Demand for Special Transit Systems to Serve the Rural Elderly

Robert J. Popper, Department of Civil Engineering, Virginia Polytechnic Institute and State University
Charles B. Notess, Department of Sociology, Winthrop College
Ricardo N. Zapata, Department of Engineering Science and Systems Engineering, University of Virginia

Regional planning agencies have become increasingly aware of the transportation needs of the rural elderly. A promising solution to some of these problems has been the development of a rural special service transit system that gives elderly persons who lack means of transportation access to crucial social services. A preliminary, important step in planning such systems is estimating demands; unfortunately little demand information is available to aid in making such decisions as selection of vehicles, routing, and scheduling. This paper examines the demand for transportation services for the elderly and presents techniques for approximating travel demands. Methods based on attitudinal surveys, comparative trip rates, and participation frequencies illustrate that the best estimates currently possible are based on average travel behavior. Further, such methods only approximate the many factors affecting demand. Data monitoring to formulate an economic demand model, which would account for the significant variations of behavior, is suggested by this study as a relevant future research activity.

Significant portions of the elderly population living in rural areas have difficulty obtaining transportation to receive medical care, social services, groceries, and supplies. Some analysts believe that providing special transportation services may be a key element in improving the quality of life of the rural elderly. These transportation services would supplement private travel modes and would also be coordinated with existing public transportation.

Guidelines are needed to help local planning agencies devise optimal special transit systems. To made decisions on routing, scheduling, and selection of vehicles requires a forecast of passenger demand. Unfortunately, demand forecasting of rural transportation planning has often been glossed over by planners of special transit services. Demand is often confused with concepts of need and latent demand. Often demand is expected to materialize independent of the quality of the transit services provided.

This paper presents methods for estimating existing and potential demands for rural transit alternatives and distinguishes among the factors that influence the levels of demand. The characteristics of travel to rural social services in Virginia counties are used to illustrate some of these demand relationships. In addition, a number of demand estimation techniques, methodologies, and approaches are compared. Accurate travel demand estimates should be of special interest to social service agencies, regional planning bodies, and other organizations considering the development of special transit systems to serve the elderly.

BASIC CONCEPTS AND DEFINITIONS

The demand for transportation to a social service agency is a derived demand in that, primarily, the social service activity is demanded by the user and not the transportation to the agency. Transit travel demands are, therefore, contingent on the character and quality of the social services provided at the agency or destination activity. However, the ability of a rural special transit system to attract passengers also depends on the character and quality of the transportation services that it provides. Indeed, both factors are crucial to the evaluation of demand.

An economist might view the demand estimation process in terms of a traditional demand curve relating the quantity of trips purchased to the price of the trip for social services. However, an elderly individual would probably view the price paid for a service trip in more than just monetary terms. The price of the trip might rightfully be termed the impedance cost of a trip for social service. Impedance values are determined by such factors as waiting times at home and in the agency, discomfort levels on the vehicle, lack of privacy, necessity for making an advance reservation, and possible rescheduling of pickup times.

In economic terms, the decision to provide a rural transit service for the elderly is clearly related to the potential volume of social service trips that would be generated by a transit system and its costs. This volume is an indicator of willingness to pay the monetary and nonmonetary impedance costs of the trip. Demand volume is difficult to forecast accurately because of the many influencing agency, transportation, and population characteristics of a particular rural environment.

Publication of this paper sponsored by Committee on Transportation for the Disadvantaged.

Most planning agencies concerned with developing a transportation system are not interested in individual users' demand characteristics, but rather in the aggregate demands of all users within a specific geographic area. Aggregate demand curves reflect the travel behavior of many elderly persons often from quite different socioeconomic backgrounds. In formulating a demand equation, one should include variables to serve as descriptors of the client population. Thus, three primary components basic to the determination of the aggregate demand of the elderly for rural social service delivery systems are characteristics of

1. The elderly client population,
2. The available transportation systems, and
3. The activity system including environmental and agency characteristics.

