NATIONAL COOPERATIVE
HIGHWAY RESEARCH PROGRAM REPORT 262

PLANNING TRANSPORTATION SERVICES FOR HANDICAPPED PERSONS

USER'S GUIDE

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NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
REPORT 262

PLANNING TRANSPORTATION SERVICES FOR HANDICAPPED PERSONS

USER'S GUIDE

F. J. WEGMANN, K. W. HEATHINGTON, D. P. MIDDENDORF,
M. W. REDFORD, A. CHATTERJEE, and T. L. BELL
Transportation Center
The University of Tennessee
Knoxville, Tennessee

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WASHINGTON, D.C. SEPTEMBER 1983

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are the responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

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FOREWORD

By Staff
Transportation
Research Board

This User's Guide will be of use to planners and analysts employed by medium-to-large-sized transit agencies and city governments, and metropolitan planning organizations having responsibilities for identifying solutions to the problems of providing transportation to meet the needs of handicapped people. Such persons also will find the Guide useful in conducting investigations of the more cost-effective ways transit operations can meet various regulations concerning handicapped persons.

Recognizing the mobility problems faced by physically and mentally handicapped people, transportation providers are trying to develop cost-effective ways to meet the transportation needs of these people. There is a need for methods to allow transportation providers to evaluate the cost-effectiveness of the various transportation options available. The costs and benefits of carrying out directives such as The U.S. Department of Transportation's ruling implementing Section 504 of the Rehabilitation Act of 1973 are uncertain. Existing transportation services are sometimes competitive, thereby draining away available public resources.

The purpose of this Guide is to assist planners and analysts in identifying and evaluating alternative ways of providing mobility to the handicapped population who have difficulty using regular public transportation services. The intent is to address the mobility needs of an entire transportation handicapped population as well as specific market segments with diverse needs, located throughout a geographical area.

The approach presented relies on comparing the estimated demand for travel by different segments of the transportation handicapped population versus the ability of different transportation service alternatives to accommodate these demands in a cost-effective manner. In this User's Guide, transportation handicapped market segments refer to the degree of handicap and automobile availability. The transportation service options include: accessible fixed-route, fixed schedule bus; specialized door-to-door services; user-side subsidy programs; and combinations of the foregoing. Service can be provided by creating new entities in the transportation system of a community or by making incremental additions to the transportation services already being provided.

Estimation of demand for an alternative service is a critical aspect of the cost-effectiveness analysis. There are different approaches to estimating demand. The User's Guide employes the concepts of "unmet needs" to define in a "first-cut" order of magnitude approximation the extent of handicapped mobility needs. Unmet needs are not adequate for service planning, but they can help define the need for alternative services.

The User's Guide is based on the research results described in *NCHRP Report 261*, "Cost Effectiveness of Transportation Services for Handicapped Persons—Research Report," and a synthesis of previous research documented in "Current Practices in Providing Public Transportation Services for the Handicapped." (Microfiche of the synthesis may be purchased from Transportation Research Board (TRB) Publications.) The research results in *NCHRP Report 261* are based on an extensive review of relevant literature, augmented by mail surveys and personal interviews of transportation providers and handicapped persons.

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PLANNING TRANSPORTATION SERVICES FOR HANDICAPPED PERSONS

USER'S GUIDE

SUMMARY

The objectives of National Cooperative Highway Research Program (NCHRP) Project 8-27 were to study the cost-effectiveness of alternative transportation services for handicapped persons and to develop guidelines for state and local planners, transportation providers, and decision-makers on determining the most cost-effective way of meeting the transportation needs of handicapped people.

Transportation handicapped people constitute a small, but highly diverse, segment of the population. Their functional limitations and abilities, frequency of travel, desire for additional travel, economic status, and access to private automobiles vary considerably. Therefore, it is important that planners stratify the transportation handicapped population into distinct market segments so that transportation solutions can be tailored more closely to the needs of each. The most important and useful ways of segmenting the transportation handicapped population are by overall ability to use public transportation, functional disability, and access to private automobiles.

