arrangements was obtained by comparing responses to retrospective questions in the workplace survey asking respondents to identify their primary mode of travel to work 2 years previously with responses to questions about current mode choice. The relative duration and stability of ridesharing and other modal commuting patterns were remarkably similar across the five sites. The responses showed a considerable amount of movement into and out of carpools and other modes over time, as shown in Figure 3. The amount of movement varied by mode. For example, of those who were driving alone to work 2 years before

TABLE 5 Percentage Distribution of Carpoolers by Method of Carpool Formation for Selected Size Car- or Vanpools (five-site average)[a]

How Formed	Carpool Size All	>6	2
Household	38	4	53
Neighborhood	7	1	7
Informal work contact	44	43	38
Firm newsletter	4	28	1
Firm matching	4	12	0
Rideshare program	2	6	0
Newspaper advertisement	0	6	0
Other	1	1	1
Total	100	100	100

Note: Results rounded to nearest percent; values less than 0.5 percent listed as zero.

[a]From NRDP workplace survey.

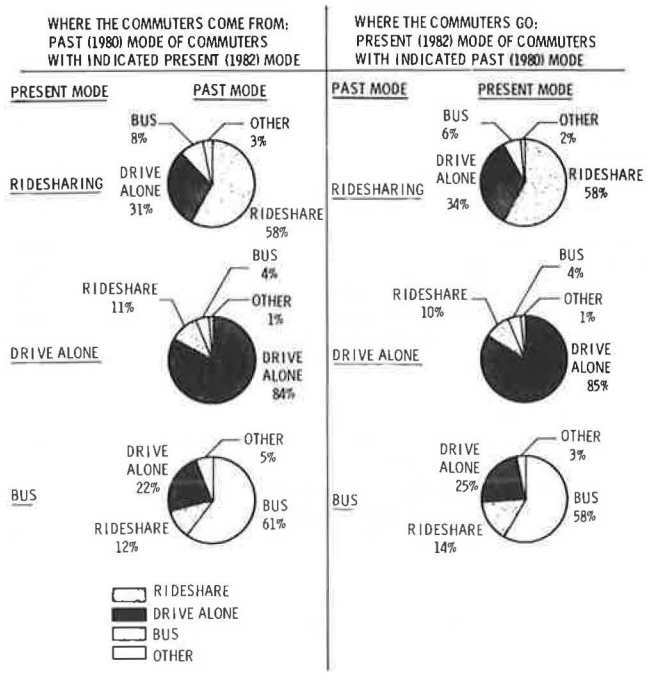

FIGURE 3 Movement into and out of modes during a 2-year period (five-site average).

the survey (1980), 85 percent were still driving alone at the time of the survey. In contrast, the percentage of employees carpooling 2 years earlier who were still carpooling in 1982 was much lower, 58 percent. The retention rate of transit riders was similar to that of carpoolers: 58 percent of those who were taking transit 2 years earlier were transit riders at the time of the survey. Some commuters in all three groups may have switched modes more than once during the 2-year period, but this does not affect the overall conclusions.

Responses to the same set of questions provided evidence about the source of entrants to all three major transportation modes. More than 70 percent of new carpoolers (i.e., those carpooling in 1982 who were not carpooling in 1980) formerly drove alone, and nearly 20 percent formerly used transit. The remaining new carpoolers included those who formerly walked, worked at home, or took other modes. The mode-switching process works in several directions, of course. About 65 percent of those new to the drive-alone mode were ridesharing 2 years ago, and 24 percent on average were former transit users. Because the drive-alone mode is so large (approximately 60 percent of all commuters at any one site), even a small increase in the percentage of newcomers to this mode can represent a substantial drain on ridesharing and transit mode shares.

EMPLOYER INVOLVEMENT IN EMPLOYEE RIDESHARING

Characteristics of Surveyed Firms

Survey results yielded a profile of firms in five metropolitan areas by size, type of business, type of schedule, parking availability, and length of time at current location. Most of the firms at each of the five sites were small enterprises. More than 80 percent of the firms had fewer than 20 employees, and more than 95 percent of them had fewer than 100 employees. At the same time, larger firms accounted for more than one-third of the employees at each site. A substantial majority of firm employees (70 percent) at the five sites had fixed work hours. On average, 9 percent of employees were able to set their schedule, which was thereafter fixed, and another 8 percent were allowed to vary their start time provided they worked the same number of hours each day. The rest worked rotating shifts or had irregular hours.

Free (non-employer-provided) parking was available within a quarter mile of the work site at most firms. About three-quarters of all employers provided parking (usually free) for their employees. At sites where parking was not available, with the exception of Seattle, most firms furnished employee parking.

Transportation Assistance

The proportion of firms offering transportation assistance of any sort to employees was examined to determine whether there was a relationship between employee mode split and the amount and kind of assistance offered. It was found that, on average, more than half of the firms did not offer any transportation assistance to their employees. The proportion of firms offering assistance ranged from 28 percent in Houston to 50 percent in Seattle. Of those offering transportation assistance, fewer than one-third offered ridesharing assistance, defined here as carpool formation assistance, ridesharing incentives such as preferred parking, and vanpool transportation. At every site a large majority of employers offering ridesharing assistance stated that the benefits of employer-sponsored ridesharing outweighed the cost. At the same time, for all sites except Houston, employers not providing ridesharing assistance were much less likely to view such assistance as beneficial.

Ridesharing assistance was correlated with firm size (Table 6). At large firms employees were more likely to rideshare, carpools were apt to be larger, and employees were more likely to use firm assistance in forming carpools. Because the firms that offered ridesharing assistance were large, the aid they offered could reach a large number of employees.

The employee ridesharing mode split at those firms offering "active" ridesharing assistance (defined as help in joining or forming a carpool, such as matching services) was higher than at other firms, as might be anticipated. This can be seen

TABLE 6 Proportion of Larger and Smaller Firms Offering Ridesharing Assistance (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Larger[b] firms	21	32	38	38	55	37
Smaller[b] firms	1	2	2	5	10	4
All firms	1	3	3	6	11	5

[a]From NRDP workplace survey.
[b]Larger firms have 100 or more employees, smaller firms fewer than 100 employees.

from the data in Table 7, although the direction of causality cannot be determined from these statistics alone. An active ridesharing assistance program may well induce some employees to rideshare; on the other hand, such a program may be the result of employee demands. Because larger firms offered assistance more often than smaller ones, the ridesharing mode split was examined for employees of firms in all four size categories to see whether firm size alone explained the higher rideshare mode split; it did not.

Area Ridesharing Programs

Area ridesharing programs were active in each of the five sites at the time of the workplace surveys. An important focus of the surveys was on examining the impacts of these programs on employee ridesharing. These impacts were evaluated in two ways: (a) by comparing rideshare mode split at firms having "contact" with an area ridesharing program with the mode split at firms not having such contact and (b) by examining employees' perceptions of the impacts of the programs. Contact with a ridesharing program included both contact of employers by the ridesharing program as well as successful attempts by firms to receive ridesharing information or aid, or both, from the ridesharing program. In other words, "contact" could work in either direction.

For those firms that were in contact with a local ridesharing program, the percentage of employees ridesharing was significantly higher at all sites than it was for those firms that were not in contact, as the data in Table 8 indicate. As with firm ridesharing assistance, however, the direction of causality cannot be deduced from these statistics alone. That is, it cannot be definitely concluded that contact increased ridesharing, because the programs may have tended to contact firms that already offered ridesharing assistance. Although the survey results showed that assistance was much more likely to be found at contacted firms, there is no way to tell, on the basis of the survey, whether assistance or contact came first.

To see whether firm assistance explained the effect of program contact on ridesharing behavior, the population of employees was subdivided by whether the firm offered ridesharing assistance. For each subgroup the ridesharing mode split at firms contacted was compared with the mode split at firms not contacted. Results, given in Table 9, were mixed. For firms that offered ridesharing assistance, contact was associated with a significantly higher mode split at three sites--Atlanta, Houston, and Seattle. Little difference was seen in the ridesharing mode split of employees at contacted versus noncontacted firms that did not offer ridesharing assistance, except in Portland where a higher rideshare mode split was associated with contacted firms.

It was hypothesized that firm size, which was associated with more firm contact, might account for the higher ridesharing mode split at contacted firms. Further analysis showed that this was generally not the case. Mode split was usually higher for contacted firms offering assistance, regardless of

TABLE 7 Employee Ridesharing Mode Split at Firms Offering Various Types of Transportation Assistance (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
No assistance	19	16	24	14	13	17
Non-RS[b] assistance	16	19	22	22	16	19
Active RS assistance	27	35	36	27	22	29
Passive RS assistance	27	30	NA	21	19	24
All firms	19	20	26	21	17	21

Note: Values less than 0.5 percent are listed as zero.

[a]From NRDP workplace survey.
[b]RS refers to ridesharing. Non-ridesharing assistance includes other forms of transportation assistance, such as transit pass sales or subsidies. Active and passive ridesharing assistance were defined as help in joining or forming a carpool, with the two categories differing only by degree. For example, active assistance involves provision of vans, special incentives, in-house matching services, and employee get-togethers; passive assistance involves distribution of ridesharing brochures, display of posters, and general encouragement of ridesharing by management.

TABLE 8 Employee Ridesharing Mode Split by Firm Contact with Rideshare Program (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Firms with contact	24	26	36	25	21	26
Firms without contact	17	18	24	17	14	18
All firms	19	20	28	19	16	20

[a]From NRDP workplace survey.

TABLE 9 Employee Ridesharing Mode Split by Firm Contact with Rideshare Program at Firms That Do and Do Not Offer Active Ridesharing Assistance (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Firms that offer active ridesharing assistance						
Firm contact	31	33	38	29	26	31
No firm contact	18	38	28	25	13	24
Firms that do not offer active ridesharing assistance						
Firm contact	19	16	23	21	14	19
No firm contact	17	18	24	16	14	18

[a] From NRDP workplace survey.

size. Again, the results presented here do not prove causal relationships between program contact and ridesharing. On the one hand, contact with the ridesharing program may enhance the effect of a firm's ongoing ridesharing efforts. On the other hand, area ridesharing programs may simply have contacted firms whose ongoing rideshare assistance programs were most successful.

The effect of area ridesharing programs was also assessed from the point of view of their relative usefulness to employees. The vast majority of employees at all five sites received no assistance at all from the ridesharing program, as the data in Table 10 indicate. An additional group received aid but did not use it, for whatever reason. Only about 1 percent stated that they were helped to form or join a carpool by the ridesharing program. When the question was limited to current ridesharing employees, about 3 percent had found the ridesharing program of direct help. These figures are consistent with those in Table 5 where, on average, 2 percent of carpoolers indicated that they joined or formed their carpool as a result of the area ridesharing program. However, the figures likely represent a lower bound on rideshare program impacts. Assistance to employees was often channeled through employers because many ridesharing programs consciously strove to transfer responsibility for such assistance to the firms. Such policies in turn could mean that employees perceived rideshare marketing efforts as coming from their firms, instead of from the area ridesharing programs that had initiated the assistance.

CONCLUSIONS

Results of the NRDP study hold a number of implications for the design and focus of rideshare programs. Most of the findings suggest that persons living relatively long distances from work are more likely candidates for ridesharing than are other commuters, all else being equal. Both firm-specific and areawide rideshare programs should continue to emphasize cost savings from ridesharing, because they are an important factor in a commuter's decision to rideshare. Other factors that should be emphasized are convenience and time savings, where applicable.

Most employees at firms offering ridesharing assistance worked for large firms, where employees were more likely to rideshare, to form larger carpools, and to use formal mechanisms for forming carpools. Thus, given an areawide rideshare program, it is reasonable to focus on large firms. It is also possible that multiemployer work sites may function like large firms; that is, they may provide opportunities for ridesharing development, but this hypothesis could not be tested with NRDP data. Firms already offering ridesharing assistance should not be ignored because contact with the rideshare program may enhance a firm's own efforts.

Although ridesharing programs had contacted firms employing about half of the employees in a region, on average, fewer than 20 percent of all employees in a region had actually received program materials. Even at contacted firms, fewer than one-third of the employees received such materials, which suggests that rideshare programs might try more intensive follow-up efforts. On the other hand, more than 60 percent of carpoolers (five-site average) were in two-person carpools, and more than 50 percent of two-person carpooling (five-site average) was done by family members. The likelihood that a substantial portion of carpooling arrangements will continue to be made at home, and not by rideshare assistance at the work place, limits the potential market for ridesharing development through employers.

The impact of both areawide and firm-specific ridesharing programs on commuter travel behavior cannot be conclusively determined from NRDP data. It is important to remember, however, that such an impact is likely to affect a small percentage of the overall commuter market. On average, 2 or 3 percent of those carpooling at the time of the survey credited their local ridesharing program directly with helping them to rideshare. About 8 percent of carpoolers stated that their firm's matching program

TABLE 10 Distribution of All Area Employees by Receipt and Use of Material from Rideshare Program (%)[a]

	Atlanta	Cincinnati	Houston	Portland	Seattle	Five-Site Average
Material helped in carpooling	0.5	1.2	1.2	0.4	1.2	0.9
Material not used or unsuccessful	6.6	16.3	14.6	8.9	16.3	12.5
No material received	92.9	82.5	84.2	90.7	82.5	86.6
Total	100.0	100.0	100.0	100.0	100.0	100.0

[a] From NRDP workplace survey.

or newsletter was their primary reason for joining or forming a carpool. Some of this ridesharing assistance by firms could have been the result of area ridesharing program efforts channeled through employers. Other indirect effects of ridesharing programs on mode split may be considerable but could not be measured. The actual number of persons assisted varied, of course, depending on the size of the local commuter market. It is clear that a rideshare marketing program should expect to be an ongoing effort because nearly half of the ridesharing commuters surveyed were found to revert to other modes during a 2-year period.

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REFERENCES

1. National Ridesharing Demonstration Program Evaluation Plan. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., Jan. 1980.
2. P. Fulton. Are We Solving the Commuting Problem? American Demographics, Nov. 1983.
3. P.W. Bonsall, A.H. Spencer, and W.-S. Tang. What Makes A Car Sharer? A Motivational Investigation. Working Paper 158. University of Leeds, Institute for Transport Studies, Leeds, England. March 1982.
4. G. Weisbrod and E. Eder. Evaluation of the Minneapolis Ridesharing Commuter Services Demonstration. Final Report. U.S. Department of Transportation, June 1980.
5. R. Wiley-Jones et al. Wisconsin Rideshare: 1982 Public Opinion Survey of Ridesharing. Summary Report. Wisconsin Department of Transportation, Milwaukee, May 1983.
6. J.M. Brunso and D.T. Hartgen. Can Employer-Based Carpool Coordinators Increase Ridesharing? In Transportation Research Record 823, TRB, National Research Council, Washington, D.C., 1981, pp. 45-50.
7. G. Kulp, H.J. Tsao, and R.E. Webber. An Evaluation of Ridesharing Programs in Michigan. ORNL/CON-99. Oak Ridge National Laboratory, Oak Ridge, Tenn., Oct. 1982.
8. C. Heaton, M. Abkowitz, and D. Damm. Impacts and Effectiveness of Third-Party Vanpooling: A Synthesis and Comparison of Findings from Four Demonstration Projects. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., March 1983.

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Pleasanton TSM Ordinance: a New Approach to Traffic Mitigation

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ABSTRACT

A transportation system management (TSM) ordinance adopted by the city of Pleasanton, California, in October 1984 requires all employers of 50 or more persons, and all employers in complexes, to implement a TSM program designed to achieve a 45 percent reduction in the number of peak-period commute trips that would occur if all such trips were made by solo drivers. The reduction can take place over several years. The ordinance includes requirements for annual surveys of employee commute modes and assigns most monitoring and enforcement responsibilities to a task force drawn from large employers and complexes plus the Downtown Merchant's Association. The task force feature was important in obtaining employer support for adoption of the ordinance because it provides for specification of remedial TSM measures by peers, instead of by city staff, in case of need. The Pleasanton TSM ordinance avoids many of the problems with other types of traffic mitigation ordinances, particularly failure to reach all employers and predetermination (by guesswork) of the effectiveness of given TSM measures. Other cities will find much to emulate in Pleasanton's approach, although several precautions are offered on the transfer of Pleasanton's experience to other cities.

Continued reliance on single-occupant automobiles by the majority of U.S. commuters--about 75 percent, with about 20 percent ridesharing and 5 percent transit users on the average--contributes significantly to the traffic congestion burden in most urban areas. How much it contributes is impossible to say without defining a practical upper limit to ridesharing and transit use.

