

SERVING THE TRANSPORTATION DISADVANTAGED WITH DEMAND-RESPONSIVE TRANSPORTATION

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The first section of this paper assesses the nature of the transportation problems of poor, elderly, and handicapped people. It is shown that demand-responsive transportation systems such as dial-a-ride are demonstrably superior to conventional transit in providing for the transportation needs of transportation-disadvantaged people. The impact of various demonstration projects of demand-responsive transportation is reviewed. Emphasis is on the effect these projects had on serving elderly, poor, and handicapped people. The final section of the paper reports on the role of the federal government in providing demand-responsive transportation to facilitate more mobility among poor, elderly, and handicapped people.

• PROVIDING transportation services for elderly, handicapped, and poor persons recently has come to the fore and demanded the attention of all levels of government. Especially at the federal level, the issue of transportation for elderly and handicapped persons has been highlighted by legislation, litigation, and rule making that promises to have far-reaching effects on public transit.

In a paper prepared in early 1974, we presented a case that favored demand-responsive transportation for disadvantaged people (1). This paper updates our original concepts. Recent results of demonstration programs have been added, and recent legislation is highlighted. The basic premise that demand-responsive transportation can alleviate many of the transportation problems of those who are transportation disadvantaged, however, remains the same.

This transportation-disadvantaged group is by no means small. Various estimates indicate that, in the United States, between 70 million (2) and 100 million (3) persons fall into the overlapping groups of elderly, poor, and disadvantaged people. In an automobile-oriented society, remembering the needs of those who do not have access to an automobile is especially important.

Adequate public transportation would seem to be the solution for these persons. But many things indicate that current transit systems are far from being adequate. Both rail rapid transit lines and fixed-route bus operations offer a solution to some transportation demands, but the services they offer are not sufficient to serve all the needs of those with mobility problems. Barriers to the use of conventional mass transit are physical and operational. For example, a high step on a bus is a physical barrier for a handicapped person; insufficient route coverage causing long walks to bus stops is an operational barrier for an elderly person. In addition to these physical and operational barriers are psychological barriers, such as fear of assault, which can affect any potential rider. An economic barrier to a poor person is the standard transit fare.

Perhaps the overriding barrier in conventional public transportation is that it does not take people where they want to go. Transit is still radially oriented and usually does not offer good service unless the destination or origin of travel is the central business district. And conventional transit cannot provide door-to-door service.

Thus conventional transit is not responsive to the demands of the traveling public. However, some paratransit modes, including taxicabs, jitneys, car pools, subscription buses, and dial-a-ride, are more demand responsive than conventional transit is. In recent years, the dial-a-ride system has been the subject of substantial research and demonstration projects in various cities (4). Dial-a-ride is a hybrid bus service that combines the door-to-door service of the taxicab and fares that are close to those of conventional buses because several passengers share a minibus. To use it, a customer telephones the central dispatcher and tells the dispatcher the point of origin, destination, and number of passengers. The dispatcher assigns a vehicle either manually or with computer help to handle the request and tells the customer how long the wait will be. By radio, the dispatcher tells the driver of the assigned vehicle to make the pickup.

The door-to-door, on-demand service that is provided by dial-a-ride is one of the most promising innovations in public transportation. In providing for the special needs of poor, elderly, and handicapped people, dial-a-ride has some characteristics that are superior to those of conventional transit. However, dial-a-ride should not be thought of as a panacea for all transportation problems. It is merely one way of alleviating transportation problems, and it has its limitations.

The purpose of this paper is to explore the role that demand-responsive transportation, particularly dial-a-ride, can play in serving the needs of poor, elderly, and handicapped people. The travel characteristics and needs of these groups will be analyzed. It will be shown that demand-responsive transportation can increase their mobility significantly. The role of various federal agencies in funding research and demonstration projects of demand-responsive transportation also will be explored.

TRAVEL NEEDS

Transportation-disadvantaged people usually are defined as those who have no access to an automobile. Although this is a useful statement for general purposes, a more precise and analytical definition is necessary to consider this group's travel needs and proposed solutions to their problems.

Data on trip frequency per person will be the prime determinant for describing degree of disadvantage. A transportation-disadvantaged person is defined as one who takes fewer trips per person per day than one who is not disadvantaged. This procedure is a modification of a procedure used by researchers in a more detailed study (5)

Identifying a transportation system that will alleviate some of the significant problems of poor, elderly, and handicapped people is difficult. Although this paper does not attempt to present a panacea for the transportation ills of transportation-disadvantaged people, it does attempt to understand the major differences in conventional modes of dial-a-ride systems as a vehicle for addressing some of the critical needs of poor, elderly, and handicapped people. Therefore, to fully understand these major differences, one must focus on the major travel problems and features of each of the prime groups identified as being transportation disadvantaged.