Transportation handicapped people generally travel less than half as much as other people. However, much of this difference in trip-making is because most transportation handicapped persons are unemployed. The transportation-handicapped 16 years of age or older make about one-fourth as many work trips as other individuals in this age group, but they make about 70 percent as many nonwork trips. Although it may be important to narrow and possibly close the 30 percent gap in nonwork travel, this gap, nevertheless, is not as large as commonly believed. Barrier-free transportation, therefore, could have a much greater impact on the mobility of transportation handicapped persons if it enabled a larger number of them to gain employment rather than to enable simply some of them to make a few more nonwork trips. However, it is doubtful that barrier-free transportation services will significantly lower the unemployment rate of transportation handicapped people. Nearly half of all transportation handicapped persons are over 65 years of age, and a lack of transportation is not one of the major reasons why many younger handicapped people are unemployed.

Although the transportation-handicapped do not travel very often, their latent demand for additional travel appears to be surprisingly low. Various measures of latent demand show that it is only a fraction of the current average daily trip rate of transportation handicapped people. Even if a barrier-free transportation service could satisfy the apparent latent demand, the resulting average daily trip rate would still be much lower than that of the general public.

Three general approaches to improving the mobility of handicapped people have been suggested and tried in the past--modification of existing fixed-route bus systems, specialized door-to-door transportation services, and subsidies to individual transportation handicapped people to enable them to use available taxi services at lower fares. The average additional cost of operating a fixed-route bus system that has been made accessible to the handicapped is approximately $2,000 annually per lift-equipped bus. Depending on lift use, the cost per lift user can range from a few dollars to over $50. Specialized transportation services can cost between $8 and $23 per vehicle-hour of service. The cost per trip depends on many factors and can range from $2 to $15. The average cost of subsidizing taxi use can vary from less than $1 to over $7 per trip.

To date, none of the foregoing approaches has had a significant impact on the mobility of large numbers of handicapped people. Accessible fixed-route bus systems, specialized transportation services, and user-side subsidy programs have not been heavily used by most handicapped people. In most cases, a few people have accounted for a large majority of the trips made under each of these alternatives.

The reasons for the low use of existing transportation services for handicapped persons are many. As previously suggested, the latent demand for additional travel appears to be extremely low. There is also the possibility that most existing transportation services, for one reason or another, do not quite meet the needs of many transportation handicapped people. Many of the handicapped have access to private automobiles and prefer not to use lift-equipped buses, special door-to-door services, or taxis. Another factor that must also be considered is the inaccessibility of the rest of the environment. Transportation handicapped people face numerous other barriers to mobility besides a lack of accessible transportation. These barriers are architectural, physical, economic,

psychological, and institutional. Until these other man-made and natural obstacles are also removed, there is a limit to what any barrier-free transportation system can do to increase the mobility of transportation handicapped people.

Equipping conventional transit buses with wheelchair lifts does not appear to be a particularly cost-effective way of meeting the transportation needs of large numbers of wheelchair users. Under current lift utilization rates, the incremental cost of making a bus transit system accessible to wheelchair users and other severely handicapped persons who cannot board regular buses is largely independent of the demand for the lifts. Thus, the cost of a wheelchair passenger trip decreases as the number of bus trips made by wheelchair users increases. In order for the cost per lift user to equal that for a high cost specialized transportation service, an accessible fixed-route bus system would have to average close to 0.56 lift boardings per day per lift-equipped bus. The highest lift utilization rate attained thus far is 0.33 lift boardings per day per lift-equipped bus by Seattle Metro. No other large or medium-sized transit agency has come close to Seattle's lift-use rate. Moreover, it is questionable whether Seattle Metro's lift-use rate will increase any further. Between the autumn of 1980 and the summer of 1982, as Seattle Metro increased the number of lift-equipped buses from 163 to 338, the average number of lift boardings per day per lift-equipped bus dropped slightly from 0.33 to 0.31. Only in small urban areas with bus systems having 15 or fewer buses would an accessible fixed-route bus system have a chance of being as cost-effective as a specialized transportation service.

Door-to-door specialized transportation services with either lift-equipped or ramp-equipped vehicles constitute one of the few alternatives that can potentially serve all types of handicapped people for all types of trips. However, the cost-effectiveness of these services varies widely. Many-to-many specialized transportation services (those serving many origins and destinations) tend to have the highest costs per passenger, particularly when they are operated by transit authorities or local governments. Low vehicle productivity and high wage rates account for the high cost per trip. Specialized transportation services can be made more cost-effective by subdividing the service area into zones, by emphasizing subscription service for regularly occurring trips, or by requiring at least two day's notice prior to the trip. Such measures enable service providers to increase the productivity of the vehicles. Some of the most cost-effective specialized transportation services are the many-to-one (many origins to one destination) or many-to-few (many origins to a few destinations) services operated by social service agencies and private, nonprofit organizations. These agencies often use volunteer drivers. In some cases, agency personnel may drive the vehicles as one of their functions. One of the reasons these services are often so cost-effective is because they serve a limited, well-defined group of people and one or a few specific kinds of trips. Thus, the cost-effectiveness of a specialized transportation service will greatly depend on its function. The more general its function, the higher the cost per passenger is likely to be.

