

be offered, and the city would control service coverage and fare levels through the redemption value of the tickets.

CONCLUSIONS

Transportation programs for the elderly and the handicapped that earmark funds by the type of transportation expenditure (capital versus operating) or by provider type (profit versus nonprofit) impede the efficient provision of transportation service. Turf-protection attitudes on the part of administrative agencies also create impediments to efficiency. In addition, the disbursement of funds exclusively through provider-side subsidy techniques tends to deny many qualified providers the opportunity to participate in publicly funded transportation programs, thereby reducing competition and removing some of the incentives for the participating providers to operate efficiently.

Relaxation of earmarking requirements for transportation programs will in most cases require legislative action, but turf-protection attitudes and disbursement procedures can often be changed through administrative action. Procedures should be introduced to encourage or mandate greater cooperation between agencies administering transportation programs. User-side subsidy techniques should be considered as a means of maintaining competition between service providers and rewarding efficient operation.

Experience with user-side subsidies for public transportation is rather limited although recently funded demonstration projects will provide new empirical information over the next 2 years. Existing applications of user-side subsidies have demonstrated the administrative feasibility of this approach under a number of different institutional arrangements. Although a comprehensive evaluation of service levels and costs associated with the approach is not yet available, the evidence suggests that user-side subsidies deserve serious consideration by agencies administering transportation programs for the elderly and the handicapped.

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REFERENCES

1. Coordinating Transportation for the Elderly and Handicapped. Institute of Public Administration, U.S. Department of Transportation, 1976.
2. A. E. Kidder, L. Sen, G. Amedee, and D. McKelvey. Cost of Alternative Systems to Serve Elderly and Handicapped in Small Urban Areas. Proc., Transportation Research Forum, Vol. 17, No. 1, 1976.
3. R. F. Kirby. Paratransit: A State-of-the-Art Overview. TRB, Special Rept. 164, 1975, pp. 37-44.
4. R. F. Kirby and R. G. McGillivray. Alternative Subsidy Techniques for Urban Public Transportation. TRB, Transportation Research Record 589, 1976, pp. 25-29.
5. G. Nelson. FAIRTRAN: Operation of a Credit-Card Transit Fare System. TRB, Transportation Research Record 590, 1976, pp. 27-30.
6. W. B. Tye. The Capital Grant as a Subsidy Device: The Case Study of Urban Mass Transportation. In *The Economics of Federal Subsidy Programs*, Part 6—Transportation Subsidies, U.S. Congress Joint Economic Committee, U.S. Government Printing Office, Feb. 26, 1973.
7. Transportation Authorities in Federal Human Services Programs. Office of the Regional Director, U.S. Department of Health, Education and Welfare, Atlanta, 1976.
8. Urban Mass Transportation Act of 1964 and Related Laws. U.S. Department of Transportation, 1975.
9. Transportation for Elderly and Handicapped Persons Federal Register, Vol. 41, No. 85, April 30, 1976.
10. Private Taxi Firm to Provide UMTA-Funded Service. Urban Mass Transportation Administration, News Release, Nov. 5, 1976.
11. Department of Transportation and Related Agencies Appropriations for 1977. Committee on Appropriations, U.S. House of Representatives, U.S. Government Printing Office, 1976.

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Transportation for the Elderly and the Handicapped: The San Diego Study

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The purpose of a recent transportation study in the San Diego region was to estimate the needs of elderly and handicapped citizens and to develop a comprehensive program and policy package to meet those needs. Both

the methodology and the recommendations of the study may be applicable elsewhere. Because of the varying financial, operational, and management structures associated with different types of transportation service,

demand estimates were built around five categories of transportation service. This classification system directly related limitations on the mobility of different groups of handicapped persons to the types of transportation service required by those limitations. Statistical surveys were avoided. Demand for each type of service was estimated from available statistics, from other studies, and from extensive interviews with social service agencies. The study found that there was heavy demand for services other than conventional, fixed-route bus transit. Because this implied that cost was a major issue, emphasis in program and policy design was placed on the development of cost options. Operational and institutional aspects of the service were also considered.

A study of transportation services for the elderly and the handicapped in the San Diego region was undertaken for the San Diego County Comprehensive Planning Organization (CPO) between late September 1975 and early 1976. The purpose of this study was to assess the transportation needs of the elderly and handicapped population of the region and to identify and evaluate methods for meeting those needs. A program of transportation service, management, and financing was developed to respond to the needs determined by the study, and key policy issues for action by local and regional governments were identified.