Two related concepts, demand and need, are crucial to the evaluation and implementation of a rural transportation system for the elderly. Demand has been defined as an indication of willingness to pay impedance costs; therefore, any particular demand volume is related to characteristics (social service and transit service) that determine it. Demand is not to be confused with a need to travel; need is a fixed quantity of travel that the users or planners deem necessary to maintain minimum standards of living. Need is a subjective estimate and is not based on economic considerations of willingness to pay. Need may be assessed to exist whether or not one can afford to travel.

CURRENT DEMAND ESTIMATION APPROACHES AND TECHNIQUES

A number of estimation techniques have been incorporated into the demand forecasting processes for existing rural transportation systems. These approaches are reviewed for their usefulness in future rural transportation system design.

A common approach to demand estimation is door-to-door attitude surveys. The reason for such surveys is generally not to generate a workable demand model but to provide evidence for justifying the selection of vehicles, routes, and schedules for the initial service. There are two serious flaws with this method of demand projection. The first flaw is that multipurpose journeys are often not measured properly by the questionnaire. Generally, respondents are asked to indicate how many trips they would make on the service, if it existed, for each trip purpose. In doing so, they often neglect to consider multipurpose trips and provide an overestimate of the actual number of person trips. Second, and of critical importance, the demand forecast indicated by these questionnaires is not verified by actual travel behavior. In a survey of prospective travel frequencies in Oneonta, New York, public response indicated that a demand-activated bus service would generate 33 700 trips/week when an actual service in a nearby small town, Batavia, New York, only generated 1500 trips/week (1). Clearly, public opinion surveys cannot accurately predict vehicle trip demand. Indeed, one of the serious problems facing rural transportation systems in many parts of the country has been an oversupply of vehicles (2). Faulty or overzealous demand estimates are assumed to have contributed to this oversupply. Demand forecasts should consider the existing levels of demand for similar transportation services in similar localities.

DEMAND ESTIMATES BASED ON TRIP GENERATION RATES

Usually an initial estimate of demand considers the total number of transit trips per person made during a year by residents of a comparable area. This rate of transit use varies with income level, age distribution, population density, and other such factors. In general, most transit systems operating in rural areas seem to carry less than 1 annual trip (one-way)/resident.

Burkhardt and Miller suggest that service to groups with special needs would result in much higher rates of travel demand (3). For example, in Pennsylvania senior citizens average as many as 10 to 15 one-way transit trips/year. Nonelderly, low-income riders also demonstrate high rates of travel. Data from Pennsylvania, New York, and Minnesota all indicate that use of public transportation is greater in small towns than in rural country.

One method for estimating travel demand is to use rates of trip-making observed in other localities where life-styles are similar. This method assumes that elderly persons demonstrate a comparable trip-making behavior, independent of geographic variations, transportation service, or any agency differences. For example, a consultant's study for the state of Georgia investigating the development of rural transportation to serve elderly and handicapped states (4), "Since Georgia borders Tennessee and socio-economic and demographic characteristics of the two states are similar, it was agreed that the travel demand of the target group would be approximately the same." A target group of elderly and handicapped was then divided into four categories (above poverty, below poverty, rural, and urban) to validate the group differences in trip making as indicated by the Tennessee survey.

Rates of trip making may be measured on a daily, weekly, monthly, or yearly basis. These rates are usually calculated by referring to the total population (trips per person) or by referring to a target population (trips per elderly resident). Occasionally the rates are reported as a trip density for a study area (daily trips per person per square kilometer). The following are trip rates of some rural transit programs.

