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CONTENTS

FOREWORD

In this RECORD 5 full papers and 3 abridgments are presented on the subject of transportation for the disadvantaged.

Lee, Falcocchio, and Cantilli examine the use of legal and illegal taxicabs in the Central Brooklyn Model Cities area. Even though the area was well served by other forms of public transportation, taxi usage in this poverty area is extremely high. The paper contains recommendations for legalizing and controlling New York City taxis.

Falcocchio, Pignataro, and Cantilli further examine the transportation problems of the inner-city poor. The purpose of the study, which dealt with the inner-city poor in New York, was to identify the transportation constraints that inhibit mobility. The effect or lack of transportation on poor peoples' mobility is examined, and recommendations are made on how to satisfy the needs of the transit-dependent poor.

Carp discusses the way older people depend on walking as a means of transportation. Walking would better serve the needs of the elderly if walkways were improved and the danger and instrusion of motor vehicles across the walkways were minimized. The study points out that, although the elderly heavily rely on walking, they also need vehicular transportation for medical emergencies, shopping, and a sense of independence.

The relation between transit ridership and walking distances for the elderly is examined by Neilson and Fowler. The Florida Department of Transportation developed a project to study the ridership and costs of operating five 29-passenger buses on fixed routes in low-density, senior-citizen communities. The study found that transit usage was primarily for shopping and recreation rather than for business and that transit usage was very dependent on proximity of origin and destination to the transit line.

To plan for the transportation needs of the urban disadvantaged requires an accurate data base. Benson and Mahoney point out that the present data sources used in urban transportation planning are inadequate to provide necessary data on the disadvantaged segment of the urban population. They suggest the use of several social welfare data bases. The prime element is small-area identification of specific types of disadvantaged persons and locational constraints. Planning strategies and data sources are recommended for different government levels of transportation planning programs.

TAXICAB USAGE IN NEW YORK CITY POVERTY AREAS

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As part of an overall transportation study of the Central Brooklyn Model Cities area, the use of legal, semilegal, and illegal taxicabs was studied in some depth to determine the reasons for and the extent of usage of this form of public transportation. Although the area is extremely well served by other forms of public transportation, taxi usage is extremely high in this poverty area, and informal taxi systems, companies, and individual owners have filled the apparent need. Recommendations for legalizing and controlling this important industry were developed.

•TAXICABS are a unique form of public transportation. Their flexibility and convenience are comparable to the same qualities of private automobiles, although they are the most expensive mode of public surface transportation. Taxicabs are generally considered to be used most often by persons with high-paying jobs and by members of high-income households.

However, a large number of taxicabs are known to operate in the poverty areas of New York City. This fact, among others, prompted a detailed study of taxicab usage in central Brooklyn, which contains one of the worst and largest poverty areas in the nation.

HISTORY OF TAXICAB INDUSTRY IN NEW YORK CITY

Any discussion of taxicabs in New York City requires some understanding of the history of the taxicab industry. The industry can be broken down into two groups; medallion and nonmedallion taxicabs.

Medallion taxicabs are licensed to operate on city streets by a law enacted in 1937. Since 1937, the number of such cabs has actually declined slightly, although population and economic expansion of the city has certainly increased the demand. This situation is well illustrated by the fact that the value of a medallion license has increased from the original $10 to the present level of $20,000. Medallion taxicabs are owned by individuals who drive their own cabs or by companies that hire drivers to operate the cabs. Operating rules and fare rates are set and regulated by city law. Because the medallion cabs secure passengers almost exclusively by street hails, they are essentially attracted to shopping and business areas with heavy pedestrian traffic. A trip study of these cabs shows that 3 out of every 4 trips begin or end in Manhattan.

It has been widely reported that outlying residential areas of the city, especially poverty areas, lack medallion taxicab service, mainly because drivers avoid low-income neighborhoods for fear of robbery or lack of business or both. Because of these unfilled needs, there are reported to be several thousand nonmedallion taxicabs operating in the poverty areas of the city where the shortage of medallion taxicabs is most critical. Because they are not city licensed and because some proportion of them operate illegally, exact numbers are impossible to determine. Nonmedallion taxicabs, sometimes called "livery cars" or "gypsy cabs," are licensed by the state of New York as vehicles for hire. They are allowed to pick up passengers only by telephone call or

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prearrangement. Because they are not allowed to accept street hails, they are usually equipped with 2-way radios. A potential customer calls a central dispatching office, and the call is relayed to an available cab.

No regulatory supervision of this industry exists, and fare rates vary widely. In recent years, an increasing number of nonmedallion taxicabs have been reported as accepting street hails in direct conflict with medallion taxicabs and the law. The conflict between these 2 groups of taxicab drivers and owners sometimes takes on a racial tone because nonmedallion taxicabs principally serve areas populated by low-income persons and are largely owned and driven by members of minority groups; this is not true of medallion taxicabs.

Several reasons can be given to explain the large participation of minority groups in the nonmedallion industry.

1. Driving taxicabs does not require any special skills or much training.
2. Driving taxicabs provides better income for unskilled workers than do other jobs.
3. To own a nonmedallion taxicab, one is required only to secure a state motor vehicle registration and to pay a $100-a-year city tax. On the other hand, a medallion taxicab requires an initial investment of more than $20,000.

STUDY AREA

The study area (Central Brooklyn Model Cities area) shown in Figure 1 encompasses approximately 5.1 square miles and a population of about 400,000. The composition of the population is 78 percent black, 19 percent Spanish-speaking, and 3 percent others. The average household income of the area is $5,300 annually, and 40 percent of the households are poverty households with an annual income of less than $4,000. The average unemployment rate was about 14 percent of the labor force in 1969 (it is probably a good deal higher at this writing), and average car ownership is 0.29 car per household.

SCOPE OF THE STUDY

The objective of the study was to measure the importance of taxicabs to poverty area residents not only as means of mobility but also as an economic asset of the poverty-stricken community. Efforts were also made to find any possible effects of a dual taxicab service on the residents' trip and user characteristics. Both groups of taxicabs were studied separately to measure the extent of usage and the quality of service of each group. A study of nonmedallion taxicabs, including their distribution, drivers, fare structures, and ownership, was made to determine their social and economic roles in the neighborhood. Opinions of the residents were gathered through home interviews in which data were gathered on the frequency of taxi trips, trip purposes, and the trip-maker's evaluation of the service.

MAJOR FINDINGS AND CONCLUSIONS

Travel Characteristics

Taxi trips consitute about 3.5 percent of the total trips made, excluding walking trips. Eighty-five percent of taxi trips are made by nonmedallion taxicabs. A total of 17,000 residents use taxis every day.

The average cost per trip (for trips of equal length) is slightly higher for nonmedallion trips than for medallion trips. Thus, poverty area residents pay more for taxi service than do other New York City residents.

The average taxi trip length in the CBMC area is shorter than the taxi trip length in the entire tri-state region, an area including northern New Jersey, New York City and surrounding counties, and southern Connecticut. One out of every 3 trips is made within the community.

The purposes of taxi trips by CBMC area residents are somewhat different from those for the entire tri-state region, as shown in Figure 2. Work trips by taxicab are very few in the study area compared to the numbers for the tri-state region. This is

probably because the CBMC area residents cannot afford taxi trips regularly. They ride taxicabs only for special occasions such as medical, recreational, and shopping trips.

Trips by taxicabs are made most often during nonrush hours, when other public transit service is infrequent. It appears that taxicabs substitute to a certain degree for other public transportation, which is composed of buses and subways.

User Characteristics

Households with an annual income of $4,000 or less constitute 20.0 percent of the households in the tri-state region, and their share of taxi trips amounts to about 8 percent. On the other hand, households with an annual income of $4,000 or less constitute 39.7 percent in the CBMC area, but their share of taxi trips is 43.5 percent. It appears that low-income households in the CBMC area depend more on taxicabs (Fig. 3). By doing so, they must sacrifice other essential needs.

Persons working in unskilled jobs constitute 14.0 percent of the labor force in the tri-state region, and their share of taxi trips amounts to 9.0 percent. Persons with unskilled jobs constitute 47.6 percent of the labor force in the CBMC area, but their share of taxi trips is about 50.9 percent (Fig. 4).

Seventy-two percent of taxicab riders in the CBMC area are members of households without automobiles; 71 percent of households do not own automobiles. It appears that members of households without automobiles rely heavily on taxicabs for essential or emergency trip purposes. A heavy reliance on taxicabs by households with a low car ownership is clearly shown in Figure 5.

Economic Aspects

There are a total of 1,500 taxicabs registered in the CBMC area, 1,300 of which are nonmedallion taxicabs. Therefore, they constitute a significant investment by the CBMC community.

The taxi industry provides about 3 percent of the total employment of the CBMC area labor force. It can be considered a significant contribution in job supply to the unskilled labor force in the CBMC area, where unemployment among unskilled persons is approximately 30 percent.

Ninety-six percent of taxi drivers are heads of households. The annual income of households whose heads are taxi drivers is $6,800, compares to the $5,300 for all households in the CBMC area.

Home ownership among taxi drivers is 15 percent, compared with 13 percent for the entire CBMC area.

RECOMMENDATIONS

The essentials of the recommendations are as follows:

1. Integrate both groups of taxis to provide a better climate for development of the nonmedallion industry because it is important not only as a means of mobility but also as a provider of economic opportunity to the residents;
2. Allow group riding to reduce the cost per rider, especially in view of the extensive use made of taxicabs by low-income families; and
3. Allow nonmedallion taxis to operate in the same way as medallion cabs in the CBMC area because residents of the CBMC area should be entitled to the same quality and types of taxi service as other New York City residents.

Though there are some deficiencies in the transit (subway and bus) system in the CMBC area, the overall accessibility to transit in the area can be considered satisfactory. Therefore, it is concluded that a transportation mode as flexible as taxicabs should supplement the fixed-route transit system in areas like the CBMC area, where automobile ownership is low. Fixed-route transit cannot satisfy all the demand in an area like the CBMC area, no matter how comprehensive such a system may be. But, because taxis are expensive, some other form of transportation, which is as flexible as the

Figure 1. CBMC area in New York City.

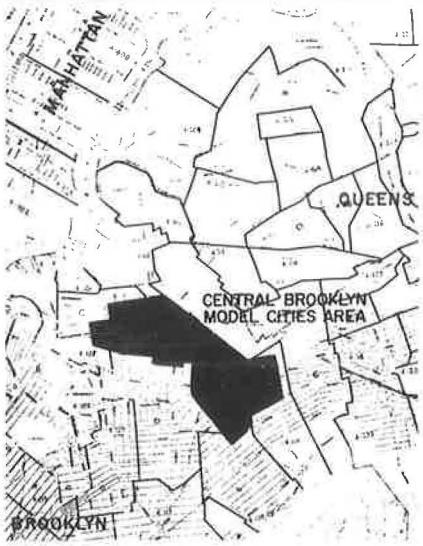


Figure 2. Taxi trip purpose at destination.

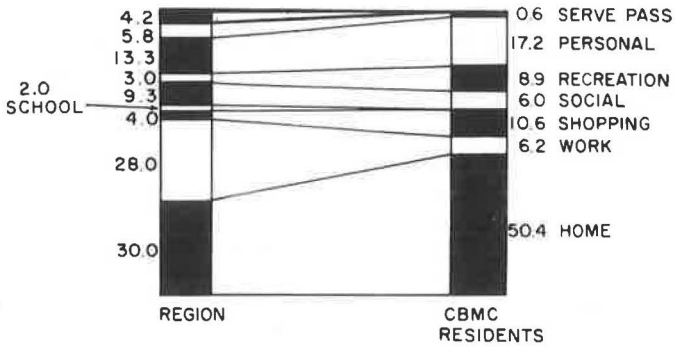


Figure 3. Taxi user's household income and total household income.

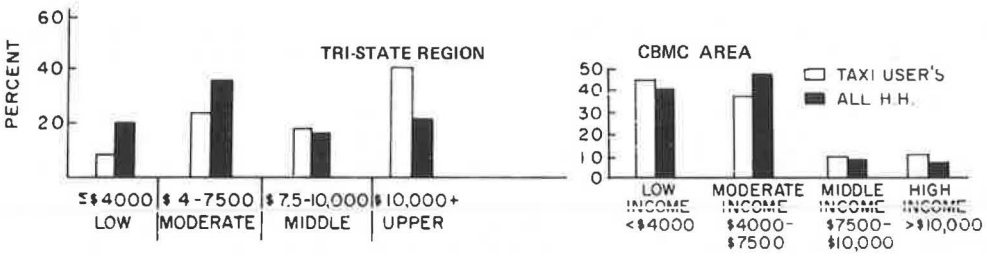


Figure 4. Jobs of taxi users and labor force distribution.

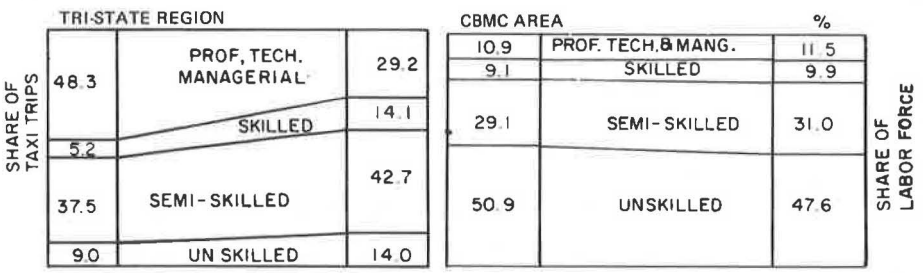
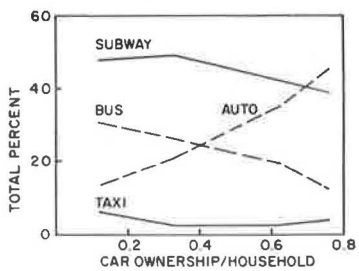


Figure 5. Mode of trip versus car ownership in CBMC area.



taxi, but much more economical, appears necessary in these areas. Dial-a-bus, jitneys, or similar services may meet these requirements.

REFERENCES

1. Central Brooklyn Model Cities—Transportation Needs of Residents. Polytechnic Institute of Brooklyn, 1971.
2. Who Rides Taxis? Tri-State Transportation Commission, 1968.
3. Recommendations to John V. Lindsay, Mayor of the City of New York. Mayor's Taxi Study Panel, 1966.

MODAL CHOICES AND TRAVEL ATTRIBUTES OF INNER-CITY POOR

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This paper examines the transportation problems of the inner-city poor. The paper is based on a study of the transportation needs of Model Cities residents in one of the largest poverty concentrations in the nation. The scope of the study was to identify the transportation constraints that inhibit mobility. Discussed is the need for transportation to jobs, shopping, medical facilities, and recreation. The effect of transportation (or lack of it) on the mobility of the poor is investigated, and recommendations are developed to satisfy the needs of each population group that is transit-dependent.

•THIS PAPER is based on a study that analyzed the transportation needs of residents of the Central Brooklyn Model Cities (CBMC) area.

The study area is made up of 3 communities: Bedford-Stuyvesant, Brownsville, and a part of East New York. At the time of the study in 1969, it contained more than 404,000 people, 40 percent of whom lived in households earning less than $4,000 per year. The unemployment rate in the area was 14 percent of the total labor force of 121,000 persons. The amount of underemployment in the area was also reported to be quite high. The population in the area was 78 percent black, 19 percent Spanish-speaking, and 3 percent white.

In the past 20 years there has been a significant reduction of the white population accompanied by an even larger increase of the Spanish-speaking and black populations. This change has brought about a radical rearrangement of the entire economic and social structure.

The exodus of the more affluent Whites, who left in large numbers, created a new set of conditions in the area, requiring a careful review of the efficiency of the public transportation system in serving the needs of the new residents.

The Whites who left consisted largely of middle- and upper-income groups, holding jobs primarily located in the Manhattan business districts or downtown Brooklyn. The rapid transit lines are generally oriented from the CBMC area to these points, providing fast and direct service between central Brooklyn and those places of employment. The rapid transit lines are complemented by an extensive system of feeder bus routes crisscrossing the CBMC area, with connections to the subway stations.

This public transportation system, laid out many years ago, remains the same today. No significant changes have been made to reflect new needs for public transportation in the area. And today's transportation needs for central Brooklyn are different from the needs of the past. For example, manufacturing and wholesaling jobs have moved away from the traditional center-city locations to the less congested areas of the metropolis, where access by public transportation is either costly or excessively time-consuming.

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CAR OWNERSHIP

The degree of dependence on public transportation for the CBMC area resident population can be measured by an analysis of car ownership per household.

The members of a household that does not own a car will depend completely on public transportation for their travel. Even if, from time to time, occasional trips can be made in a neighbor's or a friend's automobile, non-car-owning household members are basically dependent on a bus, subway, taxicab, or train for a trip that cannot be made on foot. Approximately 73 percent of the households in the CBMC area owned no car.

The distribution of non-car-owning households, with respect to households, is shown in Figure 1, for the purpose of identifying the groups of families with greatest dependence on public transportation for their mobility. The low-income group, which makes up 40 percent of all households in the area, contains the largest proportion of households (91 percent) that own no cars.

TRIPS PER HOUSEHOLD

In the home interview travel survey, trips made by CBMC area residents were recorded by purpose and mode of travel. The types of trips reported include trips made by all modes, including walking. However, only walking trips of 15 min or longer were included in the travel survey.

The average number of daily trips (walking trips are not included in rate calculations) made by members of CBMC area households was found to vary as a function of the following variables: income, car ownership, size of household, race, and the distance of the household to the nearest subway station. These trip rates are shown in Figures 2 through 6.

Figure 2 may be viewed as the constraint of income on travel. For every household size, the number of trips made by the members of a household increases with increasing income. This finding is not at all surprising. What is important is the magnitude of differences in trip-making among various income groups. When these differences are compared among households of adjacent income groups, they can be regarded as the marginal effect of income on trip-making.