The study was conducted with the assistance of an ad hoc advisory committee established by CPO for purposes of guidance and review. The committee, headed by the mayor of San Diego, included leaders of social service and transportation organizations that provide services to the handicapped and the elderly as well as representatives of the handicapped and elderly themselves.

The study was conducted during a time of nationwide concern for the plight of the elderly and the handicapped. Then as now, however, there was uncertainty as to what policies and guidelines were most appropriate for serving the needs of these groups. Federal law then required that regions of the country that were to receive federal transportation funds have plans for providing "equal access" to the elderly and the handicapped by October 1976. But the probable costs and the operating consequences of providing equal access were not known. There were, for example, serious engineering obstacles to the design and manufacture of equipment by which persons confined to wheelchairs could be provided equal access to transit vehicles. It was partly for these reasons that, shortly after the completion of the study, UMTA published its April 30, 1976, guidelines giving local jurisdictions freedom to use approaches other than full equal access to conventional transit. Controversy continues with regard to the use of full-access or separate-service approaches in supplying transportation for disadvantaged groups.

Several planned or probable actions in the San Diego region added to the uncertainty. A regional transportation development board was being created, and the future roles of this body and of the CPO were uncertain. In addition, the CPO was planning a study of rural transportation; the San Diego Transit Corporation was studying the feasibility of fixed-route buses with lifts and a possible takeover of the city's dial-a-ride system; and the County Office of Senior Citizens Affairs continued to work on its regional plan, which included a transportation element.

Because of this fluid situation, the approach used in this study was to form a framework into which new developments could be incorporated over time. This framework consisted of (a) easily understood methods for estimating demand and determining what services were needed, (b) identification of key policy decisions that would need to be made in order to proceed further, and (c) formulation of short- and long-term recommendations for improved services based on stated policy assumptions.

STUDY DESIGN

The study was divided into two phases: the estimation and description of transportation demand and the planning of services to respond to that demand.

Demand Estimation

Demand was defined as the total current need minus the service provided by existing transportation systems. This relatively simple concept was easily understood by all the nontechnical participants on the ad hoc advisory committee for the project.

Techniques used to identify transportation demand were chosen to provide a quick, relatively inexpensive, acceptably accurate picture of needed services. Travel behavior and the needs of the handicapped were found to be adequately documented for the purposes of the study by previous investigations in the San Diego region and by studies done in other areas. Use of a statistical survey of elderly and handicapped persons was rejected as both costly and unnecessary. It was felt that a survey of reasonable size and cost would not have yielded results that would be much more useful than existing data, and a survey large enough to provide statistically reliable estimates of such details as trip patterns by user type would have been too slow and expensive. Both survey approaches would have suffered from the fact that many respondents are unable to estimate accurately, in advance, their use of some hypothetical service. Both would also have consumed study time and funding that could be used for purposes such as in-depth field research, the involvement of representatives of the affected groups, and inventories of existing services. A small sample of elderly and handicapped persons was interviewed to check the results found in other studies, and these results were combined to estimate travel needs for each class of transportation service.

The study also determined what services for the elderly and the handicapped currently exist and how much they are being used. Interviews were conducted with representatives of nearly 70 social service agencies and charitable groups, which were drawn from a much larger list of such groups assembled from various inventories. Those interviewed were chosen to represent different kinds of services, such as home care, nursing homes, specific kinds of health care, education, general financial aid, and recreation.

Service Planning

The study's estimation of transportation demand indicated that a three-part approach providing improved transportation for the elderly and the handicapped was needed: coordination of the operations of social service agencies, acquisition of fixed-route transit coaches equipped with special features, and formation of a program of door-to-door, shared-ride service. The role of each of these services was described, and options for financing and operations were presented.

FINDINGS OF THE DEMAND STUDY

Eligibility and Classes of Service

Central to the process of demand estimation were the definition of who was to be eligible for service and a set of service categories that would be tied to distinct types of demand. The elderly were defined as including all those 60 years of age and older (the policy of local San Diego transit operators). The term handicapped was

broadly defined in accordance with the final regulations on transportation for elderly and handicapped persons issued by the Urban Mass Transportation Administration in April 1976:

... individuals who by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability including those who are non-ambulatory wheelchair-bound and those with semi-ambulatory capabilities, are unable without special facilities or special planning or design to use mass transportation facilities and services as effectively as persons who are not so affected.