Annual Trips per Person	Location
5.00 to 10.00	Batavia, New York, dial-a-ride (1)
3.00 to 4.00	Small urban areas in Pennsylvania (3), high estimate
2.00 to 3.00	Rural areas in Pennsylvania (3), high estimate
1.00 to 2.00	Mid Delta, Arkansas (12)
0.50 to 1.00	Raleigh County, West Virginia (12)
	Small urban areas in Pennsylvania (3), low estimate
0.25 to 0.50	Venango Action Corporation, Pennsylvania (12)
	Rural areas in Pennsylvania (3), low estimate
0.00 to 0.25	Kingsport, Tennessee (12)
	Potter County, Pennsylvania (11,13)
	McKean County, Pennsylvania (11,13)

Some of these programs include special service to the elderly; others have a broader ridership base. The rates were calculated in terms of annual transit trips (one-way) per person. Most systems service less than 1 annual transit trip/resident. Many systems do not even produce this level of ridership. In a Pennsylvania study (3), a range of rates between 0.3 and 2.4 annual trips/person was used to develop a forecast of statewide potential rural transit demand. This expansive range (where the highest estimate is eight times the lowest) may prove to be of little use to a planner trying to decide on a realistic demand level for a particular county or planning district.

This comparative modeling technique can be used to estimate the total demand for travel in an area, by summing the products of group population times trip-making rate for all groups in the area. Trip rates for particular target groups (elderly or subgroups of elderly) may be used to refine estimates by disaggregating the population into more homogeneous subgroups. In mathematical terms a simple trip rate model is stated as

$$D = \sum_{i=1}^{n} d_i P_i = \sum_{i=1}^{n} (\alpha_i A_i) P_i \qquad (1)$$

where

D = total demand (annual transit trips),
d_i = anticipated transit demand for target group (annual trips per person),
P_i = population of target group,
α_i = appropriate dimensionless design parameter,
A_i = annual transit trips per person for target group in a comparable area, and
n = number of target groups.

A planner should assume that all a_i's = 1.0 unless the comparable region does not seem to be truly equivalent in trip-making potential to the region from which the rate was derived. This is perhaps the least refined but most popular technique for demand estimation.

DEMAND ESTIMATES BASED ON PARTICIPATION RATES

A second technique used to approximate demand is to identify the activity participation rate of potential users such as the rural elderly. While similar to the trip models, this approach often attempts to identify travel behavior with regard to specific trip purposes by particular subgroups of elderly. With this technique, at least an indirect attempt to identify relationships between agency attractiveness and travel demand is undertaken. However, these methods are also insensitive to the quality of the transportation provided and therefore represent simple approximations.

Identifying participation rate requires the collection of participation percentages and participation frequencies. Participation percentages refer to data that indicate the fraction of elderly who would be expected to use a special transit system. Participation frequencies refer to the number of trips per week, month, or year that would be made for each purpose. Unfortunately, a review of studies on elderly travel characteristics has not provided a completely uniform and comprehensive data base from which accurate demand forecasts of this sort can be made. Thus, a set of assumptions is necessary.

If particular rates and frequencies are forecast, or even roughly estimated, then a simple multiplication yields the travel demand for each trip purpose in terms of the total number of trips desired.

$$T_p = (POP)(R_p)(F_p) \qquad (2)$$

where

T_p = number of trips for purpose (p);
POP = elderly population in region;
R_p = participation percentage of elderly for purpose (p) ($0 < R < 1.0$); and
F_p = frequency of travel for purpose (p).

Research efforts and resulting data (5, 6, 7) describe to some degree the travel frequency of different groups of elderly. Data collected by Carp (8) give travel mode and frequencies for various trip purposes for the urban elderly. However, data on participation percentages by transit bus (R_p) are scant. Attempts at approximating R_p generally involve separating the elderly into groups according to life-styles and thus eliminating those persons who are not likely to be expected to participate. For example, Carp's data indicate that about one-third of the elderly travelers are vehicle drivers, about one-third are vehicle passengers, and the remainder are users of other modes such as bus, walking, or taxi. In rural areas the percentage of drivers appears to be much higher and to be related to income levels and the environment of the elderly. A reasonable approximation is to assume that few, if any, of the drivers will participate in the transit service. Further, a small percentage of the vehicle riders would be expected to switch modes, particularly if they were paying for existing rides. Those riding with a relative or friend are unlikely to switch initially. The fraction of elderly who would initially participate primarily include some who previously walked, used a taxi, or rode as a passenger with others.