If it is agreed that ridesharing and transit use could be doubled, on the average, from 25 to 50 percent, there could be a reduction of about 20 percent in the number of automobiles on the road (assuming an additional 5 percent for transit, bicycling, or walking and an average of 2.5 persons per vehicle in the 20 percent additional shift to carpooling or vanpooling, which leaves 66 automobiles where before there were 83 to carry 100 commuters). This would significantly reduce present and future commute period congestion levels in most urban and suburban areas. Alternative working hours could shift additional commuter traffic from the peak congestion periods.

The principal immediate causes of congestion in urban areas are aggregations of employment known variously as major activity or employment centers or complexes--anything from central business districts to major airports to business or industrial parks. Major activity centers bring about concentrations of employment and commuter automobile traffic that often tax or overload adjacent streets and access roads. This is especially true in suburban environments where the majority of intensive development now takes place--areas typically not well served by public transit and with their road systems largely in place. At the same time, the concentrations present opportunities for more intensive transit service, for extensive promotion of ridesharing (carpooling and vanpooling), and for other traffic mitigation measures.

In the opinion of the authors, such measures could reduce the use of single-occupant automobiles in peak periods to between 40 and 50 percent of commuters. However, to realize such reductions requires at least these critical conditions or steps:

- An understanding of the traffic problem and a firm commitment to its solution by developers and employers;
- Development of activity center transportation system management (TSM) plans with specific traffic mitigation targets;
- Support for the TSM plan by the activity center employers, which usually leads to their participation in a transportation management organization or association (TMO or TMA) and appointment of a transportation manager; and
- Finally, of course, implementation of the plan and monitoring to assure that its traffic mitigation objectives are met.

The issue that is addressed in this paper is how a community can best encourage or require that these conditions be met by existing employers and by prospective activity center developers. For this purpose, the recent experience of Pleasanton, a California city of 36,000 persons 32 miles southeast of San Francisco, in coping with a massive prospective influx of development by means of a comprehensive piece of traffic legislation called the "TSM ordinance" is drawn on. Among other provisions, the ordinance sets specific traffic mitigation goals for all employers of 50 or more persons in the city.

ORIGINS AND APPROVAL OF ORDINANCE

An ordinance of this scope and novelty is not developed and accepted overnight or without broad community support. Some actions that made passage of the TSM ordinance possible were firm city council commitment to the concept, early backing by key developers, bringing employers and developers together

to discuss the ordinance, incorporating their comments in subsequent drafts, and city staff efforts to explain the ordinance to employers on an individual basis when necessary.

Consideration of a TSM ordinance for Pleasanton began in a citizen's General Plan Review Committee early in 1984. Development proposals were expanding rapidly, totaling about half of the 31 million square feet of space permitted by the general plan on the 1,500 acres of commercial and industrial land at the north end of the city. In looking at transportation studies for that area, committee members discovered that significant use of flextime and commute alternatives was assumed by the transportation engineers. Through discussions with the city's planning consultant, they learned that other jurisdictions were using TSM to mitigate traffic. They were particularly interested in the transportation ordinance established by Placer County, California.

The citizens also reviewed the covenants, conditions, and restrictions (CC&Rs) that set forth the planned unit development guidelines for Hacienda Business Park, the largest development approved in Pleasanton. Hacienda's CC&Rs establish a parkwide commuter transportation program in which all owners, lessees, or other occupants are required to participate. With this background, the citizens suggested that the city establish a transportation systems management ordinance.

It took 6 months thereafter to bring the TSM ordinance through several drafts, numerous meetings, and innumerable discussions. The city staff met initially with a small group of developers and employers to gather their input before drafting the ordinance. At these early meetings it was decided that both new and existing employers of all sizes should be required to participate in the TSM program established by the ordinance.

From the beginning developers supported the concept because they knew their building permits could be delayed if traffic became a problem. In contrast, the majority of employers ignored the invitations to attend meetings to learn about the ordinance. The city gained employers' attention when a draft of the ordinance with severe fines for noncompliance was made public.

When the employers became involved several meetings were held where traffic engineers, planners, Hacienda Business Park's transportation manager, and the city attorney explained why an ordinance was necessary. A slide show and several case studies were presented to demonstrate that the goals of the ordinance were achievable. At these meetings employers revealed strong objections to having mandatory TSM elements prescribed by the city of Pleasanton, out of fear that the prescribed elements might not be feasible or cost-effective.

After employers' comments were heard, it became clear that the TSM program should be a joint effort of the business community and the city. The city was asked to commit itself to developing a local transit service. Employers also requested that a full-time city transportation coordinator be hired to assist them in complying with the ordinance requirements. The local businesses maintained that these measures were necessary to support them as they developed their TSM programs and promoted commute alternatives. Finally, local businesses suggested assigning enforcement responsibilities to a TSM task force with predominately employer representation. They preferred "a group of peers" instead of the city telling them how their program measured up and what could be done to improve it.

Most of the suggested clarifications and changes were incorporated in the ordinance. The city found that many of the employers just needed reassurance that the city would help them develop their programs. In addition, city staff and Hacienda Business Park's transportation manager talked to many employers individually. This personal approach responded successfully to their concerns and comments.

The Pleasanton City Council adopted the ordinance on October 2, 1984, with no opposition. One employer who had protested the ordinance when it was first introduced told the city council that his organization now fully supported the ordinance. This rather vividly demonstrates the importance of having employers involved in drafting the ordinance, responding to their needs, and spending the time to deal with them one on one.

OBJECTIVES AND PROVISIONS OF ORDINANCE

The twin aims of Pleasanton's TSM ordinance are to minimize the traffic effects of rapid commercial and industrial development of the city and to transfer most of the burden for success of traffic mitigation efforts from the public to the private sector. Provisions of the ordinance are summarized as follows:

- All employers are required to conduct annual surveys of employee commute modes, work schedules, and residential distribution by June 30 and to submit an annual report by August 1 with any survey results specified by the Pleasanton coordinator. Illustrative contents of the survey report as listed in the ordinance include (a) commute mode, typical arrival and departure time, and residential zip code of each employee and (b) maximum number of employees on each shift.
- All employers of 10 or more persons on a single shift not located in complexes are required to design and implement a TSM information program for posting and to distribute materials on ridesharing, transit, and nonvehicular commute modes to employees.
- All employers of 50 or more persons on a single shift, and all employers in complexes, are required to implement a TSM program designed to achieve a 45 percent reduction in the vehicle commute trips during peak periods that would occur if all were made by solo drivers. In the first year, a 15 percent reduction is required, increasing by 10 percent each year until 45 percent reduction is achieved in the fourth year. The peak periods are defined as 7:30 a.m. to 8:30 a.m. and 4:30 p.m. to 5:30 p.m. In cases where the shift ends of one nonretail employee coincide with the peak periods and those of another nonretail employer fall outside the peak periods, the two employers may be treated as one for counting reductions in peak-period traffic.
- Prescribed elements for the TSM programs of employers are (a) appointment of a workplace coordinator for TSM program implementation, (b) dissemination and posting of information, and (c) any reasonable combination of TSM measures that will achieve a 45 percent reduction in vehicular trips during peak periods compared with the trips required for 100 percent solo driving. TSM programs required for complexes are similar but must include a complex coordinator who will provide for coordinating, monitoring, and assisting the TSM programs of employers within the complex--including direct responsibility for employers in the complex with fewer than 50 workers if requested to do so by the employer. Each employer and complex that is required to have TSM programs must report to the city annually by August 1 on (a) its TSM program and results through June 30 and (b) the program it intends to implement in the ensuing year.

• References to requirements of the TSM ordinance must be made in the recorded conditions and covenants governing each complex and in every business lease entered into after the effective date of the ordinance.

• A TSM task force is assigned responsibility for coordinating, implementing, and monitoring the ordinance through various activities specified in the ordinance. Membership in the task force includes someone from each complex and from employers of more than 100 persons who is empowered to commit the organization to TSM measures; a downtown coordinator appointed by the Downtown Merchant's Association; representatives from each transit authority serving Pleasanton; and the Pleasanton coordinator, who will be the director of planning and community development or his representative.

• The Pleasanton coordinator will participate in the TSM task force, monitor intersection traffic, provide support to employers outside complexes, and review and evaluate employers' TSM programs and reports. If substantial traffic reductions are not being made by an employer or complex after 2 years, the coordinator will recommend implementation of the mandatory provisions of the ordinance to the city council.

• If the city council after a hearing determines to implement the mandatory provisions of the ordinance, the Pleasanton coordinator may reject an employer's or complex's TSM program and require its resubmittal within 2 months with revisions or additions to achieve the required reduction in peak traffic within 1 year of resubmittal.

• The task force may then require additional TSM program elements of employers or complexes to meet their staged TSM goals. The task force may also increase the commute trip reduction goals for particular employers or complexes where warranted by traffic conditions and may specify the type of measures that may be used to achieve acceptably modified TSM programs at such sites.

• Failure to provide information required by the ordinance is subject to fines of up to $50, $100, and $250, respectively, for the first, second, and third infraction in a calendar year. Failure to comply with a task force requirement for TSM program revisions deemed necessary to achieve specified peak-period traffic reductions is subject to fines of $250 per day after city council review and finding of noncompliance.

The analytical burden of processing many thousands of employee survey forms annually will be handled centrally by the Pleasanton coordinator, both for the sake of efficiency and for summary information that can then be prepared from the central file. The summary information is expected to be of use in planning bus routes and determining the potential for ridesharing from particular areas because it will include employee origin and destination information. The Pleasanton survey was developed in cooperation with RIDES for Bay Area Commuters, the regional ridesharing agency. Responding employees can request that their commute information be submitted to the RIDES data base, increasing their chance of locating a pool.

The 45 percent peak-period vehicle trip reduction goal of the ordinance requires some explanation. This goal can be achieved either by increased use of alternative (non-solo-driving) commute modes or by use of alternative work hours--flexible or staggered work hours or compressed work weeks--or by a combination of both means. The trip reduction goal was set in this way because the city's traffic consultant had relied on both means to reduce both peak-period intersection congestion and carbon monoxide levels predicted by the transportation plan for intensive development of Pleasanton to acceptable levels.

Total reliance on use of alternative commute modes to achieve the 45 percent commute trip reduction would imply high levels of those modes. For example, the two distributions of 100 commuters by mode given in Table 1 would permit all employees of a given firm to arrive in the peak period. Mix A is transit intensive and Mix B is carpool and vanpool intensive, with some increase in bicycling and walking.

The transit use assumed in Mix A is probably unattainable with prospective levels of bus service in Pleasanton. Mix B represents unusually high levels of carpooling and vanpooling, but these approximate levels have been achieved by one large suburban employer in neighboring Livermore, the Lawrence Livermore Laboratories of the University of California, through an outstanding ridesharing program. Single-occupant trips can be reduced through alternative commute modes, but, because that route alone is more difficult, most employers will probably rely in part on alternative work hours to achieve their goals. In addition, it is believed that employers will be motivated to promote carpool, vanpool, transit, and nonvehicular modes strongly in order to simplify reaching their trip reduction goals.

Results of the city's TSM program will be monitored by the TSM task force and the Pleasanton coordinator. Any changes deemed desirable in the ordinance itself will be recommended to the city council. This is an important device for making the ordinance flexible and responsive. For example, if it is found that employers are relying too heavily on alternative work hours to reach the peak-period trip reduction goals, with the result that the actual peak period in the city grows to 2 hours of heavy congestion, there are at least two possible ways of amending the ordinance:

• A certain proportion of the total trip reduction could be prescribed for attainment through employee use of commute alternatives instead of through alternative work hours.

• The length of the peak period defined in the ordinance could be increased--for example, to 2 hours morning and evening--which would have the

TABLE 1 Distributions of 100 Commuters by Mode

	Mix A		Mix B	
Mode	Commuters	Vehicles	Commuters	Vehicles
Carpooling, 2.5 persons each	25.0	10.0	35.0	15.0
Vanpooling, 12 persons each	6.0	0.5	11.0	0.9
Transit or buspools, 42 persons each	20.0	0.5	6.0	0.1
Bicycling and walking	5.0	0	8.0	0
Solo (single-occupant) driving	44.0	44.0	40.0	40.0
Total	100.0	55.0	100.0	55.0

effect of further spreading the traffic and probably also increasing the reliance on commute alternatives to achieve the trip reduction goals.

FIRST IMPLEMENTATION STEPS

A transportation coordinator was hired by Pleasanton shortly after passage of the ordinance. She has prepared a checklist for use by employers of 50 or more persons on a single shift in submitting their TSM plans. The TSM program elements on that checklist, edited by the authors for the context of this paper, are found in the Appendix. TSM program elements are listed within each category either in order of increasing cost or in their logical sequence of implementation. Employers are asked to note the applicable elements for the quarter of the year in which they intend to implement each element, to add their own ideas if they are not found on the checklist, and to return a copy of the completed checklist to the city.

The Appendix illustrates the relative simplicity of preparing employer TSM plans. A similar list covering only the type of information dissemination activities listed in Section C of the Appendix has been prepared by the Pleasanton coordinator for employers of 10 to 50 persons.

Procedures for monitoring actual commute trip reductions during peak periods will be worked out by the Pleasanton coordinator and the TSM task force. Tentatively, it appears that the task force has two alternatives:

- Summation of the arrival and departure times listed on the annual survey of commute modes. This will be cheap and easy to do, but listed and actual arrival and departure times may not always correspond, and significant sampling bias may be introduced when there is much less than 100 percent response to the survey.
- Traffic counts at parking lot access points during the peak period, in relation to the total number of employees and vehicles showing up that day. This is an objective but labor-intensive and probably costly method of monitoring. However, traffic counts might be made as random checks to verify the results reported on the annual surveys.

If the traffic reduction goal were restated in whole or in part as a total daily trip reduction goal (see discussion at end of previous section), then employee parking utilization counts could be used to verify achievement of that part of the goal. Parking counts are an easily done and objective measure of commute trip reduction. They can also be used to estimate the commute mode distribution on a monthly or quarterly basis in order to check on the progress of a ridesharing program. [Parking counts should usually be carried out at 10:00 a.m. or 2:00 p.m. for the day shift on a Tuesday, Wednesday, or Thursday. To derive modal estimates, vanpoolers and bicycles should first be counted independently. Transit riders can be estimated if transit passes are sold by the employer (or counts can be made of employees arriving on buses). Walkers are usually few in number and can be estimated from the previous commuter survey. This leaves only the number of carpoolers to be inferred from the parking utilization counts compared with the number of employees present on each shift the day of the counts.] However, the price of restating the traffic reduction goal in this way is some loss of flexibility for employers because alternative work hours would be less available to meet the goal, and some employers, by the nature of their work, could find it difficult or impossible to meet peak-period traffic reduction goals through commute alternatives alone. A middle course would be to add parking utilization counts to the suggested or prescribed monitoring methods so that there would be some periodic objective check on commute modes besides the annual survey.

APPRAISAL

The latest published accounts of TSM and parking management ordinances in the United States (1,2) list more than a dozen approaches that are being attempted in various cities and counties. However, most of the approaches deal only with traffic mitigation at new developments or have other serious limitations. For example, some ordinances prescribe definite TSM measures for employers to use but set no goals for their quality or effectiveness, and other ordinances assume predetermined levels of effectiveness for specified measures.

Experience to date with most of these ordinances has been disappointing. For example, the Los Angeles parking management ordinance is still unused nearly 2 years after its passage, and the rate of ordinance utilization in most cities is low. In some cases, such as the ordinances for Placer County and Sacramento County in California, their implementation is still too recent to show definite results.

Pleasanton's landmark TSM ordinance appears to be well conceived and overcomes many of the problems with other TSM ordinances:

- It reaches all employers, not only new developments.
- It avoids predetermination of the effectiveness of given TSM measures and leaves the choice of program measures to reach the specified trip reduction goals up to the employer.
- It uses annual employee surveys to determine commute mode, which will be both a frequent reminder to solo drivers and a good source of detailed planning and performance data.
- It leaves determination of minimum parking requirements as a separate issue instead of using reductions in parking requirements as an incentive for employer TSM programs.
- It provides for a series of escalating interventions by the task force and the city, culminating in stiff daily fines, in cases where commute trip reduction goals are not met by an employer. This process, together with the common wish of employers and the city to minimize commute traffic problems, is more likely to be effective than the usual ordinance penalties of either providing more parking or losing the right to occupy a building.

It is believed that the Pleasanton TSM ordinance has a high likelihood of success and will be widely emulated by other cities. It is therefore worth offering some transferability suggestions:

1. The way in which the traffic reduction goals are stated and the level of reduction targeted should be tailored to local conditions. For example, some cities may wish to state the traffic reduction goal partly or wholly in terms of vehicle trips instead of in terms of vehicle trips in the peak period. Vehicle occupancy rates, defined as the total number of employees present on a given day divided by the number of vehicles they parked, are also a plausible target.
2. The minimum size of employment for membership on the task force should be set to keep the group within reasonable size yet adequately representative. Area or zone coordinators, representing all

the employers in a particular area, may also have a place.