If any transportation solution could be singled out as the one likely to be the most cost-effective for many segments of the transportation handicapped population, it would be a taxi-based, user-side subsidy program. Private carriers, such as taxicab companies, can be highly cost-effective and have the capacity to accommodate a large number of additional trips by handicapped people without having to expand their fleets or add additional vehicle-hours of service. Special provisions, however, have to be made in a taxi user-side subsidy program to accommodate the small subgroup of handicapped people who are physically unable to ride in taxicabs. Moreover, this alternative may not be feasible in all situations for reasons having nothing to do with cost. For various reasons, local taxi companies may not be willing to participate in a user-side subsidy program. If the local taxi industry consists of numerous individual owner-operators, it may be difficult to organize them into an effective program. In some urban areas, the notion of subsidizing a handicapped person's use of taxicab services--often regarded as a premium form of public transportation--may be politically unpalatable.

Therefore, it is not possible to recommend a single transportation solution that is clearly the most cost-effective for all handicapped people in all situations. The cost-effectiveness of any alternative can vary widely, depending on local conditions and many other factors. A solution that may work well in one community can easily fail in another. Most likely, some combinations of alternative solutions will be required, each focusing on particular needs of particular market segments. For these reasons the research conducted under NCHRP Project 8-27 has resulted in the publication of two documents: NCHRP Report 261, "Cost-Effectiveness of Transportation Services for Handicapped Persons--Research Report," and NCHRP Report 262, "Planning Transportation Services for Handicapped Persons--User's Guide." This report (NCHRP Report 262) provides planners and decision-makers with guidelines on how to evaluate alternative transportation services for handicapped persons and identify the most cost-effective solutions for their communities. The companion document (NCHRP Report 261) presents the results of a study of the cost-effectiveness of alternative transportation services for handicapped persons.

CHAPTER ONE

INTRODUCTION

This user's guide has been prepared as part of National Cooperative Highway Research Program (NCHRP) Project 8-27 to determine the more cost-effective means of meeting the transportation needs of handicapped people. The purpose of the guide is to provide planners, whether they are employed with a transit agency, city government, or metropolitan planning organization, with guidelines that will permit them to identify cost-effective solutions to the problems of providing for the transportation needs of handicapped people. These guidelines should be of specific use to planners who investigate the more cost-effective ways transit operations can meet various regulations concerning handicapped services.

The material presented in this document should assist planners in identifying and evaluating alternative ways of providing mobility to the general handicapped population who have difficulty using regular public transportation services. The intent of these guidelines is to address the mobility needs of an entire population as well as specific market segments of transportation handicapped persons with diverse travel needs, located throughout a geographical area. Experience has shown that only a small percent of the total eligible transportation handicapped market is likely to avail themselves of these services, even though the services are provided to the entire market segment.

Determining the more cost-effective means of responding to transportation handicapped mobility needs at a local level depends on a system analysis approach involving the steps outlined in Figure 1. The general procedure is dependent on selection of a specific geographical area and market segment to be served and permits a cost-effectiveness analysis of alternative means of serving these needs.

The approach presented relies on comparing the estimated demand for travel by different segments of the transportation handicapped population versus the ability of different transportation service alternatives to accommodate these demands in a cost-effective manner. In this user's guide, transportation handicapped market segments refer to the degree of handicap and automobile availability. The transportation service options include: accessible fixed-route, fixed-schedule bus; specialized door-to-door services; user-side subsidy programs; and combinations of the above. Service can be provided by creating new entities in the transportation system of a community or by making incremental additions to the transportation services already being provided.

Estimation of demand for an alternative service is a critical aspect of the cost-effectiveness analysis. There are different approaches to estimating demand. The user's guide uses the concept of "unmet needs" to define in a "first-cut" order of magnitude approximation the extent of handicapped mobility needs. Unmet needs are not adequate for service planning, but they can help define the need for alternative services.