Throughout the study, persons who were both elderly and handicapped were included in estimates of the elderly to conform with statistical presentations in many of the references used. The term younger handicapped is used in this paper to identify all those under 60 years of age.

More important than these general definitions were the transportation service classes (TSCs) given below, which were devised to link demand to types of service:

Class	Service
1	Ambulance
2	Door-to-door service with lift
3	Door-to-door service without lift
4	Fixed-route transit with special features
5	Conventional fixed-route transit

The TSCs can be briefly defined as follows:

1. Class 1 represents services for individuals who are bedridden or confined indoors. These persons were considered to be outside the scope of service that can logically be offered by mass transportation and were not treated in detail in this study.

2. Class 2 represents services for those who cannot make self-propelled level changes—for the most part, those in wheelchairs who require some form of lift or elevator to get on and off mass transit. An option within this class is fixed-route buses with lifts providing door-step delivery.

3. Class 3 represents services for persons who can make self-propelled level changes but are so severely handicapped that door-to-door service with driver-attendants who have at least minimal training in assisting the handicapped is needed.

4. Class 4 represents services for many blind, deaf, and other moderately disabled persons who are ambulatory and can wait for, board, alight from, and otherwise manage travel on buses and trains but who need special system and vehicle features that ease the burden of physical movement (such as additional grab rails and lighted stairwells).

5. Class 5 represents services for all persons, whether elderly or handicapped or not, who have insignificant mobility problems or none at all.

Population and Travel Behavior

The size and the geographical distribution of the elderly and handicapped population of the San Diego region were estimated from the 1970 and 1975 U.S. Censuses and statistics of the California state departments of rehabilitation (for recipients of rehabilitation services) and education (for handicapped children). The travel behavior of the elderly and the handicapped was estimated from a variety of available local studies, information from other cities, and interviews with social service groups and transportation operators. Local studies included a 1966 origin-destination survey, a 1974 survey of bus riders, and specific 1973 and 1975 needs studies. Other informa-

tion included studies in other cities (5, 8) and more broadly based research (1, 2, 4, 7, 9, 10, 11, 12, 13). Estimates of mode of travel and the frequency, purpose, time, and length of trips were taken from these sources. Finally, population estimates for the elderly and the handicapped were distributed among the five transportation service classes by comparing and combining the fragmentary information of these different sources. The results are given below:

Service Class	Elderly		Younger Handicapped	
	Number	Percent	Number	Percent
1	8 150	4	5 600	8
2	2 000	1	3 500	5
3	50 950	25	15 400	22
4	71 350	35	21 000	30
5	71 350	35	24 500	35
Total	203 800	100	70 000	100

Existing Transportation Services

The next step in the process of demand estimation—an inventory of existing transportation sources available to the elderly and the handicapped and an estimation of their use by those groups—served three purposes:

1. To identify transportation sources that might be used more intensively;
2. To locate geographic areas in which the elderly and the handicapped were not being served; and
3. To estimate ridership by the elderly and the handicapped as an element in the calculation of transportation needs that were not being met.

The inventory was compiled from published operating data for public transit and taxi services, interviews with operators and social service agencies, and two less complete 1975 surveys on the topic by the San Diego CPO and the California Department of Transportation. The completed inventory included buses operated by schools, charter companies, and public transit agencies; taxis; volunteer automobiles; vehicles with wheelchair lifts; vans operated by a variety of agencies and groups; and the three limited dial-a-ride systems of local cities. The data were organized by TSCs for compatibility with the study's overall approach.

Vehicles available in the region to serve the elderly and the handicapped and estimated daily ridership among these groups are given below:

Service Class	Service	Vehicles	Daily One-Way Trips Served
2	Door-to-door with lift	15	100
3	Dial-a-ride systems and agencies	>236	2 200
	Taxis	508	1 500
4	Fixed-route with special features	0	0
5	Conventional fixed-route		21 200
	Fixed-route fleets	406	
	Public school buses and charter buses	755	
Total		>1920	25 000

In the study's inventory of vehicles in the region that could conceivably transport elderly and handicapped persons, approximately 2000 such vehicles were found. School and conventional transit buses accounted for most of the available vehicles. Although the region's large taxicab fleet provided most of the available door-to-door service, relatively high fares discouraged their use by many of the elderly and the handicapped.