The largest loss in trip-making, due to income constraint, occurs in the low-income households, where a marginal loss of more than 2 trips per day was found. As household income increased, however, the effect of income on the marginal loss in trip-making diminishes considerably. This loss due to income varies also with household size. Households in the low-income category having 1 and 2 members and 7 or more members exhibit higher losses in trip-making. These are households containing the highest proportion of the elderly and the young. These are the people whose mobility is affected most by income constraints. By comparison, losses in trip-making due to income differentials are least for households having above-moderate incomes.

The income constraint on the travel of 3- to 6-member households is not very different among households in the low- or moderate-income category. The differences in the distribution of marginal trip losses for this group of households are related to the fact that they include a higher representation of adult members whose travel habits are more uniformly susceptible to income differentials.

The travel characteristics of household members were also found to vary with their ethnic characteristics (Fig. 3). The Blacks who live in low-income households are more mobile than their Spanish-speaking counterparts (2.7 versus 1.8 trips per household). This relation is reversed, however, when household incomes exceed $4,000 per year. In the higher income range, the Spanish-speaking households are considerably more mobile than black households.

These characteristics do not appear to be consistent among households of different sizes (Fig. 4). For small households (1 or 2 members), black household members who live in households earning less than $7,500 are more mobile than those in Spanish-speaking households. This characteristic does not hold for 3- to 6-member households earning less than $4,000. In these households the Blacks are less mobile than their Spanish-speaking counterparts.

Figure 1. Relation of non-car-owning households and income.

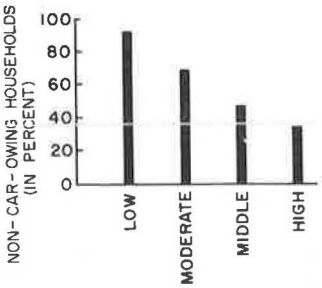


Figure 2. Effect of income on trip-making.

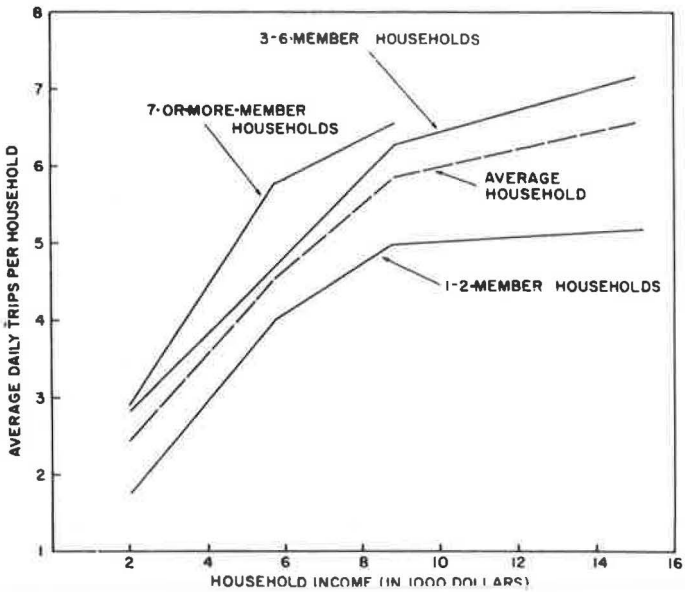


Figure 3. Effect of race and income on trip-making.

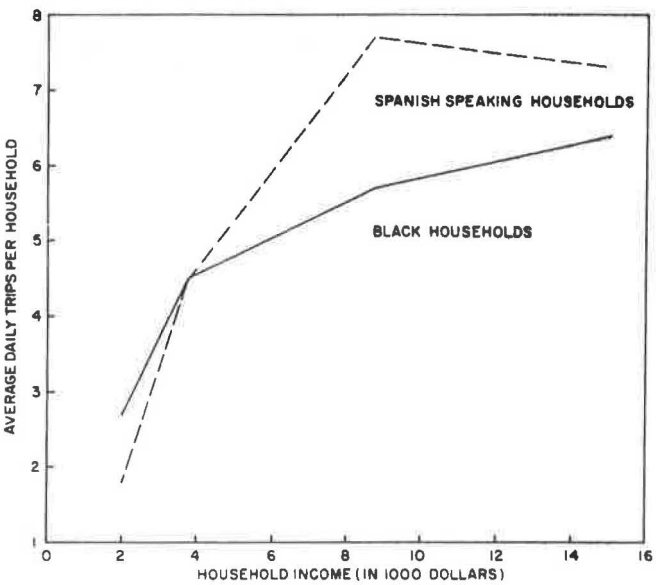


Figure 4. Effect of race, size of household, and income on trip-making.

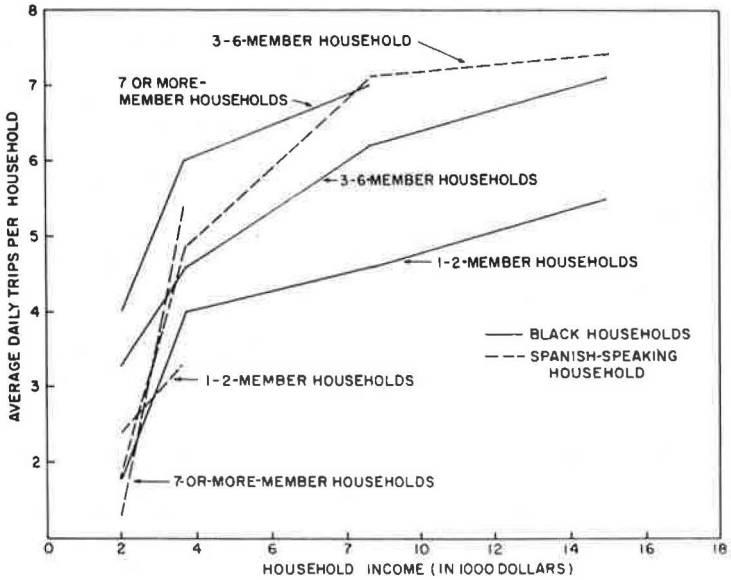


Figure 5. Effect of car ownership and income on trip-making.

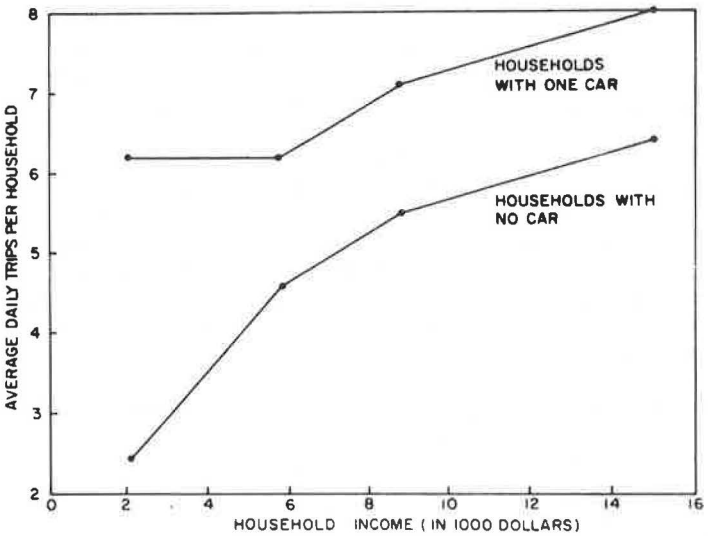
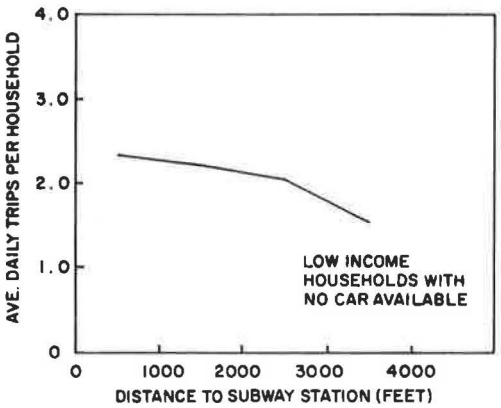


Figure 6. Effect of rapid transit accessibility on trip-making.



Whether a household has an automobile available was found to affect the rate of trips generated by members of the household. This was true among households of every income level, and, as Figure 5 shows, the low-income level was affected most by the presence of an automobile. For higher incomes, the impact of car ownership was found to be relatively constant in magnitude.

Household income, car ownership, household size, and race are the 4 endogenous variables that were found to influence the travel of CBMC area residents. The findings derived from the analysis of these variables do not suggest recommendations that, if implemented, could lead to an increase in the mobility of the population. Certainly, giving money or cars to the poor would render them more mobile. For various reasons, this would not be a viable solution.

The underlying goal of the study was to remove or minimize those constraints on travel that are related to the transportation system serving the CBMC area resident. The constraints on travel imposed by the transportation system are external in nature and have been referred to as exogenous variables. The cost of travel, the time required in making a trip, the quality of public transportation service, the reliability of time schedules, and so on are the kinds of measures that were investigated.

The impact of public transportation service on the trip-making characteristics of the CBMC area resident was measured with respect to the household's proximity to the nearest subway station. The use of walking distance to subway stations as a measure of constraint on travel was found to be significant only for low-income households. As shown in Figure 6, those households located within 1,000 ft of subway stations produce an average of 2.35 trips per household, while other households located 3,000 ft or more from subway stations generate an average of 1.55 trips per household. These differences in trip-making due to the varying proximity of a household to a subway station indicate the marginal loss of travel due to subway accessibility distances.

Thus, the amount of travel not made by members of low-income households because of distance accessibility differentials may be readily estimated by multiplying the number of households affected by the marginal trip loss.

As was stated earlier, the CBMC area is served by a very dense network of buses. It is very rare to find a location where one cannot walk to a bus in less than 500 ft, and in all cases everyone can reach a subway-bound bus by walking less than 1,000 ft. Taking a bus to reach a subway station, however, requires the payment of a double fare. It is reasoned, therefore, that low-income household members find this double-fare structure a constraint to travel and are, therefore, affected in their trip-making.

It is estimated that, if there were free transfers for low-income riders, they would increase their mobility from 40,485 to 43,700 trips per day, based on comparison of 1-fare and 2-fare zones.

At the time this study was made the transit fare was 20 cents; the present fare of 35 cents should be even more detrimental to the low-income traveler, and his trip-making might be reduced by amounts even greater than those reported here.

TRIP PURPOSE, MODE UTILIZATION, AND DISTRIBUTION OF TRAVEL

The travel activities of CBMC area residents were classified into 2 groups: work and nonwork oriented. The proportion of work travel amounted to approximately 18.5 percent of all trips made by the residents. Low-income households, however, were estimated to contain fewer work trips than households not in the low-income group (11 versus 20 percent). This difference was primarily attributable to the higher unemployment found in low-income households.

The modes of travel used for work purposes by CBMC area residents of varying economic states were analyzed. Although on the average more than 71 percent of all workers travel to work in either a subway or a bus, the low-income workers use these 2 modes more than any other group (78.2 versus 55.4 percent for the high-income worker). The use of an automobile for work purposes is much less likely for the low-income worker than for the high-income worker (12.8 versus 37.8 percent). Most automobile work trips are made by persons who drive their own automobiles, and a very

small proportion are passengers or join a car pool. Car-pool utilization, in fact, is negligible among low-income households.

The use of taxis for work travel is minimal among all income levels. Approximately 7 percent of the low-income workers walked to work. This proportion was lowest for the moderate- and middle-income catergories, but then it appears to rise to about 6 percent for people in the high-income level.

Mode utilization for work travel was found to be related not only to income levels (and consequently car ownership) but also to the location of a work site. Thus, the utilization of a car to reach work sites in areas well served by transit is considerably less than for those areas where transit is not so efficient.

Nonwork trips were analyzed to identify the nature of nonwork activities, which generate the travel of CBMC area residents.

If the trip purposes are interpreted to represent the importance of one activity relative to another, then one may rank the trip purposes in order of importance to the trip-maker in a manner that is proportional to their frequency. On this basis one may logically relate nonwork travel needs among travelers of different economic status. Thus, it was noted that the trip-making priorities among the low-income groups are rather similar to those of high-income groups. Trips made for social-recreational, shopping, and personal business reasons are the top 3 activities demanded by CBMC area residents. School trips made by residents are the next most common activity, and trips made for health reasons are fifth in order of importance. In this latter trip category, however, it should be noted that the medical-dental trip becomes less important as household income increases (8.4 percent for low-income versus 2.0 percent for high-income households). The least frequent trips were those for adult education and for seeking employment.

Nonwork trip purposes were further stratified by sex of traveler. Again it is seen that social-recreational, shopping, and personal business are the most frequently made trips by both sexes, and, in general, the traveler's sex does not seem to indicate any radical differences in travel behavior. It does appear, however, that males go more often for adult education, less often to shop, and more often to activities that are of a personal-business nature.

The transportation modes used to satisfy the nonwork travel needs were found to be largely dependent on the economic status of a traveler. The persons most dependent on public transit were those living in low-income and moderate-income households, and as household income increased a larger proportion of nonwork travel took place in automobiles.

Modes of travel used by persons living in households of different economic levels were determined for 3 major activities of concern to the CBMC area residents: shopping, social-recreational, and medical-dental activities. Definite patterns of mode usage emerge. For example, although the low-income households make the least use of automobiles, simply because they do not own them, nevertheless they manage to use automobiles more often for some purposes than others. For travel to a doctor or to a dentist, they make 17.5 percent of their trips by automobile, whereas for shopping less than 11 percent of their trips are by this mode. The middle- and high-income households use the automobile most often for social-recreational travel. Trips by subway or bus are most abundantly made by low-income and moderate-income household members. These 2 modes are used 70 percent of the time by the low-income resident to travel to social-recreational activities, 58 percent of the time to go to a doctor or a dentist, and 53 percent of the time to go shopping.

Members of low- and moderate-income households walk to shopping more than 10 times as often as those of higher income groups. This characteristic may be indicative of the fact that local shops are most heavily patronized by the low- and moderate-income families. The low-income households also walk most often to see a doctor or a dentist, and they also use taxis most often for this purpose.

The importance of each mode to people of different economic status is given in Table 1 for 4 major trip purposes: work, shopping, social-recreational, and medical-dental trips. The numbers shown are to be interpreted as the ranking of a specific mode compared to the other modes considered. The modes have been grouped into 4

functional groups: automobile, including automobile driver, automobile passenger, and car pool; taxi (medallion and nonmedallion); transit, including subway and bus; and walking.

Thus, for work purposes there is no switch of mode ranking because of household income differentials. For shopping purposes, transit remains the most used mode across all incomes. For the low- and moderate-income households, walking is the next most common way of traveling, and automobile and then taxi are the next most common.

Low-income households exhibit the same mode-usage pattern for social-recreational trips as for shopping. For middle- and high-income households, the automobile replaces transit as the most frequently used mode.

The medical-dentist trip made by the low-income group ranks transit as still the most frequently used mode; the automobile is the next highest. This combination is the same as that found for the work trip. Unlike the work trip, however, for medical-dentist travel, the taxi mode is ranked third and walking last. Thus, the importance of the taxi mode to the low-income traveler is related to the purpose of the trip and the need associated with it. He finds it an expensive mode and uses it in a rational manner.

Approximately 91.4 percent of all trips made by CBMC area residents either began or ended at home. The remaining 8.6 percent were made from and to nonhome locations. The most frequent nonhome to nonhome travel, however, involved either changing modes of travel or transferring within modes (31 percent). It would appear, therefore, that the CBMC residents' travel is almost exclusively home-oriented.

TIME DISTRIBUTION OF TRAVEL

The distribution of travel by time of day is shown in Figure 7; 48.1 percent of all trips made occurred during the morning and evening rush periods (24.1 and 24.0 percent respectively). During those hours, transit operations provide for the greatest number of vehicles to serve the concentrated demands for travel. During the remainder of the day, however, when the remaining 51.9 percent of the people travel for reasons other than work, headway of transit vehicles almost doubles, according to schedules published by the NYC Transit Authority. This is a normal procedure for non-response-actuated transit systems and is a consequent outcome dictated by sound economic principles. Also, a 15-min scheduled waiting period for a transit vehicle would certainly not seem unreasonable, especially when the expected wait for a passenger is reduced to 7.5 min. If this were the situation for off-peak service, it would appear that transit service quality, viewed from the headway criterion, should be considered satisfactory. A field check on these headways, however, disclosed that buses and subways do not run according to scheduled performance and that headways deviate considerably. As a result the traveler must, in many cases, wait twice as long or longer in some cases every time he takes a subway or a bus during off-peak hours. Although for bus service a large part of this problem is attributable to street congestion, which creates bunching of buses, for subways it must be attributed to the operational deficiencies of the system.

Figure 8 shows the daily distribution of travel for 5 selected trip purposes. As one would expect, work and homebound travel peak during the normal daily rush hours. Shopping, social-recreational, and medical-dentist trips are more evenly distributed, and their peaks occur during the off-peak hours. These types of trips, therefore, are most affected by the transit system's operational delays occurring during off-peak hours.

GEOGRAPHIC DISTRIBUTION OF TRAVEL

One fundamental objective of this study was to investigate the problem faced by the poor in connection with their travel needs. Do the poor travel to less distant points than the nonpoor? Do they spend more time traveling the same distance than the nonpoor? Do they pay higher fares? These and similar questions are answered here. The types of trips analyzed for this purpose were work, shopping, social-recreational, and medical-dentist.

In general, regardless of trip purpose, most of the trips made by the CBMC area residents terminate within the boundaries of New York City; very few go to the adja-

Table 1. Importance of travel mode for selected trip purposes by household income.

Trip Purpose	Household Income	Automobile	Taxi	Transit	Walk
Work	Low	2	4	1	3
	Moderate	2	4	1	3
	Middle	2	4	1	3
	High	2	4	1	3
Shop	Low	3	4	1	2
	Moderate	3	4	1	2
	Middle	2	3	1	4
	High	—	—	—	—
Social-recreation	Low	3	4	1	2
	Moderate	2	4	1	3
	Middle	1	4	2	3
	High	1	—	2	3
Medical-dentist	Low	2	3	1	4
	Moderate	2	4	1	3
	Middle	—	—	—	—
	High	—	—	—	—

Figure 7. Distribution of trips by time of day.