Assessing the cost-effectiveness of a particular service option requires a more extensive analysis of demand. Latent demand values are presented as a theoretical approach, while utilization rates reflect the experiences encountered by operating systems in providing handicapped transportation services. Because of the broad ranges in utilization experiences, low, average and high estimates are provided for the planner's consideration.

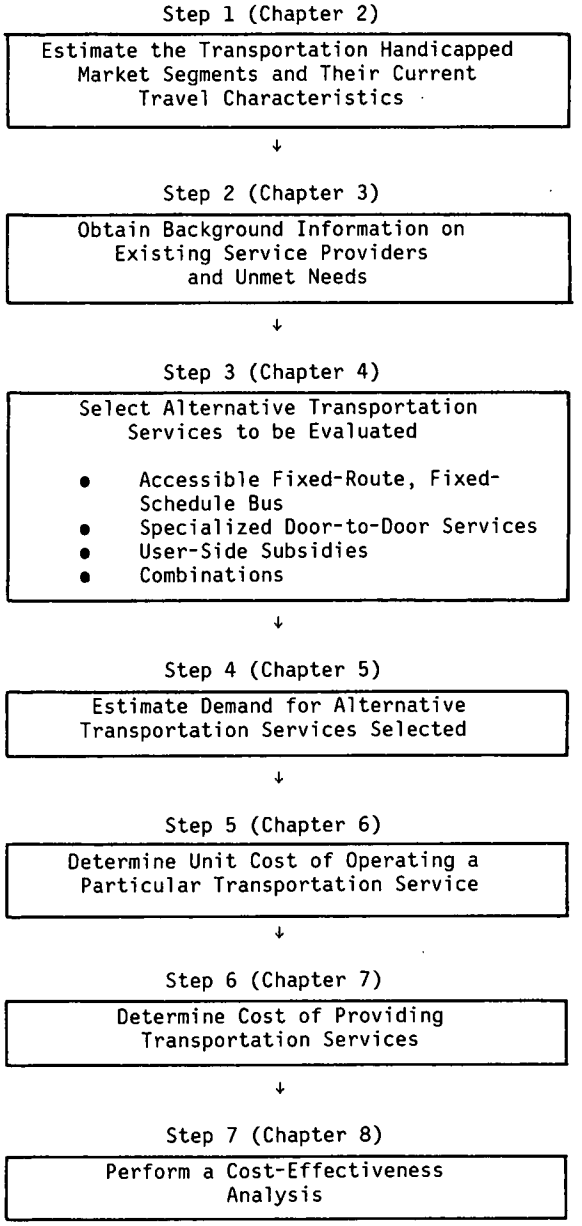


Figure 1. General steps in a cost-effectiveness analysis.

Latent demand usually speaks to a maximum potential for handicapped travel, while the utilization rates reflect the fact that resource restrictions usually limit the amount of services to be provided and thus the ability to accommodate all mobility needs. Without local considerations, the planner would be best served by using the average utilization rate estimate. However, it is important that local information and considerations be used whenever possible.

Once demand estimates have been provided for each of the service concept, a cost estimation is used to determine the probable cost of providing specialized services and/or the incremental cost of providing fixed-route, fixed-schedule transit services. Service design concepts are presented to determine the extent of services required for a

given demand level and, when multiplied by unit cost values, provide an estimate of the cost of providing transportation services. Finally, it is possible to perform a cost-effectiveness analysis by comparing trade-offs and compromises entailed by the adoption of one alternative over another. This cost-effectiveness analysis provides information to support the selection of a given alternative.

Although the steps in Figure 2 are portrayed in a linear sequence, there will be opportunities to conduct various steps in parallel, and iterations may be required. Each major step is treated separately in Chapters Two through Eight. (A comprehensive bibliography and a glossary are provided following Chapter Eight. Appendices A through D include worksheets and tables of cost data, and other information on use of volunteer services.)

The material is structured to provide practical guidance on how to perform a cost-effectiveness analysis at the local level. By use of the procedures contained in these guidelines, the planner can estimate the various levels of effectiveness from a wide choice of transportation options for the handicapped. In addition, the planner or analyst can estimate the use of the services by the handicapped. The measures of effectiveness do not have to be reduced to dollar values and can, therefore, be presented to decision-makers who may have objectives of other than a monetary nature. The planner also has the ability to provide a sensitivity analysis that will permit an evaluation of marginal increases or decreases in services, and to determine the impacts that these changes will have on utilization, as well as on costs to the agencies providing the services. A very comprehensive set of alternatives can be generated and evaluated through the procedures outlined.