Poor People

Poor people are one of the most readily identifiable groups of transportation-disadvantaged people. They are, because of insufficient income, unable to conveniently fulfill their travel needs and desires. Low incomes result in low trip-making rates as indicated by the data given in Table 1. The household trip rates for those with annual incomes of more than \$4,000 are much higher than for those with lower incomes. Many trips desired by poor people are not being made. Of course, the intervening variable between incomes and trip rates is automobile ownership. Data from 1971 show that, although only 20 percent of all U.S. households were without an automobile, 46 percent of households with less than \$3,000 annual earnings did not own an automobile (6). Furthermore, because many of the automobiles owned by the poor are old and not

in good operating condition, the mere availability of an automobile does not necessarily guarantee mobility.

If income is held constant, members of carless households seem to take about 1 trip less per person per day than did people from 1-car households. The difference in the total number of trips is much greater, however, between carless and 1-car households than between 1- and 2-car households (5).

The location of carless individuals also has a considerable effect on available transportation alternatives and, therefore, on trip-making rates. In the larger cities where public transportation is more readily available, the trip frequency gap between individuals with and without automobiles is reduced. In these cities, transit is used for a much larger percentage of trips taken by carless individuals. This is quite different from that which occurs in sparsely populated areas. In smaller cities, ride sharing and car borrowing by carless households exist to a much greater degree than in larger cities (7). These informal methods, however, do not allow poor residents of smaller cities the mobility afforded by the better transit systems of the larger cities.

Inner-City Poor People and Nonwhites

Special transportation problems are associated with poor people and nonwhites, including blacks, Puerto Ricans, Chicanos, Orientals, and American Indians, who live in the inner cities of major metropolitan areas.

The lack of adequate areawide coverage by many inner-city public transit systems has been, in part, responsible for the lack of accessibility to jobs and critical services. The decentralization of jobs and services as a result of suburban growth has not been followed by the development of a convenient transit system that inner-city residents can use to reach desired work and nonwork destinations (8).

The relationship between race and transportation is an important issue because, even when income is held constant, minority group members across the nation take from 0.4 to 0.9 less nonwork trip per person per day than do whites (5). Nonwhites are most disadvantaged compared with whites in their trip rates to social and recreational activities and in their trip rates to shop.

Mode choice data also are revealing. In a comparison of the percentage of public transportation used by inner-city whites and inner-city nonwhites, it was found that nonwhites were more dependent on public transportation than whites were. This relationship was true within each income group of inner-city residents.

Many of the trips made by nonwhites and poor people are walking trips partly because of the densities of the neighborhoods in which many of them live. This larger number of walking trips, however, does not change the fact that poor people and nonwhites make considerably fewer trips than higher income persons make (5).

Elderly People

One group of the transportation disadvantaged that has received considerable attention from researchers in recent years has been elderly people.

Elderly people make up a significant portion of the U.S. population and will continue to increase as a proportion of total population. In 1970, 20 million Americans were over age 65, and about 65 percent of these lived in urban or suburban areas. It is estimated that there will be 28 million elderly people by the year 2000 (9).

Two major factors are associated with the transportation problems of elderly people. The first is that many have limited incomes and are not able to pay for automobile or taxicab expenses. The second relates to the physical condition of elderly people as an obstacle to operating an automobile and to riding conventional transit systems. Auditory and visual problems of many senior citizens considerably reduce their ability to safely operate an automobile. Elderly people are inhibited by a number of problems in using conventional public transportation. Design problems such as high entrance steps, overhead grips, and fast-acting doors act to their disadvantage. In addition,

other problems occur when too many transfers are required, and long waits are necessary at stops. An elderly person who is subjected to these discomforts and inconveniences is discouraged from using public transportation.

Some of the effects of not being able to afford an automobile and the barriers to using public transit are evident in the data given in Table 2. The average number of trips per person per day by income, age, and trip purpose is given. Because of the factors we have mentioned, the trip-making rate for elderly people is considerably lower than that for nonelderly people within each income group.

The effect of income on trip-making rates for elderly people also is given in Table 2. As income increases, elderly people take more trips for both work and nonwork purposes.

Mode choice data indicate that, although elderly people are described as captive riders, they do not use transit for a large number of their trips. In fact, they tend to use transit for a smaller proportion of their total trips than do nonelderly people, according to nationwide data on elderly people within standard metropolitan statistical areas (5).