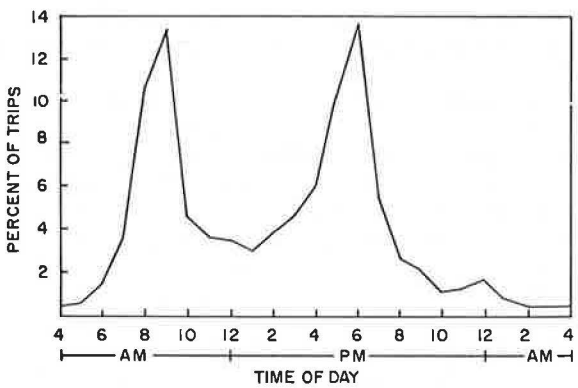
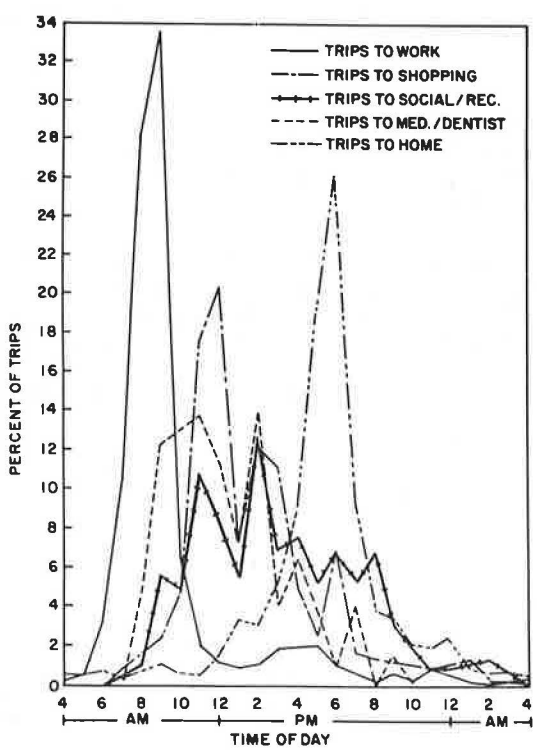


Figure 8. Distribution of trips by purpose and time of day.



cent suburbs. Also, most of the trips made in New York City terminate in Brooklyn and Manhattan.

The central business districts of Brooklyn and Manhattan are the largest attractors of work trips for all occupational groups. Also, there appears to be no fundamental difference in the distribution of work destinations among the occupational groups.

The relation between the distance traveled and the travel time required to cover this distance was analyzed for each of the 4 trip purposes. Figure 9 shows the distribution of work trips for each occupational category. No startling difference in work travel distribution exists among the occupational groups, and it appears that the amount of time spent in traveling is also similar among types of work (Fig. 10). Since most of the work trips take place during peak hours, most of them are made via transit, and most of them are destined to job sites well served by transit. This finding may not be at all surprising for New York City.

Analysis of the shopping trip distribution gives a different situation (Fig. 11). The low-income travelers make shorter trips than high-income travelers and, therefore, exhibit a stronger orientation toward local neighborhood stores. Trips to a medical doctor or a dentist are also shorter for low-income household members (Fig. 12), but trips made for social-recreational activities are similar for both economic groups (Fig. 13).

The time spent on traveling to these non-work-oriented activities is shown in Figure 14. Contrary to the findings of the work trip analysis, where no differences in travel times were found among different economic groups, for non-work-oriented travel, the poor travel longer to cover the same distance traveled by the high-income traveler. This finding may be attributable to the fact that the low-income traveler, who depends primarily on transit, experiences more than any other group the increase in travel time required to use transit vehicles during off-peak hours; the higher income groups are less affected because they use their automobiles more often during the off-peak hours. As shown in Figure 13, the average travel time differentials, for trips longer than 7 miles, vary between 15 and 20 min. It may be due to this factor that low-income groups tend to keep their nonwork travel to areas closer to home than do those of higher incomes.

Thus, the distance traveled by a typical CBMC area resident is a function of trip purpose and the resident's income level. If the distances traveled by the 85th percentile group are used as standards of reference, it may then be possible to compare the "life space" of a typical low-income resident with that of a resident in a higher income bracket.

Figures 15 and 16 show work and nonwork life spaces; work life space is the most extensive, with 85 percent of the professional-technical workers traveling as many as 7.9 miles. The unskilled worker travels 7.3 miles, and the skilled and semiskilled travel 6 to 8 miles. Thus, as was mentioned earlier, there are no radical differences in the work life spaces of groups of different skill levels. In the shopping activity, the higher income groups have a life space radius 50 percent greater (5.9 versus 3.9 miles) than that of low-income groups. For the medical-dentist trip, these differences increase to 100 percent (4.9 versus 2.5 miles); for the social-recreational activity, no significant difference was found, with both economic groups traveling 7.7 miles.

THOSE WHO DO NOT TRAVEL

Heretofore, the discussion of travel characteristics has been confined to those CBMC area residents who travel, and their trip rates were calculated on the basis of all household members, irrespective of whether they made any trips.

CONCLUSIONS AND RECOMMENDATIONS

It is apparent that the travel desires of the poor are not different from those of the more well-to-do public. Indeed, the poor exhibit the same preferences for shopping, recreation, health, and work. How they achieve these objectives, however, is quite different from the pattern observed for the nonpoor. The poor are constrained in their mobility by both their economic predicament and the physical characteristics of the transit system.

Figure 9. Distribution of work trips by distance.

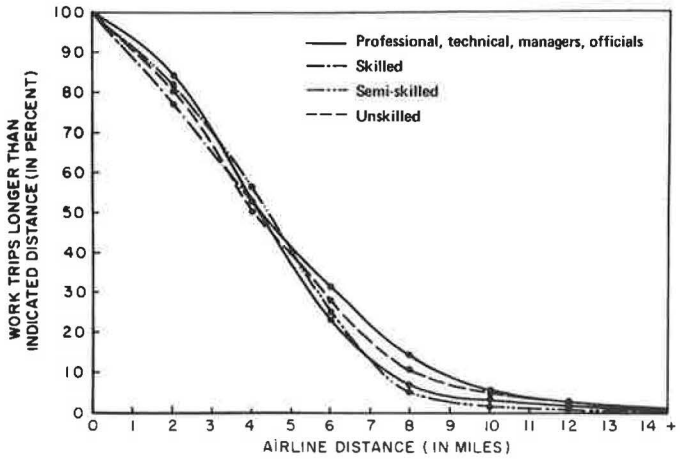


Figure 10. Relation of time and distance for work trips.

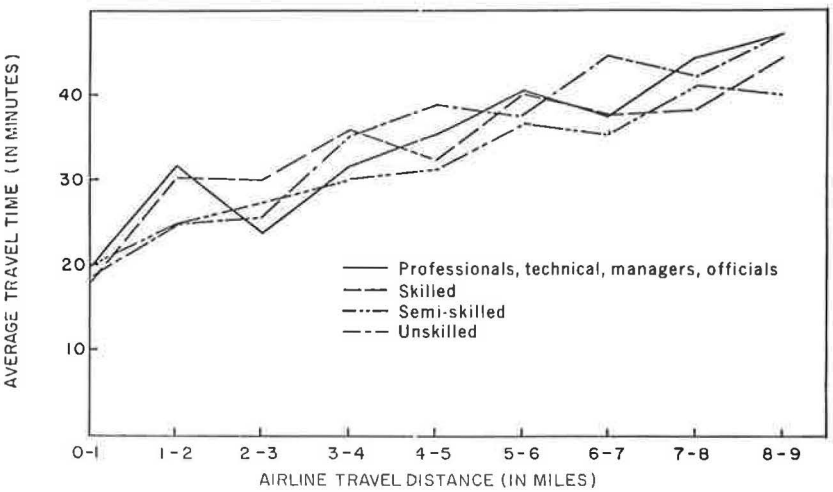


Figure 11. Distribution of shopping trips by distance.

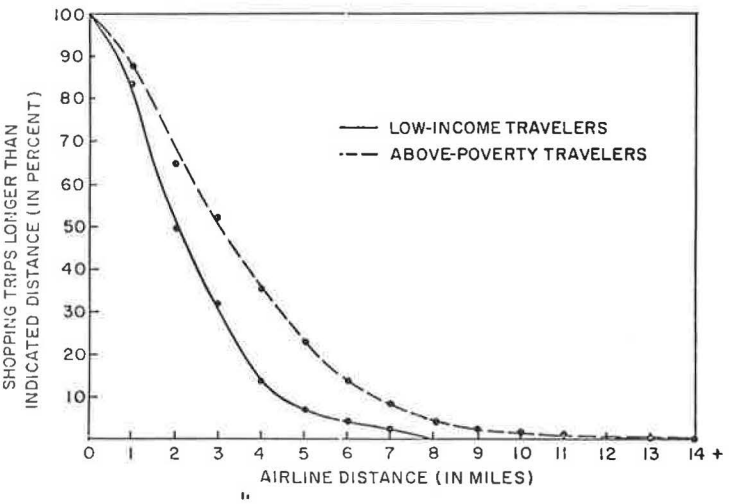


Figure 12. Distribution of medical-dentist trips by distance.

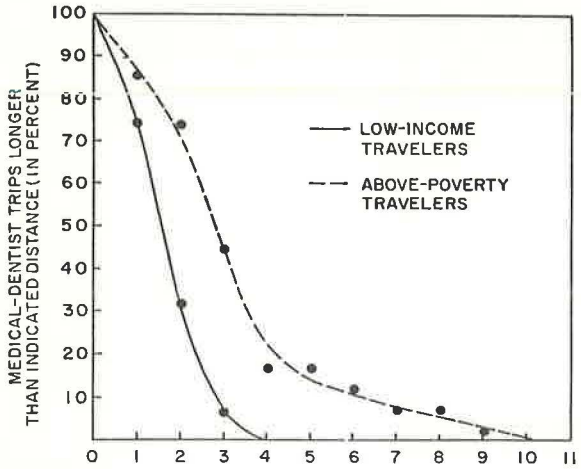


Figure 13. Distribution of social-recreation trips by distance.

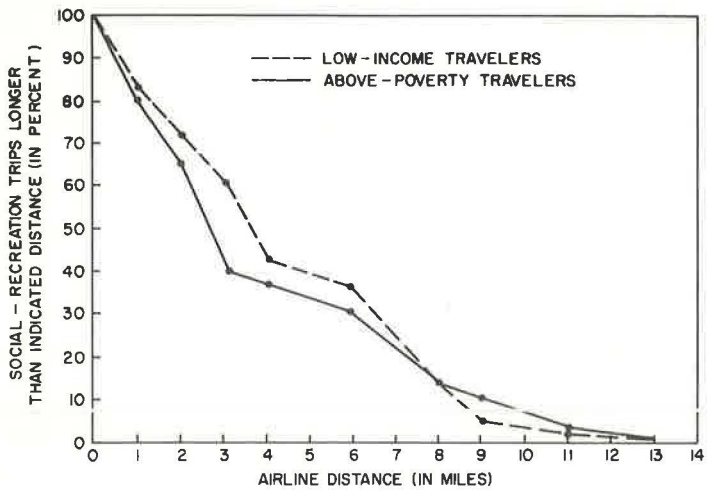


Figure 14. Relation of time and distance for nonwork trips.

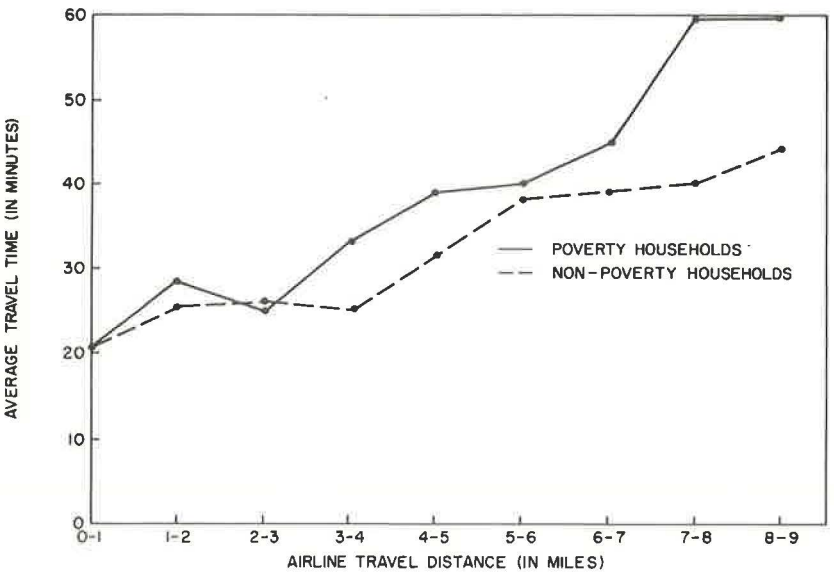


Figure 15. Work life space for 85th percentile travel distance.

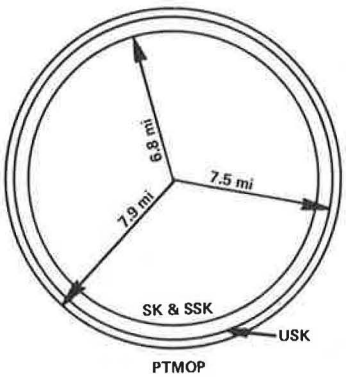
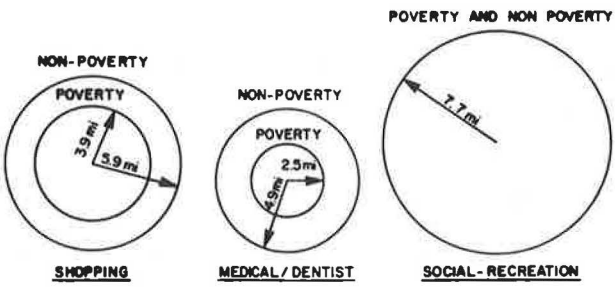


Figure 16. Nonwork life space for 85th percentile travel distance.



1. They travel less simply because they have less money to spend.
2. They are further constrained in mobility when they reside in areas requiring multiple fares to ride the transit system.
3. They rely almost exclusively on public transportation for mobility and are, therefore, dependent on a unimodal system of transportation.
4. Although they have exhibited work travel patterns similar to those of the nonpoor, this is a reflection more of the land use service characteristics of the transit system than of the choice of work destinations.
5. Trips made for shopping, medical reasons, or recreation involve, on the average, a longer travel time for the poor than for the nonpoor.
6. The poor travel to less distant places than the nonpoor when the trips are made for shopping or medical reasons.
7. The poor have a reduced choice of opportunities for shopping, health care, recreation, and jobs.

Based on these findings, it appears that several areas of improvement are possible to remove some of the barriers that inhibit the mobility of low-income persons who live in poverty such as the CBMC area.

Some recommendations that might produce immediate results are: (a) elimination of the multiple-fare system; (b) increasing off-peak operations for some important routes; (c) allowing group riding in taxis to reduce costs; (d) installing new transit routes from major transit terminals to points of industrial job concentrations, major shopping areas, hospitals and clinics, and regional recreational areas; and (e) improving the coordination of arrivals and departures of transit vehicles at major interchange points, especially during off-peak hours.

For the more distant future, however, more effective solutions should be implemented. Such solutions would not constitute the kind of patchwork remedies that were suggested above but instead should concentrate on the necessary attributes that a public transit system should have to serve the increasing dispersal of activities in metropolitan areas.

The use of the conventional bus in a transit operation is limited in applicability to corridors of higher densities, which are usually radial in character. The standard bus, moreover, is not suitable to serve nonradial travel, especially when it operates on a fixed-route pattern. In these cases what is needed is a transit vehicle that most nearly approaches the attributes of the private automobile. Thus, the development of a low-cost (to the user) door-to-door transit system, operated on the principle of dial-a-bus, might provide the appropriate solution to the mobility needs of low-income persons. Such a system should be coordinated with conventional transit vehicles at all major interchange points and should penetrate the low-density areas where significant job opportunities and other activities are located.

THE OLDER PEDESTRIAN IN SAN FRANCISCO

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This is a report on the second phase of a study on the use of walking as a means of transportation by older people. San Francisco data confirm conclusions drawn from earlier results in San Antonio and emphasize the need for attention to the problems of the older pedestrian. The consistency of findings in the quite different sites lends credence to the wider applicability of conclusions. Older people commonly depend on their feet to take them places they need and want to go. They perceive advantages for walking—independence, convenience, opportunity to be among people, health, and economy. However, distances are often too great, walkways are poorly constructed and not secure from intrusion by vehicles, and traffic is confusing. The inconveniences and hazards of going on foot are intensified by poor health, inclement weather, and hilly terrain. (Adequacy of diet is inversely correlated with slope of the street of residence.) Walking would better serve the transportation and other needs of older people if walkways were improved, particularly by the exclusion of vehicles from them. In addition, older people need vehicular transportation for medical emergencies and food shopping and also as an option they can exercise in order to maintain, in dignity and independence, life styles of their own choosing.

•ATTENTION to transportation—on the part of both service and research programs—has focused on vehicles. Walking, an alternative for getting from place to place and a necessary adjunct to public transit, has been largely ignored. A long history of medical research documents the health benefits of walking; more recently, ecologists urge its use to reduce environmental pollution. Despite these values, pedestrianism remains a minor transportation theme in the United States.

However, certain population subgroups in this country are highly dependent on their feet to take them places they need and want to go. Older people are one such group (1). For reasons of financial resources and physical condition, automobile driving and the use of public transit are limited among the old (2, 3, 4, 5, 6). The offer of rides with other drivers is inadequate to meet mobility needs (7). Few older people can afford taxis or have a jitney type of service available (3, 6). Therefore, the old are forced to use their feet to take them places.