Three cities in the region operated dial-a-ride services within their borders, each according to different eligibility criteria and operating methods. All of these services were limited in size and range, but all provided at least some service to persons who had no other means of travel. Two of these systems used taxis; the third—that of San Diego—operated small buses that included some with wheelchair lifts.

Ridership estimates given in the table above indicated heavy use among the elderly and the handicapped of conventional fixed-route transit buses and relatively little use of vehicles operated by social service agencies. Interviews with agency representatives revealed that there was little interagency coordination of these transportation activities. Vehicle occupancy rates were generally low and many vehicles were not in continuous operation throughout the day. In addition, some agencies without adequate transportation had no way of making use of other agencies' services.

Unmet Travel Needs

Unmet travel needs were calculated by multiplying the number of eligible persons in each TSC by a target daily trip rate and then deducting present ridership by TSC on existing transportation services. This procedure required making a number of assumptions. To avoid over-estimation of demand, a generally conservative approach was taken in defining such assumptions. In addition, the sensitivity of the demand estimates to alternative assumptions was determined; this produced no change in the key conclusions. The major assumptions made were that

1. Both automobile drivers and their passengers need no additional transportation,
2. Automobile drivers occur in the same proportion to the totals in classes 4 and 5 and in no other classes, and
3. Automobile passengers and persons without access to automobile travel occur in the same proportion to the totals in all five classes.

A key factor in the assessment of unmet travel needs was the selection of desired daily trip-making rates as targets. Based on other studies of reported demand (1, 2, 9), rates of 1.1 trips/person/d for the elderly and 1.4 trips/person/d for the handicapped were adopted. These rates contrast with typical values for the general population (2.5 to 3.0 trips/person/d and higher) (3) but are significantly higher than the current trip-making rates estimated for these special groups in San Diego (0.5 to 0.9 trips/person/d) (1, 2, 9, 12).

Results of the estimation of unmet travel needs are given below:

Service Class	Desired Trips per Day	Current Daily Ridership	Unmet Need (trips per day)
2	3 400	100	3 300
3	30 400	3 700	26 700
4	14 600	21 200	9 600
5	16 200		
Total	64 600	25 000	39 600

These data indicate that about 40 000 desired trips/d were not served by existing transportation services. The large share of this need was for door-to-door service without wheelchair lifts (class 3).

Sensitivity tests were applied to this estimate of unmet need. Different assumptions were made for the distribu-

tion of automobile drivers and the trip-generation rates in the five TSCs. When the assumed distribution of drivers was varied, the heaviest demand was still found in classes 3 and 4. When it was assumed that the rate of desired trips among those who did not use automobiles was only as high as the estimated rate of travel among automobile drivers and passengers, somewhat smaller trip totals were derived. However, the travel need of class 3 was still calculated at four times the level now being served.

Obviously, figures derived in this way must be used with caution, as must all forecasts. These are target numbers. All of these desired trips would not necessarily materialize even if there were high-quality, barrier-free transportation. Use of new transportation services will require significant changes in the customary daily routines of the elderly and the handicapped; it is reasonable to expect that such changes will occur only gradually and to an unknown extent. Although the derived estimates should be considered as order-of-magnitude numbers, they are quite adequate for use in transportation service planning.

PLANNING OF SERVICES

The logic of the study design and the demand-estimation results indicated that service needs could be divided into three distinct elements:

1. Transportation provided specifically by social service agencies;
2. Modifications to conventional fixed-route buses (class 4); and
3. Door-to-door services with and without lifts (classes 2 and 3).

Recommendations on the first two types of need were derived directly from the collected and estimated demand data. The cost of bus modifications for class 4 services and sources of funding for these services were the only additional factors involved and were easily identified. Therefore, class 2 and class 3 door-to-door service became the focal point of the study's effort in service planning.

COORDINATION AMONG SOCIAL SERVICE AGENCIES

The survey of existing transportation services indicated that there was obvious potential for achieving greater efficiency through coordination among the various independent agencies but that institutional factors and the agencies themselves had inhibited such cooperation (10, 14). The need for services was found to be continuing and even increasing at the same time that funding was tightening. This, coupled with forthcoming federal regulations (16), was expected to increase the chances for more efficient service through interagency cooperation.