An application of a participation rate calculation of demand is illustrated in Table 1 for Montgomery County, Virginia. At the current stage of development, the method requires both empirical data on travel behavior and the judgment of the analyst. The advantage of this approach for deriving a demand estimate is that it readily enables the planner to measure demand projections against three observed average measures from current transit operations for the rural elderly.

1. Riders of many special transit systems use services approximately once a week (9). This observation is clearly not a defined goal or standard, but rather an observed fact from typical operations.
2. At most, 3 percent of the total elderly population of an area might be expected to initially become system users during the initial year or two of operation (9).
3. Annual trip-making rates for the area's total population should be consistent with comparative travel data such as those given above for rural transit systems (less than 1 annual trip/person).

Any estimate that violates one of these observed indicators of demand levels should be fully justified by particular variances in local conditions relative to those of

Table 1. Estimate of transit travel demand of elderly persons in Montgomery County, Virginia.

Mode (1)	Elderly in County: Number (2)	Elderly in County: Percent (3)	SS Survey Destinations per Month (4)	Likely Transit Destinations per Month (5)	Likely to Switch: Percent (6)	Likely to Switch: Number (7)	Total Transit Destinations per Month (8)	Total Estimated Transit Trips per Month (9)
Drive	935	31	12	—	—	—	—	—
Ride	1538	51	4	4	3	46	184	331
Other	60	2	2	4	5	3	12	22
Do not go	482	16	0	—	—	—	—	—
Total	3015	100	18	8	8	49	196	353

the system previously predicted. Otherwise, a refined estimate, consistent with these observations, is required.

To derive the demand estimate given in Table 1, the elderly are divided into four travel groups according to modes of travel that are related to their life-styles (active, moderately active, locally active, and inactive). The purpose is to obtain typical rates of trip making for elderly who drive, are driven, walk, and use taxis or other means. The percentages of elderly in each travel mode (life-style) category were calculated from a Social Security (SS) survey of the elderly in Montgomery County, Virginia, by adding a "do not go" group of 16 percent to the modal breakdown for walkers, riders, and drivers. These percentages may differ from county to county, but are typical of rural areas having moderate income levels. The SS survey data are as follows:

Trip Purpose	Trips per Month	Do Not or Seldom Go (%)
Shop	1.4	22
Visit	6.0	37
Attend church	1.6	49
Obtain medical care	1.3	28

Two assumptions are inherent to this procedure. Those elderly who drive and those who do not go are considered to be unlikely candidates to switch to a new special transit system during its initial years of operation. Those who do not go are considered to include those who have physical mobility limitations. On the average, about 15.5 percent of the elderly are unable to perform any work (10). This percentage compares with the finding that 16 percent of the Montgomery sample was totally inactive and did not visit, shop, or go to church. These incomplete data suggest that, for purposes of a preliminary demand estimate, this fraction of elderly drivers and elderly unable to travel may be eliminated as potential riders. Although some of these types of elderly might be attracted if there were a concentrated outreach program, their contribution is minimal in approximating initial system demands.

Current destinations per month (Table 1, column 4) were obtained from the SS survey and include travel for grocery shopping, visiting, church, and medical care. Estimates of the number of monthly destinations by users of currently operating and comparable special transit systems are given in column 5. These systems currently service shopping, medical, and social service trips such as food stamp eligibility checks, nutrition, and senior center activities. On the basis of monthly destinations for social-recreational travel presented by Carp (8) and the SS survey data above for shopping and medical travel, we estimated that 4 destinations/month (1/week) are typical. This rate agrees with those of currently operating systems in Rhode Island and Delaware (9).

We assumed that, primarily, automobile riders and those using taxis, walking, or using other modes might switch during the first year of operation and that the walkers and taxi users who switch might increase their frequency of trip making. Although few data are available to support this contention, two lines of reasoning seem feasible: (a) We may assume that those switching will not, initially, alter their travel frequency for these trip purposes; and (b) we might estimate an overall frequency of about 1 trip/week (4 destinations/month) that seems to be typical of other systems in operation.