3. Parking utilization counts (see discussion under "First Implementation Steps") could be specified either in place of some of the annual commute mode surveys or in addition to the surveys in order to reduce the cost or increase the frequency and verifiability of monitoring.

4. It is worthwhile for a city to review its total traffic mitigation efforts at the time it considers the need for a TSM ordinance. Many cities already are using other types of traffic mitigation measures (2). Some of these are complementary to a TSM ordinance, and others are partial substitutes.

5. The longer a city waits to implement its own TSM ordinance, the more evidence will be available from Pleasanton on how well theirs works and on what refinements may have been conceived to make it work better in Pleasanton. On the other hand, the sooner a city gets its own ordinance, the sooner it will learn the game itself--and the rules of the game may need modification for new players.

6. Although there may be initial resistance from the private sector, full participation and support of employers is essential to both passage and successful implementation of such an ordinance.

One of the conditions in Pleasanton that favored adoption of the TSM ordinance was the rapid prospective development of major employment centers in the city. Both developers and city officials recognized the risk of traffic inundation. They had the nearby example of Silicon Valley at the southern end of San Francisco Bay for how bad traffic congestion could get, and how fast. In contrast, many cities experience more gradual traffic increases from year to year. The slow strangulation that results may not sufficiently galvanize the needed understanding and cooperation between public and private sectors.

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APPENDIX--TSM Program Elements

A. Information Collection
   1. Read the Commute Alternatives Handbook, developed for transportation coordinators by the Metropolitan Transportation Commission (MTC).
   2. Meet with city of Pleasanton coordinator.
   3. Attend commute alternatives class offered by MTC.
   4. Evaluate company resources and style to prepare a TSM plan.
   5. Document annual TSM plan for submission to city.
   6. Organize a commuter advisory committee among employees.
   7. Plot all employees on zip code map.
   8. Analyze zip code data to determine promotion strategies.
   9. Distribute transportation surveys.
   10. Ask new employees to complete the survey.
   11. Evaluate survey results.

B. Management Support
   Adopt company policies supporting commute alternatives, such as
   1. Letter of support from CEO to employees.
   2. Show executive role models using commute alternatives in information materials.
   3. Transportation policy statement in employment information.
   4. Scheduling courtesy (avoiding overtime meetings).

C. Information Dissemination
   1. Post commute alternatives information on bulletin board and have transit schedules on hand.
   2. Post, distribute, or publish "rides wanted" and "rides offered" information.
   3. Publish company newsletter articles on transit fares and schedules, on car- and vanpool cost savings, on sources or ridesharing information, on other benefits reported by ridesharers, and on annual employee survey results.
   4. Respond to employee telephone inquiries about commute alternatives (e.g., designate a "transportation hotline").
   5. Maintain a file of current match lists as well as an active register of carpools and vanpools.
   6. Distribute commute alternatives information as part of employee orientation.
   7. Prepare talk or slide show on commute alternatives for use during employee orientation.
   8. Set up a transportation table in lunch room.
   9. Conduct an annual transportation fair with displays by ridesharing and transit agencies (and possibly prize drawings and refreshments).

D. Facilitation of Carpooling and Vanpooling
   1. Survey employees about willingness to carpool or vanpool.
   2. Distribute RIDES car and vanpool applications.
   3. Prepare zip code maps summarizing locations of potential carpoolers and vanpoolers.
   4. Set up coffee meetings for people who want to carpool or vanpool.
   5. Provide personal matching service.
   6. Provide preferential parking.
   7. Allow flextime (e.g., up to 1/2 hr) for poolers.
   8. Provide guaranteed ride home to ridesharers (for family emergencies or after unscheduled overtime) via taxi or company car.
   9. Offer company cars and bikes to ridesharers for personal business purposes during the day.
   10. Facilitate owner-operated vans, including guarantee of 100 percent bank or credit union loans.
   11. Start company-owned vanpool service or authorize use of company vehicles for ridesharing at cost.
   12. Provide carpool and vanpool loading zones.
   13. Provide lanes for priority vehicle ingress and egress, especially for evening departure from large employment centers.
   14. Subsidize either a trial period in vanpools or their continued use.
   15. Provide lunchtime shuttle to shopping and restaurants.

E. Facilitation of Transit Use
   1. Coordinate with local transit agency on stops, schedules, and routes serving the company.
   2. Provide transit amenities, such as bus shelters, benches, and turnouts on-site.
   3. Sell transit passes on-site either at or below cost.
   4. Sponsor buspools or subscription bus service either at cost or subsidized.
   5. Provide a shuttle bus to transit stops or park-and-ride lots.

F. Facilitation of Bicycling and Walking
   1. Provide information on bicycle and pedestrian routes.
   2. Provide bike racks.
   3. Offer bicycle repair facilities or "tool library."
   4. Form a company bicycle club.
   5. Install showers and lockers.
   6. Organize a "bike to work day" or a bike race.
   7. Allow employees to dress casually one day a week (or relax the whole dress code).

G. Alternative Work Hours and Flextime
   1. Offer flextime.
   2. Offer staggered work hours.
   3. Allow employees to work at home as appropriate.
   4. Allow four 10-hr workdays per week.
   5. Establish regular work hours outside the norm.

H. Other Marketing Programs
   1. Conduct drawing for prizes among respondents to TSM surveys.
   2. Recognize users of commute alternatives in company newspaper.
   3. Give awards to commuter of the month (e.g., savings bond, company dinner, added vacation time, free tune-up, diagnostic testing of vehicle).
   4. Negotiate discounts at local stores.
   5. Combine a monthly parking fee with a transportation cost allowance for all employees (which can be used for the parking fee or for transit passes, and can be pocketed by bicyclists, walkers, and poolers).
   6. Provide child care facilities at work site.

I. Program Monitoring
   1. Determine number of employees in each shift commuting by different means, by methods such as
      a. Tabulations from employee survey results.
      b. Tabulations from carpool and vanpool register augmented by information about transit pass sales and bicycle counts.
      c. Gate counts of arrival mode and vehicle occupancy.
      d. Employee parking lot utilization counts by shift in relation to the number of employees present each shift.
   2. Record the number of employees participating in an alternative work hours program.

REFERENCES

1. S. Smith and S. TenHoor. Model Parking Code Provisions to Encourage Ridesharing and Transit Use. JHK & Associates, Washington, D.C.; FHWA, U.S. Department of Transportation, Sept. 1983.
2. Traffic Mitigation Reference Guide. Metropolitan Transportation Commission, Oakland, Calif., Dec. 1984.

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Transportation Brokerage: Key Findings from Crosscutting Analysis

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ABSTRACT

Some of the key findings of a crosscutting analysis of 13 transportation brokerage projects studied under the auspices of the Urban Mass Transportation Administration's Service and Methods Demonstration (SMD) program are presented. Most projects were SMD-funded demonstrations; others represented case study evaluations. Transportation brokerage is characterized by an orientation toward understanding and accommodating the actual demand for transportation services as identified by and for specific target groups. This approach differs from traditional transportation arrangements that design and operate single-mode, somewhat static delivery systems that are intended to serve areawide, aggregated demand for a range of needs. Several key definitional issues (centering around the degree to which the broker intervenes in the marketplace) are resolved by defining brokerage as an approach to problem solving instead of as an explicit organizational structure or planning process. The conclusions, based on findings from the SMD-sponsored evaluations, suggest that the future of transportation brokerage is dependent on the ability of brokerage advocates to adapt the approach within the existing decision-making environment instead of trying to force new institutional relationships on often entrenched organizational allegiances.

The urban transportation system is composed of numerous transportation resources that are owned, operated, and managed by a host of public and private entities. These resources can vary from the empty seats in an automobile trip to a capital-intensive regional rail system. In the aggregate, these resources provide a range of transportation options to the potential user. The discrepancy between the available supply of transportation and the knowledge of potential users about that availability gave rise to an innovative concept termed "transportation brokerage." In its purest form, transportation brokerage is the facilitation of activities aimed at matching targeted demand for services with existing and potential suppliers.

Beginning in the mid-1970s, the Urban Mass Transportation Administration's Service and Methods Demonstration (SMD) program sponsored a number of demonstrations and case study evaluations under the general concept of transportation brokerage. Some of the key findings of a larger crosscutting evaluation of 13 brokerage projects studied under the auspices of the SMD program (1) are presented here. The findings, therefore, may not be applicable to other, locally sponsored brokerages initiated during the same period. The number and variety of demonstrations studied present both an opportunity to draw more valid conclusions about the concept and, at the same time, a challenge to compare what outwardly appear to be quite different projects and outcomes.

The conceptual foundations of transportation brokerage lie in the use of brokerage in the private sector. Examples of private sector brokerage include real estate, stocks and bonds, commodities, insurance, and travel. Here the term "brokerage" refers to "an intermediate market function that serves to remove the barriers to the exchange of goods and services between suppliers and consumers" (2,p.22). The purpose of the broker is to locate areas of surplus and need, resolve potential barriers and market imperfections that could constrict the exchange, and, finally, to consummate the sale or transaction.

The brokerage concept, as applied to transportation, is similar to the private sector concept in that the broker's role is primarily to identify the specific needs of potential riders and match them to the most appropriate transportation provider. In some cases in which a feasible provider does not exist, the broker serves to facilitate the provision of the service deemed necessary. One major difference between transportation brokerage and more traditional transportation arrangements is the emphasis on determining specific demand before arranging for service delivery. This is in contrast to a more mode-specific, supply-oriented agency that provides a somewhat static service and depends on induced demand for that service.

The demonstrations exhibited a great deal of variability in terms of targeted users, services brokered, organizational structures, and the impacts on users and the general public as a whole. Table 1 gives the brokerage projects used in this study and notes the target groups served. The common elements across the brokerage projects were the targeting of specific client groups and the facilitation of innovative services to satisfy their unique demand patterns. Targeted client groups included special user groups (elderly, handicapped, low income, commuters), individuals in low-density areas, general populations, and even local agencies as a brokerage client group. The projects spanned mode-specific services, modal integration, regulatory and institutional revision, marketing, and interagency liaison. Organizational mechanisms ranged from an individual acting as a broker to an entire transit agency centered around the brokerage concept. Finally, some demonstrations had a relatively significant impact on targeted users whereas others were more limited in their ability to match potential users and sup-

TABLE 1 Brokerage Project Sites and Markets Served

Project Site	Targeted Markets	Project Dates
Knoxville, Tenn.	SSAs, commuters	10/75 – 12/78 (d)
Mt. View, Calif.	E&H	2/76 – 2/77 (t)
Westport, Conn.	General public	4/77 – 3/79 (t)
Minneapolis, Minn.	Commuters	6/77 – 2/80 (d)
Lancaster, Pa.	SSAs	11/77 – 5/83 (c)
Northeastern Illinois	E&H, general public	2/78 – 6/82 (c)
Newport News, Va.	E&H, commuters	7/78 – 7/81 (d)
Pittsburgh, Pa.	E&H, SSAs	7/78 – 6/82 (c)
Bridgeport, Conn.	SSAs, general public	9/79 – Present
San Diego, Calif.	E&H, SSAs	8/81 – Present
Dade County, Fla.	SSAs, commuters, general public	12/81 – Present
Los Angeles Co., Calif.	E&H, general public	6/82 – Present
St. Louis, Mo.	SSAs, commuters	Not implemented

Note: SSA = social service agency, E&H = elderly and handicapped individuals, (c) = brokerage activities continued beyond demonstration period, (d) = brokerage activities significantly descoped, and (t) = brokerage activities terminated.

pliers. The impact on the entire transportation system varies from slight improvements in mode split to achievements made solely in the area of regulatory reform, which could lead to systemwide improvements after the demonstration period.

Two distinct topics are covered in this paper. First, several definitional issues are addressed in an attempt to resolve certain conceptual arguments about exactly what constitutes a brokerage. The range of brokerage applications is presented, followed by a number of interpretations of the concept and its applications. These interpretations revolve around the issue of the degree to which the broker actively intervenes in the transportation market. From this discussion, a working definition is formulated.

Second, conclusions from the crosscutting analysis, which speculate about the future of transportation brokerage, are presented. Several of the transferable "lessons" from the projects are enumerated. In addition, critical differences between demonstration and future brokerages will be discussed. Finally, the underlying question is addressed: Is brokerage a single "recipe for success" or is it simply an approach or "philosophy" guiding the planning and implementation of transportation services?

The crosscutting analysis is designed to provide planners or decision makers contemplating the formation of a brokerage (or comparing organizational options) a better understanding of the concept and some of the lessons gained from the demonstrations. As such, the analysis did not strive to document which brokerage was the "best" type for a given situation or that brokerage was the most effective means of solving particular transportation problems. The brevity necessary for this synthesis precludes detailed assessment of each project. The reader is encouraged to consult the larger crosscutting study or the individual evaluation reports for project specifics.

APPLICATIONS OF THE BROKERAGE CONCEPT

No one organizational structure, planning process, or set of services typifies brokerage. Applications of the concept varied from project to project. In this section the development of the brokerage concept, as conceived by those involved with the specific projects, is presented. The set of definitions put forward by project initiators and evaluators provides an interesting background on how the concept was originally defined and how it has since evolved. Applications of the concept included specialized brokers for commuters or elderly and handicapped users, "community" brokers, "decentralized" brokers, and those brokers who sought to integrate a "family of services" and coordinate specialized brokerage activities with conventional, fixed-route services. Although many projects seemed to be a combination of these categories (especially the earliest projects), definitions and illustrations of each type are provided.

The first brokerage, in Knoxville, Tennessee, (2,p.2) foresaw that the purpose of the broker would be

> To locate areas of surplus and areas of need, to resolve institutional barriers and to consummate the sale. Whatever the form or mode of operation, the broker acts as a clearinghouse by helping buyers find solutions to their needs.

The Knoxville project was, in theory, an attempt to reorient the management of transportation toward the dynamic matching of supply and demand, taking neither for granted. Although the project originally emphasized commuter ridesharing and social service agency coordination, the Knoxville model of brokerage was not mode specific; it envisioned becoming involved with whatever target group it identified as potentially being served. The key to this initial definition was the implicitly passive, intermediary stance of the broker. It was foreseen that, through regulatory and institutional changes, transportation efficiencies could eventually be realized.

Several demonstrations represented the application of the brokerage concept to transit agencies. Brokerage was viewed as a means of accomplishing certain paratransit and transit integration objectives. As such, separate "brokerage departments" were established that were designed to be coequal with their fixed-route counterparts. The Dade County (Miami), Florida, (3,p.2) demonstration used a definition of brokerage based on matching of demand and supply but went on the further define the role of broker:

> Beyond linking consumers with transportation services, the brokerage will fulfill the function of integrating the provision of transportation services with community and economic development objectives throughout Metropolitan Dade County.

The Dade County brokerage represented an attempt to fully and efficiently use all potential suppliers to serve a variety of markets and specific user needs.

A similar project within a transit agency was undertaken in Newport News, Virginia. The Easyride brokerage project became involved in services for

commuters and the mobility impaired. The stated role of the brokerage (4,p.2) was:

> Easyride, in its role as transportation broker, promotes and facilitates ridesharing in public/private vehicles in much the same manner that a real estate broker advertises and arranges property sales. Easyride also acts as a ridesharing advocate and encourages citizens to participate in ridesharing for their own benefit as well as for larger, societal goals. Easyride also operates special transportation services for the handicapped and works to coordinate the supply of and demand for transportation at social service agencies.

The key difference between this brokerage and those mentioned previously was its operation of a transportation service for handicapped persons. This service was neither a coordination attempt nor a contracted service, either of which might loosely be defined as brokerage. The reason for this in Newport News was that the broker tried to coordinate and offer contracted service, and, when it failed to do so effectively, it resorted to providing the service itself to fulfill a need identified as crucial.

Another brokerage application focused on commuters. In targeting a single user group, specific needs and opportunities were to be identified and alternatives explored to serve the travel demands of that group. One brokerage project, housed within the transit agency in Minneapolis, Minnesota, sought to "test the feasibility of using transportation brokerage to promote and coordinate a variety of commuter services" (5,p.2-2). A key element of this new role for the transit agency was the client orientation of brokerage as opposed to the service orientation associated with more traditional transit operations.

Another demonstration that targeted a single set of users was the ACCESS demonstration in Allegheny County (Pittsburgh), Pennsylvania. The demonstration established a network of service providers to serve the transportation needs of the elderly and handicapped population who could not use the fixed-route system. The ACCESS project was designed to establish the broker as a "marketplace coordinator" (6,p.60). On the supply side the broker contracted with a number of private providers to form a transportation network for elderly and handicapped persons; on the demand side the broker established relationships with a number of social service agencies (SSAs) to address the transportation needs of their clients. The broker was an intermediary, placed between the demand for services for elderly and handicapped persons and the potential suppliers.