Unfortunately, this dependence on pedestrianism is accompanied by vulnerability to its hazards. People aged 65 and over contribute a quarter of the nation's pedestrian deaths but constitute only about 10 percent of its population (8). It is not clear to what extent the high fatality rate is due to sensory-motor and other age changes (9) and to what extent it reflects the higher incidence of walking among older people. Attention to the plight of this group, among whom walking is both necessary and problematic, is overdue (1). Investigations using older respondents may cast light also on the lack of enthusiasm for walking among the nonaged, for whom other options are more commonly available.

BACKGROUND

Study of a 1.3 percent sample of the retired people in San Antonio confirmed the impression that walking is a common form of transportation for older people and showed

Sponsored by Committee on Social, Economic and Environmental Factors of Transportation.

clearly that it is not well liked by them (10, 11). The more dependent the person was on his feet to take him places, the more strongly negative was his evaluation of walking as a means of transportation. Most favorable ratings of walking came from people who drove automobiles everywhere they went.

The disadvantages of pedestrianism were many. Most of the places the retired people needed or wanted to go were beyond walking distance from their homes. For many, health problems impeded walking, particularly in the intense Texas heat. Fears were common—fear of falling, being hit by a car, being attacked, becoming lost. Nevertheless, walking was seen to have significant potential advantages not only for reasons of health and economy but also for reasons of sociability, independence, and convenience. Incidence of walking and evaluation of it varied according to characteristics such as location of the person's residence in the urban-suburban complex, the predominant ethnicity of the neighborhood, the person's sex and health, and the composition of the household in which he lived.

DESCRIPTION OF STUDY

The present study is an extension of the earlier one and a test of the generality of its findings. Data were collected in San Francisco, a city quite different from San Antonio in topography, climate, and population composition.

Subjects

Respondents were selected on the basis of census figures to represent by ethnicity and sex older people in the 5 health department districts. The composition of the 899 subjects, a 1.3 percent sample of the population of the city aged 65 and over was as follows:

Ethnic Group	Number
Black	107
Chinese-American	138
Spanish surname	76
"Other" white	578

Other ethnic groups were not included in the sample because of the small numbers of people in them and because of the lack of specificity about them in census figures.

Data Collection

Information was obtained in individual interviews in respondents' homes. Data collection instruments were translated into Spanish and Chinese; interviewers were assigned to subjects of similar ethnicity; and interviews were conducted in the language or dialect preferred by each respondent. In addition to typical interview questioning, an activity and food dairy was recorded, each respondent described himself and was described by his interviewer through use of an adjective checklist, and the revised set of 11 mobility and transportation apperception pictures (available from the author) was administered. Interviewers rated steepness of the sidewalk by matching the view of the respondent's residence from across the street with one of a set of drawings of residential streets varying in slope; and they rated quality of housing by comparing the respondent's residence with a set of photographs compiled for this purpose.

RESULTS OF STUDY

Dependence on Walking

The San Francisco data strongly support earlier conclusions in regard to the dependence of older people on their feet to take them places they need and want to go. Walking was even more common among San Francisco people aged 65 and over than it was among retired people in San Antonio; the frequency is as follows:

Frequency	Respondents (percent)
Daily	57
2 or 3 times a week	24
Once a week	9
Less often	10

Nearly 60 percent used their feet to take them some place every day, and more than 80 percent made several walking trips each week. Less than 5 percent "never" went places on foot, and nearly 40 percent said they walked to all or most of the places they went.

Problems With Walking

Though it was common, walking was not popular as a means of transportation among the older residents of San Francisco. As in Texas, the more a person walked, the less he liked it as a means of getting places. The most sanguine evaluations of walking came from people who generally went places in cars and who walked with pets or for their own exercise or pleasure.

The following specific difficulties were voiced:

Difficulty	Respondents (percent)
Destinations too far	83
Depends on weather	78
Hills	72
Fears	65
Tired, feet hurt	55
Takes too long	52
Health problem	37
Traffic confusing	36

As in San Antonio, the most commonly mentioned problem was that places they needed to go were too far from their homes for them to walk. Some destinations were at such distances that no attempt was made to go. Others were at sufficient distances that the trip was overly time-consuming, and the walkers became weary and footsore.

The hills were a problem for many. The city lies on a cluster of hills, and many residential and downtown streets are steep. Respondents' ratings of satisfaction with walking correlated significantly with interviewers' judgments of street slope. The old people mentioned the exertion of going up and down. Other factors complicate the problem. San Francisco lots are narrow, so that driveways may occupy half their width. As a result, sidewalks constantly change in grade from lot line toward the street. Therefore, the walker has 2 kinds of grade to contend with: the fairly constant slope of the street behind and ahead, and the irregular pattern of slope from side to side.

The intrusion of automobiles into pedestrian territory further complicates the walker's problem. Parking space is scarce in most parts of town. Cars parked in driveways usually cover the sidewalk because of the absence or very small size of front yards. A car so parked is an obstacle that ordinarily can be circumvented only by stepping out into the street, where there may be moving vehicles, and by renegotiating the curb to regain the sidewalk. If there is sufficient space to detour on the house side, there are likely to be 2 sharp grade changes where the driveway enters the garage.

One of the mobility and transportation apperception pictures (No. 10) portrays a car parked across the sidewalk. Responses to it were revealing. The large majority of respondents (88 percent) clearly were emotionally involved in their response to this picture, and the effect expressed was negative for all but 6 percent of them. The predominant affective tone was fear (45 percent). One story in 5 dealt with death or injury. Less frequent than fear was a reaction of anger (29 percent). Resentment was revealed

even more broadly by the score on blame attribution than by that on dominant emotion. Most (94 percent) of the stories were clearly extrapunitive from the point of view of the pedestrian. Usually the driver of the parked car was at fault; less often, "they" who failed to make such parking illegal were at fault. Only 1 percent of the stories placed any blame on the pedestrian, and few (5 percent) failed to assign blame. Clearly, the intrusion of automobiles into pedestrian territory is a matter of widespread and serious concern among older walkers.

Responses to picture 11 revealed another aspect of this painful vulnerability. This picture shows pedestrians crossing at a street corner in a safety lane and an automobile turning right and headed toward them. The amazing thing about stories to this picture is the very high percentage (90 percent) of those scored "withdrawal": The pedestrian would turn back—either from that attempt to cross the street or from the entire trip—out of fear of the vehicle. Nearly all (95 percent) of the stories blamed the driver for creating a dangerous and frightening situation. Only 2 percent cast any blame on the pedestrian. Once more, emotional tones were negative, and fear (42 percent) and anger (10 percent) were the common reactions. Ten percent of the stories included death or injury. Vulnerability of pedestrian territory to invasion by automobiles is a serious problem to older pedestrians. Walkways should be designed to give walkers freedom from this fear.

Some pedestrians (36 percent) found traffic confusing. The number and diversity of signs and signals make it difficult to know what to do. When lights are involved, there is pressure for speed, which greatly emphasizes the difficulty for an older person, of a perceptual-motor task such as crossing a busy street according to a timing device (9). There is another element in this matter of traffic confusion. In many residential areas, vehicle-control signs seem inconsistent from one block to another: a 4-way stop on one corner, no stop on the next, a north-south stop on the third, and an east-west stop on the fourth, perhaps followed by a corner with a 1-way stop. Often, the distribution of stop signs does not seem to conform to differences in street slope or to any other logic. Pedestrians are not so much worried about their own behavior in such situations as they are apprehensive lest the inconsistency in signaling lead to driver error that imperils them.

In addition to fears to being hit by an automobile and falling, there were fears of being mugged and of losing one's way. As in San Antonio, the older people did not think others would give them assistance, or even information.

More than a third of the respondents said they had health problems that made walking—as transportation—inadvisable or difficult. This figure is only slightly higher than the national average for older people who have health problems that might interfere with mobility (1). The difference may be due to the topography of San Francisco. For example, walking up steep hills may tax people with relatively mild heart dysfunctions or minor arthritis.

Weather is an important conditioner of the entire pedestrian situation. More than three-quarters of the respondents mentioned that damp and cold accentuate the drawbacks of having to go places on foot. Weather is an important determinant of the "go-don't go" decision. On a dry, sunny day the hazards of walking, and the physical and time drain, may be overbalanced by the need or desire to reach a destination. However, when the fog rolls in or the rains come, the streets are slippery, and it is cold, anticipations of the trip on foot may outweigh any benefits, and the person may stay at home. Considering the impact of weather on the valence of walking in San Antonio and in San Francisco, one must wonder about the older pedestrian during winters in New England and the Midwest.

Walking to Various Destinations

Any form of transportation is a means to an end rather than an end in itself. Therefore, it is useful to look at the incidence of walking and the assessment of it in terms of its use to reach various places people need and want to go. Destinations of walking trips are as follows (the number of respondents is 899, but the number of respondents who made each type of trip varies):

Destination	Respondents (percent)	Trip-Makers (percent)
Food	69	75
Friends and acquaintances	41	46
Religious services	31	44
Park	29	42
Medicine	31	38
Out to eat	20	25
Other shopping	20	23
Other recreation	20	21
Doctor	14	15
Other relatives	8	14
Children	6	10

Of the San Francisco respondents, 3 in every 4 made trips to the grocery store and did so on foot. In San Antonio, slightly fewer than a third did so. Grocery shopping is the instance of widest divergence between people in the cities in regard to the use of feet as means of transportation. The difference may be due to the higher incidence of scattered shopping districts and neighborhood stores and the much greater compactness of San Francisco.

Although it is apparently possible for a very high percentage of older San Franciscans to fetch their groceries on walking trips, there is little in the data to indicate that they are pleased with this arrangement. The few who "prefer" this means of obtaining necessary supplies do so because the alternatives are to give up their independence by becoming burdens on neighbors or relatives or to go into institutions.

All of the pedestrian problems are intensified when the walker is also a load-bearer. Visibility is reduced, balance is altered, fatigue occurs more quickly, and the several problems in regard to keeping one's footing become more acute. Yet the majority of San Francisco's old carry their groceries home. Older citizens are badly in need of door-to-door transportation to grocery stores or of inexpensive and dependable delivery service to bring the groceries to them. It is hoped, that communities will provide both, so that older people can enjoy the right of exercising options (12). Both options should include the availability of a strong person to carry the bundles into the house. This is of particular importance in a city like San Francisco, in which the kitchen is normally a full flight of stairs above the street level, even in single-family dwellings or wherever upstairs living quarters do not have elevator service.

Reactions to picture 12, which shows a person standing at the top of a flight of stairs, headed toward them, were distinctly different from responses to the 2 pictures of pedestrian-vehicle interaction. This picture was less evocative of strong emotional involvement, and more than half the stories were told in a matter-of-fact way. Responses were almost unanimously (98 percent) impunitive: No one was to blame for the situation. Anger was rare (1 percent). The most common effect was fear, which was expressed in more than a quarter (28 percent) of the stories. Ten percent mentioned death or injury.

Quite unlike the stories to the pedestrian-crossing picture, there were few cases of withdrawal (1 percent): It was impossible for the story character to avoid the use of the stairs. Some (5 percent) stories had a compromise solution: The person would phone the friend instead of going to see him, or ask a neighbor to bring the groceries. However, the large majority (87 percent) use some direct approach: The person might put off the trip until tomorrow or wait until the light or weather was better; and he might be careful to use the handrail and go slowly and carefully, but sooner or later he would take the trip down the stairs. Many stories included his anticipation, with chagrin, of the return trip when he would be tired and perhaps loaded down with groceries.

The importance of providing food-delivery service is underlined by the finding that the nutritional adequacy of the older pedestrian's diet is significantly and inversely correlated with the slope of the street that runs in front of his house (14). The steeper the slope is, the less adequate the diet is. The tendency of little old ladies to exist on

toast and tea may be less due to mental deterioration or ignorance of nutrition than to their inadequacies as transport vehicles. Meat, milk, fruit, and vegetables not only are costly, but also make heavy and bulky armloads.

Less than a quarter of other shopping was done on foot. The same disadvantages occur as with grocery shopping, with the important exception that life depends on fairly frequent replenishing of food supplies, while shopping for most other items can be delayed or even foregone. To put off grocery shopping only means that a larger and heavier package will have to be carried. The main reason older people shop for food as often as they do is to keep the load small. Most would prefer to shop only once a week. On the contrary, most older people would like to shop more often for items other than food or to just go to town to "window wish" and believe they would do so if they had transportation for this purpose.

Sociable visits are vital in the life styles of older persons. This was the most common trip purpose in both San Antonio and San Francisco, including all travel modes. Nearly half (46 percent) of the San Francisco respondents who paid visits to friends, neighbors, and acquaintances usually went on foot. This is similar to the number in San Antonio (42 percent). Generally, old people are quite content with walking to see friends in the neighborhood, but lack of another mode of transportation for friendly visits means that they cannot see old friends who live at any distance. As people age, this tolerable distance probably diminishes. Older people say they would pay more visits to friends and would much enjoy being able to do so if transportation were available to make it possible.

Walking to religious services was somewhat more common in San Francisco than in San Antonio, perhaps again because of the greater dispersion of the Texas city and the consequent distance between churches. Older church-goers would prefer to live within walking distance of the religious institution of their choice; and those who do so find this a highly satisfactory state of affairs. However, for the majority, the distance is too great. As in the San Antonio transportation study and in others (13), the lack of concern with their plight on the part of church people was a source of deep hurt. Institutions of religion would benefit their older members greatly by attention to their needs for transportation to services.

A large proportion of older San Franciscans walked to a park—nearly a third of the total group and more than 40 percent of those who used parks. Living within walking distance of a park was a major consideration to these old people. However, they would prefer having vehicular transportation to the park, unless they lived very near, because walking in the park was much more pleasant than on the city streets.

More than a third of the old people fetched their medicines on foot. This was not out of preference but due to lack of an automobile and of money to pay for a taxi or to trade at a drugstore with delivery service. The situation was aggravating but not serious for diet supplements and medications for chronic conditions. However, walking was extremely unsatisfactory during illness. Older people are badly in need of door-to-door transportation or a delivery system they can afford, or both, to bring them medicines and other drug items.

A small minority (15 percent) walked to their physicians' offices simply because most doctors are in medical centers outside of residential neighborhoods. Most older people would much prefer to have a doctor within walking distance. They can manage the yearly visit for a checkup, but one of the most common worries is over the lack of suitable transportation to the doctor or hospital in case of a medical emergency. Availability of such medical-emergency transportation would do much for the peace of mind of many older people.

Relatively small numbers usually walked to visit members of their families. This is largely due to the fact that few older people live within walking distance of their children and other relatives and to the fact that families provide transportation for this type of visit far more than they do for any other trip purpose. Older people who walk for family visiting usually are content with this state of affairs, glad to be close by.

A quarter or less of the people who went out to eat or to a play or to other entertainment went on foot. These were for the large part residents of the central city. One of the advantages of living downtown is access to restaurants and places of entertainment.

For most people, distances to restaurants and theaters are too great for walking. Those who do not have other means of transportation simply cannot go.

Potential Advantages

Despite the serious disadvantages of walking, which were voiced by large numbers of respondents, going on foot was seen by San Franciscans, as it was by San Antonians, to have significant potential values. Responses were as follows:

Advantage	Respondents (percent)
Good for health	92
Inexpensive	90
Independent	85
Convenient	82
Contact with people	81

For destinations within a reasonable distance, and when walkways are reasonably safe, walking is often preferred. Not only is it good for one's health and inexpensive but also it allows the older persons to maintain their independence—not to become a burden on others and to come and go where and when they please. Another significant value of walking is the opportunity it provides to be among other people. Under favorable conditions, walking is considered convenient: There are no waiting, no parking, no traffic problems.

IMPLICATIONS

Even in a hilly city such as San Francisco, most older people look with favor on walking when conditions are favorable, that is, when distances are not too great and walkways are safe. The strongly negative reaction to walking is to dependence on it as a means of getting places under existing conditions. Many destinations are beyond comfortable walking range and walkways are not safe, particularly from vehicles. Furthermore, the necessity to go on foot, even when the weather is bad, even if bundles must be carried home, and even when one is not well, is onerous. Some older people have health problems that make walking inadvisable. However, the problem for most older people is not walking but the absence of alternatives for some trip purposes and in certain situations.

Two types of action are called for. Conditions for the pedestrian must be improved so that he has good footing on walkways that are safe from intrusion by vehicles. Where vehicles and walkers must share territory, directions should be clear and unambiguous. When timing is involved at crossings, intervals must be adequate to allow slower pedestrians to feel they can get across safely. Generally, decisions regarding the design and management of city streets and sidewalks should be influenced by the needs of the pedestrian as well as those of the automobile driver. City planning should take into account the possibility of providing access, by foot, from residences to services. Walking, then, would better serve the needs of old people and quite possibly also those of other age groups.

Even with such improvements in pedestrian facilities, it is unreasonable to expect older people to depend on their feet for all trip purposes and at all times. Vehicular transportation must be provided for medical visits. Either vehicular transportation must be provided to drug, grocery, and other stores, or delivery of necessary commodities must be made to them. It is hoped that both will be developed. People enjoy exercising options, and needs vary. For example, when one is ill, delivery service is more appropriate. However, many old people suffer loneliness; and when they feel well, the opportunity to be among other people in the course of a shopping expedition may be an important benefit.