No description of the transportation characteristics of elderly people would be complete without some mention of the importance of transportation solely as an activity. Revis stated: "Transportation for the elderly needs to be provided not purely for getting from 'here to there' but also as an 'antidote' for the entire process of aging" (10).

Handicapped People

The major transportation problem of handicapped people lies in their inability to find a convenient mode of transportation that does not cause them serious discomforts. The U.S. Department of Transportation has calculated the total number of handicapped people who cannot use transit or who use transit with difficulty. A list of the dysfunctions of the transportation handicapped is given in Table 3. The first interesting fact that is apparent from this table is that 53 percent of handicapped people are elderly. As we indicated in the previous section, the problems of elderly people in driving and riding on conventional modes of transportation are, to a large extent, associated with the physical impairment of persons 65 years of age and over. Their difficulties in getting to the bus stop, boarding high entrance steps, safely riding buses, and getting to their destinations mean that handicapped people ride public transit only when absolutely necessary (9). Their attempts to use inadequate public transit result in both physical endangerment and psychological frustrations.

Travel patterns, because of some of the previously mentioned impediments, show a large gap between the trip frequencies of handicapped and nonhandicapped people. Data from a study in Boston showed that handicapped people took 1.13 trips per day; the general population averaged 2.23 trips per day (11).

Finally, a look at the modal split of handicapped people shows that a significant number of trips by handicapped people are taken by taxicab. Handicapped people, for example, take 14 percent of their trips by taxicab; nonhandicapped people take 2 percent of their trips by taxicab. Although the handicapped are generally less able to afford taxicab fares, they need the door-to-door taxicab service (12).

INDICATION OF DIAL-A-RIDE POTENTIAL

We have pointed out the characteristics and travel needs of poor, elderly, and handicapped people. We shall now link these needs and ways of fulfilling them. Both research studies and empirical data from a number of sources have indicated that demand-responsive transportation can accommodate many needs of transportation-disadvantaged people.

Table 1. Travel data by household income (11).

Annual Household Income (dollars)	Trip Rate per Household	Vehicle Miles per Household	Average Trip Length (miles)
<4,000	580	4,708	8.1
4,000 to 9,999	1,433	12,262	8.6
10,000 to 14,999	1,949	17,497	9.0
>15,000	2,526	24,410	9.7

Note: 1 mile = 1.6 km.

Table 2. Average number of trips per person per day for standard metropolitan statistical area residents (12).

Trip Purpose	Poverty Income Level (\$0 to \$4,000)		Low Income Level (\$4,000 to \$6,000)		Middle Income Level (\$6,000 to \$10,000)		High Income Level (\$10,000 and higher)	
	Elderly	Nonelderly	Elderly	Nonelderly	Elderly	Nonelderly	Elderly	Nonelderly
Work	0.11	0.38	0.19	0.48	0.39	0.56	0.37	0.59
Shopping	0.29	0.24	0.27	0.28	0.24	0.42	0.27	0.44
Social and recreational	0.38	0.46	0.41	0.42	0.49	0.72	0.29	0.74
Personal business	0.10	0.22	0.24	0.31	0.24	0.41	0.20	0.41
Other	0.62	0.77	0.52	0.76	1.07	0.63	0.69	0.67
Total nonwork trips	1.39	1.69	1.44	1.77	2.04	2.18	1.45	2.26
Total trips	1.50	2.07	1.63	2.25	2.43	2.74	1.82	2.85

Note: Sample size was 5,187 persons.

Table 3. 1970 estimates of handicapped people with transportation dysfunctions (13).

Class	Elderly People	Nonelderly People	Total
Noninstitutionalized persons with chronic conditions			
Visual impairment	1,460,000	510,000	1,970,000
Deafness	140,000	190,000	330,000
Wheelchair use	230,000	200,000	430,000
Walker use	350,000	60,000	410,000
Other special aid use	2,290,000	3,180,000	5,470,000
Other mobility limitations	1,540,000	1,770,000	3,310,000
Noninstitutionalized persons with acute conditions			
	90,000	400,000	490,000
Institutionalized persons			
	930,000	30,000	960,000
Total	7,030,000	6,340,000	13,370,000

Research Studies

Research studies are being made of the transportation characteristics preferred by the elderly, handicapped, and low-income groups. One survey of more than 1,603 households revealed strong preference among the elderly for the service attributes of a dial-a-ride system (14). This survey also showed that dial-a-ride systems meet some of the important service attributes preferred by low-income respondents.