Although several brokerages have been organizationally housed within transit agencies, and others worked with operators, two demonstrations involved the transit property reorganizing itself as an "integrative" broker. The brokerage concept was not applied only to the paratransit or ridesharing elements of an operator--the broker was the operator. Demonstrations in Bridgeport and Westport, Connecticut, involved total reorganization of the agencies to better function as brokerages. The definition of brokerage provided in the Bridgeport evaluation (7,p.37) states:

> Brokerage is the combination of management functions that conceives initiatives and then sees to their orderly development and operation, fostering and applying the necessary planning and evaluation tools and criteria to fine-tune the action to success.

This brokerage process would identify needs, assure services met those needs, and manage the process within a single planning and operating organization. Market research activities were explicitly foreseen as aiding in identifying needs, and innovative services (fixed route, services for elderly and handicapped persons, community-based transit, shared-ride taxi, employment center bus service) were developed to address those needs. Although these integrative brokerages may appear to be a far cry from the passive, intermediary role envisioned for the Knoxville project, the key was still a client or demand orientation and the belief that different user groups or target markets required different and often innovative services.

A final application of the concept was termed "decentralized brokerage." The decentralized approach was applied to large metropolitan areas and regions and involved the needs assessment and service identification functions being vested in the hands of localities. The role of the regional body, in managing the areawide "brokerage" program, was seen as reviewing locally initiated plans and service policies, channeling funds, and offering technical assistance to those localities. The advantage of this approach, as cited by the evaluators, was the ability of the regional body, through funding and technical assistance leverage, to coordinate the various local services and to coordinate these activities with regionwide services, programs, and policies.

In the decentralized demonstration in Northeastern Illinois, the services funded were paratransit services and included both services for elderly and handicapped persons and community-based and feeder services (8). In the case of the Los Angeles County demonstration, the funds could be used for any transportation purpose including the purchase of additional regional fixed-route service (9). The motivation for each of these demonstrations was a dedicated regional tax to be used for improving transportation services. The commonality between decentralized brokerage and centralized brokerage is again the orientation toward identifying disaggregate transportation needs and facilitating the provision of services deemed appropriate to effectively address those needs.

EMERGING DEFINITION OF BROKERAGE

The preceding discussion emphasizes the variety of applications of the brokerage concept in the public transportation field. This same variety may serve to preclude the formulation of a single, all-encompassing definition at this point. The discussion does suggest, however, two general conclusions. First, the one common factor brokerage represents is the reorientation or refocus of transportation planning and implementation toward the identification and accommodation of demand instead of the promotion of service. In concept, a demand-oriented agency and a supply-oriented entity may appear to be two ways of viewing exactly the same agency or outcome. In practice, however, the two orientations tended to operate quite differently.

Second, the degree of market intervention appears to be the key differentiating factor that causes a single definition to be elusive. Although it was the intent of most brokerage projects to simply facilitate the matching of supply and demand, many projects resulted in various services being directly provided by the broker. The issue of market intervention by the brokerage is the primary focus of the following discussion concerning the various interpretations of the brokerage concept as put forward by others studying the concept.

INTERPRETATIONS OF BROKERAGE: PASSIVE VERSUS ACTIVE MARKET INTERVENTION

Many of the brokerage demonstrations appear to have outstepped the initial passive, intermediary role outlined for the Knoxville project and others. The key point of departure from the original brokerage concept appears to be the actual provision of transportation services by the brokerage organization, referred to as market intervention. The key issue thus becomes: does the brokerage function cease to exist when the broker is forced to directly provide a service even if that service is deemed necessary to satisfy some unmet demand identified by the broker? A host of brokerage "analysts" and "interpreters" have expressed their thoughts on the concept, on the variability exhibited across demonstrations, and on the range of roles assumed by brokers. Some interpretations defined a more passive brokerage role; others directly questioned the more activist role.

One interpretation of brokerage viewed the broker's function as simply persuading various parties to engage in activities related to the objectives of the brokerage. This interpretation (10,p.29) further defined the broker's role:

> The broker, serving some overall public objective, decides upon the type of service it wishes to facilitate which will best meet the needs of the target population(s) and the overall objective. Its role is then to persuade: 1) the parties involved in the provision of the service that it is in their best interest to offer the service, 2) the target population that it is in their best interest to use the service, and 3) the parties involved in the (transportation) environment who stand to oppose the service or whose support is necessary for provision of the service.

This interpretation appears to support the passive, intermediary role outlined for the broker in the Knoxville model and redefines matching as persuasion.

Several interpretations focused on the evolution of the brokerage concept from a passive to a more active stance in fulfilling brokerage objectives. One interpretation (11,pp.4-5) stated:

> If (brokerage) can identify markets and understand each market's preference for service, it should be able to match supply with demand--to broker between markets and services. This intervention can take several forms: the most limited form is that of the pure brokerage which restricts itself to improving the flow of information between buyer and seller; a more activist form is the regulatory approach which seeks to open or close market opportunities; and the most interventionist role which seeks to change the actual supply and demand functions.

Other, similar interpreters contended that the brokerage concept, as applied in a number of the early demonstrations, had changed to describe approaches to coordinate and integrate service providers and as such represented attempts at actively modulating transportation demand. Whereas brokerage was originally conceived as oriented principally toward demand determination, applications of the concept were actively involved in determining the form and amount of transportation supply. These interpreters contended that earlier efforts had relied on regulatory change and later efforts on negotiated attempts, often fostering a previously nonexistent service. As such the focus of brokerage was management as opposed to planning. These interpreters concluded by pointing to the need for a new breed of transportation professionals to become brokers--individuals who were skilled managers and negotiators instead of strict planners and technicians (12).

A final set of interpretations attempted to structure the differing forms and degrees of intervention of the brokerage concept. One such interpretation (S. Edner, unpublished data) explicitly stated:

> The brokerage concept, while intuitively appealing, is a conceptual nightmare. Outside of a common sense notion and commitment to effectively exploiting all transportation options and possibilities within urban areas, there does not seem to be much in the way of commonality in the definitions used.

One solution to this dilemma was presented in the form of a brokerage typology. Several researchers delineated a range of possible brokerage roles, which varied most notably with respect to the degree of broker activism in reshaping the market structure. One such typology (13,p.39) enumerated four distinct brokerage roles:

- Passive facilitator of market transactions (e.g., carpool matching);
- Activism limited to the removal of market-distorting rules and practices (e.g., regulatory barriers to vanpooling);
- Entrepreneurial activism to provide services that would otherwise be unavailable; and
- Comprehensive activism to change the overall institutional and planning context and perhaps also to integrate the full array of transit and paratransit.

Beyond formulating a brokerage typology, these interpretations further suggested two conclusions related to brokerage. First, brokerage may just be a "tool or attitude toward some preferred (transportation) future." Thus, brokerage was viewed as a term attached to what can also be called multimodalism, systems integration, systems management, public entrepreneurism, or a host of other things. Second, although brokerage may have represented a slightly different orientation to this "preferred future" than the other terms offered, brokerage really "only accelerates an already present tendency--slow evolution toward multimodalism" (Edner, unpublished data).

BROKERAGE AS A TRANSPORTATION APPROACH

Although the purpose of the preceding discussion was to formulate a single definition of "brokerage," the range of applications and the variety of interpretations dictate that no one definitive explanation is possible. As stated earlier, no one organizational structure, planning process, or institutional arrangement typifies brokerage. Therefore, a definitive statement about brokerage would have to emphasize the distinctive approach adopted by "brokers." This approach refers to the philosophy subscribed to by the broker--the way of looking at a transportation problem. Whereas the means of addressing and structuring the solution may differ significantly enough to preclude a single definition, this philosophy, or approach, or orientation remains the singularly common element.

For the purposes of this analysis, brokerage is defined as an approach characterized by an orienta-

tion toward understanding and accommodating the actual demand for transportation services as identified by and through specific target populations. This orientation differs from that of traditional transportation agencies that design single-mode, somewhat static delivery systems that are intended to serve areawide, aggregated demand for a range of needs. Whereas this type of "supply orientation" begins with the service and induces travel behavior changes, the brokerage approach attempts to understand that behavior on a manageable level and tailor services to those needs.

To better delineate the brokerage approach, six components of this orientation can be enumerated. Although each specific brokerage demonstration may not have formally adopted all components, each exhibited a definite subscription to the approach. The brokerage approach is as follows:

1. Market oriented
   a. Assesses specific needs of target groups;
   b. Designs, facilitates, and may operate tailored services; and
   c. Serves to inform potential users of options.
2. Action oriented
   a. Is entrepreneurial, geared toward specific tasks;
   b. Links planning and implementation; and
   c. Views brokerage as means to task-specific ends.
3. Innovation oriented
   a. Unbiased toward modes or techniques and
   b. Willing to try new and untested methods and services.
4. Multimodal oriented
   a. Seeks to achieve best mix of services (public and private) and
   b. Promotes range of services and options.
5. Management oriented
   a. Broker is manager of service elements and
   b. Service elements are provided in a number of ways (including direct operation by broker).
6. Advocacy oriented
   a. Promotes services it deems necessary to potential suppliers,
   b. Promotes services it facilitates to consumers, and
   c. Promotes services it facilitates to key decision makers.

Given this definition of brokerage as an approach to transportation problem solving, the complicating issue of the degree of market intervention is largely resolved. Thus, although "entrepreneurial" or "comprehensive" activism (service provision, demand modulation) may not be brokerage as defined in its purest sense as an intermediary role, such activism does still conform to the brokerage approach and can be identified along one or more of the orientations listed previously.

FUTURE OF TRANSPORTATION BROKERAGE

The outcomes and impacts of the demonstration brokerages examined in the crosscutting study were mixed at best. The reader, however, should keep in mind the experimental nature of the projects. The approach, although intuitively attractive and plausible, needed the period of testing afforded by the SMD program. Testing the feasibility of the brokerage approach in diverse political and regulatory environments was one of the objectives of funding a number of projects. In general, three steps were involved in moving from the brokerage concept to implementation. First, the appropriate role for the broker within the local transportation environment needed to be clarified. This step included identifying the specific problems that the broker would address and finding an acceptable location for the broker within the existing institutional structure. Second, certain formal regulatory barriers that prevented the broker from carrying out its objectives (e.g., vanpool insurance rates or carrier certification authority) often had to be addressed. Finally, with a clear set of objectives in hand and institutional and regulatory barriers overcome, the broker could go to work developing service alternatives.

Unfortunately, the time required to address the first two sets of barriers was often equal to the demonstration period. In many cases, such issues were dealt with throughout implementation to the exclusion of other, more central project elements. In addition, community transportation needs, political attitudes, and economic conditions often changed during the project period, possibly presenting new travel demands and concomitant barriers and attitudes. Although this might be an oversimplification of the reasons behind the mixed success of the demonstrations, it does point to some of the overriding, unforeseen frustrations experienced at the brokerage sites.

The brokerage approach, as implemented, produced results that differed little from a variety of other approaches aimed at meeting a targeted set of needs (e.g., third-party ridesharing, social service agency coordination). Costs, user impacts, supply arrangements, and institutional constraints, which were similar to those associated with other approaches, were experienced by the brokers. The projects may have produced such similar results because the brokerage approach served to accelerate the same trends as those being pursued elsewhere. This is not to say that the brokerage approach itself should be discounted, for as an approach (as opposed to a new type of service) it could not be expected to produce radically different outcomes. However, anyone speculating about the future of transportation brokerage should be more cognizant of the multimodal, demand-oriented nature of the concept, whether it is referred to as brokerage, coordination, integration, or any number of other things.

TRANSFERABLE FINDINGS

The transferability of the brokerage approach will be greatly determined by local circumstances and the progressiveness of those institutions responsible for the transportation system and its component parts. The brokerage approach is not appropriate for all localities and situations. A key conclusion from the demonstrations should be that the workability of the concept in a given urban area or situation may only be determined by actual experience. This is because the approach primarily involves institutional and attitudinal change not more tangible, physical change.

The individual evaluations do, however, provide a number a valuable insights concerning the transferable elements of the demonstration brokerages. Although the transferable "lessons" identified by the individual evaluations will not be foolproof predictors of future brokerage success, they may serve to underscore not the simplicity of the concept but the complexity of its effective application. Given that a more rigorous, comparative testing of various brokerage mechanisms was not and cannot be produced, these lessons should serve as an initial guide to those contemplating forming or facilitating a brokerage. By learning from the mistakes, experiences,

and achievements of the projects, decision makers can better cope with future brokerage applications and decisions may be made in a more rational and locally acceptable manner. The following is a set of transferable lessons extracted from the evaluations and is organized by the three steps enumerated previously.

1. Lessons on Institutional Change
   a. Institutionalization of the brokerage approach is most successful when it is implemented in response to a clearly defined and widely acknowledged local transportation problem (or set of problems).
   b. Substantial preimplementation planning and consensus building are necessary before the brokerage approach can be made operational within a given local environment.
   c. Brokerage advocates must realize that the approach and the projects fostered may be threatening to many established modal entities and planning agencies. Consequently, an important preimplementation brokerage activity is to assuage the fears of these other organizations.
   d. A strong local base of support for transportation and public service innovation can be a great asset in gaining acceptance of the brokerage approach.
   e. The presence of an energetic entrepreneur or core of entrepreneurial managers can do much to facilitate institutionalization and implementation of the brokerage.

2. Lessons on Regulatory Change
   a. Regulatory authority over certain local transportation service providers (e.g., taxis and paratransit providers) represents a powerful tool that the brokerage can use to promote various supply objectives. However, these regulatory controls should be used sparingly so as not to compromise the intermediary role of the broker.
   b. A brokerage acquires only that regulatory or organizational power that is delegated from an existing organization or political body. Consequently, brokerage advocates must first convince local decision makers and responsible agencies of the merits and potential benefits of the approach.

3. Lessons on Brokerage Implementation
   a. The brokerage should have a clear sense of its goals, target markets, and scope of activities.
   b. Brokerage planners need to realize the complexity of the urban transportation system and understand the trade-offs involved in influencing different parts of the system.
   c. The brokerage approach offers the flexibility to continually search for better solutions instead of accepting the status quo.
   d. A comprehensive marketing program is needed both to inform the potential user and as a tool for demand determination (market research).

Finally, the Bridgeport evaluation (7,p.133) offers a somewhat different conclusion on the subject of brokerage transferability. Paraphrasing from that conclusion: Much of the demonstration work is experimental, and this is reflected in the results and the costs. Brokerage in the more transferable sense is much more pragmatic. It represents a continuous search for innovation and improvement in the delivery of mass transportation services. A large staff and budget are not required to pursue such a program under normal circumstances, and in most cases it is simply necessary for existing staff to broaden their awareness of concepts, techniques, constraints, and resources. Specialized skills can be acquired on an as-needed basis. Funding for most improvements can be realized under existing federal and state programs. The demonstrations have performed a valuable service in not only piloting several potentially useful concepts, but in identifying the major constraints to implementation and effectiveness. This knowledge should help sharpen the focus and reduce the effort of future users of the brokerage approach.

Most of the evaluations agreed that, in concept, the brokerage approach is a valid, workable notion if implemented carefully and when accompanied by the right local political, institutional, and regulatory conditions. Some of the lessons presented appear to be platitudes for any good planning process. Many of the projects studied here, however, lacked such foundations and were consequently subject to some basic pitfalls. Perhaps the single most important transferable element, therefore, is that a true need for the broker must exist. The application of the concept needs to make sense given travel and land-use patterns and potential transportation alternatives. In addition, the brokered services have to make sense in terms of economics, operations, and their overall effect on travel patterns. This may appear to be an obvious precondition to any successful project or program. However, in the absence of a clear mandate for the brokerage approach, the barriers to the approach's successful implementation and institutionalization are nearly insurmountable.

DIFFERENCES BETWEEN DEMONSTRATION AND FUTURE BROKERAGES

Several factors suggest that future brokerages may not be close replications of the demonstration projects. This is not to say that future brokerages will not exist, but rather that they will most likely be somewhat different than the demonstration projects. These differences, and the reasoning for such differences, include (a) the influence of federal demonstration monies, (b) the impact of the demonstrations' mixed results, and (c) the success of those demonstrations with more limited scopes.

First, the influence of federal demonstration monies on the past projects cannot be overstated. The fact that the major financial burden and concomitant accountability did not rest on the local government probably accounted for the lack of vehement opposition during demonstration inception. Without the need for financial commitment, however, local decision makers and agencies were often not actively involved in project development and ongoing commitments were not obtained. Consequently, political and institutional conflict often did not arise until after implementation. The lack of meaningful commitments from key participants was one reason for the ineffectiveness of some of the demonstrations.