We then evaluated the participation percentages of each modal travel group that would be likely to switch to the transit service. Unfortunately, the modal-split equations and graphs commonly used in urban transportation evaluation have not been developed for rural areas. Such curves would relate the percentage of transit users to variables describing the quality of transportation service.

In the absence of better information, estimates based on the observed ridership of similar systems were used. We assumed that 3 percent of the elderly automobile riders and 5 percent of the elderly who travel by walking and other modes might initially switch to the special transit system (Table 1, column 6). The number switching (column 7) is obtained by multiplying data in columns 6 and 2. Total transit destinations per month (column 8) were obtained by multiplying data in columns 7 and 5. To convert from destinations per month to trips per month, we also assumed that each destination represented 1.8 one-way trips (e.g., some journeys include more than one destination). Hence, column 9 was determined as 1.8 times the data in column 8 or an estimated 353 transit trips/month.

The estimate of 353 trips/month is equivalent to 4236 trips/year or 1.40 annual trips/elderly resident. Another view of the estimate is to consider the monthly frequency of trip making by those riders who would use the system. Each rider would make about 7.2 trips (one-way)/month or nearly 1 round trip/week. Based on this example of 3015 elderly in Montgomery County, 49 riders are expected to be initially attracted. This represents about 1.6 percent of the elderly population. All of these indicators are representative of current data from other systems. The elderly trip rate (1.4 annual trips/elderly) is approximately equivalent to 0.14 annual trip/person, based on the fact that about 10 percent of the population is 65 or more years old. This annual rate per person is consistent with existing operations in many rural areas for which data are given above.

ACHIEVING A COMPREHENSIVE DEMAND ESTIMATION PROCEDURE

As previously stated, the demand for rural transportation delivery systems must finally be evaluated in terms of those factors that directly influence demand levels. Demand volumes are a function of the levels of service provided by existing transportation modes, the levels of service provided at the service agencies, and the socioeconomic status of the elderly population. Demand models can be formulated and validated once a comprehensive data base of these characteristics has been collected. These models would indicate the sensitivity of demand volumes to changes in the system parameters. Before describing the formulation of such models, we should outline the types of factors that might significantly influence demand. Local personnel may suggest that particular relationships be emphasized in the systems design process.

Two sets of systems factors are reviewed. The first group, TRANSEL, refers to the transportation level-of-service variables that might influence demand. The second group, ACTSEL, refers to the level-of-service variables that describe agency (activity) operation.

The TRANSEL factors listed below are not meant to be an exhaustive list of all the variables that possibly influence transportation demand but a representative sample of the variables that are most crucial.

Factors	Variables
Convenience	Pickup and delivery proximity Multipurpose destination capability Frequency of service Reservation time requirements Compatibility with agency schedule

Factors	Variables
Comfort	Seating comfort
	Special provision for elderly and handicapped
	Overall trip length
	Average wait at stops
Privacy	Traveler mix
	Information requirements
	User status and self-image
Fare	
Dependability	
Safety	
System coverage	Number of users served
	Area served
	System reachability
	Scope of services
	Demand satisfaction level

An individual elderly person of a particular socioeconomic background is assumed to choose a mode of travel based primarily on the first six level-of-service factors, particularly one mode (e.g., automobile riding) over the alternative (social services bus). Each of these factors, or the lack of them, contributes to the transportation impedance or cost of the trip. Obviously, certain groups of elderly tend to be quite sensitive to these variables. For example, those elderly who live with relatives and do not own an automobile have at least two travel mode choices. They may wait for a ride with relatives, or they may use the special service bus. In such cases, the bus quite possibly could provide a superior level of service as indicated by the list of variables. At the other end of the spectrum are those elderly who drive and are quite active (perhaps 50 percent of the rural elderly). These elderly would find that the special service bus cannot match their private vehicle on most of the level-of-service factors. Hence, their decision, although based on the factors of relative comfort, convenience, privacy, cost, safety, and dependability, is viewed as hardly a choice at all, and they are unlikely to switch.