REFERENCES

1. Shmelzer, J. L., and Taves, M. J. The Older Pedestrian: A Social Gerontological View. Paper presented at Seminar on Pedestrian Movement and Passenger Transportation Planning, Smithsonian Institution, Washington, D. C., Nov. 20, 1969.
2. Carp, F. M. On Becoming an Exdriver: Prospect and Retrospect. Gerontologist, Vol. 11, 1971, pp. 101-104.
3. Carp, F. M. Correlation of Mobility Among Retired Persons. In Proc. of Second Annual Environmental Design Research Conf. (Archea, J., and Eastman, C., eds.), Carnegie-Mellon Univ. Press, 1970.
4. Carp, F. M. Automobile and Public Transportation for Retired People. Highway Research Record 348, 1971, pp. 182-191.
5. Carp, F. M. Public Transit and Retired People. In Transportation and Aging (Cantilli, E., and Shmelzer, J. L. eds.), USAPO, Washington, D. C., 1971, pp. 181-186.
6. Carp, F. M. Mobility Habits and Attitudes of Retired People. In Transportation and Aging (Cantilli, E., and Shmelzer, J. L. eds.), USAPO, Washington, D. C., 1971, pp. 23-41.
7. Carp, F. M. Retired People as Automobile Passengers. Gerontologist, Vol. 12, 1972, pp. 66-72.
8. Accident Facts. National Safety Council, 1967.
9. Birren, J. E. The Psychology of Aging. Prentice-Hall, Englewood Cliffs, N.J., 1964.
10. Carp, F. M. Walking as a Means of Transportation for Retired People. Gerontologist, Vol. 11, 1971, pp. 104-111.
11. Carp, F. M. Pedestrian Transportation for Retired People. Highway Research Record 356, 1971, pp. 105-118.
12. Delegate Workbook. White House Conference on Aging, 1971.
13. Carp, F. M. A Future for the Aged: The Residents of Victoria Plaza. Univ. of Texas Press, Austin, 1966.
14. Carp, F. M. Nutrition, Mobility and Transportation Among Old People. In preparation.

RELATION BETWEEN TRANSIT RIDERSHIP AND WALKING DISTANCES IN A LOW-DENSITY FLORIDA RETIREMENT AREA

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In response to demands from senior citizens in central Pinellas County for economical public transportation, the Florida Department of Transportation initiated a demonstration project to study the ridership characteristics and costs of operating five 29-passenger buses in October 1970. This paper examines the trip characteristics and the service limitations of fixed-route bus operation in scattered residential developments that contain a high percentage of senior citizens. Most trips made by senior citizens were for shopping and social-recreational purposes. Results indicated that most riders traveled 2 to 4 days per week and that, prior to the initiation of the system, 90 percent of the elderly riders had no form of independent transportation. About 70 percent of the elderly riders lived within 1/8 mile of the bus route, and 90 percent of all riders were bound for destinations located within 1/8 mile walking distance of the route. Transit usage at a total walking distance of 1/8 mile was 3 times greater than the usage at a distance of 1/4 mile.

•TYPICAL urban public transportation research has been focused on the home-to-work-and-return trip with its twice daily peak traffic. Such research, both analytical and experimental, has concentrated on ways and means of luring the commuter out of his automobile and onto public transit. It has been concerned with relieving congestion, reducing travel time, optimizing the use of existing roadway lanes, and postponing the need for new highway lanes. So far, these efforts have not been very successful, especially in low density, automobile-oriented cities such as those in Florida.

There is another aspect of public transportation, however, that is more difficult to measure and has received less attention from research groups. This is the service aspect of transit.

The Florida Department of Transportation recognized the role of the state in the research and demonstration of service-oriented transit free from the pressures of the fare box. The department, likewise, accepted the responsibility of testing a transit service that was designed primarily to operate within the socioeconomic conditions typical of Florida cities and suburbs. These conditions are characterized by scattered residential development, high-density pockets of low- to middle-income residents, and a large percentage of retirees living on fixed incomes.

Consequently, the department selected the area under the jurisdiction of the Central Pinellas Transit Authority (1), in the vicinity of Clearwater, to institute a demonstration project in October 1970.

The experiment was intended to test user reaction to the following major changes: basic service; fare changes; route and schedule changes; new, attractive, comfortable equipment; advertising campaign; and acclaimed need versus actual use.

The experiment also was intended to provide the department with insight into the actual costs of providing bus service, the user and nonuser reaction to methods of

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financing such a service, and the role of the state and local governments in extending mobility to a large segment of the population that is currently not served or served poorly.

PROJECT DESCRIPTION

The overall strategy of the project was to establish a certain route configuration and fare structure and then to alter the level of service on a route or change the fare. In this way, the impact of each change could be isolated.

The service was started with 5 new 29-passenger Twin Coach buses, of which 4 operated over fixed routes and 1 was retained as a spare. The buses had a large Department of Transportation (DOT) sign on the side and therefore became known locally as the DOT bus. This terminology will be retained throughout this paper. The routes were designed to cover areas previously without bus service and to complement and connect with the private operator in the area, Clearwater Transit, Inc. Figure 1 shows Clearwater Transit routes and all DOT routes that were operated from October 19, 1970, through July 1, 1971. On July 1, St. Petersburg Transit initiated a connecting link from Seminole Mall to Crossroads Shopping Center, thereby creating a county-wide network.

The buses operated on 1-hour headways, 12 hours per day, 7 days per week. The fare was set low (10 cents) initially in order to attract riders and allow for a reasonable fare increase at a later date.

At the time this report was written, the major changes to the system as given above were being analyzed and evaluated. However, with the current interest in increasing the mobility of the elderly, it was felt that the information gained to date might provide useful input to the design of transit facilities. For this reason, the limitations of a fixed-route transit system in serving the needs of typical low-density area with a high percentage of retirees are brought forth at this time.

TRIP CHARACTERISTICS

If a transit system is to satisfy the needs of the area that it serves, it must be sensitive and responsive to these needs. In the case of this demonstration project, which serves low-density areas with a high percentage of retirees, the service area population does not have the normal time constraints associated with the 5-day workweek. A selection of trip characteristics obtained from on-board interviews is presented below.

The travel patterns by day of the week and hour of the day are shown in Figures 2 and 3 respectively. It is immediately obvious that these results are totally different from those of a customary transit operation; here, Saturday has the highest daily ridership and each remaining day, including Sunday, has a uniformly lower passenger count. There are no morning or evening peaks, simply a gradual buildup with the maximum ridership occurring around 3:00 p. m. Although the system was intended and primarily designed as a service for the senior citizens of the area, it has been established that the latent demand for transportation is equally great in the teen-age sector of the population. This is especially true on weekends and school holidays when the under-20 ridership constitutes about 70 percent of the total (Table 1).

Another significant difference between the DOT bus system and the accepted norms for transit lies in the trip purpose distribution, shown in Figure 4. Work trips, normally the backbone of transit, account for a mere 9 percent of the total trips. Shopping and social-recreational trips are the major purposes for the elderly and the under-20 groups respectively. Bus routes 1 and 4 are shopping-oriented and primarily serve large shopping centers. As a result of the optional nature of the trips, the average trip frequency for each age group is 2 to 4 times per week (Fig. 5). Figure 6 shows the mode of travel used prior to the DOT bus service. The majority of the teen-agers made no similar trip, and almost half the elderly made the trip by automobile. Since only 10 percent of the latter group had both a license and access to an automobile, this clearly suggests that the majority were dependent on other persons to provide transportation for them.

Figure 1. Bus routes.

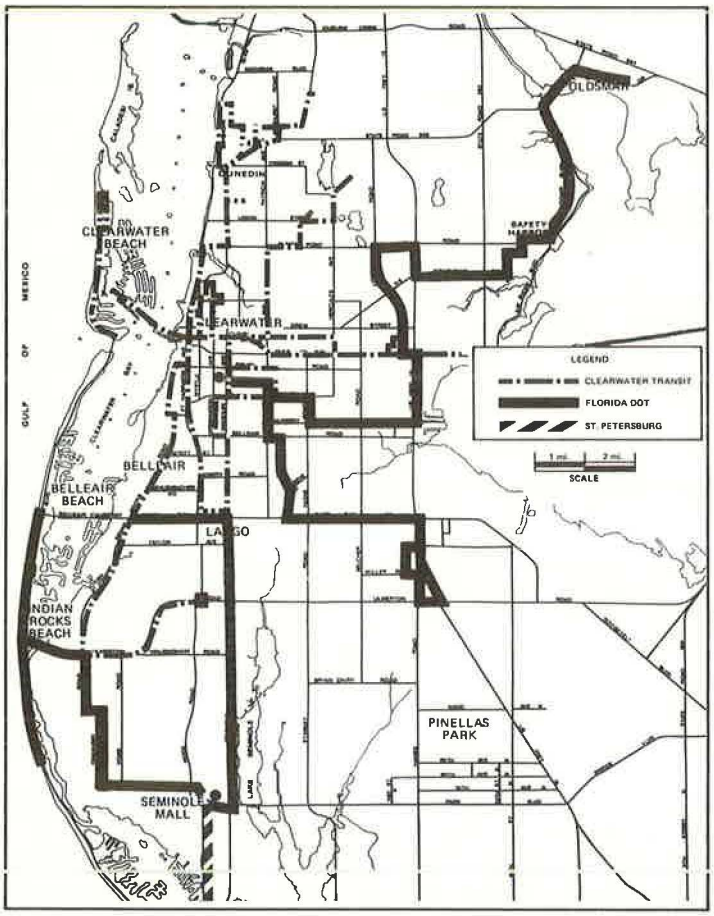


Figure 2. Average daily ridership.

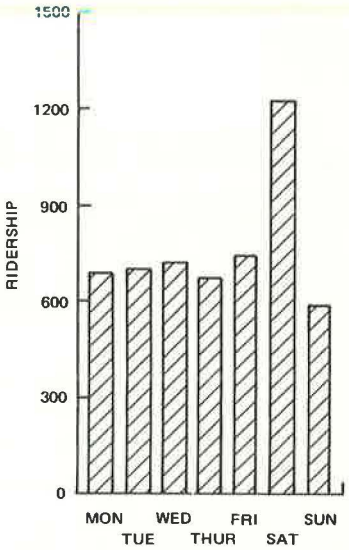


Figure 3. Average hourly ridership.

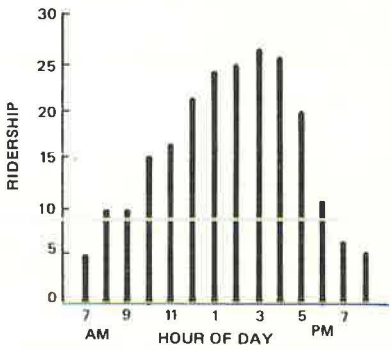


Table 1. Ridership by age group.

	Weekday		Saturday		Sunday		School Holiday	
Age	Number	Percent	Number	Percent	Number	Percent	Number	Percent
< 20	219	38	530	69	276	66	809	72
20 to 59	121	21	82	11	55	13	91	8
> 59	230	41	153	20	84	21	222	20
Total	570	100	765	100	415	100	1,022	100

Figure 4. Trip purpose by age group.

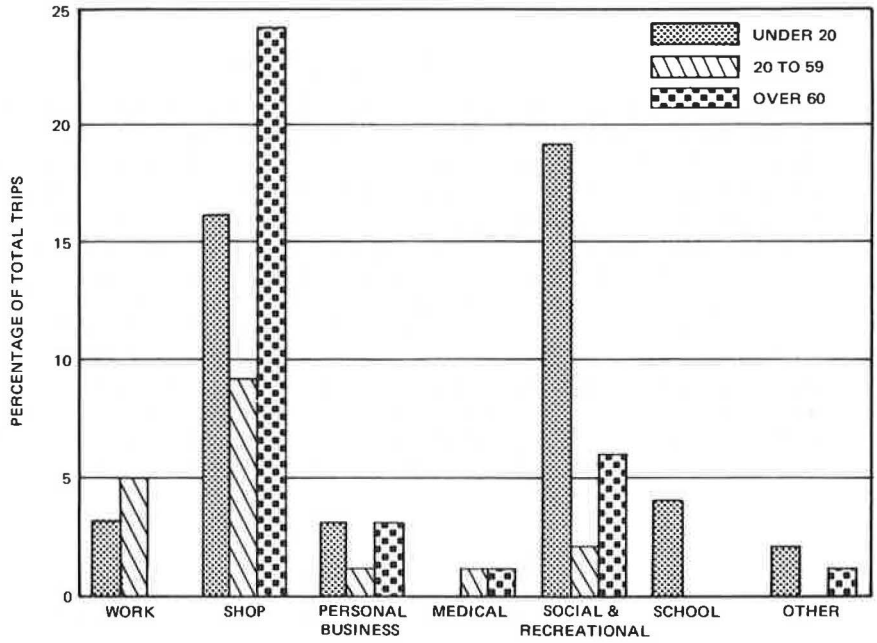


Figure 5. Trip frequency by age group.

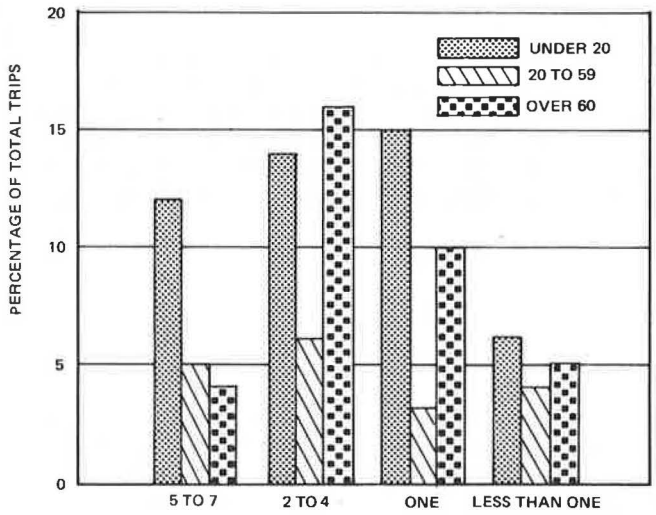
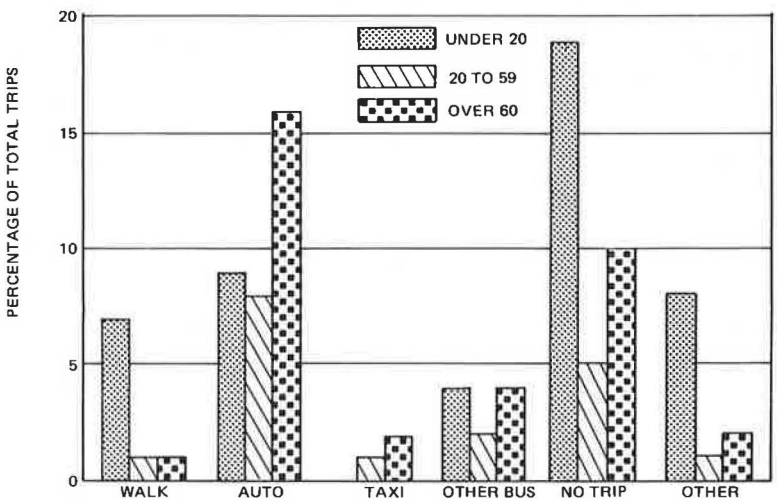


Figure 6. Previous mode of travel by age group.



WALKING DISTANCES

From an appraisal of the first on-board interviews that were completed, it was obvious that the distance between origin or destination and the bus route was an extremely significant factor in determining ridership. Since more than 90 percent of the riders walked to and from the bus, the following aspects of walking distances were examined in greater detail: distance from place of residence to bus route, distance from bus route to ultimate destination, and impact of total walking distance on modal split.

Since detailed questions on origin and destination were asked in the on-board surveys, all the information necessary to identify locations was available. Therefore, a zoning and coding system was required that would enable the data to be manipulated in such a manner that walking distances, or locations on the bus routes, could be easily obtained. Such a system, which was sensitive to the bus lines, was developed by dividing each route into 9 sections. Each section, in turn, was subdivided into 5 bands paralleling the bus route at distances of ⅛, ¼, ½, 1, and more than 1 mile (Fig. 7). Each zone therefore had a 3-digit code composed of the following:

Item	Position	Code
Bus route	1	1 or 4
Section	2	1 through 9
Bandwidth	3	1 through 5

Specific attractors such as Sunshine Mall/Sears Town, which are located directly on a route, were coded 0 in position 3. Thus, by grouping the results by the third digit, the walking distances at either the origin or destination end of the trip could be obtained.

Trip information on the base population was obtained by means of 640 interviews conducted at dwelling units within 1 mile on either side of routes 1 and 4. The units were selected from 1 in. = 200 ft land use maps (1970) in such a manner that a cumulative count of the dwelling units in each bandwidth was kept while a systematic 2 percent sample was selected. Dwelling units in each bandwidth were as follows:

Bandwidth	Dwelling Units
0 to ⅛	3,922
⅛ to ¼	6,132
¼ to ½	11,100
½ to 1	10,308

The trips that were reported in the on-board survey were grouped by origin bandwidth and then subdivided by age and mode of travel to the bus route as given in Table 2. Since the total number of dwelling units in each bandwidth had been established, it was possible to normalize the number of trips from each bandwidth, i.e., adjust the total to give trips per 10,000 dwelling units. The percentage of normalized trips represents the transit trips originating from the bandwidth expressed as a percentage of the total transit trips made by that age group. The cumulative percentage results in a straight-line relation when plotted on semi-logarithmic graph paper as shown in Figure 8. The vertical axis represents the percentage of riders who live a greater distance from the bus route than the corresponding distance shown on the horizontal axis. Thus, if there is a uniform number of dwelling units in each bandwidth, about 30 percent of the elderly riders live at a distance greater than ⅛ mile, or, conversely, 70 percent of the elderly live within ⅛ mile of the bus route. The normal assumption that transit serves ¼ mile on either side of the route is shown to be questionable in this instance since the vast majority of the elderly—for whom the system was primarily intended—consider half this distance to be their limit.

A similar pattern was observed at the destination end of the trip. Almost 90 percent of all trips on routes 1 and 4 were bound for destinations within ⅛ mile of the route as shown in Figure 9. There are 2 distinct portions to these curves: an elastic region for the first ⅛ mile and a relatively inelastic portion that suggests that the last few percent are essential trips to specific locations made by truly captive riders.

Figure 7. Zoning scheme.