Future brokerage proposals will probably need the kind of financial and participatory commitment lacking in these earlier projects. Whereas the experimental status and funding may have appeased many local constituencies in the past, future brokerages may have to acquire a broader base of support for the approach to be even tenable. This is not to say federal monies will not be available for brokerage planning and operations. Section 4(i) (Innovative Techniques and Methods Program) provided some $750,000 for four brokerage projects in FY 1983. The change, however, from experimental to operational projects will still necessitate a greater amount of planning and consensus building to assure both that a greater local share is raised (25 percent or more) and that the broker's role is an effective and non-

threatening mechanism for addressing transportation problems.

Second, the influence of the demonstration results may cause future decision makers to be skeptical of the approach, as intuitively appealing as it may be. Few of the demonstration brokerages facilitated overwhelming shifts in travel behavior or improved operating efficiencies, and this may be a deterrent to future applications. The current initiation and implementation of a large number of brokerage projects would tend to counter this presumption. Projects funded by the previously mentioned federal monies, as well as state and local sources, are being fostered. The difference, however, seems to be that these new projects are existing ridesharing or transit programs renamed or reoriented to reflect the brokerage approach. This is consistent with the finding that many of the demonstration projects differed little from a host of other projects operating under the auspices of third-party ridesharing, coordination, integration, and so forth. Such brokerage "by name only" runs the risk, however, of ignoring the experiences of the demonstrations and heeding the warnings to fully develop an environment more conducive to the brokerage approach.

Finally, the relative success of those demonstrations that had limited scopes of activities (targeting only one or two specific markets) may foretell a more limited application of the concept in the future. Indeed, the set of currently forming brokerages appears to be oriented specifically to commuters or markets made up of elderly and handicapped people. This notion may appear to go counter to the brokerage concept because effectiveness is seen as contingent on the range of options. However, experience has shown the opposite to be true; flexibility in using different alternatives may be more important than the sheer number of options available and the user groups served. As also mentioned previously, future brokerages will more likely be housed in existing agencies or at least be of a smaller scale. This is because resources may not be available for large semiautonomous staffs and because the staff size and resources available did not appear to be a good indicator of a successful program.

CONCLUSIONS

The first section of this analysis concluded with a definition of brokerage as an approach to urban transportation planning and service delivery. Although the range of applications and project scopes defied a single definition, brokerage as a way of approaching transportation problems appeared to best describe the brokerage concept. As stated in that definitional section, the brokerage approach is characterized by an orientation toward understanding and accommodating the actual demand for transportation services as identified by and for specific target populations. This orientation differs from traditional transportation agencies that design and operate single-mode, somewhat static delivery systems that are intended to serve areawide, aggregated demand for a range of needs. Whereas this type of "supply-orientation" begins with the service and induces travel behavior changes, the brokerage approach attempts to understand travel behavior on a manageable level and tailor services to those needs.

Although the approach may have been common to all the demonstrations analyzed here, the actual techniques used and the results achieved varied dramatically. Brokerage per se cannot be considered a definitive "recipe for success." Techniques, organizational relationships, and specific projects that were effective in one situation were often ineffective in others. Brokerage is not a step-by-step plan for solving all transportation problems. Brokerage cannot be neatly packaged like some explicit planning or operational tools and methods. Brokerage is more a "frame of mind," a way of approaching a problem, regardless of the resulting solution technique. One brokerage analyst called brokerage an "attitude geared toward a preferred transportation future"--that preference being for a multimodal management orientation to meeting actual demand and using existing suppliers to the greatest possible extent (Edner, unpublished data).

The approach is not an explicit plan or model, yet it does suggest a planning process. This process is attuned to market trends, imperfections, and opportunities. This process seeks to build the necessary consensus up front among suppliers, public agencies, decision makers, and private interests in order to effectively implement a feasible plan. The process is reiterative in that priorities change as travel patterns and institutional relationships change and as new needs or opportunities, or both, arise. The process is guided by a transportation entrepreneur to keep it dynamic and progressive and to act as a focal point for establishing credibility for the approach.

If brokerage can be implemented in existing organizations and amidst existing institutional arrangements, the approach becomes far more feasible than establishing an entirely new organization. Such a revolutionary change (superimposing a new organization) would tend to force new institutional relationships on the environment. The adoption of the brokerage approach by existing and incoming transportation professionals and decision makers, however, would work to create a new environment more conducive to the approach.

Brokerage is not a panacea for all transportation ills, nor is it an explicit blueprint for success. Brokerage is an approach aimed at improving the ability of the transportation system to be an effective, responsive means of satisfying transportation needs. Although the approach may or may not be adopted on a widespread basis, the lessons learned and experiences discussed in this analysis (and in the individual demonstration evaluations) may serve to assist planners and local decision makers who are contemplating alternative ways to address transportation issues and even those seeking solutions to specific transportation problems and needs.

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REFERENCES

1. E.N. Schreffler. Brokerage Cross-cutting Study. Staff Study SS-64-U.3-10. Transportation Systems Center, U.S. Department of Transportation, Cambridge, Mass., July 1984.
2. F.W. Davis et al. The Knoxville Transportation Brokerage Project, Volume 1: Philosophy and Institutional Issues. Report UMTA-TN-06-0006-78-3. Transportation Center, University of Tennessee, Knoxville, Nov. 1978.
3. Application for Service and Methods Demonstration Brokerage Project. Office of Transportation Administration, Metropolitan Dade County, Fla., Oct. 1980.

4. The Newport News, Virginia, Easyride Transportation Brokerage Demonstration Project. UMTA/TSC Project Evaluation Series Report UMTA-VA-06-0050-82-1. Peat, Marwick, Mitchell & Company, Washington, D.C., Sept. 1982.
5. Evaluation of the Minneapolis Ridesharing Commuter Services Demonstration. UMTA/TSC Project Evaluation Series Report UMTA-MN-06-0008-80-1. Cambridge Systematics, Inc., Cambridge, Mass., June 1980.
6. Paratransit Brokerage Demonstration Project: Pittsburgh, Pennsylvania. UMTA/TSC Project Evaluation Series Report UMTA-MA-06-0046-84-10. Charles River Associates, Boston, Mass., Dec. 1984.
7. Transportation Brokerage Demonstration: Bridgeport, Connecticut. Interim Report, UMTA/TSC Project Evaluation Series Report UMTA-CT-06-0008-83-2. Comsis Corp., Silver Spring, Md., April 1984.
8. The Northeastern Illinois RTA Decentralized Brokerage Program. UMTA/TSC Project Evaluation Series Report UMTA-IL-06-0038-82-1. DeLeuw, Cather & Co., Sept. 1982.
9. Providing Technical Assistance: the Los Angeles County Experience. Initial Evaluation Report. Cambridge Systematics, Inc., Cambridge, Mass., March 1984.
10. A. Bickford. Interorganizational Theory, Transportation Coordination, and Transportation Brokerage: A Preliminary Investigation. Working Paper 82-1. Center for Transportation Studies, Massachusetts Institute of Technology, Cambridge, Feb. 1982.
11. L. Grenzebeck. Notes on Brokerage. Greater Bridgeport Transit District, Bridgeport, Conn., April 1981.
12. R.H. Bradley and E.M. Casebeer. A New Role for Transportation Systems Managers: Public Entrepreneurs. Presented at World Conference on Transport Research for Social and Economic Progress, London, England, April 1980.
13. A. Altshuler. Memorandum on Institutional/political Evaluation Issues. Policy and Management Associates, Inc.; Transportation Systems Center, U.S. Department of Transportation, Oct. 1981.

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Estimating Ridesharing Levels for Reductions in VMT

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ABSTRACT

The research described is a set of supply models for estimating the number of commuters needed to participate in ridesharing programs to achieve a desired level of travel reduction. Supply models have been developed that estimate the number of commuters needed to participate in carpooling and vanpooling to achieve given levels of reduction in vehicle-miles of travel and energy consumption. Determining participation levels identifies the degree of effort necessary to reach desired reduction levels and provides a means of assessing whether to continue with these reduction levels or adjust target reduction values to coincide with acceptable intensity and funding levels. Estimating the number of necessary commuters early in the planning process makes possible a realistic assessment of the feasibility of achieving reduction goals given the magnitude of participation levels. For even small reduction levels the number of new ridesharing commuters quickly approaches levels that are realistically difficult to attain.

Transportation activities have changed significantly in recent years with emphasis shifting from major highway construction and long-range master planning to a more diverse set of issues and concern for achieving a set of short-term objectives. A fundamental strategy of short-term objectives is to encourage more efficient use of existing highway facilities through increased vehicle occupancies. Ridesharing offers the chance to extend the use of existing transportation systems in ways that increase their efficiency and reduce the need for additional vehicles and roadway capacity.

Given this renewed interest in ridesharing, transportation planners are increasingly interested in determining the number of commuters needed to participate in ridesharing to achieve a desired

level of travel reduction. The ability to estimate the necessary magnitude of ridesharing participation is beneficial in the early planning stages to identify whether desired reduction levels in vehicle-miles of travel (VMT) and energy usage are feasible. Matching these supply estimates with demand estimates provides an assessment of the ability to reach desired reduction levels and the resulting level of program intensity. This in turn provides a means of assessing whether to continue with these reduction levels or adjust target reduction values to coincide with acceptable intensity and funding levels. To accommodate this need, a set of supply models has been developed that estimate the number of commuters needed to participate in ridesharing to achieve given levels of reduction in VMT and energy consumption. Separate figures have been developed for each of these reductions for both carpools and vanpools. These modal breakdowns enable planners to develop an optimum balance in ridesharing modes given the travel characteristics of their community. The use of these models also makes possible an assessment of the practicality of reduction levels in light of the number of commuters needed to participate and the resulting level of program intensity.

MODEL CONSIDERATIONS

In developing the supply models, consideration must be given to vehicle load factors and travel distances in order to make even rough estimates of the potential for ridesharing. Factors that have been considered in the models include prior mode of new carpoolers, vehicle occupancy of new carpools, home-to-work trip length, frequency of carpooling, trip circuity of new carpools, use of vehicles left at home during the work day, and miles of travel generated by persons meeting at pickup points. Failure to account for these various factors could result in estimates that would underestimate participation levels by 50 to 70 percent. A discussion of these considerations and their impact in estimating participation levels follows.

Prior Mode

It cannot be assumed that all new ridesharers are diverted from single-occupant vehicles; many may come from existing carpools and transit. Accounting for these other diversions significantly decreases the expected reduction in VMT because prior mode determines the number of vehicles that are no longer driven to work. For example, if 25 commuters switch to ridesharing and all 25 formerly drove alone, previous vehicle occupancy would be 1.0 and 25 vehicles would no longer be driven to work. On the other hand, if five of these 25 commuters formerly carpooled in five different carpools of two persons each, the previous occupancy would be 1.2 and only 20 vehicles would be removed, a 16 percent decrease from the initial case. In a recent evaluation of FHWA carpool demonstration projects it was reported that 20 percent of new carpoolers were diverted from other than single-occupant vehicles with a vehicle occupancy of 1.2 (1). In the case of vanpooling, a greater percentage of new riders is diverted from carpools than from single-occupant vehicles because of the longer trip distances associated with vanpooling and a greater previous incentive for commuters to form carpools. An examination of previous mode of van riders for various vanpool programs reveals that 57 percent were former carpool riders with an average previous vehicle occupancy of 1.79 (2).

In the case of vanpools, the percentage of riders diverted from carpools can be misleading in determining reductions because the nucleus of riders usually comes from one or more entire carpools. Thus, unlike most situations in carpool formation, commuting vehicles are no longer driven to work. To reflect this situation previous mode data for van riders were examined and the percentage of riders who formerly carpooled was reduced to 45 percent for calculation purposes in the supply models.

Vehicle Occupancy of New Pools

The formation of new pools results in a number of vehicles still being used for commuting to work. In most instances single-occupant vehicles have added riders and are now being used as pool vehicles. In determining energy reductions, the number of vehicles that are still being driven to work, especially those used for commuting, must be accounted for to obtain accurate reduction values. This is accomplished by dividing the total number of new poolers by the vehicle occupancy of new pools. This number in turn is subtracted from the earlier estimate of the number of vehicles no longer driven to work and yields the actual number of vehicles removed. The FHWA carpool evaluation found new carpool occupancy to average 2.85 persons per car (1). Vanpool occupancy averaged approximately 11 riders per van for 12-passenger vans.

Frequency of Ridesharing

The number of days per week each pooler participates in a pool is an important consideration because additional mileage is generated when riders drive to work by themselves. This situation happens frequently when riders need their vehicle during or after work. At some companies where employees must be away from the office during the week a lower frequency of pooling can be anticipated because employees may drive alone on days they will be out of the office or do not make the trip if business takes them out of town. If commuters rideshare only 3 or 4 days per week, a decrease in the expected energy reduction resulting from pooling may occur; this means that additional commuters must participate in pooling to achieve the desired reductions. From carpool evaluation programs throughout the country, it appears reasonable to estimate that, on the average, 84 percent of carpoolers participate in a carpool 5 days a week. The frequency of vanpooling has not been reported in rider evaluations, but it appears reasonable to assume that the rate is higher than that for carpooling because riders purchase a seat on a subscription basis instead of paying for the number of days they actually ride. On the basis of this information and conversations with Knoxville vanpoolers, and considering vacations and sickness, it is assumed that 92 percent of vanpoolers participate 5 days per week.

Trip Circuity of Pools

In most instances carpool trips tend to be longer than single-occupant trips because of the trip circuity of picking riders up at their homes or designated meeting points. Estimates of the added distance are not well documented because they have not been included in program evaluations and, like most distance values, are difficult for riders to estimate. Cambridge Systematics, Inc., analyzed several data sources and estimated trip circuity at 0.5 mile (0.8 km) per person per trip for those carpooling

(3). Trip circuity for vanpooling is not reported in evaluations but is assumed to be longer at 0.75 mile (1.2 km) per rider per trip because of the greater dispersion of vanpoolers.

Vehicle Left at Home

Another distance factor that has received considerable attention is the amount of travel that takes place by vehicles that are left at home by carpoolers. Travel that takes place during the day by these vehicles can be of two types, either additional new travel generated by other family members or existing travel for shopping and so forth that has been diverted to the midday because a vehicle is now available. The ability to distinguish between new and diverted travel and the difficulty in its estimation by poolers has led many evaluators to question its reliability. For this reason and because even if this additional mileage were accounted for it would be slight compared to the many other uncertainties in vehicle occupancy estimates, adjustments have not been made in the supply models to compensate for this additional mileage.

Travel to Pickup Points

A distance factor also to be considered is the amount of travel generated by commuters who arrange to meet their pool at designated pickup points. In these instances a portion of the trip is being made by one or more single-occupant vehicles, not the pooling vehicle, and consequently this practice generates additional mileage that is not considered in the trip distance of the pooling vehicle. In the case of carpools this additional trip distance has not been reported in evaluation studies and consequently is not considered in the supply models. Vanpool evaluations on the other hand have investigated this area because a greater proportion of riders meet at designated points because of the increase in travel time that would result if each rider were picked up at home. Reported results of various vanpool programs indicate that an average of 43.5 percent of the riders meet at a pickup point 3.23 miles (5.2 km) from their homes (2).

MODEL FORMULATION

Formulation of the supply models is relatively straightforward and similar for both carpools and vanpools. To illustrate the general procedure of the models a numerical example is first presented, followed by the algebraic formulation.

Numerical Example

Consider a situation in which a reduction in daily VMT of 500 miles (805 km) is desired and the average round-trip commute distance is 20 miles (32.2 km). The first step is to account for trip circuity of carpoolers, 1 mile (1.6 km), and subtract this distance from the round-trip distance. Dividing the desired VMT reduction of 500 miles (805 km) by the corrected 19-mile (30.6-km) trip distance equals 26.3, which is the number of single-occupant vehicle trips that must be discontinued. Because not all new carpoolers were previously drive-alone commuters, this value must be multiplied by the percentage of new carpoolers who previously drove alone, 80 percent, to yield the number of single-occupant vehicles, 21.0, that are no longer driven to work. The next step is to subtract the number of vehicles that will be used as pooling vehicles from the number of vehicles removed. The number of pooling vehicles is determined by multiplying the number of needed poolers, 26.3, by the percentage who form new carpools, 95, and dividing by the vehicle occupancy of carpools, 2.85. This equals 8.8 vehicles and subtracting from 21.0 results in 12.2 vehicles being removed. This value is then adjusted for the frequency of carpooling by multiplying by 85 percent to yield 10.4 vehicles. Thus, after correcting for vehicle occupancies and additional travel distances, only 198 miles (319 km) or 39.6 percent of the original 500-mile (805-km) reduction has been attained. To attain the 500-mile (805-km) reduction the original estimate of 26.3 single-occupant vehicles is divided by the 39.6 percent reduction to yield 66.4 as the number of total necessary commuters. Energy reductions are calculated in a similar manner except that VMT reduction is replaced with the desired reduction in gallons of gasoline and the appropriate fuel usage rate.