The last level-of-service factor, system coverage, may not influence individual mode-choice decisions, but is useful to transit planners. System coverage usually correlates highly with demand volumes (e.g., area served is usually related to demand levels). However, many of the system coverage variables are related to the comfort, convenience, privacy, cost, and dependability factors that directly influence individual travel choice.

Some of the less obvious TRANSEL variables are related to the convenience factor. Pickup proximity appears to be especially important to the elderly, and door-to-door service is advised. Multipurpose capability refers to the ability of a journey to serve more than one purpose. This convenience factor depends on both transportation and agency scheduling. Frequency of service refers to the number of times per week that the trip could be scheduled. One day per week service offers the potential traveler little flexibility of choice and may detract from demand. However, a potential exists for a regular service pattern to develop in which elderly persons would expect transportation on a particular day. Important economies can be achieved if agencies are effective in accommodating their case loads to this service. Reservation requirements, if necessary long in advance of trips, also tend to detract from potential demand. Providing transportation service that is compatible with agency schedules is necessary to avoid long wait periods.

Primary among the comfort variables are the necessary special provisions such as seats, steps, and lifts to serve an elderly and handicapped clientele. Also of importance to a comfortable ride are the amount of in-vehicle travel time and the number and length of in-vehicle stops.

Privacy has been noticed especially in some rural Virginia and Carolina counties to reflect the degree of vehicle utilization. Elderly have been observed to be adverse to social class mixing and to cultural, racial, or even healthy-and-handicapped mixing on buses. These observations are based on limited data, but should be investigated in detail in particular localities when a transit service is designed.

Weights of levels of importance have not been attached to the various transportation level-of-service factors. The relative importance of each can only be assessed from the actual observed behavior of the elderly who use a system and are influenced by these factors. Hence, these data must be collected, when feasible, from a large number of operating systems that vary considerably as to service provided. Not all factors influence travel demand; in fact, not all factors are totally independent from other variables. Therefore, those variables used to estimate demand can be considerably fewer than those listed above.

Simultaneously with the mode-choice decision, the decision concerning whether to make the trip (travel frequency) is reached. This decision depends on the quality of transportation modes and also on the levels of service provided at the agencies or other destination activities. The following is a list of agency level-of-service factors that must inevitably influence demand for the services and, therefore, the derived demand for transportation to the services. Variables are related to user convenience, comfort, cost, and privacy.

Factors	Variables
Convenience	Operating hours
	Prior appointment requirements
	Compatibility with transportation
	Compatibility with other activities
	Service rate capability, staffing
	Wait time for service
	Outreach
Comfort	Accommodations for elderly and handicapped
	Waiting room facilities
Privacy	Social distance among user groups
	Information requirements
	User status and self-image
Cost of service	

One other important factor that influences the demand for agency services and, thus, agency transportation is not given in either the TRANSEL or ACTSEL factor list. This factor is the outreach of the agency as influenced by personal contact, advertising, and communications media. Agencies with significant outreach programs tend to change the perceptions of the ACTSEL and TRANSEL variables to the individual elderly. The perceived value of the level-of-service factors influences travel behavior, not actual values. Often the outreach tends to generate new customers by initiating a perception of TRANSEL and ACTSEL where no prior knowledge existed.

ECONOMIC DEMAND MODEL FORMULATION

A rigorous demand model formulation would incorporate most of the previously mentioned level-of-service factors into a mathematical expression. Such an expression should be the focus of continued research and data monitoring for rural transportation systems. Mathematical forms for a demand model are briefly described to encourage planners and agency personnel to be cognizant of the requirements of producing a valid, working demand model.

In this case, a demand model is generated as opposed to a demand forecast. The advantage of the model is that it can be used to forecast demand under a variety of socioeconomic circumstances. Demand models may be sensitive to changes in social or economic policy and, therefore, be used as tools in future rural development plans used in policy research.

We have stated that demand for rural transportation services to social agencies is functionally related to the characteristics of the elderly population, the level of service provided by transportation systems, and the level of service provided at the agency.

$$D_{IJK} = f(\overline{E}, \overline{T}, \overline{A}) \quad (3)$$

where

D = demand,
$\overline{E}$ = set of population characteristics (age, sex, income, or health),
$\overline{T}$ = set of transportation systems characteristics for available modes,
$\overline{A}$ = set of destination activity system characteristics,
I = origin,
J = destination, and
K = mode.