The study therefore recommended creation of the position of central transportation coordinator—an official who would work among the region's social service agencies and groups. The functions of the coordinator would be

1. To operate a day-to-day central referral service to match the transportation needs and the available transportation facilities of agencies throughout the region,
2. To develop data on specific institutional barriers and other barriers to such coordination for use by policy makers in encouraging change, and
3. To increase the transportation resources available

to agencies by developing a modest pool of vehicles, some of which would have special equipment (this would be optional and would be done only if demonstration funding were available).

Modifications to Conventional Fixed-Route Buses

The estimated transportation needs of the elderly and the handicapped indicated that an overall approach to improved transportation service should include conventional fixed-route transit vehicles equipped with features such as lower or extendable steps, stepwell lights, handrails, and larger destination signs. This recommendation responded both to the large number of class 4 persons who required transportation and to the many class 3 persons who could use such fixed-route service in conjunction with separate door-to-route feeder service. The overall costs of improving transportation for class 3 users could thus be minimized.

It was estimated that equipping 50 or more buses with the required special features would involve the same capital cost as adding one new bus to the transit fleet. Therefore, implementation of such a recommendation would result in only a small reduction in planned bus acquisitions.

Installation of wheelchair lifts was recommended as an item for long-term consideration. Immediate retrofitting of conventional buses was not recommended because of high cost, design problems, and the small proportion of handicapped persons who would benefit from the improvement. The low density of the San Diego region and the fact that bus routes are often far apart would mean that many wheelchair users could not get to the bus stops. Separate (class 2) systems for the relatively few persons who would benefit from retrofitting of fixed-route buses appeared to be more practical for the present. Since the study, the San Diego Transit District has begun experimenting with five lift-equipped coaches on designated routes. This demonstration will provide important guidance for future policy concerning the use of lifts on regular bus routes.

Door-to-Door Services

Three general components of door-to-door service (classes 2 and 3) were considered: (a) operations (type and level of service, priorities, and equipment); (b) management (functions and responsibilities); and (c) financing (subsidies and fares). Many options were found for each of these components, both in the literature and in current experience elsewhere. The objective of the analysis in this study was to reduce these options to a limited number for consideration by citizens and policy makers of the San Diego region.

Evaluation Criteria

The criteria established for the evaluation of door-to-door service options included items such as the number of trips served, service accessibility, coordination with existing transportation services, ease of adjustment to future conditions, impacts on other transit users, and simplicity of the management structure.

Evaluation of Operations Options

The unique transportation needs of those requiring class 2 and class 3 service dictated that the most extensive effort in the design of a transit system be devoted to the specific operating features of the system. First, 24

alternatives representing combinations of routing, scheduling methods, and area coverage were generated; these were then reduced, on the basis of logical compatibility, to 8 alternatives. Application of the relevant evaluation criteria led to the selection of methods of operation for both service classes 2 and 3. The proposed class 2 system (for wheelchair users and others who require special attention) would use vans operating on a subscription basis during peak hours and at other times prearranged deviations from fixed routes to pick up and deliver passengers. To maximize coverage, the routes would vary by day of the week. The class 3 system (basic door-to-door service without lift) would function on a fully responsive dial-a-ride basis wherever the demand density proved sufficient and use prescheduled route deviations elsewhere.

Management

Both the management of service delivery and responsibility for policy guidance were considered. Evaluation of options for the management of service delivery focused on private taxi versus public transit approaches; the funding level was held constant. An extensive review of operating costs for both private taxi and public transit systems in San Diego and elsewhere revealed that unit costs were not significantly different within the limits of accuracy allowed by available data. Application of the full set of evaluation criteria led to the conclusion that, although both types of systems appeared to have similar person-trip costs, the taxi-based management approach was superior in almost all other respects. Among its advantages were transferless service, 24-h availability, faster response, ease of user understanding, and simplicity of administration.

It was also concluded that control over local financial commitments and their use should rest at the local level and that there should be a minimum of policy making, beyond agreements in principle, at the regional level. The following plan was recommended. Each participating city would set its own maximum funding level each year. At the same time, each city would decide whether to use this to subsidize more trips at a lower subsidy or fewer trips at a higher subsidy (up to 100 percent). The city would then pledge this amount (plus the fare increment to be collected) to the central agency that provides the service and in return receive trip vouchers or tokens corresponding in value to this amount. The city would then "sell" these tokens to its own citizens at whatever fare level it had elected. Eligibility and other restrictions, such as a maximum number of tokens per person per month, would be set and controlled by each city at the point of sale. The user would then use the tokens in whatever amount was required for a particular trip with fare dependent on trip length.