Algebraic Notation

Before developing the algebraic notation of the supply models it is necessary to define the following variables:

- NC_m = number of commuters needed to participate in ridesharing for mode m: m = carpool (c) or vanpool (v);
- VMT = desired or target level of reduction in vehicle-miles of travel (number of miles);
- GR = desired or target level of reduction in fuel (gallons of fuel);
- DIST = round-trip commute distance (number of miles per commuter or vehicle trip);
- MPG = fuel mileage, 17.0 miles per gallon;
- PO_m = percentage of new poolers who previously drove alone in mode m: 80 percent carpools, 43 percent vanpools;
- CO_m = current vehicle occupancy of newly formed pools of mode m (number of passengers per vehicle): 2.85 carpools, 11 vanpools;
- PE_m = percentage of poolers who form new pools for mode m: 95 for carpools, 100 for vanpools;
- FO_m = percentage of poolers who will be pooling any given day for mode m: 85.0 carpools, 92 vanpools;
- TC_m = trip circuity of poolers in mode m (miles per commuter or vehicle trip): 1.0 miles (1.6 km) carpools, 1.5 miles (2.4 km) vanpools;
- PD_m = distance from home to meeting point for those pooling in mode m (miles per commuter or vehicle trip): zero carpools, 6.46 miles (10.4 km) vanpools; and
- PP_m = percentage of poolers in mode m who meet their pool at a designated meeting place: zero carpools, 43.5 vanpools.

The first step in formulating the supply model is to determine the number of commuters or single-occupant vehicle trips that must be removed. For a specified VMT reduction and round-trip distance, the number of initially removed commuters or vehicle trips for ridesharing mode m is

$$IVR_m = VMT/[DIST - TC_m - (PD_m\ PP_m)] \quad (1)$$

where IVR_m is the number of commuters or single-occupant vehicle trips initially removed for ridesharing mode m.

Correcting for the fact that not all new poolers are former drive-alone commuters, the number of single-occupant vehicles actually removed for mode m is

$$AVR_m = IVR_m \; PO_m \tag{2}$$

and the number of vehicles that new poolers will be using as pooling vehicles for mode m is

$$PV_m = (IVR_m \; PE_m)/CO_m \tag{3}$$

where PV_m is the number of vehicles new poolers will occupy for mode m.

Because the initial estimate of removed vehicles included those that will be used as new pooling vehicles, Equation 3 is subtracted from Equation 2 to define the number of vehicles removed as

$$VR_m = AVR_m - PV_m \tag{4}$$

where VR_m is the number of vehicles removed for mode m.

The percentage of target or desired vehicle-miles actually reduced by ridesharing mode m, out of the desired number and corrected for frequency of pooling for mode m, is

$$PR_m = \{VR_m \; FQ_m \; [DIST - TC_m - (PD_m \; PP_m)]\}/VMT \tag{5}$$

where PR_m is the percentage of desired vehicle-miles actually reduced by mode m. Therefore, the total number of commuters (both single occupants and former carpoolers) needed to participate in ridesharing mode m to achieve a desired VMT reduction is

$$NC_m = IVR_m/PR_m \tag{6}$$

Estimated participation levels for energy reductions are determined in a similar manner except that the fuel usage rate is incorporated in the model. In this case the number of single-occupant vehicle trips or commuters that must be removed with ridesharing mode m is

$$IVR_m = GR \; MPG/[DIST - TC_m - (PD_m \; PP_m)] \tag{7}$$

Correcting for the percentage of poolers not diverted from single-occupant vehicles, the number of single-occupant vehicles actually removed for mode m is

$$AVR_m = IVR_m \; PO_m \tag{8}$$

and the number of vehicles that new poolers will be using as pooling vehicles for mode m is

$$PV_m = (IVR_m \; PE_m)/CO_m \tag{9}$$

The number of vehicles removed for mode m is

$$VR_m = AVR_m - PV_m \tag{10}$$

and the percentage of gallons actually reduced with ridesharing mode m, out of the desired number when corrected for frequency of pooling for mode m, is

$$PR_m = \{VR_m \; FQ_m \; [DIST - TC_m - (PD_m \; PP_m)]\}/GR \; MPG \tag{11}$$

Therefore, the total number of commuters needed to participate in ridesharing mode m to achieve a desired energy reduction is

$$NC_m = IVR_m/PR_m \tag{12}$$

To facilitate quick use of the supply models a set of figures has been developed to estimate participation numbers for each ridesharing mode. Figures 1-4 show calculations for various round-trip commute distances. Use of the supply model figures

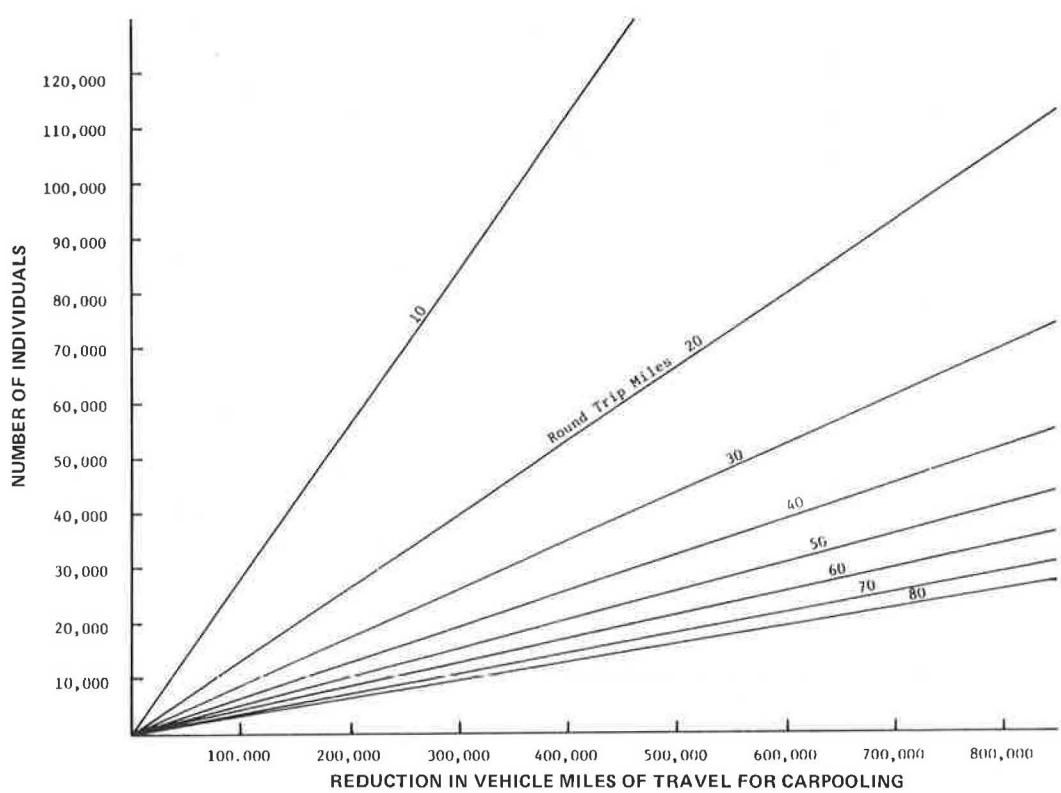

FIGURE 1 Number of individuals needed to carpool for reduction in VMT.

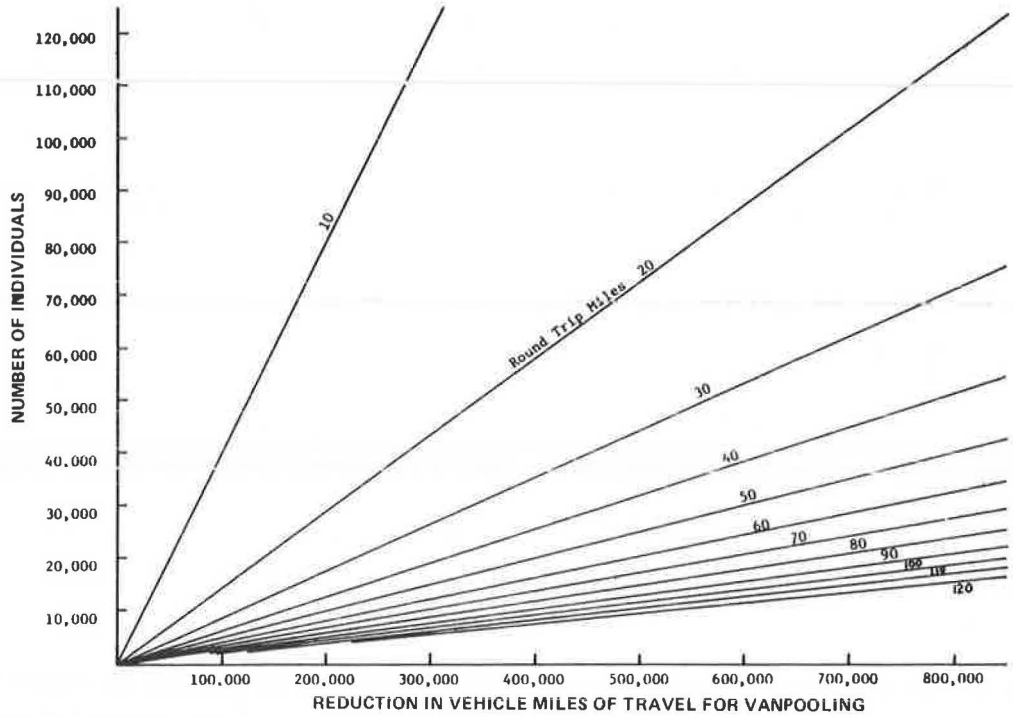

FIGURE 2 Number of individuals needed to vanpool for reduction in VMT.

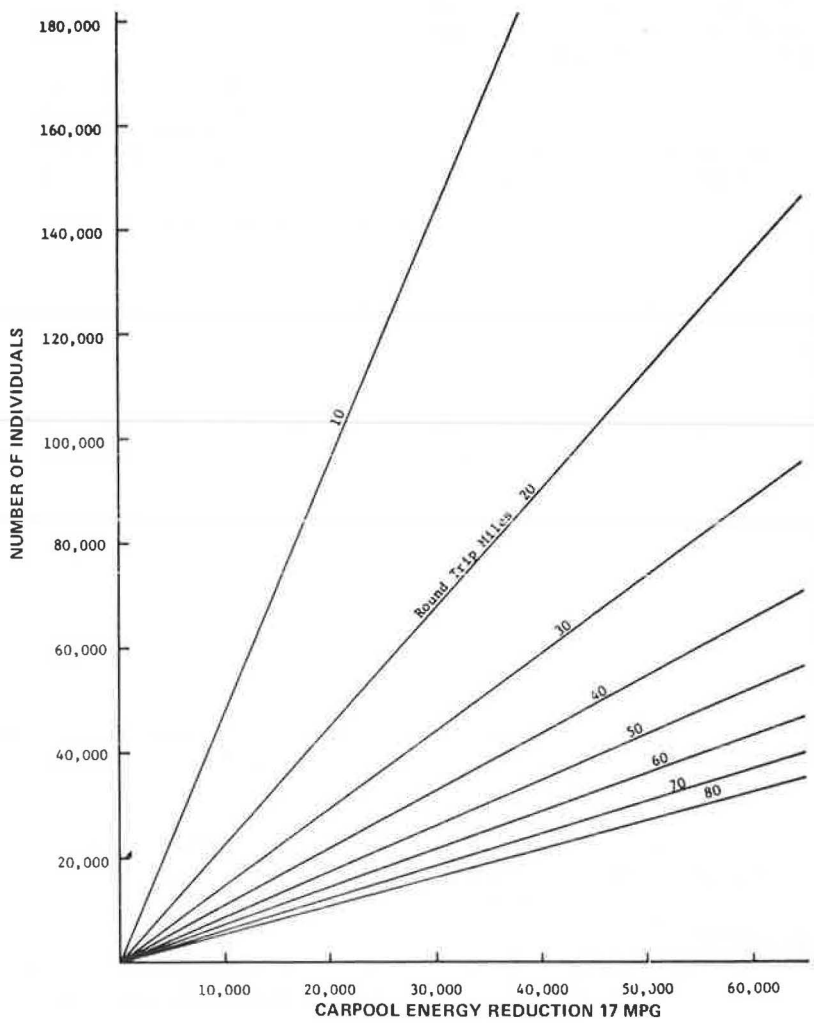

FIGURE 3 Number of individuals needed to carpool for reduction in energy usage.

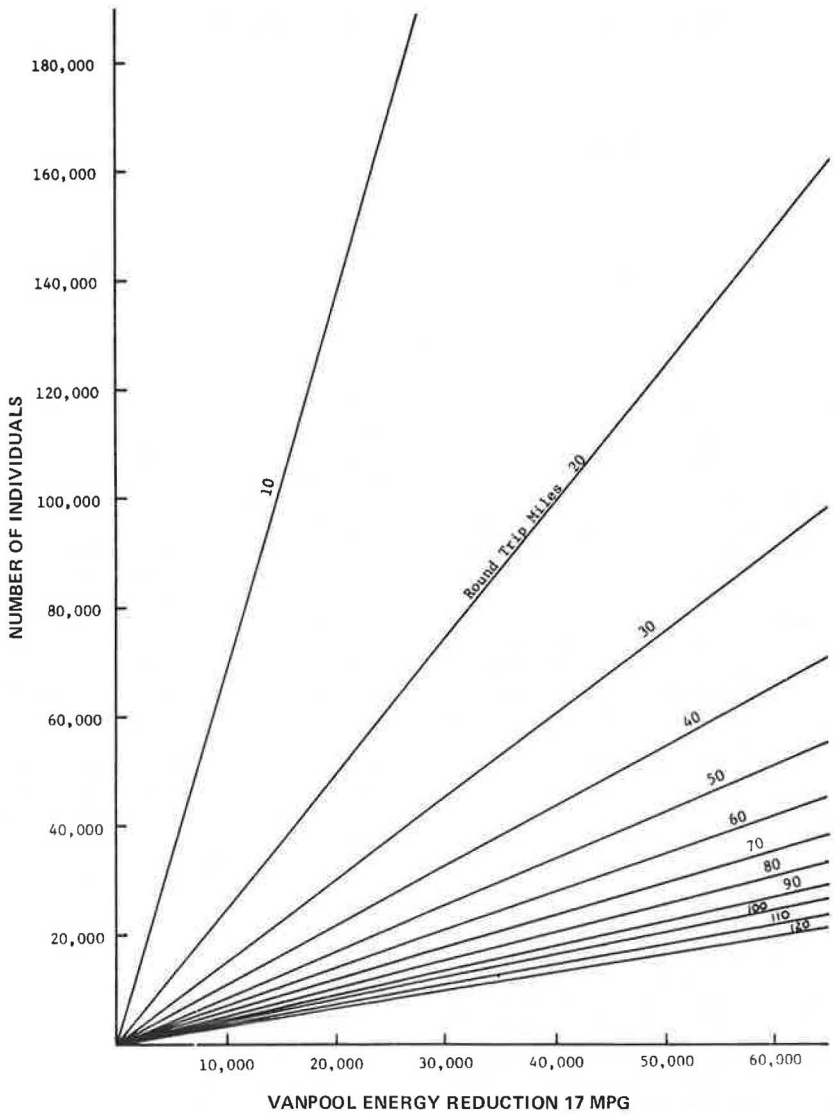

FIGURE 4 Number of individuals needed to vanpool for reduction in energy usage.

is straightforward and requires the following information about commuter characteristics:

1. The percentage distribution of two-way commuter trip lengths. This information may be obtained from origin-destination (O-D) studies, journey-to-work census tabulations, or other planning data or studies that collected information on home-to-work trip lengths. In cases in which these data are not available, it is recommended that the average round-trip commute distance for the entire area be used or the national average of 19 miles (30.6 km) (4).

2. In a comprehensive reduction program ridesharing may be one of many strategies being implemented, and knowing the portion of the reduction that ridesharing is responsible for greatly affects participation levels. For example, ridesharing may be expected to account for 70 percent of the desired reduction of VMT with transit and other programs encompassing the remainder. Thus the percentage of the reduction that ridesharing is expected to account for should be specified if it is part of a total program. Also to be specified is the percentage participation in each ridesharing mode by new poolers. If both car- and vanpooling are being promoted it can be expected that a certain portion of new poolers will carpool while the others vanpool. Because the two modes require different participation levels to achieve the same reduction, it is important to develop a balance between the modes given the potential of each in the area. In most areas it would be unrealistic to expect vanpooling to capture more than 5 to 10 percent of the total trips unless extensive employer-based vanpool programs and financial incentives are undertaken. In these situations vanpooling may capture between 15 and 25 percent of the total trips depending on the intensity of the program.