A 1974 assessment of transportation alternatives for elderly and handicapped persons in Eugene, Oregon, also concluded that a dial-a-ride system would best suit their travel needs (15). The researchers tried to evaluate the potential effect of both modifications to vehicles of the fixed-route system and introduction of a new dial-a-ride system. They concluded that, although 14.5 percent were capable of using the existing system, the addition of lifts to vehicles of this fixed-route system would allow an additional 7.2 percent of elderly and physically limited people to have access. However, a demand-responsive, door-to-door system consisting of specially equipped small vehicles could be used by 78.3 percent of the respondents.

The taxicab offers service that is close to the dial-a-ride system. It is, therefore, relevant that use of taxicabs in low-income neighborhoods is relatively high (16). Even though taxicab rates are high, they are used because of their door-to-door, on-demand service. For those without automobiles, a taxicab ride may be expensive compared to a conventional transit alternative. However, when taxicabs are used selectively (only when door-to-door convenience is required for heavy packages, weather protection, and emergency trips) the total yearly transportation costs are much lower than those incurred by automobile owners.

Taxicabs were found to be especially important to elderly people in many medium-sized communities under 100,000 in population where other public transportation systems do not exist (10). In larger cities where other public transit alternatives exist, the literature also indicates a trend of frequent taxicab use by both elderly and handicapped people (13).

Empirical Evidence

The best test of a system is one that is not theoretical or simulated, but rather one that occurs under actual operating conditions. Over 70 demand-responsive systems have been demonstrated over the past few years in the United States and Canada (17). They have provided a variety of services in a variety of circumstances and have been sponsored by varying combinations of federal, state, and local governments with significant input from private industry.

ROLE OF FEDERAL GOVERNMENT

Poor People

The first use of federal funds for demand-responsive transportation occurred in the middle 1960s when the U.S. Department of Housing and Urban Development initiated a series of demonstration projects that were aimed at solving some of the transportation problems of poor people (7). These projects were in response to the national prominence that had come to the issue of the immobility of the poor after the 1965 racial riots in Watts in Los Angeles. Inadequate transportation to employment centers had been identified by the McCone Commission as a factor leading to high unemployment rates in Watts (18).

In response to these conditions, federally supported demonstration projects were launched in riot-prone major metropolitan areas. Buses would provide daily door-to-door service from workers' homes to outlying suburban jobs. These services had a number of demand-responsive characteristics. Routes usually were changed daily or

weekly to accommodate new clients. Pickups were made at or close to the clients' doors and provided direct access to their place of employment. Some of these projects improved employment access enormously and more than justified the large initial investment in the operation by the consequent increase in lifetime earnings of new job holders. Others suffered from waning ridership and were not continued beyond the demonstration phase.

Poor people have been the focus of a number of other federally funded demand-responsive transportation services primarily planned for non-work-related trips. Model Cities agencies in Columbus, Ohio; Detroit and Grand Rapids, Michigan; and Buffalo, New York, have experimented with dial-a-ride services that allow residents better access to health and social service agencies (8). In Grand Rapids, Michigan, for example, a special supplement to the fixed-route system is providing increased mobility to the poor and elderly. A demonstration grant to the Grand Rapids Transit Authority from the Urban Mass Transportation Administration (UMTA) has provided for a demand-responsive transportation system within the Model Cities neighborhood. Five small buses provide services to or from anywhere in the city as long as one end of the trip is in the Model Cities neighborhood (2).

The Office of Economic Opportunity (OEO) was a prime mover behind efforts to provide demand-responsive transportation to those in rural areas. Public transportation prototype systems have been started in rural areas with demonstration grants from OEO. In their efforts to help people out of the poverty cycle, local OEO-funded Community Action Agencies consistently had identified transportation as a major problem area. In response to these needs more than 50 rural transportation projects had been funded by OEO by 1972 (19). The dispersed nature of the trips and lack of high population densities have dictated that few of these systems have conventional fixed routes or schedules. They are primarily social service delivery systems that provide door-to-door service for agency clients.

Transportation programs funded by both Model Cities and OEO will face a drastic reduction in resources when these federal programs are terminated. They will cease providing services unless funds are found to cover operating expenses.

Elderly and Handicapped People

The Urban Mass Transportation Administration and the Administration on Aging (AOA) are the 2 federal agencies that have been active in developing demand-responsive transportation that services elderly and handicapped people.

Urban Mass Transportation Administration

The Urban Mass Transportation Administration has the congressional mandate to ensure that elderly and handicapped persons are provided accessibility to mass transit. A series of legislative enactments have indicated the intent of the Congress. The Urban Mass Transportation Act of 1964, the Urban Mass Transportation Assistance Act of 1970, and the National Mass Transportation Assistance Act of 1974 have emphasized the need to provide for the mobility of elderly and handicapped persons.