Because most urban areas lack a specific data base concerned with transportation handicapped travel characteristics, extensive reliance is placed on transferable parameters derived from national surveys or other urban areas. However, it is important for the planner to utilize local knowledge and information whenever possible. Material presented in this user's guide is developed from its companion documents--the Interim Report literature review ("Current Practices in Providing Public Transportation Services for the Handicapped") and NCHRP Report 261, "Cost-Effectiveness of Transportation Services for Handicapped Persons--Research Report." Reference should be made to those reports for general background and justification of specific procedures and values presented.

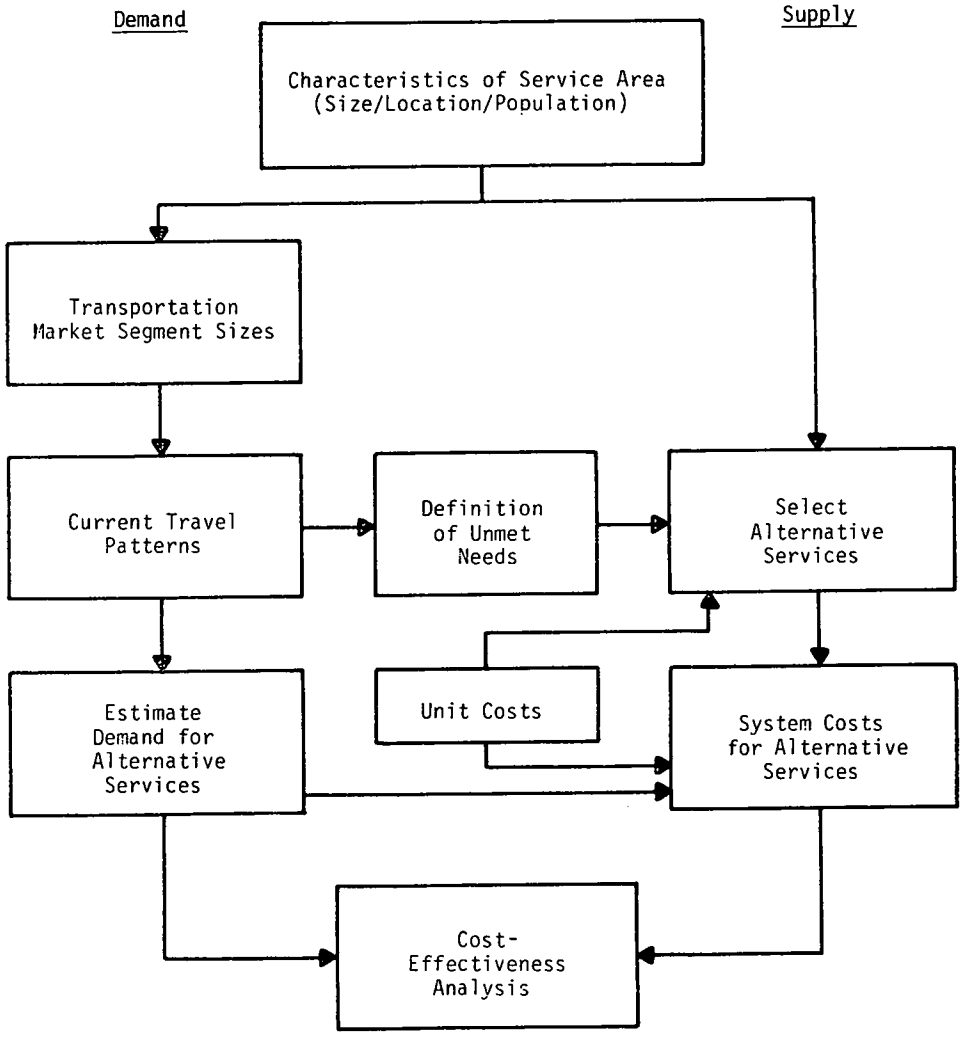


Figure 2. General steps in cost-effectiveness analysis.

CHAPTER TWO

TRANSPORTATION HANDICAPPED MARKET SEGMENTS AND THEIR TRAVEL CHARACTERISTICS

Step 1

Estimate the Transportation Handicapped Market Segments and Their Current Travel Characteristics

To design and operate cost-effective transportation services for handicapped people, the planner needs to understand the characteristics of this segment of the population. For example, the planner needs to know approximately how many handicapped persons there are in the community; where these people live; their physical capabilities and limitations; their salient social, economic, and demographic characteristics; the modes of transportation available to them; how often they currently travel; the purposes for which they make trips and the modes of transportation they currently use; their desire for travel; and the external factors that limit their ability or desire to travel.