Example Application

Use of the figures is most easily explained through the following example. Consider the case of Knoxville, Tennessee, where it is desired to reduce daily VMT by 10 percent and current daily VMT is 2.5 million miles (4.6 million kilometers). The distribution of two-way commute trip lengths in the Knoxville area is as follows: 10 miles (16 km), 55 percent; 20 miles (32 km), 25 percent; 30 miles (48.2 km), 11 percent; 40 miles (64.3 km), 3.5 percent; and 50 miles (80.5 km), 3.5 percent. Ridesharing is expected to account for 80 percent of the reduction

TABLE 1 Participation Levels for Car- and Vanpooling in Knoxville, Tennessee

Trip Distance (miles)	No. of Commuters		Percentage of Trips for Each Distance (col. 3)	Normalized Vanpool Porportions (col. 4)	No. of Commuters Adjusted for Trip Distribution	
	Carpool (col. 1)	Vanpool (col. 2)			Column 1 x Column 3 (col. 5)	Column 2 x Column 5 (col. 6)
10	56,022	80,594	55.0	0.0	30,812	0
20	26,537	29,227	25.0	0.0	6,634	0
30	17,386	17,850	13.0	65.0	2,260	11,603
40	12,928	12,849	3.5	17.5	452	2,249
50	10,290	10,037	3.5	17.5	360	1,756
Total			100	100	40,518	15,608

and the split between ridesharing modes is 92 percent carpool, 8 percent vanpool.

The first step is to adjust the 250,000 VMT (402 336 km) to reflect the 80 percent rideshare contribution that yields 200,000 VMT and determine the number of commuters needed to carpool and vanpool for each of the commute distances. These values are obtained from Figures 1 and 2 for the 200,000-VMT (320 000-km) reduction and are tabulated in Columns 1 and 2 of Table 1. The next step is to correct these participation levels to reflect the percentage of trips for each commute distance by multiplying the number of commuters by the corresponding percentage. Because vanpooling is applicable for commute distances greater than 15 miles (24 km) one way, the corresponding percentages for the proportion of trips greater than 30 miles (48.3 km) have been normalized to 100 percent (Column 4) and multiplied by the corresponding participation levels. These values are tabulated in Columns 5 and 6 of Table 1. Summing these columns yields 40,518 and 15,608, which are the numbers of commuters needed to carpool or vanpool to achieve the 10 percent reduction level. If vanpooling was not being considered in the area the number of commuters needed to carpool (40,518) would be the necessary participation level. In the present case vanpooling is included and requires that participation levels be adjusted to reflect the percentage of participation in each mode. The number of commuters needed to participate is determined by multiplying the participation levels for car- and vanpooling by 92 and 8 percent, respectively, and summing. This results in a total participation of 38,526 commuters.

Estimates of participation levels for energy reductions are determined in a similar manner.

SUMMARY

Through use of the supply model figures, it is quickly recognized that, for even small percentage reductions in VMT and energy usage, participation levels are large and can quickly approach the size of the work force. In the Knoxville application an additional 38,526 commuters would need to rideshare to achieve the 10 percent reduction. Currently the work force is approximately 130,000 individuals, and 40 percent (52,000) of these individuals already rideshare. Thus, expecting an additional 38,526 commuters (30 percent of the work force) to rideshare would be questionable unless an extensive change in commuting conditions such as a decrease in the supply of gasoline were to occur.

The supply models have been developed such that they incorporate numerous considerations affecting load factors and travel distances that in turn provide a fairly good estimate of participation levels for decision-making purposes. Proceeding through the process and assessing needed participation levels against the size of the work force, demand estimates, and the resulting level of program intensity and cost enables an in-depth analysis to be undertaken. Through this assessment, changes can be made to reduction levels if resulting participation values are too high, which readjusts the scope of the ridesharing program to acceptable intensity and funding levels. Even with increases in carpool and vanpool occupancies, ridesharing may have a more limited potential than first expected. These implications can quickly be identified through use of the supply models.

REFERENCES

1. F.A. Wagner. Evaluation of Carpool Demonstration Projects. Phase I Report. Office of Highway Planning, FHWA, U.S. Department of Transportation, Aug. 1978.
2. D.W. Wiersig and F.J. Wegmann. Results from Two Operational Programs. In TRB Special Report 184: Urban Transport Service Innovations, TRB, National Research Council, Washington, D.C., 1979, pp. 38-43.
3. Federal Energy Administration, Carpool Incentives: Analysis of Transportation and Energy Impacts. FEA/D-76/391. Office of Energy Conservation and Environment, FHWA, U.S. Department of Transportation, June 1976.
4. National Personal Transportation Study: Home to Work Trips and Travel. Report 8. FHWA, U.S. Department of Transportation, Aug. 1973.

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City of Los Angeles Parking Management Ordinance

DAVID CURRY and ANNE MARTIN

ABSTRACT

The process by which the Los Angeles parking management ordinance was developed and implemented is documented and an assessment of reasons for its lack of use is offered. The ordinance was adopted in April 1983 as a result of a federally sponsored parking study conducted by the city in 1980 and 1981. Under the provisions of the ordinance, developers can reduce code-required parking up to 40 percent on site and up to 25 percent for remote parking in exchange for the promotion of commute alternatives at the development. The landowner must (a) reserve land for added parking if it turns out to be needed and (b) record a covenant running with the land for future owners to maintain specified compliance levels or to develop additional parking spaces. Only one serious inquiry about use of the ordinance has yet been received by the city of Los Angeles. Several possible reasons for nonuse of the ordinance, which may have relevance to other cities considering such measures, were offered by developers and city staff: (a) the low level of minimum parking already required; (b) lenders' fear that overreducing parking would lessen marketability of a property; (c) lack of familiarity with the ordinance by developers (due in part to lack of city resources for publicizing the ordinance); and (d) restrictive provisions of the ordinance protecting the city, especially land set-asides and covenants. Two other reasons mentioned for nonuse of the ordinance are probably relevant only to large cities: (a) delays of 3 to 9 months in obtaining conditional use permits under the ordinance and (b) diffusion of responsibility for the ordinance among different city departments.

Effective April 20, 1983, the city of Los Angeles adopted a parking management (PM) ordinance the purpose of which is to grant land developers reduced employee parking requirements in exchange for successful encouragement of commute alternatives that would lessen parking demand at the site. The ultimate aim of this ordinance is to reduce motor vehicle emissions through the mitigation of commuter traffic, although traffic mitigation itself was regarded as a worthwhile aim as well. The ordinance was the result of a detailed city-managed study, in 1980 and 1981, that was financed by a grant from the Service and Methods Demonstration (SMD) program of the Urban Mass Transportation Administration, U.S. Department of Transportation.

The purpose of this paper is to document the process by which the Los Angeles parking management ordinance was developed and implemented, emphasizing the features of the adopted ordinance and reasons for its nonuse by developers up to the present time. The staff study report for the parking management program (1) is heavily drawn on.

BACKGROUND

Parking Management

There have been a number of new ventures into urban traffic mitigation and parking management within the past 5 years. Most of these ventures are documented in two recent reports on parking management ordinances and other traffic mitigation measures (2,3). The more extensive documentation of the Los Angeles study process discussed in this paper provides insight into the range of conditions that can affect the feasibility of a parking management ordinance. Following this introduction to the concept of parking and ridesharing trade-offs and the study issues, the study that developed a recommended ordinance is described; next, differences between the recommended and adopted ordinance are discussed; and, finally, the probable reasons for nonuse of the ordinance are presented. Lessons for other cities from Los Angeles' experience are outlined in the final section.

Parking and Ridesharing Trade-Offs

Minimum parking requirements for buildings are one way that cities control the traffic effects of new construction. The aim is generally to require enough parking so that building occupants or visitors do not need to park on city streets, especially in residential neighborhoods.

In general, the parking minimums range from 1 or 2 spaces per 1,000 gross square feet of office space in central business districts (CBDs) well served by transit, to 3 or 4 spaces per 1,000 gross square feet in suburban areas with poor transit service. Requirements for industrial and commercial property vary; the aim is to assure each commuter and visitor vehicle a parking space without imposing undue expense on an employer.

Office space usually averages about 250 ft^2 per employee, so 4 spaces per 1,000 ft^2 would permit every employee to drive alone. However, if employers are successful in encouraging commute alternatives to single-occupant vehicles or other traffic mitigation measures among their employees, they can reduce their parking needs far below the level of one space per employee. The principal commute alternatives are ridesharing (carpools, vanpools, and buspools); transit and paratransit modes; and bicycling or walking. Sometimes the term "ridesharing" is used loosely to refer to all of these modes, as will be done in the balance of this paper.

Figure 1 shows the wide variation of parking

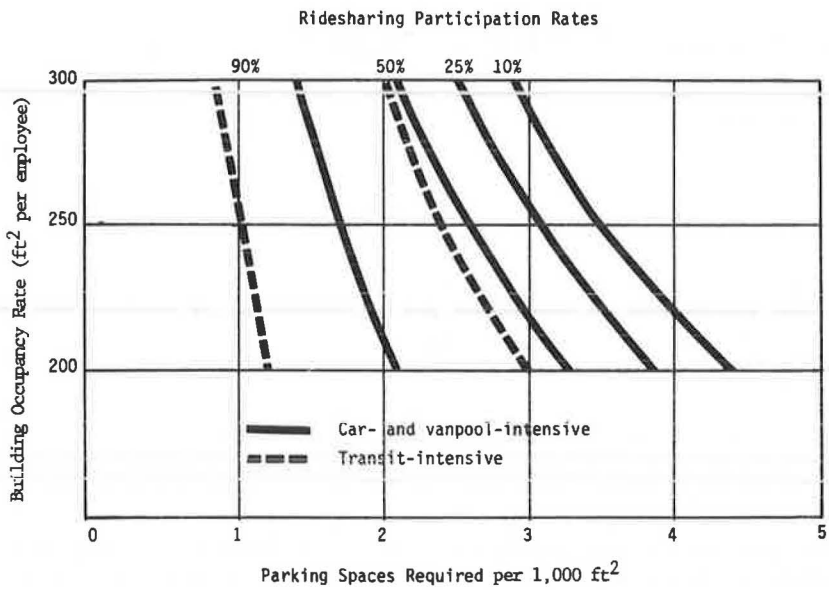

FIGURE 1 Parking spaces required at various ridesharing participation and building occupancy rates.

spaces required under different assumptions of building occupancy and employee participation in commute alternatives. A developer or an employer considering plant expansion could use Figure 1 to estimate the decrease of parking needs with higher commute alternative participation rates. For example, if the applicable city parking requirement is 3.5 spaces per 1,000 ft^2 and the anticipated building occupancy rate is 250 ft^2 per employee, a participation rate of about 27 percent will be needed to reduce the estimated parking requirements to 3 spaces per 1,000 ft^2. A 50 percent participation rate would reduce parking needs to about 2.5 spaces per 1,000 ft^2 depending somewhat on what fraction of ridesharers uses transit.

Table 1 gives the mode split assumptions underlying Figure 1, and Tables 2 and 3 give the derivation of the corresponding points plotted in the figure. Assumptions are as follows: Vanpools require one space per 12 vanpoolers, carpools require one space per 2.5 carpoolers. One HOV (high-occupancy vehicle) "floater" space is required per 10 ridesharers to accommodate their occasional need to bring their own car. SOV (single-occupant vehicle) users have a 10 percent absenteeism rate due to trips, sick leave, vacations, and so forth and thus require 9 spaces per 10 persons. Two visitor spaces are required per 100 employees.

Study Issues

A reduced parking requirement appears to be a logical trade-off for reducing parking demand through ridesharing promotion. If a bargain can be struck early and adhered to, the property owner can reduce building costs and the public can gain the benefits of less automotive traffic in the form of reduced congestion and better air quality. However, in the Los Angeles case and probably in all U.S. cities, there are three central issues or difficulties that must be resolved in adopting such an ordinance. These issues emerged early in the Los Angeles study and permeated the debate on the feasibility of implementing a parking management (PM) ordinance. The three issues are (a) leverage--can the city obtain PM agreements by offering reduced parking as an incentive? (b) legal assurances--how can the city be

TABLE 1 Illustrative Percentage of Employees Using Each Mode for Varying Ridesharing Programs and Participation Rates

	Transit Intensive [participation rate (%)]		Car-, Vanpool Intensive [participation rate (%)]			
Mode	90	50	90	50	25	10
Transit, bicycle, walk	70	25	20	10	8	2
Vanpool	10	7	20	12	3	0
Carpool	10	18	50	30	4	8
SOV	10	50	10	50	75	90
Total	100	100	100	100	100	100

TABLE 2 Parking Spaces Required for Varying Ridesharing Programs and Participation Rates (spaces per 100 employees)

	Transit Intensive [participation rate (%)]		Car-, Vanpool Intensive [participation rate (%)]			
Parking User Category	90	50	90	50	25	10
Transit and other users	0	0	0	0	0	0
Vanpool users	0.8	0.6	1.7	1.0	0.3	0
Carpool users	4.0	7.2	20.0	12.0	5.6	3.2
HOV floater spaces	9.0	5.0	9.0	5.0	2.5	1.0
SOV users	9.0	45.0	9.0	45.0	67.5	81.0
Visitors	2.0	2.0	2.0	2.0	2.0	2.0
Total spaces	24.8	59.8	41.7	65.0	77.9	87.2

TABLE 3 Corresponding Parking Spaces Required per 1,000 Ft^2

	Transit Intensive [participation rate (%)]		Car-, Vanpool Intensive [participation rate (%)]			
Square Feet per Employee	90	50	90	50	25	10
200	1.2	3.0	2.1	3.3	3.9	4.4
250	1.0	2.4	1.7	2.6	3.1	3.5
300	0.8	2.0	1.4	2.1	2.5	2.9

assured that the bargain will be kept? and (c) monitoring--what information can the city obtain to measure ongoing compliance? How the Los Angeles study addressed these issues is covered in the next section.

STUDY PHASE AND RECOMMENDED ORDINANCE

Objectives and Approach

The initial purpose of the parking management study was to determine the viability of "a parking substitution proposal." This proposal would have allowed a reduction of the number of parking spaces required on site or within 750 ft of the work site (1,500 ft of the site in the downtown parking district) in exchange for a space-for-space parking substitution at off-site, remote locations within the city. The initial proposal was considerably expanded and refined in the course of the study.

The major components of the study, their purpose, and the performing agencies may be summarized as follows:

Steering committee meetings were held to integrate views of relevant public and private sector interests. Meetings were conducted by the city's project manager.

A background study of the development of the city's parking requirements, procedures for administering those requirements, and the role of parking in the city's general plan was performed by the planning department. The purpose of the background study was to ensure that any new ordinance was developed in the context of existing parking regulatory procedures.

A survey of local parking requirements was conducted to evaluate actual parking demand at various types of office and industrial sites compared to city parking requirements. This determined the degree of leverage the city might have in offering to reduce requirements. The survey was performed by the planning department with much of the input data coming from site studies.

A survey of alternative ridesharing programs to evaluate the forms of employer-based ridesharing programs that are possible, the conditions under which they best operate, their costs and benefits, and their impacts on parking demand was performed by the city department of transportation (DOT).

A survey of PM programs in other cities, to profit from what has been learned in other applications, was performed by the planning department.

Detailed site studies were performed by the city DOT of specific office and industrial buildings to evaluate the various proposed PM measures in real-world settings and to develop some data on relevant functional relationships (e.g., the degree of ridesharing required to reduce parking demand below city-required levels).

Case studies--adjuncts to the site studies--were also performed on six additional sites with emphasis on exploring the feasibility of various methods of legal assurance and monitoring of compliance.

Alternative ordinance language, legal assurance, and monitoring procedures were developed for review by the steering committee. The evaluation and selection of the approach to be recommended to the planning commission was led by the project manager with most of the detailed preparation done by the planning department.

Selection of final ordinance language was led by the project manager and developed through consensus of the steering committee, the planning department, and the office of the city attorney, with lesser involvement of other city departments.

Preparation of guidelines for use by the zoning administrator in implementing the ordinance was done by the planning department with input from the city DOT.

Study Findings

The study began with the appointment of the steering committee in June 1980. The final task of the steering committee was to submit a draft parking management ordinance to the mayor and the city council. This task was completed in September 1981, at which time the review and modifications of the ordinance became the responsibility of the planning commission and the city council.