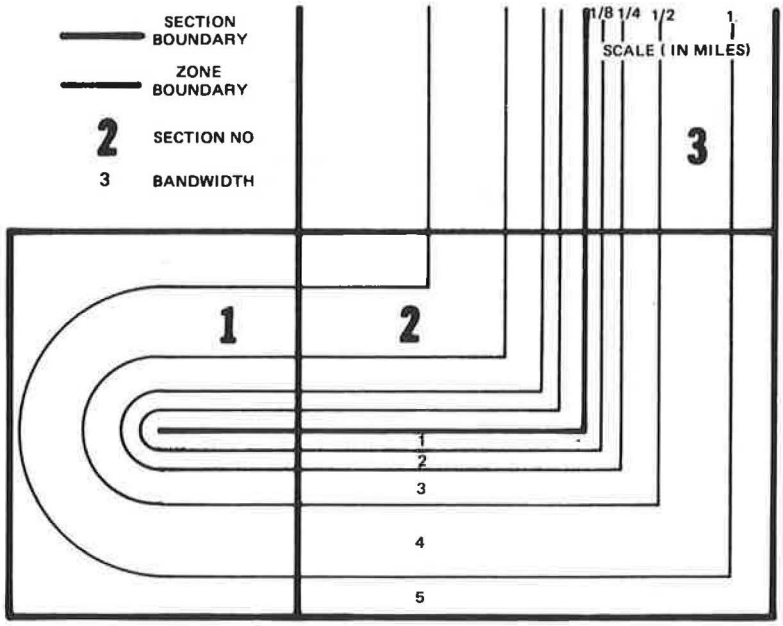


Table 2. Normalized transit trips by bandwidth at origin.

Age	Bandwidth (miles)	Survey Trips	Normalized Trips		
			Number	Percent	Cumulative Percent
<20	0 to 1/8	55	62	50	100
	1/8 to 1/4	22	36	29	50
	1/4 to 1/2	17	15	13	21
	1/2 to 1	7	7	6	8
	>1	3	3	2	2
20 to 59	0 to 1/8	46	52	59	100
	1/8 to 1/4	16	26	29	41
	1/4 to 1/2	8	7	9	12
	1/2 to 1	2	2	2	3
	>1	1	1	1	1
>59	0 to 1/8	90	102	75	100
	1/8 to 1/4	13	21	15	25
	1/4 to 1/2	9	8	6	10
	1/2 to 1	5	5	4	4
	>1	0	0	0	0

Figure 8. Rider origins for total walking distance.

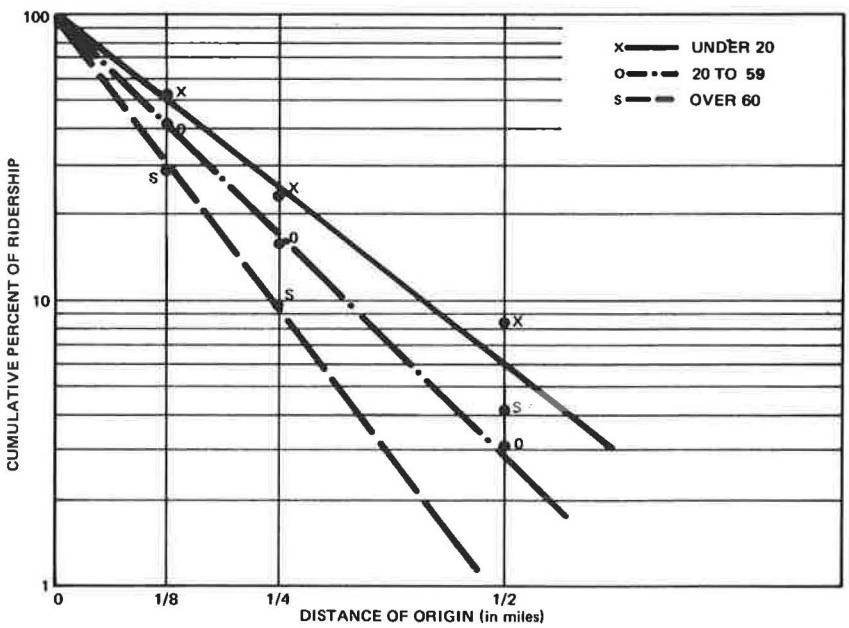


Figure 9. Rider destinations for routes 1 and 4.

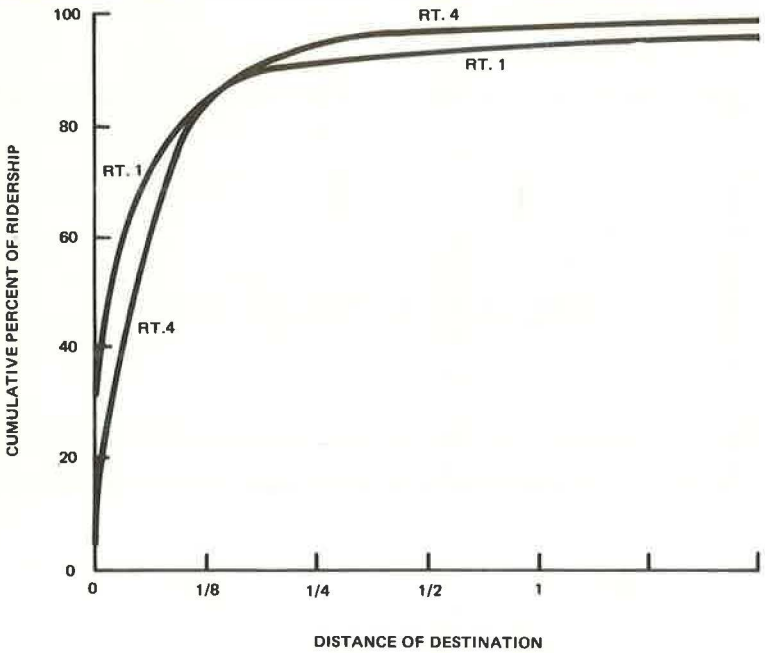


Figure 10. Transit usage by total walking distance.

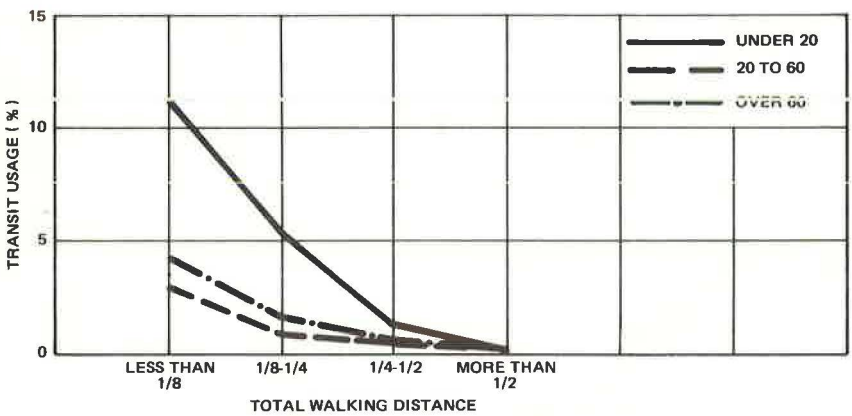


Table 3. Route characteristics.

Route	DU	WDU	Average Weekly Ridership	Trips per WDU per Week
1	10,941	5,124	2,083	0.406
3	8,068	3,777	983	0.26
4	15,119	8,377	2,751	0.314

The final aspect studied was the effect of walking distances on the modal split, i.e., the relation between total walking distance and transit usage. Since the total number of dwelling units in each bandwidth was known, the trips by all modes for the base population, obtained from the home interviews, were expanded by distance from the route. The reported trips were zoned according to the system previously explained and subsequently classified by equivalent walking distance, i.e., the total distance that would have been walked had the trip been made by transit. The decrease in transit travel due to the negative impact of walking distance is clearly shown by the curves in Figure 10. The percentage of transit usage in the adult age groups fell by about 70 percent as a result of the total walking distance increasing from $\frac{1}{8}$ mile to $\frac{1}{4}$ mile. The initial high percentage of transit usage in the under-20 age group is due to the low number of total trips (by all modes) going to the shopping malls reported in the home interviews sample. This is supported by the results of the on-board survey in which more than 40 percent of the teenagers stated that, prior to inception of the bus system, they had made no similar trip.

SERVICE AREA

One question that constantly arises when a transit system is evaluated is, How can one determine which areas are in fact being given adequate service?

In this study, an index of the dwelling units (DU) around the bus line was used as a measure to reflect the relative accessibility to the route as perceived by the riders. This measure, the weighted dwelling unit (WDU), was obtained from data shown in Figure 8. These data show that an average of 60 percent of the riders live within $\frac{1}{8}$ mile, 25 percent live between $\frac{1}{8}$ and $\frac{1}{4}$ mile, and 10 percent live between $\frac{1}{4}$ and $\frac{1}{2}$ mile. Therefore, assuming that the 0-$\frac{1}{8}$ mile band has a saturation trip generation rate, it was weighted at unity; and the dwelling units were weighted in the ratio of 1.0:0.4:0.2 for the 0-$\frac{1}{8}$, $\frac{1}{8}$-$\frac{1}{4}$, and $\frac{1}{4}$-$\frac{1}{2}$ bands respectively.

Although routes 1 and 4 formed the data base for this paper, one other route, route 3, was operated at the start of the project but was discontinued before the home interviews were conducted. However, sufficient ridership and dwelling unit data are available to be included for discussion at this point.

The total weighted dwelling unit and the ridership at 10-cent fare for the routes are given in Table 3.

The trip generation rates indicate which of the routes is receiving the highest utilization from the service area population. Also, expressing the sum of the weighted dwelling units for all routes as a percentage of the total number of dwelling units in the tax base gives an idea of the coverage being provided.

CONCLUSIONS

The problem facing Clearwater and other similar communities, in Florida and elsewhere, is how to design transit service that meets all reasonable transportation needs in the most economical fashion. There is still much to be learned, but the information presented here may provide some input for the design of future transit routes serving similar areas.

Many parallels have been drawn between transit service and other services such as police, street lighting, and health clinics. However, there is one basic difference between transit and other services. Although those who pay for the major share of other services do not necessarily make the most use of them, each service is available to all when, and if, it is required. In comparison, the same cannot be said of a fixed-route transit system.

There has been a recent trend toward the creation of transit authorities as a result of the local private operator either providing inadequate service or going out of business voluntarily. It would appear that the authority has one additional problem that private company did not have. The public authority must surely make an attempt to provide as equitable a distribution of transit facilities throughout the tax base as possible. Although there will be districts whose need for transit is much less than others, this should not entirely preclude the latter districts from service.

A second responsibility in a tax-supported system is optimizing revenues for a given set of operating costs. Figure 10 shows the change in transit usage with distance from the bus route and shows that only a very narrow corridor is adequately served.

The elderly frequently complained that the distance of ¼ mile to and from the bus route was too far for them to walk, especially when they were carrying groceries. Also, many voiced apprehension about crossing major arterial routes to get to the bus; some riders commented that they rode to the end of the route and back again to avoid having to cross US-19, a 4-lane divided highway. In some instances this caused an increase in travel time of almost ½ hour. Therefore, despite the fact that on paper an area appears to be served, in effect, the limitations on the resident's physical abilities render the bus service totally inadequate. In the case of a public authority operating the transit service with fares subsidized through some form of taxation, the system that attempts to provide an equal level of service to each individual must represent a more equitable distribution of public funds than a system that favors one group of the population, in this instance those persons living right beside the bus line.

The case for a demand-actuated system operating up to, say, ¼ mile from the basic route, is a strong one. The cost of communications equipment represents a very minor part of the overall costs, yet Figure 10 shows that the ridership could be almost doubled by such a service.

The Central Pinellas Transit Authority, which was given taxation powers in December 1971, is considering a demand-actuated service for some of the areas that were discussed. Further information may result that will test the validity of the conclusions presented in this paper.

REFERENCE

1. Transit in Central Pinellas County. Simpson and Curtin, 1971.

DATA REQUIREMENTS IN TRANSPORTATION PLANNING FOR URBAN DISADVANTAGED

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The usual data sources for urban transportation planning studies are inadequate for either identification of urban disadvantaged persons or estimation of capital and operating requirements of systems that are needed to overcome their mobility disadvantages. Some nontypical data sources are required to identify disadvantaged persons and determine their travel needs. Several social welfare data bases are recommended that offer specific identification of physical, economic, or racial handicaps; describe special travel requirements by destination, mode, and cost; contain historical trend data; and provide high sample rates. An approach to a transportation planning process integrating needs analysis of transportation-disadvantaged persons is outlined. Prime elements are small-area identification of specific types of disadvantaged persons and investigation of trip-maker and locational constraints on employment access and nonwork travel needs. Development of new transit facilities and hardware modifications for the physically handicapped is made explicit. New operating strategies for existing or new systems are shown to benefit disadvantaged users.

•TRANSPORTATION planners and operators at various levels of government are seeing that, like every other facet of American life, transportation planning has been oriented predominantly to the highly mobile, middle-income trip-makers. They have been provided with highways for their cars and transit for their downtown journeys to work. Those who do not own a car have been expected to make use of the available public transportation while it lasts. In the same manner, the Nation's health system works well for upper-middle- to upper-income persons. The Nation's education system works well in some places for those students who are moderately bright and moderately motivated.

But poor people cannot get to the new suburban jobs. Welfare agencies must pay for taxis to medical centers and to job interviews. Handicapped persons cannot get on buses. Illiterate and blind persons cannot figure out bus routes or read destinations. There are locations in densely populated cities where a bus to downtown goes by every few minutes but no bus goes across to the hospital, which is much closer. These important travel desires are neither analyzed nor programmed for solution in many current studies. The problem is an example of a significant general public expenditure question: Whom does the public policy decision affect? It is not enough to show total benefit of a project; we need to show who benefits and who does not.

In the late sixties for a time, and again in 1972, significant federal and local interest has emerged in questions about the mobility needs of the large number of persons whose incomes, travel desires, and community impact wash out as "system noise" in transportation analyses.

Sponsored by Committee on Transportation Information Systems and Data Requirements.

The problem is with us not only because transportation systems are designed to serve predominantly middle-income persons but also because few data with which to design systems to serve the disadvantaged are available.

This paper suggests specific considerations to be included in transportation studies of the needs of disadvantaged persons and alerts experienced analysts to additional sources of transportation needs data. If current transportation facilities limit opportunities for disadvantaged persons to get good-paying jobs and have access to other activities that broaden the quality of life, then data of the type discussed here are needed in transportation planning.

KEY ELEMENTS OF AN APPROACH TO NEEDS STUDIES OF DISADVANTAGED GROUPS

Disadvantaged Target Groups

The first step in determining these transportation needs is to filter out or isolate the disadvantaged persons. No longer can they be assumed to be covered by "transit ridership" or some other substitute. Each homogeneous disadvantaged target subgroup must be identified and located and its characteristics determined before subgroups are aggregated.

What is a disadvantaged person or group? Some concepts of what to look for in the data are needed. Classifications of persons and mobility levels to be evaluated can be developed. Figure 1 shows a simplified classification of disadvantaged persons. The classes are physical, economic, and racial; within each class several breakdowns can be further made, as shown in Figure 2.

Disadvantage can be measured as the number and the extent of goods and services neither personally provided nor received from others. Demand for services can be measured, at the risk of falling into pitfalls of demand economics, wherein desires must be related to marginal willingness to pay for and wait for a service and reasonable potential that the service can be economically supplied. Latent or unexpressed desires as well as any survey responses must be added, possibly by extrapolation beyond expressed needs or by using substitute services and goods sought (1).

What is meant by a person being transportation-disadvantaged? Each set of goods and services or jobs desired by a disadvantaged person implies a desired travel service to obtain them. A travel desire must be established. Existing or future transportation networks must be established to learn whether the trip desired can be fulfilled in a car or by reasonably convenient transit.

An example of the classification of disadvantaged persons is useful here. Social welfare agencies have categorized the disabled, and, by using this classification, one can extract information and statistical data for each class. Figure 2 shows that the disabled can be subdivided into physically disabled and mentally disabled. Subsequent breakdowns in hierarchy illustrate how one can start building opportunity boundaries related directly to transportation needs. The records available, for example, for the physically disabled provide information on the types of disability, household size, and requests made by the physically disabled for transportation and other services. This information contains details of the time that the request was made, the desired destination of the disabled, and, in many instances, the time required to arrive at the designation. The data also contain information as to how and under what circumstances the transportation need was met. In the category of "able to navigate," this service can be divided into licensed driver versus nondriver. The analyst would be particularly interested in the nondriver categories since these must be related to the availability of public transportation in an urbanized area.

We find that even the nondriver who is somewhat able to navigate has considerable difficulty in achieving life-style objectives. On the other end of the scale, the totally disabled are quickly put into the situation of not being able to use the private transportation unless there is a driving member of the family, a relative, or a friend available to provide private transportation to the desired destination. In most instances, we found that the totally disabled would have to depend on some form of public transportation.

For analysis purposes, 2 types of transportation disadvantage must be analyzed separately: trip-maker constraints and location constraints.

Trip-maker constraints are the inherent problems of the trip-maker in getting anywhere by an available mode of transportation. Examples include blindness, crippled legs, insufficient income to purchase a car, and inability to read or understand directions. These constraints are present no matter where the person lives or what public transportation is available nearby.

Location constraints are concerned with the transportation services available or known to a resident or employee where he is or wants to go and the distribution of destination needs and opportunities of that trip-maker—his realistic travel demand. Transportation services are provided by location, at locations.

The constraints of the transportation system as it appears to him are, of course, compounded by his trip-maker characteristics; he may be able to afford only public transportation, and it does not go to the new suburban industrial job concentrations. Inadequate public information services and publicity in certain areas of the city about not generally known routes cause location constraints. Infrequent bus service, multiple transfers, or lengthy travel times inhibit employment opportunities, as was demonstrated in Watts (2).

Trip-maker constraints will generally require special services, bus hardware, or fares, independent of location. Only to the extent that disadvantaged persons tend to concentrate in certain locations are they locationally constrained, for example, black persons who have low incomes and are constrained by housing discrimination and who need to get to suburban factories (3).

Location constraints are a problem to all persons in an area but particularly to disadvantaged persons. Changes in the total transportation network can do much to resolve these constraints if they respond to disadvantaged travel demand.