Not everyone afflicted with a physical or mental disability or health condition has difficulty using public transportation services and facilities. Recognition of this fact has led to the use of the term "transportation handicapped person." Section 16(c) of the Urban Mass Transportation Act of 1964, as amended, defines a transportation handicapped person as: "any individual who by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability, is unable without special facilities or special planning or design to utilize mass transportation facilities as effectively as persons who are not so affected." In practice, this definition has been difficult to apply.

NUMBER OF TRANSPORTATION HANDICAPPED PERSONS BY MARKET SEGMENTS

The number of transportation handicapped persons 5 years of age or older in the United States is estimated to be 5 percent of the total population. This number is for communities of 2,500 population or more and does not include transportation handicapped individuals who are institutionalized. The percentage of the U.S. population that is 5 years of age or older is estimated to be 92.8 percent of the total population. Reference can be made to census data for a localized estimate of the percent of the population that is 5 years of age or older. Thus, for an urban area of 240,000 population the estimated number of transportation handicapped persons 5 years of age and older would be:

$$240{,}000 \times 0.928 \times 0.05 = 11{,}136$$

Table 1 gives the percentage of the population that is transportation handicapped by region of the country. The percentage varies from a low of 3.9 percent in the North Central region to a high of 7.6 percent in the Southeast region. Thus, for an urban area of 240,000 population that is in the State of Arizona, which is in the mountain region, the estimated number of transportation handicapped persons would be:

$$240{,}000 \times 0.928 \times 0.071 = 15{,}813$$

This number of 15,813 is the estimate for the number of transportation handicapped persons who are 5 years of age or older and are not institutionalized.

Table 2 gives the percentage of the transportation handicapped population that can be classified as slightly, moderately, or severely handicapped. Fifty-one percent of the transportation handicapped population is considered to be slightly handicapped. These are individuals who have a little more difficulty using public transportation than do persons who are not handicapped. The moderately handicapped

Table 1. Percentage of population 5 years of age or older who are transportation handicapped by census geographic region.

Northeast - 4.4%	North Central - 3.9%
Connecticut	Illinois
Maine	Indiana
Massachusetts	Iowa
New Hampshire	Kansas
New Jersey	Michigan
New York	Minnesota
Pennsylvania	Missouri
Rhode Island	Nebraska
Vermont	North Dakota
Southeast - 7.6%	Ohio
Delaware	South Dakota
District of Columbia	Wisconsin
Florida	South Central - 6.1%
Georgia	Alabama
Maryland	Arkansas
North Carolina	Kentucky
South Carolina	Louisiana
Virginia	Mississippi
West Virginia	Oklahoma
Mountain - 7.1%	Tennessee
Arizona	Texas
Colorado	Pacific - 4.1%
Idaho	Alaska
Montana	California
Nevada	Hawaii
New Mexico	Oregon
Utah	Washington
Wyoming	

National Default Value = 5.0%

Source: 1977 Urban Mass Transportation Administration National Survey of Transportation Handicapped People.

Table 2. Percentage of transportation handicapped population by severity.

Slightly Handicapped[a]	Moderately Handicapped[b]	Severely Handicapped[c]
51.0	30.0	19.0

[a]Persons who have a little more difficulty using public transportation than persons who are not handicapped.

[b]Persons who can use public transportation, but only with a lot more difficulty than persons who are not handicapped.

[c]Persons who have extreme difficulty using public transportation or who cannot use public transportation at all.

Source: 1977 Urban Mass Transportation Administration National Survey of Transportation Handicapped People.

(30 percent) are those who have a lot more difficulty using public transportation than do persons who are not handicapped. The severely handicapped (19 percent) are those who have extreme difficulty using public transportation or who cannot use public transportation at all because of their disability. For an urban area of 240,000 population that is in the State of Arizona, which is in the Mountain region, an estimate of the severely handicapped population would be:

$$240{,}000 \times 0.928 \times 0.071 \times 0.19 = 3{,}004$$

In Table 3, one can find the percentage of transportation handicapped persons that have a specific type of dysfunction. As can be seen from Table 3, 5.5 percent of the transportation handicapped are wheelchair users. For an urban area of 240,000 population that is in Arizona, which is in the Mountain region, the estimated number of wheelchair users would be:

$$240{,}000 \times 0.928 \times 0.071 \times 0.055 = 870$$

As will be shown later, the number of trips made by public transportation by the handicapped decreases as the availability of an automobile increases. Thus, it is important to be able to estimate the percentage of the transportation handicapped persons that will usually have an auto available. As can be seen from Table 4, 69 percent of the moderately as well as the severely transportation handicapped population usually has an automobile available. Thus, for an urban area of 240,000 population that is in the State of Arizona, which is in the Mountain region, the estimated number of the severely handicapped population that would usually have an automobile available would be:

$$240{,}000 \times 0.928 \times 0.071 \times 0.19 \times 0.69 = 2{,}073$$

Unless there are data at the local level which indicate otherwise, a uniform distribution of handicapped individuals throughout the geographic area should be assumed for any of the categories of the transportation handicapped. For example, if 5 percent of the population resides in a section of the city, it can be assumed 5 percent of the transportation handicapped also reside there and are distributed throughout the area in proportion to the general population.

Table 3. Type of functional disability of the transportation handicapped.

Specific Dysfunction Group	Percent of Transportation Handicapped Population[a]
Wheelchair	5.5[b]
Mechanical Aids	26.1
Visual	21.0
Hearing	21.1
Other Problems	47.1

[a]These percentages add to more than 100 percent because some transportation handicapped persons have more than one type of dysfunction.

[b]Wheelchair users are assumed to be accessible bus lift users and are classified as severely transportation handicapped. Wheelchair users represent 30 percent of the total severely handicapped market segment.

Source: 1977 Urban Mass Transportation Administration National Survey of Transportation Handicapped People.

Table 4. Auto availability for transportation handicapped.

	Moderately Transportation Handicapped Population (%)			Severely Transportation Handicapped Population (%)		
	Low	High	Average	Low	High	Average
Auto Usually Available[a]	52	86	69	56	82	69
Auto Usually Not Available	48	14	31	44	18	31
	100	100	100	100	100	100

[a]"Auto available" means as a driver or as a passenger.

Source: Portland and Dayton Surveys.

LOCATION OF TRANSPORTATION HANDICAPPED FROM CENSUS DATA

The 1980 census obtained data on the incidence of public transportation disability. Summary Tape File 3A and the PHC80-2 series of printed reports from the 1980 census contain tabulations of the estimated number of people with a public transportation disability in each census tract. The Census Bureau defined a public transportation disability as any physical, mental, or other health condition lasting 6 months or longer that either limits or prevents a person from using public transportation. Thus, the census data do not include transportation handicapped people with temporary physical, mental, or other health conditions such as pregnancy or a broken bone that is expected to heal normally. The census data also exclude transportation handicapped persons who are inmates of institutional group quarters such as homes, schools, hospitals, or wards for the physically handicapped; homes, schools, hospitals, or wards for the mentally handicapped; psychiatric hospitals or wards; hospitals or wards for tubercular patients; hospitals or wards for the chronically ill; and nursing, convalescent, and rest homes for the aged and dependent. The census tract tabulations of persons with public transportation disabilities are stratified into two age groups: 16 to 64, and over 65. Thus, the 1980 census does not provide any statistics on transportation handicapped persons between the ages of 5 and 15.

Despite some of these limitations, planners can use the results of the 1980 census to determine the geographic distribution of transportation handi-

capped persons within their urbanized area. As an example of how this can be done, consider an urban area of 240,000 population in the State of Arizona. It was shown earlier that this urban area would contain an estimated 15,813 transportation handicapped persons 5 years of age or older. Suppose that the 1980 census data for this urban area show that there are an estimated 12,285 persons 16 years of age or older with a public transportation disability and that 157, or 1.28 percent of these 12,285 people, live in census tract number 10. The planner could assume that 1.28 percent of the 15,813 transportation handicapped persons 5 years of age or older in the urban area also live in census tract number 10. Thus, the estimated number of transportation handicapped persons in census tract number 10 would be:

$$15,813 \times 0.0128 = 202$$

The same procedure could be carried out for each of the other census tracts in the urban area. Thus, if the 1980 census data indicate that 206, or 1.68 percent, of the 12,285 persons with a public transportation disability live in census tract number 42.01, the estimated number of transportation handicapped persons 5 years of age or older in that census tract would be:

$$15,813 \times 0.0168 = 265$$

The 1980 census statistics on persons with a public transportation disability are available either on magnetic tapes or in printed reports. The Summary Tape File 3A series of tapes were issued in late 1982. Tapes were issued separately by state. Planners can purchase the tapes for their State at $140 per reel from the Data User Services Division of the Census Bureau. Alternatively, planners may be able to obtain computer printouts of the tabulations from their State Data Center, the repository of 1980 census products for their state. The PHC80-2 series of printed reports is tentatively scheduled to be released starting in mid-1983. A separate report will be issued for each SMSA. When they become available, planners can order them from the Government Printing Office.