UMTA has funded a number of demonstrations that have included demand-responsive transportation for elderly and handicapped people. Under its service development program, UMTA is experimenting with innovative transportation services for those with mobility constraints.

A project in the Lower Naugatuck Valley of Connecticut has a demand-responsive component that is providing transportation services to clients of health and social service agencies (20). Telephone requests for the door-to-door demand service are made in advance and are serviced by 6 vehicles, 5 of which were modified to meet the special needs of elderly and handicapped people. The Valley Transit District also offers to the local agencies other specialized transportation services including charters. The project also features a new concept in automated fare collection. It uses credit

cards instead of cash and allows agencies to pay all or part of a client's trip through the feature "fairshare." Demand for the service has grown to the point that the system is saturated and the operators have moved to expand the system by more than doubling the size of the fleet.

Financial support of the project also has been received from AOA. These additional funds have been used to help the agencies pay for client transportation. UMTA and AOA officials are hopeful that the consolidation of social and health service agency transportation needs and the flexible service developed in this demonstration will be a model for serving the transportation needs of many small- to medium-sized communities (2).

Another UMTA project started in 1973 in St. Petersburg, Florida, is called TOTE which stands for transportation of the elderly. Handicapped and aged persons receive door-to-door service within a 10-mile² (26.9-km²) area that contains the central business district and where a large majority of the citizens are senior citizens. Riders call 24 h in advance of the intended trip for a 35-cent trip. They also may request a higher priced, same-day demand-responsive service that is available on a limited basis.

Ridership on the TOTE system has increased steadily. Public acceptance and use of the service were slower than anticipated by the sponsors, but those who did use the service were pleased with it and many of them became steady riders (21).

In addition to these and other projects of the service development program, other UMTA-funded projects provide demand-responsive transportation services. However, the only major demonstration of the dial-a-ride concept, which was conducted in Had-donfield, New Jersey, was halted in early 1975 for lack of funds. This system was not designed specifically for elderly and handicapped people, but it did have a significant effect on their mobility. Elderly and handicapped persons, as well as housewives and young people, found that the new service decreased their dependence on friends or the family car. One specially equipped bus accommodated wheelchair passengers and others with handicaps that prevented them from using conventional transit vehicles.

Administration on Aging

The Administration on Aging of the U.S. Department of Health, Education and Welfare was authorized to conduct transportation research and demonstration programs under Titles 3 and 7 of the Older Americans Act.

One of the first pilot projects funded by AOA was the YMCA Senior Citizens Mobile Service, which was funded from September 1966 through November 1969. Two 7-passenger vans provided door-to-door service to participating elderly people on request. Service to health centers, welfare agencies, supermarkets, senior centers, and libraries was provided to senior citizens who called in their requests for transportation 1 day in advance. The project showed that isolated persons living in a large city would use a free demand-responsive service to get where they wanted to go (22).

This was just 1 of some 920 projects involving the provision of transportation for elderly people that was enumerated by a research project being conducted for the AOA (10). All of this activity is being conducted at local and state government levels, and a majority of the projects are receiving funds under Titles 3 and 7 of the Older Americans Act and Title 6 of the Social Security Act.

An enumeration of these services strongly supports the idea that demand-responsive transportation is superior to fixed-route systems. Of the 314 projects that reported on type of service, some form of demand-responsive service accounted for 36 percent; fixed-route service accounted for 18 percent; combination of fixed-route and demand-responsive systems accounted for 28 percent; volunteer systems accounted for 15 percent; and taxicabs at reduced fares accounted for 4 percent (10).

Two hundred and fifty-five projects were involved in routing vehicles. Of these, only 55, or 22 percent, did not have a demand-responsive component. Clearly, local agencies are recognizing the benefits of demand-responsive transportation for elderly people.

CONCLUSION

What was predicted in theory and suggested by systems with similar characteristics has been verified, at least partially, by existing demonstrations. Dial-a-ride substantially improves the mobility of transportation-disadvantaged people. This paper has presented an assessment of the travel needs of poor, elderly, and handicapped people and has shown that many of these needs can be met by demand-responsive transportation. The system characteristics of the dial-a-ride system compared favorably with the user preferences of mobility-limited individuals. The role of the federal government in supporting demand-responsive transportation was traced. Although various federal agencies already have made substantial inputs, continued and increased support of demand-responsive transportation for transportation-disadvantaged people is needed.

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