What are the data requirements for identification? For the state of Vermont, we have undertaken a comprehensive social services needs and delivery study, including a determination of the demand for social services and requests for funds to travel to essential service centers. The transportation analyst can evaluate these transportation needs in the context of total opportunities, desires, and capabilities of the disadvantaged population to achieve a definitive activity objective, related to available transportation services and prices. The propensity of each subgroup of the disadvantaged to desire a set of activities must be seen in its own opportunity surface and is not related solely to the availability of transportation.

Past efforts to shed light on these needs have depended too much on urban transportation study data aggregated by zones and supplemented occasionally by special survey data on employment travel (4).

Accessing automated welfare files as we have done in several metropolitan areas provides the following (5):

1. Source of information on broad needs or trip purposes other than just work trips;
2. Updated file of both person characteristics and requests for services;
3. Historical or longitudinal file indicating changing needs of disadvantaged persons over time;
4. Sample approaching 100 percent of the disadvantaged persons in an area because of financial incentives to register, although welfare agencies do not seek out new clients; and
5. Potential to sort data in several useful ways, including address or zone, income, types of handicaps, services needed, and requests for special travel payments.

Much has been written on census data (6); and in 1971 for the first time in many years, the fourth count is a useful recent data source, particularly on journey-to-work trips by tract. Not to be overlooked are special tabulations offered by the U.S. Bureau of the Census; these allow the analyst to request cross tabulations of disadvantage indicators.

Employment data from primarily state agencies can identify specific types of employment problems and programs (7).

Urban transportation survey data of the type collected by the authors for the Chicago Area Transportation Study in 1970 can provide breakdowns by race, income, and age, but only in certain zones and for certain disadvantages will the number of disadvantaged subgroup samples be adequate to do travel analyses. Since home interview surveys are designed to achieve minimum sample sizes of total trend, subgroups of disadvantaged travelers appear in less than representative numbers.

Some data sources not generally considered by transportation planners are shown in Figure 3. Table 1 gives a description of these sources.

Transportation Demand

The next step is to determine the actual and latent demand for transportation by the disadvantaged subgroup and to estimate future demand. The study of travel demand for disadvantaged persons requires understanding of recent sophisticated research in travel demand, modal choice, and transportation economic analysis (8, 9, 10). Considerations include the following:

1. Induced demand as a function of the attractiveness of transportation services existing and proposed (stereotyped images of public transportation services, i.e., ancient, dirty, slow, and unsafe, affect projection of modal-choice attitudes);
2. Latent demand for transportation services not now expressed but expected to occur when individuals perceive travel needs or the facilities available to transport them;
3. Effect of aggregating data on the reasonableness of demand estimates;
4. Changes in demand curves with excessive trip lengths and excessive waiting times required of disadvantaged persons [the Skokie Swift studies (7) long ago indicated that inner-city residents are unwilling to endure excessive waits for suburban feeder buses to factories after a long rapid transit ride, even though the reward may be a steady job, and that transportation facilities available may affect whether a trip is made at all either by the disadvantaged or by the advantaged];
5. Whether trip cost or perceived cost directly affects rates of low-income persons as expected (taxis paid by welfare agencies and the cultural attractiveness of expensive cars indicate areas for careful study); and
6. Whether many commonly used travel survey data bases are statistically invalid when disaggregated to specific disadvantaged groups in small areas because insufficient disadvantaged persons were sampled in a zone (in particular, the usual home interview survey sample size is quite low).

The extent of these problems indicates that a useful approach would be to use welfare files of various types to build up trip files from basic individual data on disadvantaged subgroups. Figure 4 shows this approach.

Among the characteristics of welfare files of particular benefit to current research in small-area disaggregated behavioral travel demand and modal-choice modeling are the following:

1. Almost 100 percent sample of disadvantaged families based on the incentive for the welfare recipient of continued payments and the incentive to the welfare agency to eliminate costly excess payments;
2. Heavy coverage of the nonwork trips that are essential to the recipient in requests for travel money and destination costs (e.g., doctor fees);
3. Longitudinal (historical) data on changing trip-making and income over time including relations between changing travel patterns and income (a link of successions of residential address changes for these highly mobile persons is possible); and
4. Behavioral data for cause and effect research (for example, Are people unemployed because they lack transportation? or Is lack of transportation to doctors common to high infant mortality areas?)

Some possible problems associated with transportation studies based on or supplemented by welfare data are

1. Possible extreme sensitivity to privacy issues in welfare agencies (some welfare

Figure 1. Classification of disadvantaged.

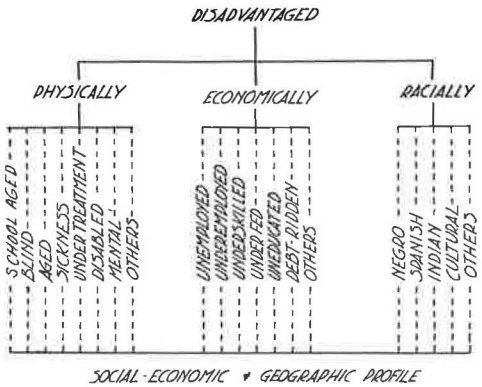

Figure 2. Subclasses of physically disadvantaged.

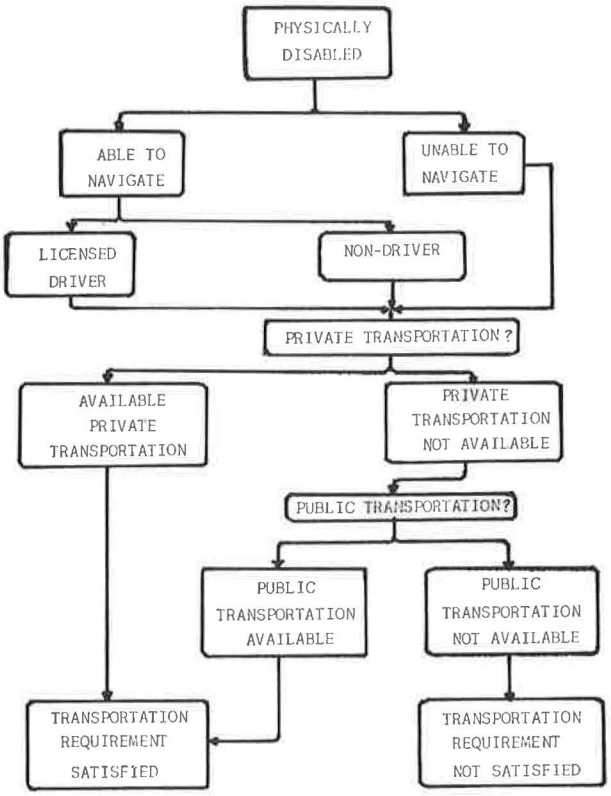

Figure 3. Data sources for transportation planning.

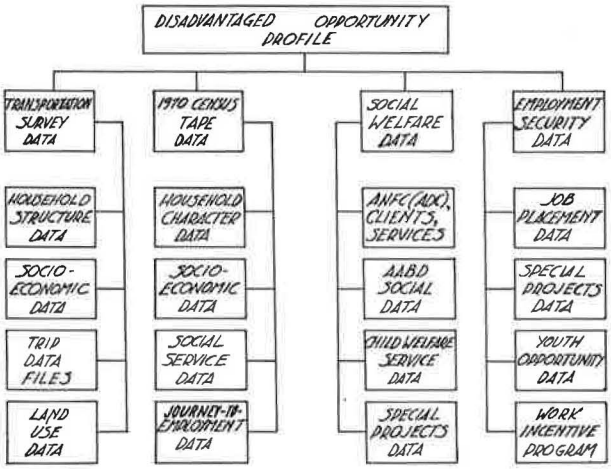

Table 1. Data base.

Study or Source File	Specific File Identification	Data Content and Data Items Used	Purpose for Disadvantaged
Transportation			
Home interview	B-1, C-1, and D summaries	Household structure, socioeconomic data, employment classification, occupation, trip data, trip purpose, time of trip, mode of travel, land use, cost, geographic location of trip and household, length of trip; dominated by middle-income travel, by travel zone, or by sample	Determine activity pattern for homogeneous groups particularly those selected as urban disadvantaged; obtain profile related to transportation network
Land use	Land use summary LU-116; land use field listing file	Detail description of urban land uses in urban area, usually by 99 categories located by block in built-up areas and by land classification in suburban areas	Relate existing land uses, e.g., industrial, commercial, institutional, to residential location
Facilities	Network inventory on various card and tape; link-mode file for highway and transit; public transit frequency file	Description of transportation-retrieval in urban areas for highway and transit; transit availability by time of day	Relate service facilities to areas reviewed
Welfare			
Aid to needy families with dependent children	FS201, 2015, FS211, DWS106	A complete socioeconomic profile with detailed information on all aid to needy families with dependent children—household size, location, income and service requests, including transportation; continuous time series data on changing patterns not available in any other data base	Trace mobility patterns of classes of disadvantaged persons in a zone
Aid to the aged, blind, and disabled	FS201, FS211, FS214	Detailed description of aged, disabled, and blind; federal support requirements; profile of urban disadvantaged subgroup case history and summary statistics on each individual description of transportation service needs, trips, time of day, mode of travel, and disabling factors mitigating travel	Relate impact on the aged of stricter driver licensing
Case and Administrative Services System (CASS) operating in a number of states	CASS file for related areas	Detailed case and administrative system of client objectives, services needed (transportation), trips or visits made, household data, income, time series data; universal profile of all opportunities available as part of urban disadvantaged group; national computer-based system	Relate need for services to actual consumption of services, such as transportation
Child welfare services	CWS301, service request; CWS 314 family	Detailed description of family structure and service needs for all children up to age 21 not picked up on other surveys	Separate serve-passenger trips, for which no occupation industry codes exist in home interview surveys, into trip purposes of children subgroup served, including trips to care centers, foster homes, and juvenile courts
Employment			
Work incentive program (WIN)	Work incentive case file (similar to DSW FS201)	Complete profile on client participation in WIN; particular emphasis on employment training and employability for specific subgroups; data on household and family characteristics, income, employment, training and related service needs	Develop detailed profile on disadvantaged subgroup, e.g., unemployed fathers; relate to specific training and job opportunities and transportation services
U.S. Census			
1970 Census of Population and Housing, selection of summary tapes for specific geographic areas	1970 summary tape 4 (13,000 tabulations by tract) and tape 3 (400 tabulations by block, without travel and income data)	Summary of population and household statistics by various geographic configurations; journey to work, mode choice, income, time lost from work, age, race	Use as universal control for all subgroups; relate location of disadvantaged groups to employment locations and mode of travel to work, to employed-unemployed, and to socioeconomic and household characteristics
Census of Transportation	Geographic summaries	Census of transportation, particularly location, mode, and length of travel by various categories	Relate overall profile of transportation use to facilities of mode; use as control for specific modal choices influencing locational decision related to industry
1970 Census of Population and Housing, special tabulations of data not in summary tapes	1970 special tabulations and cross tabulations of A against B	Income by age groups, time lost from work, race; smaller than tract level	Determine coincidence of multiple disadvantages

agencies, however, spend considerable funds on special transportation services or taxi fares, which a transportation study could attempt to reduce);

2. Predominantly unautomated data bases, or partial automation, with certain useful types of data in handwritten or typed form; and

3. Uneven accuracy of recorded data, depending on the welfare recipient, the caseworker, the availability of information on welfare services, and the keypuncher (a high sample size can reduce these problems).

A final transportation demand problem is that of estimating future demand. A couple of approaches are possible. The historical data in welfare files might be extrapolated. Land use characteristics might be broken down to determine any consistencies in trip generation by disadvantaged subgroups traveling there. The uncertainties of national economic prosperity, discriminatory attitudes, and medical research for the handicapped make forecasts particularly hazardous. At any rate, the immediate problems are serious enough to make current data in themselves quite valuable.

Transportation System Requirements of Each Group

Recommendations should be made for public transportation service system requirements of each disadvantaged group. This is the phase in which data on expressed and implied transportation needs of the disadvantaged are analyzed and expressed as requirements for a transportation system to serve those needs. The functions to be performed by the system are spelled out, and operating requirements are "optimized." Implied in any quasi-optimizing analysis is a demand and modal-choice analysis responsive to a system's proposed characteristics.

A wide range of hardware characteristics and operational strategies can be proposed. Specially designed buses, rail networks, or helicopter emergency systems have been developed. Demand-responsive operating strategies are being offered for specialized needs. Their characteristics can be evaluated by a first-stage, manual-analysis, filtering process without recourse to sophisticated mathematical analysis. Graphical analysis may be used to identify the few most promising functional systems.

The 2 or 3 most promising solutions can be tested by detailed transportation modeling to estimate demand, including demand by disadvantaged persons, benefits-disbenefits, and responsiveness to other criteria for evaluation of transportation plans.

The plan that serves the most disadvantaged trips may not be the most cost-effective for the general welfare of the total population in a study area. Although it should not be the transportation planner's role to absorb such high-level policy decisions in the preliminary evaluation process, he should now be prepared to answer some questions about who is served well by the system and who is not, what operating strategies are feasible, what pricing options are available, and what personal or welfare agency transportation expenditures are reduced.

Design and Operation of System

A detailed engineering design and operation plan of the recommended system hardware and software are the next elements. In a study emphasizing the transportation needs of a subset of the population new hardware or operational strategies or both are quite likely. Seattle, Atlanta, Baltimore, Detroit, and Honolulu and numerous large and medium-sized foreign cities have recently selected capital-intensive rapid transit systems. Thus, more is required than in refined freeway location and design studies.

Hardware engineering studies are necessary even when no heavy new capital investment is anticipated. Buses, rail cars, and stations generally need to be modified to admit physically handicapped persons (1, 11).

An increasingly integral part of detailed design is the computer program requirements for transit or highway command and control systems. On-time performance is essential to job stability for low-income persons. Our recent research experience in a police crime and traffic study indicates that automated analysis of transit or highway on-time performance with software that reports exceptional system behavior in a meaningful way is necessary to achieve original performance specifications regularly.

Meaningful exception reporting requires that bad weather or a one-point bottleneck not merely be reported as "all cars late." The software should simulate what is normal behavior in such exceptional situations so that additional bottlenecks can be recognized and corrected while the abnormal (e.g., bad weather) conditions continue.

The detailed operations plan can carry out strategies selected to maximize transportation service to disadvantaged persons. Demand-responsive feeder systems, shuttle systems, or parking facilities could be developed here. Neighborhood or public welfare agencies can be organized to provide for volunteer-driven feeder or short-haul needs.

Implementation of New Transportation Systems

A pilot test is recommended for implementing innovative systems. If a small-scale test is economically feasible, it can provide realistic prototype evaluation data and will avoid disrupting an existing smooth operation. In some cases, such as some demand-responsive systems, a manual test can be misleading. The computer software required for the pilot will be the same as is required anyway for full development.

The new system must be given an opportunity (1 to 2 years) to develop new ridership and travel habits. As old, dirty, slow, unsafe, and noisy subways and buses give way as images of American transit, new levels of transit ridership can be reached.

Evaluation of Transportation Plans and Programs

The impact of programs aimed at the disadvantaged needs to be determined. Will jobs be obtained by disadvantaged people because of the project? Will trips to medical clinics increase? A range of social indicators influenced by improved transportation services is needed and can be accessed from nontransportation data bases. No attempt is made in this paper to show that special transportation services aimed at disadvantaged persons are needed, though a number of such studies have been made (2).

SOURCES OF DATA REQUIRED FOR VARIOUS GOVERNMENTAL UNITS

Transportation Planning Data

Interest in transportation planning for disadvantaged person needs has produced some specialized surveys and research analyses on the scope and depth of needs. Some have resulted in successful new services. Frequently, however, researchers have identified needs that were never implemented by the transit operator, or special demonstrations have been launched with insufficient planning. New routes were merely slight modifications of older ones, advertising was ineffective, or an evaluation criterion such as profitability may have replaced the original purpose, which was to open up job or leisure opportunities.

Better integration of transportation planning for disadvantaged persons in the regular data collection, analysis, and programming functions of established governmental planning agencies is needed.

Metropolitan Transportation Planning—As urban transportation planning programs develop major reappraisal planning update programs and recognize that new data collection and modeling improvements are needed, the opportunity arises to seek data on transportation-disadvantaged persons and incorporate them in the planning process.

The welfare payment agencies and social services referral centers are beginning to automate case records and statistical analysis. Even noncomputerized records may be well worth a cooperative automation effort.

Home interview data of the type collected by the authors in the fall of 1970 for the Chicago Area Transportation Study are most useful for the subgroups. Even for these groups—low-income persons, elderly persons, teen-agers and nondrivers—some zones will have insufficient interviews to estimate realistic proportions of disadvantaged persons in the population. Some useful sorts of the data are shown in Figure 5.

Land use projections benefit disadvantaged persons only if high densities are concentrated near transit facilities that have high levels of service and go where such

persons need to go. Demand-responsive and modal-choice models are necessary so that densities and incomes near transit facilities can be specified. Employment data files can be used to link high-unemployment neighborhoods and suburban job centers for low-skilled positions. Of course, actual demand and benefit to unemployed persons depend on national economic health.

Census data for 1970 will be heavily used in transportation studies for sample control and geographic file linkage. The linkages can extend to welfare and employment files that are based on street addresses.

City Transportation Planning—Sources of data of particular interest to city planners include 1970 census tapes, state employment data, and welfare data. Special surveys of Model Cities neighborhoods and planning areas offer an opportunity to identify transportation-disadvantaged persons and areas.

With or without a mid-decade U.S. population and housing census, any data base heavily dependent on census data should include an active growth-monitoring program for a city or metropolitan area. Much talk about urban data base updating has been followed by little continuing financial support since April 1970. A good generalized data base management software package such as the authors have designed and installed should contain the necessary multifile update and cross-tabulation retrieval software. Regular or continuing update data sources and procedures for the multiple-file data base discussed previously require more than a single update source. Operating data from city departments, such as building permits, assessment records, and water service changes, can update name lists of owners and residents but do not usually provide information on income and physical or mental handicaps. Depending on local availability, welfare, credit agency, or utility (possibly with income) ties can be established by housing unit and aggregated to small areas to protect confidentiality.