If necessary, demands may be further stratified by trip purpose (p) and the time of day (t).

To generate a demand model, observed values of demand (D_{IJK}) and existing characteristics as described by $\overline{A}$, $\overline{E}$, and $\overline{T}$ variables are used as input. The model parameters are then calculated by empirical techniques such as standard regression estimating procedures. Resulting models may then be subjected to a rigorous statistical validation based on correlation coefficients, significance tests, and associated evaluation indicators.

This description of demand model formulation has been quite theoretical and perhaps of little present value to agencies. Yet, if meaningful demand models are to be constructed, agencies must be cognizant of the data requirements necessary to model construction. In addition, a thorough description of demand interactions is necessary to the design of eventual rural service delivery systems for the elderly.

SUMMARY

This analysis of the transportation demand for social services illustrates two important facts: (a) Existing demand estimation techniques do not fully incorporate all system effects and are, therefore, likely to provide only mildly acceptable results; and (b) a coordinated effort to collect the data necessary to develop an economic demand model would be beneficial to further systems development. A reliable model of this nature does not currently exist.

This lack poses a serious problem to those planners faced with the task of developing initial special transit programs for the rural elderly. We recommend that, in the absence of data, a trip rate consistent with those given in this paper and tempered by local judgment be used for an approximation of demand. If relevant data are available, an analysis of participation frequencies, also tempered by local judgment, will give a first approximation to demand volumes.

REFERENCES

1. D. T. Hartgen and C. A. Keck. Forecasting Dial-A-Bus Ridership in Small Urban Areas. New York State Department of Transportation, Albany, Preliminary Research Rept. 60, April 1974.
2. D. McKelvey and K. Deucker. Transportation Planning: The Urban and Rural Interface and Needs of the Rural Elderly. Center for Urban and Regional Research, Univ. of Iowa, Technical Rept. 26, Aug. 1974.
3. J. E. Burkhardt and W. W. Miller. Estimating Cost of Providing Rural Transportation Service. TRB, Transportation Research Record 578, 1976, pp. 8-15.
4. Summary Report: Planning and Development Program for Mass Transportation Services and Facilities for the Elderly and Handicapped in the State of Georgia. Kimley-Horn and Associates, Inc., April 1975.
5. Transportation for Older Americans. Institute of Public Administration, April 1975.
6. J. Burkhardt and others. The Transportation Needs of the Rural Poor. Resource Management Corporation, Bethesda, Md., July 1969.
7. J. Burkhardt and others. A Study of the Transportation Problems of the Rural Poor. Research Management Corporation, Bethesda, Md., Jan. 1973.
8. F. M. Carp. The Mobility of Retired People. In Transportation and Aging-Selected Issues (E. J. Cantilli and J. L. Shmelzes, eds.), Proc., Interdisciplinary Workshop on Transportation and Aging, Washington, D.C., May 24-26, 1970; U.S. Department of Health, Education and Welfare, Administration on Aging 72-20232, 1972, pp. 18-25.
9. W. G. Bell and W. T. Olsen, eds. Toward a Unification of National and State Policy on the Transportation Disadvantaged: Part 2—Rural Perspectives. Proc., 4th Annual Conference on the Transportation Disadvantaged, Florida State Univ., Tallahassee, Dec. 1975, pp. 91-127.
10. R. C. Atchley. The Social Forces in Later Life: An Introduction to Social Gerontology. Wadsworth Publishing Co., Belmont, Calif., 1972.
11. Report on Pennsylvania's 21 County Rural Transit System. Rural Transportation Division, Pennsylvania Department of Agriculture.
12. A. E. Kidder. Economics of Rural Public Transportation Programs. TRB, Transportation Research Record 578, Jan. 1976, pp. 1-7.
13. Rural Transportation in Pennsylvania. Governor's Task Force, Vols. 1 and 2, May 1974.