Responsibility for lower level operating policy and control must also be placed. Such responsibility could be given to any of several existing bodies—including the CPO, the region's two transit agencies, an existing social service umbrella agency, and the city or county government—or a new public (or private nonprofit) agency could be created. Evaluation of these options was based primarily on discussions with public officials. The main objective was to place these responsibilities where the greatest cooperation and credibility could be achieved. It was concluded that the region's two public transit agencies were in the best position to carry out these management functions, including contract supervision of taxi services, negotiation of service agreements with participating cities, and establishment and monitoring of operating procedures.

Financing

Three alternative levels of annual system cost were developed to be presented with the corresponding estimates of the proportions of need served. These were based on a review of local, state, and federal funding sources and represented three levels of policy commitment:

Cost Level	Policy
1	Current per capita rate of cost for the existing San Diego city dial-a-ride system extended to the entire urbanized area
2	Maximum feasible use of local sources plus small federal-state demonstration grant
3	Same as level 2 plus maximum "reasonable" diversion of forecast federal transit subsidies from fixed-route operations

Even at the highest cost level, it was found that only about one-sixth of the estimated demand could be served. Thus, the final policy decision posed for the region was a difficult one: Given evidence of a major public need, how and by how much should taxation and spending priorities be adjusted in response? Other regions can expect to face the same difficult decision during the next few years.

This study did not analyze the impact of door-to-door service on taxes or on other services. It should be noted, however, that even the highest funding level recommended would cost approximately only \$3/year for each citizen in the region.

RESULTS OF THE STUDY

The results of the study were presented to the mayor of the city of San Diego, who headed the citizens advisory committee, and to representatives of each of the surrounding 13 cities on the CPO board. The board formally adopted the proposed policy recommendations.

At the time this research was completed, one local group had received funding to provide coordinated transportation for nursing-home patients and other referrals in the eastern suburbs of the region. The city of Chula Vista was working to coordinate the transportation services of agencies within its city limits. Other cities in the region had not yet acted to help in providing services for the elderly and the handicapped. The new taxi company management in the region had shown interest in expanding San Diego's dial-a-ride service, but no action had yet been taken.

Since the conclusion of the San Diego study, many other municipalities and regional planning agencies have sponsored similar studies. The federal government is also conducting a nationwide survey among the handicapped that it is hoped will substantially improve current estimates of the need for specialized transportation services. The resulting improvements in knowledge and technique plus emergent federal and state legislation are rapidly moving the nation toward solutions of these problems.

CONCLUSIONS

Conclusions drawn from the findings and the methods of this study may be useful elsewhere. The findings suggest several key points, including the following:

1. There is evidence of a great need for additional transportation among elderly and handicapped persons.
2. Substantial benefits can result from improved coordination and sharing of the transportation facilities of various social service agencies and groups.

3. Many people without other means of travel appear to require door-to-door services without special equipment.

4. Taxis may be a particularly useful means of providing these special services.

5. Costs of such special services are likely to be high because of heavy demand and relatively high cost per passenger. Thus, staged implementation of services and maximum policy control at the municipal level are required.

The following conclusions on the methods used in the study may be particularly applicable elsewhere:

1. Methods other than large, local statistical surveys should be considered. Existing data and the combined knowledge of local agencies may be (as they were in this study) equally useful and less costly.

2. Demand can and should be estimated based on the type of service required. The system of five transportation service classes designed for this study appears to be useful for this purpose.

3. Planning of such special services should include financing and management options as well as the technical details of operations.

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REFERENCES

1. Travel Barriers: Transportation for the Handicapped. Abt Associates, Inc., Cambridge, MA, Aug. 1969.
2. Employment, Transportation and the Handicapped. Arthur D. Little, Inc., and Rehabilitation Services Administration, U.S. Department of Health, Education and Welfare, July 1968.
3. San Diego Area Transportation Data Base—1966. California Division of Highways and San Diego County Comprehensive Planning Organization, July 1972.
4. E. J. Cantilli and J. L. Shmelzer (eds.). Transportation and Aging, Selected Issues. Proc., Interdisciplinary Workshop on Transportation and Aging, Washington, DC, May 24-26, 1970, U.S. Government Printing Office, Publ. DHEW(SRS)72-20232, 1971.
5. Transportation for the Elderly. Community Sciences, Inc., and City of St. Petersburg, FL, 1972.
6. Comprehensive Plan for Services to the Older Population. Office of Senior Citizen Affairs, San Diego County, 1975.
7. R. M. Michaels and S. N. Weiler. Transportation Needs of the Mobility Limited. Transportation Center, Northwestern Univ., Evanston, IL, Sept. 1974.
8. Study of Palo Alto Area Residents 60 Years or Older. Senior Coordinating Council of the Palo Alto Area, Palo Alto, CA, 1973.
9. The Handicapped and Elderly Market for Urban Mass Transit: Technical Report. Transportation Systems Center, Cambridge, MA, Oct. 1973.
10. Transportation for the Elderly: The State of the Art. Office of Human Development, U.S. Depart-