Small Town and Suburban Transportation Planning—In recent years some smaller towns and suburban villages have bravely sought to subsidize transit service for residents and employees. Some recognized that attracting an industrial tax base would require not only water, sewers, and good schools but also transit service for "low-cost labor" from commuter rail stations to industrial parks. Others seek relief from traffic congestion and parking problems and convenience for shoppers. Demand-responsive, subscription, and pulse-scheduled minibus systems have met considerable success, including some revenue success. Generally, these completely new systems have provided mobility to previously stranded disadvantaged persons.

Special surveys can be inexpensive in these areas, but they should be designed to identify latent travel demands and divertible automobile trips by implying new potential destinations and high-quality service (12). Factory-organized bus services can be absorbed if identified.

Statewide or Intercity Transportation Planning—High intercity travel cost excludes all but the most essential trips for disadvantaged persons, and physical barriers to the handicapped are formidable. Illinois, New York, and several other states are now considering or implementing high-speed ground transportation projects that may help these persons.

Some major modeling efforts in statewide transportation planning have been made by New York, Pennsylvania, and California, where our firm conducted the earliest study (13, 14). Most of these efforts involved adaptation of gravity model theory to urbanized areas as trip-generating point sources. As with intracity transportation studies, these models aggregate the data such that modal choice is based on income-automobile ownership rather than on more specific behavioral characteristics.

Additional research into latent demand and modal-choice determinants, such as door-to-door travel time, convenience of not having to drive, and mobility requirements at destination city, is needed; data bases on which to run such models are also needed. Economic application of Northeast Corridor research is needed. Treatment of demand as in recreation planning models should be explored. Use of urban areas as point-trip sources will not be successful unless characteristics of access to some high-speed service terminal from all parts of that urban area are taken into account in disaggregated fashion.

Figure 4. Opportunity-demand profile.

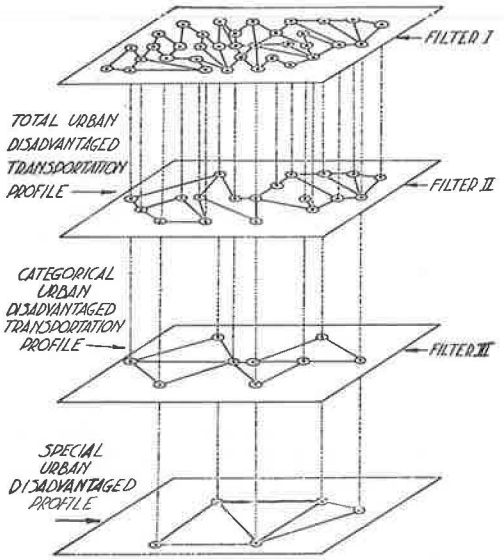

Figure 6. Distribution of travel by time of day.

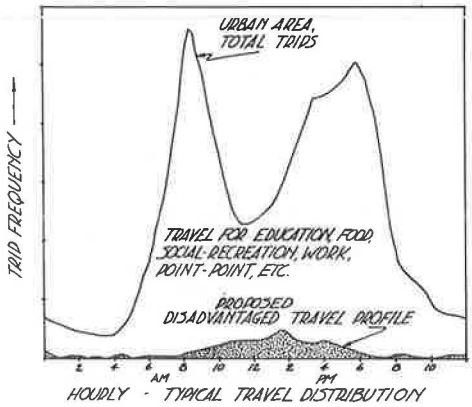

Figure 5. Home interview survey tabulation.

S ZONE		AUTO OWNERSHIP				DRIVER STATUS		TRIPMAKING ON TRAVEL DAY								
	TOTAL AUTOS	OCCUPIED NO AUTOS	DWELLING ONE AUTO	PLACES TWO AUTOS	OWNING THREE+ AUTOS	LICENSED DRIVER	NON DRIVER	BY PERS AGE 5 + OLDER	TOTAL PERSON TRIPS	AUTO DRIVER TRIPS	AUTO PASS TRIPS	COMM BUS TRIPS	SCHOOL BUS TRIPS	TAXI + INT TRUCK PASS	WALK+ OTHER	ZNE
001	192	96		96		192	96	192	927	735	192					001
002	96	96	96			192	96	192	384	192		192				002
003	96	96	96			96	96	192								003
005																005
006																006
007																007
009	192		192			384	96	288	627	435	192				192	009
010	96		96			96		96	243					243		010
011	192		192			192	192	384	1611	1317	294				243	011
012																012
013	96		96			96	96	192	972	633	339					013
014	96		96			96	96	96	441	441						014
015		192					480	192	294		294				96	015
	1056	480	864	96		1344	1248	1824	5499	3753	1311	192		243	531	
	1056	480	864	96		1344	1248	1824	5499	3753	1311	192		243	531	
016	110		110			220	330	440	2632	944	1688				110	016
017	220		220			330	770	220	834	834						017
018		220					220	110	278		278					018
019	220	220	220			220	550	330	1112	834	278					019
020	220	220	220			550	660	990	7436	3162	4274					020
021	110		110			220		110	776	776						021
022	110		110			110		110	495	495						022
	990	660	990			1650	2530	2310	13766	7048	6718				110	
023	212	106	212			318	212	530	3266	2038	960	268				023
024	318	106	106	106		636	636	848	7928	4450	3478					024

Operating Transit Agencies

Transit agencies need not wait for revisions of urban transportation planning models to assess their responsiveness to travel needs of urban disadvantaged persons. In the high-density areas of major cities with frequent, heavily used service to downtown, there are many disadvantaged persons who need to go across town or to a nearby hospital and persons who physically cannot mount a bus step. Semiliterate, low-income residents often cannot sort out a maze of bus routes and signs and do not know where to turn for help. Some disadvantaged persons can travel in the off-peak periods (Fig. 6) when marginal operating cost is low. These trips are not usually made to work but for other purposes, and the destinations are more dispersed over space and time. A demand-responsive, door-to-door service should be demonstrated for off-peak periods.

Welfare agencies are good initial sources of information, as are some Model Cities staffs, which often bring specific problems to transit operators.

Home interview survey analysis of automobile and taxi trips taken by persons who are also transit users can be explored. We have found employers to be responsive to letter surveys of company-sponsored bus services.

SUMMARY

Some approaches to considering the transportation needs of urban disadvantaged persons have been explored. The paper has pointed out the inadequacy of conventional transportation data collection processes that frequently miss trips made or needed by disadvantaged persons. The authors have identified and have utilized complementary sources to estimate travel needs of the disadvantaged. Several types of welfare files from national programs have been described and related to transportation planning requirements.

We suggest that analysts either incorporate these files in the transportation planning process or develop new techniques to collect disadvantaged time series data in urban area transportation planning studies. We are not effectively evaluating total transportation demand, and we must extend the scope of data collected.

REFERENCES

1. Hoel, L. A., et al. Latent Demand for Urban Transportation. Transportation Research Institute, Carnegie-Mellon Univ., 1968.
2. Crain, J. Reverse Commute Experiment. Stanford Research Institute, April 1971.
3. Paaswell, R. E. Planning Special Transportation Services. HRB Spec. Rept. 121, 1971, pp. 43-57.
4. Wachs, M. J. Employment, Mobility, and Public Transportation in Chicago: A Survey of Attitudes and Behavior. Highway Research Record 348, 1971, pp. 142-151.
5. Design of a Social Evaluation Planning System for Herkimer-Oneida Counties Metropolitan Area. North American Rockwell Information Systems Company, 1971.
6. Wickstrom, G. V. Use of Census Data in Urban Transit Planning. HRB Spec. Rept. 121, 1971, pp. 78-81.
7. Benson, D. E. Skokie Swift Demonstration Development Impact. Northeastern Illinois Planning Commission, 1966.
8. Kraft, G., and Domencich, T. A. Free Transit. Conf. on Poverty and Transportation, 1968.
9. Kraft, G., and Wohl, M. New Directions for Passenger Demand Analysis and Forecasting. Transportation Research, Vol. 1, 1967.
10. Stopher, P. R., and Lisco, T. E. Modelling Travel Demand: A Disaggregate Behavioral Approach—Issues and Applications. Paper presented at Transportation Research Forum, 1970.

11. Passenger Psychological Dynamics. ASCE, 1968.
12. Gustafson, R. L., Curd, H. N., and Golob, T. F. User Preferences for a Demand-Responsive Transportation: A Case Study Report. Highway Research Record 367, 1971, pp. 31-45.
13. California Integrated Transportation Study. North American Aviation, 1965.
14. Methodological Framework for Comprehensive Transportation Planning. Transportation Research Institute, Carnegie-Mellon Univ., 1969.

PROVIDING TRANSPORTATION FOR PERSONS WITH LIMITED MOBILITY IN SUBURBAN AREAS

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ABRIDGMENT

•RECENT federal transportation policy has specified a commitment to providing public transportation for persons who do not own or cannot drive an automobile. The special needs of the elderly, the handicapped, persons from low-income households, and other limited-mobility groups in an urban environment have received considerable attention. However, the travel characteristics and transportation requirements of persons with limited mobility situated in automobile-dominated suburban areas have not been well treated. This paper reviews some findings about the travel patterns of limited-mobility in Contra Costa County, California, a suburban area soon to be served by Bay Area Rapid Transit (BART). Key findings pointed to the feasibility of a limited-service, dial-a-bus system to complement the high-speed BART corridor system for those without access to an automobile.

Travel data from the 1965 home interview survey of the Bay Area Transportation Study Commission was classified by time of day, trip purpose, household car ownership, age of traveler, and household income for Contra Costa County households. These tabulations together with further analysis of the commute-to-work patterns of Contra Costa residents led to 3 principal conclusions:

1. There are only a small number of low-income persons and in-commuters with a significant need for peak-hour service to employment centers;
2. The elderly, low-income, and zero-automobile groups travel to a large degree during the midday (9:00 a.m. to 5:00 p.m.) for a variety of shopping, medical, and personal business purposes; and
3. More than half of all trips made by persons under 16 years of age are to and from school (in general, this need is satisfied by school busing service).

The predominant need for public transportation by limited-mobility groups in Contra Costa County was identified to be occasional shopping and personal business trips during the midday. To meet this demand, transportation service would only be required from 9:00 a.m. to 5 p.m.—a feature that would eliminate some of the penalty conditions of standard public transportation labor agreements.

The total coverage and doorstep service afforded by dial-a-bus made it an attractive alternative a priori in view of the nature of travel market being served. Further analysis showed that many-to-one dial-a-bus service focused on the major downtown nodes in the county and with 50 small buses could reasonably be done with manual dispatching. Patronage estimates were based on rates observed for conventional fixed-route bus service because of the captive nature of the potential users. A computer simulation model was programmed to evaluate optimum vehicle size, vehicle productivity (calls per hour), and costs for various service levels. Other simulation results (1) consider much higher levels of service (e.g., maximum waiting times of less than 10 min versus a maximum waiting time of 40 to 50 min in this case) and were not applicable. The dial-a-bus service alternative appears feasible for a limited role in providing transportation for limited-mobility groups in the suburban setting of Contra

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Costa County. Its suitability depends on the availability of corridor transportation service and the predominance of midday demand in the study area. Similar conditions in other suburban communities should point to further adaptation of the dial-a-bus system for providing special transportation for persons with limited mobility (2).

REFERENCES

1. Howsan, L. L., and Heathington, K. W. Algorithms for Routing and Scheduling in Demand Responsive Transportation Systems. Highway Research Record 318, 1970, pp. 40-49.
2. Schmidt, J. W., Arnold, R. K., and Levy, S. Specification and Evaluation of Alternative Feeder and Local Transit Systems in a Suburban Area. Paper presented at the HRB 51st Annual Meeting and to be published in a forthcoming RECORD.

TRAVEL IN THE BLACK GHETTO

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ABRIDGMENT

•INNER-CITY areas of the United States present unique transportation problems for which few data exist. The data summarized here were obtained from a household survey performed in 1968 and contain characteristics of work trips and shopping trips for the black ghetto of Buffalo, New York (1).

A study of trends in the location of working places for black workers and changes in travel time resulting from expressway construction showed that the worker could reach more than 25 percent more jobs by a half-hour bus trip in 1952 than in 1968. This decrease in access over time was due mainly to the fact that many jobs have moved to suburban locations. (Employment in the inner city dropped by 36 percent, whereas total employment in the area increased by about 23 percent.) Construction of urban expressways enabled automobile commuters to increase their average speed during the 18-year interval so that the decrease in the number of jobs accessible by car in a half-hour journey was very small (about 4 percent). In 1962, the average journey to work from the inner city was 12 min by car and 30 min by bus. The number of jobs one could reach in these average travel times was 126,000 and 113,400 respectively. These data show that the average bus commuter was willing to travel 2½ times longer to have a job opportunity equivalent to that of his neighbor who owned a car.

The proportion of inner-city workers employed beyond the city line increased sharply since 1960. In 1960 about 17 percent went beyond the city line. In 1968, 30 percent did so. A detailed study of the characteristics of 102 workers who commuted beyond the city line to work in 1968 showed that generally these were older males who were in households with a car and who drove to jobs in the operative category in manufacturing industries.

Since the Watts riot, attempts were made to improve access to suburban jobs from the inner city (2). Generally, these busing-to-work programs were not successful, and costs per person trip were in some cases higher than $2. Whether unwillingness to travel long distances to work was a factor that kept the ridership low in these experiments was examined by an analysis of answers given by workers and unemployed workers in the sample to the following question: If you could reach a good suburban job with a half-hour bus ride, would you go by bus? The responses for the entire combined sample of 278 workers and nonworkers with and without cars, and for 31 nonworkers under 60 years of age with no car, showed that there were among unemployed workers without cars significant factors that inhibit them from commuting by bus to a good suburban job. Only 25 percent of the combined sample were unwilling to travel a half hour by bus, whereas 42 percent of the unemployed without cars were unwilling to travel this long. This decrease in willingness might represent a low level of willingness to travel by bus in general, or an unwillingness to work in the white suburbs. More research is necessary to clarify the causes of this unwillingness.

Automobile ownership was shown to have an important effect on food shopping patterns. Sixty-six percent of those who shopped for food made 1 trip per week or less than 1 trip per week. Among those without automobiles, 20.4 percent shopped less than once per week, whereas among those with automobiles, only 7.5 percent shopped less

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than once per week. The distribution of shopping trip frequencies was concentrated around once per week more for car-owning households than for non-car-owning households. This seems reasonable because the car was predominantly used for work trips and was available for shopping trips on the day off from work or on Saturdays.

This research has shown that detailed information on the travel patterns and access of inner-city residents who do not have automobiles is important for 2 reasons: Travel characteristics can change singificantly in a period of several years, as can job locations and access times via bus and car; and there are important differences in the travel characteristics and willingness to travel of certain groups without automobiles.

REFERENCES

1. Notess, C. B., and Paaswell, R. E. The Mobility of Inner City Residents. Civil Eng. Dept., State University of New York at Buffalo, Prel. Rept., July 1969, and Final Rept., Dec. 1970.
2. Pignataro, L. D., Falcocchio, J. C., and Roess, R. P. Selected Bus Demonstrastration Projects. Transportation Eng. Jour., Proc. ASCE, Vol. 96, No. TE3, Aug. 1970, pp. 251-268.

PEDESTRIAN NEEDS: INSIGHTS FROM A PILOT SURVEY OF BLIND AND DEAF INDIVIDUALS

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ABRIDGMENT

•THIS exploratory study focuses on discovering outdoor pedestrian needs within the total transportation system. Specific consideration is given to special pedestrians—blind and deaf individuals—with the assumption that those persons would be more sensitive to general pedestrian needs because of their particular disability-associated mobility problems. Approximately 8,500,000 Americans sustain serious visual impairments, and about 20,000,000 Americans support substantial hearing difficulties.

Based essentially on 70 interviews and self-administered questionnaires, collected in the Washington, D. C., area, this investigation is primarily a case study rather than a statistical analysis of pedestrian needs. The blind totaled 10 subjects (6 males, 4 females); and the deaf included 60 subjects (45 males, 15 females). The subjects' ages ranged from 18 to 62 years. The entire sample lived within a metropolitan area; most of the subjects resided in the suburbs, although a few lived within the central city limits. The subjects were well educated, all having college experience.

Walking was evaluated as a pleasant activity by all groups; they emphasized the desire to do more walking to additional destinations if pedestrian conditions were improved. The most important walking trip of the blind was made daily to and from work. Those who lived in the central city indicated that shopping trips rated second in importance to work trips. Suburban dwellers, on the other hand, walked for recreation more frequently than for shopping because of inadequate pedestrian facilities to shopping malls. The deaf sample walked less than the blind groups because of their driving ability and, hence, they were less dependent on central-city living to maintain their independence.

The blind group generally voiced concern for expanding the physical design features of streets and pavements. Major recommendations included construction of more and wider pavements and crosswalks; greater segregation of pedestrian facilities as overpasses and underpasses; textured pavements; angular, instead of rounded corners (better for directional orientation); and braille maps at strategic points in the pedestrian way.

The deaf sample specified the visual dimension: better, clearer signs at more appropriate site locations. They also strongly supported installation of audible crossing signals at various frequencies; better and more lighting facilities on pedestrian routes; and support structures such as handrails at vital locations, for example, in queuing for and boarding a bus or on traffic circles.

Although the sample represents a limited number of individuals, we are able, nevertheless, to note definite patterns. The blind and deaf individuals showed sensitivity to various pedestrian issues that might have been neglected or totally unrealized. This analysis indicates the need for more in-depth pedestrian examination. The pedestrian mode needs to be interrelated with the other transportation modes within the transportation planning process. In this manner, optimal solutions for pedestrian difficulties would be more readily forthcoming.

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