Although the end result of the staff study was a proposed parking management ordinance, several intermediate research findings were also significant. These were

- A compilation of ridesharing program components, including carpools and vanpools, fleetpools, subscription buses, transit passes, and shuttle buses;
- A summary of the uses of these ridesharing program components by employers in Los Angeles, together with measures of program effectiveness;
- A review of parking management programs in other cities; and
- A review of potential applications for the ordinance, through case studies of 10 exemplary development sites.

Key Issues and Their Resolution

Leverage

For an ordinance to be attractive to developers, the local parking minimums should be high enough that many or most developers will wish to seek reductions in the parking requirements. The Los Angeles city code, however, requires minimums of 1 space per 1,000 ft^2 of floor space within the CBD, 2 per 1,000 ft^2 outside the CBD, and usually from 3 to 3.3 per 1,000 ft^2 in cases in which discretionary review indicates the need for a higher parking minimum in order to prevent spillover parking on city streets. As is clear from Figure 1, only developments with relatively large floor areas per employee or relatively high ridesharing rates can manage even with 3 spaces per 1,000 ft^2, and the rates of 1 or 2 spaces per 1,000 ft^2 are inadequate for all buildings except those with exceptional ridesharing rates. In the vast majority of cases, building developers in Los Angeles are already installing more parking spaces than required by the city code, and few would want fewer than 3.3 per 1,000 ft^2 unless they had unusually good transit service or an effective employee ridesharing program, or both.

Only in two of the ten case study sites were there potential benefits from application of the proposed parking management ordinance. Warner Center, a large business park and cultural center in the San Fernando Valley section of Los Angeles, was one of these. However, Warner Center has since installed the full requirement of 3.3 spaces per 1,000 ft^2 instead of opting for a reduction in parking--even though Warner Center has an aggressive ridesharing program. Abbott Labs was the other case, but it has subsequently moved to another site to obtain increased parking space, instead of opting for less space plus an effective ridesharing program. Hence the results of the case studies at the time overwhelmingly confirmed the potential lack of leverage

by the city, and subsequent events have negated even the two examples that were considered favorable.

Legal Assurances

If an agreement is made between a building developer or user and a city (e.g., for building occupants to rideshare in return for some concession by the city), the agreement needs to contain some legal assurance that the bargain will be kept. The problem is complex in that a city will often be dealing with developers who somehow must bind future building owners and tenants to a ridesharing agreement. Should the agreed-to ridesharing program fail, the building owner might plead successfully that no remedy was possible (e.g., there was no space to build remedial parking spaces). The form of legal assurance could be so costly, as in a requirement to hold land vacant to house a future parking facility if needed, that the bargain might not be cost-effective for the developer.

The initial approach by city staff was to write a parking management ordinance requiring that legal assurance be established in a covenant whereby a developer would obtain or hold open an area for parking in the event that the ridesharing program proved unsuccessful. This was referred to within project discussions as the "nuclear deterrent" approach, giving the city immense power to enforce agreements.

Although this particular form of assurance would be highly acceptable from the perspective of the city, it was not acceptable to people in all of the situations the program was geared to address. In particular, when nearby parking areas could not be readily found, possibly unnecessary parking in structures would have had to be added at great expense. By permitting only one form of assurance, the applicability of the program would be limited. Thus it was decided that the range of assurances would be broadened to permit a selection based on an assessment of (a) the risk of noncompliance; (b) the objectives to be achieved; (c) the potential for adverse impact on the surrounding public; and (d) the unique circumstances of a particular application. In some cases, a covenant would be the preferred mechanism and should be required.

Monitoring of Compliance

A city should have some means for monitoring users of the parking management ordinance and detecting noncompliance. The fundamental choices are between self-reporting by users of the ordinance and active monitoring by a public agency that attempts direct observation of results--or some combination of the two extremes. However, in a successful large program, a city could have hundreds of agreements in existence. The cost of total active monitoring could be prohibitive, particularly the cost of obtaining sufficient data to provide a legal basis for claiming noncompliance. Probably the best compromise is self-reporting of an easily confirmed statistic, with some spot checks by the public agency.

The Los Angeles study determined that city monitoring of employers participating in a ridesharing arrangement would be too expensive. If the city's parking management efforts were successful, city staff would be needed to periodically measure employee participation rates in ridesharing. But adding to city staff for any reason was judged politically infeasible at the time of the study.

The plan proposed was to require the applicant, as a condition of the parking management arrangement, to annually survey the commute modes of its employees and determine, using city-provided formulas, actual reductions in parking requirements. This was to function as a self-certification process, minimizing continuing city staff involvement in inspection and enforcement. The applicant would file an annual report providing these data to show the degree of compliance. The zoning administrator was then to review the annual submittals for compliance.

RECOMMENDED AND ADOPTED ORDINANCES

Results and Recommendations of Staff Study

The culmination of the Los Angeles staff study was a four-volume report, submitted to UMTA in August 1981, summarizing all aspects of the study (1). In addition, the steering committee submitted a draft parking management ordinance, as well as guidelines for implementation of the ordinance, to the city planning commission.

The recommended form of legal assurance was a covenant or "alternative legal agreements as to assurances and remedies" found adequate to protect the city against failure to achieve the levels of compliance specified in the conditional use permit. The guidelines for implementing the ordinance suggested that the legal assurance (a) last the lifetime of the project, (b) provide for adjustments for failure to meet promised levels of parking demand, and (c) protect the city's interest in terms of default, bankruptcy, or sale of property.

The proposed monitoring system required that the applicant submit an annual statement with supporting data showing compliance with the agreement. This statement was to be the basis on which the zoning administrator recertified (or denied recertification to) the project. If recertification was denied, either parking would have to be expanded to the level from which it was reduced or the developer would have to gain the zoning administrator's approval of an alternative plan.

The steering committee also recommended that the parking management measures be implemented on a phased basis, applying them first only to applications for conditional use permits. If this proved to be successful, the measures were then to be applied to other applications to the city, such as for zoning changes, zoning variances, developments with a specific plan area, and environmental impact review (EIR) approval.

Modifications and Final Approval by the City

On receipt of the recommendations of the steering committee, the proposed parking management ordinance was reviewed by the planning commission and the city council for approximately 1 year. The only point of controversy was the form of legal assurance to be required in order to protect the city. The planning department supported the requirement of a covenant in all cases. Other city agencies wanted to keep the option for alternative legal assurances to be negotiated between the applicant and the zoning administrator before approval of the permit application would be granted. Because the steering committee and the project staff had by this time been disbanded, they were not consulted on resolution of this conflict.

The final ordinance was approved by the City Council of Los Angeles to become effective April 20, 1983. The views of the planning department had prevailed, and the option for equivalent forms of legal

assurance had been removed from the measure. Revisions to the wording of the code were also made in the interest of clarity.

Adopted Ordinance

The principal features of the adopted ordinance are summarized as follows:

- A conditional use permit must be obtained by the applicant, authorizing a variance from the city's minimum parking space requirement (e.g., 1 space per 1,000, 500, or 300 gross square feet for office space, depending on the density of development in the area).
- Reductions in parking requirements of up to 40 percent for on-site or 25 percent for remote parking are authorized if supported by a parking management plan submitted with the application for a conditional use permit.
- The land owner must either set aside enough open space to accommodate the full amount of parking required by the code or gain approval by the zoning administrator of an alternative plan if projected reductions in parking demand at the site are not achieved.
- Finally, the owner must record a covenant running with the land that if specified levels of compliance are not achieved the owner at that time will develop the additional parking spaces or other measures required on written request of the zoning administrator.

The zoning administrator is responsible for explaining and promoting the ordinance and for reviewing any resulting conditional use permit applications. City DOT staff review the adequacy of the transportation alternatives that are proposed in any applications. The planning commission must approve the parking variances requested under the ordinance.

REASONS FOR NONUSE OF THE ORDINANCE

Developer Experience and Comments

Only one serious inquiry about use of the ordinance has been received by Los Angeles from a developer since the effective date of the ordinance, and that inquiry was terminated before it resulted in an application. Discussions with the developer revealed that the reason for his inquiry was his interest in reducing his minimum requirement of 3 spaces per 1,000 ft^2 to 2.62 spaces, in view of a "solid" ridesharing program that had been prepared for him by a transportation consulting firm.

The Los Angeles DOT indicated in discussions that they would not agree to the indicated parking reduction until the developer's ridesharing measures were implemented and proven to be effective. In other words, parking had to be supplied at the rate of 3 spaces per 1,000 ft^2 until the need for less parking was demonstrated. [The Los Angeles DOT requires "solid historical evidence" of developers' ability and will follow through on promises to mitigate traffic by encouraging ridesharing at their projects. For example, another variation of this type of requirement that is used by the DOT is to approve only reduced parking for the first stage of construction in the conditions of use for a multistage project with relatively low parking levels. Approval of parking for the second or final stage is then made contingent on the developer meeting the parking demand targets for the first stage.] The developer believed that this was too severe a requirement and applied to the planning commission separately for a variance. In spite of the Los Angeles DOT's objections at the hearing, the planning commission approved a reduction of parking requirements to 2.5 spaces per 1,000 ft^2. Use of the parking management ordinance was therefore unnecessary in this case.

The foregoing case illustrates the strict evidence of rideshare program effectiveness that is required by the Los Angeles DOT for use of the parking management ordinance. It also shows the differing attitudes about granting parking reductions that exist within the city government.

Four other developers or developers' agents (engineering or legislative advocacy firms) were contacted for their views on the reasons for lack of use of the ordinance. Two of the firms interviewed had not heard of the ordinance. Staff of the other two firms were familiar with the ordinance but were not interested in using it. They believed that the reasons for its nonuse were as follows:

- Most developers do not know the ordinance exists.
- Those who do know it exists would often be unwilling to tolerate either (a) the delay of 3 to 9 months typically required in Los Angeles for approval of such variances (which could delay parking designs or completion dates for construction) or (b) the lack of clearly defined evaluation criteria for permit approval, particularly specified trade-offs between transportation alternatives and parking reductions.
- One developer believed that local lenders would sometimes oppose parking reductions out of a fear that inadequate parking would lessen the marketability of a property.
- Finally, one developer cited the diffusion of responsibility for the ordinance among the three city departments concerned with transportation, planning, and zoning, none of which agencies has a strong commitment to promoting and expediting applications for conditional use permits under the ordinance.

Although these "reasons" are only the opinions of developers, they appear plausible and were not contested by city of Los Angeles staff. The city zoning administrator and staff of the city DOT did attribute lack of use of the ordinance independently (without reference to the developers' opinions just cited) to the following three causes, which also seem quite plausible--especially the first one:

- The low level of minimum parking currently required by the city code.
- The restrictive provisions of the ordinance protecting the city, specifically the requirements for land set-asides and a covenant running with the land to bind future property owners.
- The lack of any city budget, staff, or materials for publicizing the ordinance.

Of all the reasons given by both developers and city staff for nonuse of the ordinance, three appear to be most significant: (a) the low present city minimum parking requirements, (b) the lack of specified evaluation criteria for permit approval, and (c) the fear of local lenders that overreducing parking will lessen marketability. None of the developers mentioned the restrictive nature of the ordinance's provision for legal assurance as a deterrent to use of the ordinance. The problems of lack of funds for promotion of the ordinance, diffusion of responsibility, delays in granting conditional use permits, and lack of developer awareness do not need to be addressed unless changes are made to increase the usefulness and use of the ordinance.

The problem of low minimum parking requirements was foreseen in the results of the case studies but was never reconciled or fully addressed during passage of the ordinance. The low minimum parking requirements are also related to the alleged fear of local lenders that overreducing parking will lessen marketability. Higher parking minimums would certainly reduce these fears.

The lack of specified evaluation criteria for permit approvals, including advance agreement on the range of parking reduction effectiveness that will be attributed to specific transportation alternatives, has probably contributed to the lack of use of the ordinance. The absence of such criteria places both the burden of proof and the risk of not achieving predicted parking reduction levels entirely on the developer or his consultant.

There are other ways to reduce the actual or apparent developer risk under the Los Angeles ordinance, as evidenced by the approach in a transportation system management (TSM) ordinance that was recently adopted by the city of Pleasanton, east of San Francisco Bay (see paper by Curry and Fraser-Middleton in this Record). The Pleasanton ordinance specifies review of an employer's TSM program effectiveness by the city after 2 years. If ridesharing results are below agreed targets, remedial measures to increase the effectiveness of the employer's program can be prescribed by the city's TSM task force (an advisory committee of employer and business park representatives). In effect, this introduces both a peer review process and the opportunity for remedial steps short of providing more parking, which is the single threat posed by the Los Angeles ordinance.

Plans for Modifications to the Parking Management Strategy

Los Angeles is currently considering raising its basic parking requirement to a more realistic level of 3 spaces per 1,000 gross ft^2. This would also provide more incentive for use of the ordinance to reduce parking requirements. However, a change in the minimum parking requirement will not be made until funding is found for a proposed study of the city's parking requirements.

There are no plans to rectify the other possible causes for lack of use of the ordinance in the near future. There is no available funding for promotion of the ordinance. Action to quantify the effectiveness of specific transportation alternatives in reducing parking demand will probably not be taken until the specified trade-offs in parking management tactics being tested in other jurisdictions are proven valid. No changes in the institutional setting of parking management in Los Angeles are foreseen. Probably this matter is not considered to be particularly urgent by the city, because there are other means for encouraging developers to include traffic mitigation measures in their plans. The three principal ones are as follows:

- Review of applications for variances and environmental impact reports for most large developments by the city DOT, which usually results in detailed specifications for traffic mitigation measures by the city if they are not already part of the plans.
- Consulting services that are now offered to developers by Commuter Computer, the local ridesharing agency, to assist them in preparing the transportation or TSM element of their plans (other consulting firms are in the same business).
- Moratoriums on building permits in the Westwood Community Plan Area and the Westchester-Los Angeles International Airport-Venice-Palms transportation corridor. The moratoriums require developers in those areas to submit an initial traffic assessment or study and a transportation plan that reduces traffic impacts to an insignificant level before a building permit will be issued, due to exceptionally severe traffic congestion in the two areas.

In addition, the Los Angeles DOT is considering an ordinance that would require developers in traffic-impacted areas to pay a one-time fee for each commute vehicle trip generated by their project. The fees could be used to improve the regional traffic circulation system (which is affected even by local developments) as well as for local traffic improvements. No definite fee level has been arrived at, though a fee of $800 per vehicle trip was incorporated in a similar ordinance considered for the Westwood Community Plan Area. Such fees could provide some added incentive for developers to provide for ridesharing programs that would reduce the vehicle trips to their projects. Los Angeles DOT expects this ordinance to be in place, if it is accepted by the city council, by mid-1985.

CONCLUSIONS

The reasons given by developers and city staff for nonuse of the Los Angeles parking management ordinance should serve as reminders of pitfalls to other cities devising such ordinances. However, few cities are comparable to Los Angeles in size and complexity, and it is possible to separate the reasons given into those of more general applicability and those that would be peculiar to large cities. Those reasons of general applicability are

- The low level of minimum parking already required;
- Fear by lenders that overreducing parking would lessen marketability of a property;
- Lack of familiarity with the ordinance by developers (due in part to lack of city resources for publicizing the ordinance); and
- Restrictive provisions of the ordinance protecting the city, especially land set-asides and covenants.

The last of these reasons may be unavoidable. Some enforcement provisions are needed, and, given the adequacy of an ordinance on other counts, they should not be critical disadvantages of an ordinance.

The two other reasons mentioned for nonuse of the ordinance are probably relevant only to large cities:

- Delays of 3 to 9 months in obtaining conditional use permits under the ordinance and
- Diffusion of responsibility for the ordinance among different city departments.

Cities would also do well to check the model parking code (2) and Traffic Mitigation Reference Guide (3) along with progress of the new TSM ordinance of the city of Pleasanton, California, when devising their own ordinances for encouraging traffic mitigation.

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REFERENCES

1. The Los Angeles Parking Management Staff Report, Volume 1: Parking Management Program, Program Manager's Introduction and Overview; Volume 2: Parking Management Program, Code Amendment Staff Reports and Administrative Guidelines Report; Volume 3: Parking Management Program, Background Research Report; Volume 4: Parking Management Program, Employee Incentive Measure. City of Los Angeles, Calif., Aug. 1981.
2. S.A. Smith and S.I. TenHoor. Model Parking Code Provisions to Encourage Ridesharing and Transit Use. JHK & Associates, Alexandria, Va.; FHWA, U.S. Department of Transportation, Sept. 1983.
3. Traffic Mitigation Reference Guide. Metropolitan Transportation Commission, Oakland, Calif., Dec. 1984.

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