- ment of Health, Education and Welfare, Jan. 1975.
11. Characteristics of Licensed Drivers. Nationwide Personal Transportation Study, Federal Highway Administration, U.S. Department of Transportation, April 1973.
 12. Mode of Transportation and Personal Characteristics of Tripmakers. Nationwide Personal Transportation Study, Federal Highway Administration, U.S. Department of Transportation, Nov. 1973.
 13. Purposes of Automobile Trips and Travel. Nationwide Personal Transportation Study, Federal Highway Administration, U.S. Department of Transportation, May 1974.
 14. San Diego Senior Citizens' Needs in Transportation, Recreation, and Housing. Urban Observatory of San Diego, June 1973.
 15. Planning Handbook, Transportation Services for the Elderly. Office of Human Development, U.S. Department of Health, Education and Welfare, Nov. 1975.
 16. Paratransit Services, Proposed Policy. Urban Mass Transportation Administration, U.S. Department of Transportation, Federal Register, Vol. 41, No. 204, Oct. 20, 1976.

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Abridgment

Coordination and Integration of Special Transportation Services for the Transportation Disadvantaged

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In the region comprising the Michigan counties of Ingham, Eaton, and Clinton, which includes the city of Lansing, a variety of agencies offer transportation services to those whose mobility is limited because of age, income, or physical or mental handicap. This situation offered a unique opportunity for an examination of the operational efficiency and the cost-effectiveness of current transportation services for the transportation disadvantaged. It was possible, through an analysis of the transportation needs of this sector of society, to compare transportation demand with the characteristics of transportation service as it is now supplied. That comparison determined the efficiency with which such special transportation needs were being met and made it possible to identify alternative service patterns that promise greater efficiency.

ESTIMATED GROWTH OF DEMAND

Service agencies in Lansing, Michigan, currently provide approximately 43 000 trips/month to the elderly, the handicapped, and low-income residents within their service areas, which are heavily concentrated in the Lansing urban area. It has been estimated that the potential market for trip making by transportation-disadvantaged groups in the tri-county region is between 100 000 and 120 000 trips/month (this includes all persons whose mobility is limited because of age, income, or physical or mental handicap and who currently have no access to transportation service). These estimates are based on a potential expansion of service in the service areas only and do not consider changes in the characteristics of service provided. The number of trips could thus be increased by almost a factor of 3 if service

were expanded to areas that are not now being served by the special transportation agencies. Of this increase of about 70 000 trips/month, a gain of nearly 15 000 trips/month could be expected in areas outside the public transit service region (1).

Two factors will have a major influence on the future demand for trips by the transportation disadvantaged in the tri-county region. The first factor is the growth in the base population classified as elderly, low-income, or handicapped. Population projections of the state of Michigan in 1974 indicated that the elderly population is expected to grow by about 50 percent in the next 20 years. Similar data available on the handicapped and low-income population classifications show that the proportion of persons within these classifications will remain fairly constant during the next 20 years and therefore the total increase in demand from these segments is expected to be about 30 percent during that period (2). These data indicate that demand on the transportation system will increase substantially in the next 20 years and that the potential exists for ridership at a level of 200 000 trips/month as a result of population growth alone.

The second factor is the type of service offered to the transportation disadvantaged. As a basis for comparison, the demand for trips by the elderly population of East Lansing is between 3 and 4 trips/month/person. In the tri-county region, the demand from this market segment is only about 1 trip/month/person. The significant difference between these demand figures may be at least partially attributed to the difference in service offered to the elderly residents of East Lansing. As part of the East Lansing Older Peoples Program, service is provided by taxi and half the fare is subsidized by the community. This may represent the ultimate