If the census data are not available to the planner, or if a decision is made not to use the census data, the most practical alternative is to assume that the local transportation handicapped population is geographically distributed in the same proportion as the total population.

CURRENT TRAVEL CHARACTERISTICS

Table 5 indicates the current daily frequency at which different market segments of the transportation handicapped population travel via all modes of transportation. It shows, for example, that a severely transportation handicapped person who usually does not have an auto available makes approximately 0.6 trips per day. A severely transportation handicapped person who usually has an auto available generally makes between 0.7 and 1.0 trips a day. The best estimate of the average daily trip rate of severely transportation handicapped people is about 0.6 trips per person per day for those who usually do not have an auto available and 0.9 trips per person per day for those who usually do.

The trip rates in Table 5 can be used to estimate the total daily number of trips currently being made by all transportation handicapped persons within a given market segment. For example, if there were 2,000 severely transportation handicapped persons usually without automotive transportation in a community, a low estimate of the total number of trips currently being taken by these people on a typical day would be:

$$2,000 \times 0.6 = 1,200$$

Two of the often proposed solutions to the transportation problems of transportation handicapped people involve existing modes of public transportation. Under one solution, existing fixed-route, fixed-schedule bus systems serving the general public would be modified to make them more accessible to transportation handicapped people. The other solution involves giving individual subsidies to transportation handicapped persons, enabling them to use other available services at a lower fare. Table 6, in conjunction with Table 5, can be used to estimate how often transportation handicapped people currently use these two modes of transportation.

Table 6 shows the extent to which transportation handicapped people currently use local bus services. Because severely transportation handicapped people by definition are physically unable to use conventional public transit, they currently make few bus trips. Moderately transportation handicapped persons who usually do not have autos available make about 21.5 percent of their current trips by bus, while those who usually have autos available use a bus for about 3.9 percent of their trips.

As an example of how to apply the percentages in Table 6, consider an urbanized area with 4,000 moderately transportation handicapped people who usually have autos available when they want to travel. Table 5 indicates that these people currently make an average of 1.4 trips per person per

Table 5. Current trips* per person per day by market segment.

Market Segment	Current Trips Per Person Per Day: Low Estimate	High Estimate	Average Estimate
Severely Transportation Handicapped			
• Auto usually available	0.7	1.0	0.9
• Auto usually not available	0.6	0.6	0.6
Moderately Transportation Handicapped			
• Auto usually available	1.2	1.6	1.4
• Auto usually not available	0.9	0.9	0.9

*Trips are one-way.

Source: Synthesis of planning studies.

Table 6. Current modal split.

Current Modal Split--Dayton	Severely Transportation Handicapped (%): With Auto	Without Auto	Moderately Transportation Handicapped (%): With Auto	Without Auto
Auto	88.3	71.0	84.9	61.5
Bus	3.0	8.1	3.9	21.5
Taxi	0.5	4.7	0.1	3.1

Source: Dayton Survey.

day. Altogether, they make 5,600 trips a day (4,000 x 1.4 = 5,600). Table 5 shows that these people generally use the local bus service for 3.9 percent of their trips. Thus, the bus trips per day for these people are:

$$5{,}600 \times 0.039 = 218$$

Table 7 shows the percentage of travel by trip purpose for the severely and moderately transportation handicapped stratified by auto availability. The number of daily medical trips made by 4,000 moderately transportation handicapped persons without autos available would be:

$$4{,}000 \times 0.9 \times 0.134 = 482$$

Once the number, location, and current trip-making characteristics for the transportation handicapped have been defined, one should define the existing providers that are serving the mobility needs of this group and define unmet needs.

Table 7. Percentage of travel by trip purpose.

	Trip Severely Handicapped		Trip Moderately Handicapped	
	With Auto	Without Auto	With Auto	Without Auto
Work and School	19.9	16.2	21.8	18.0
Shop and Personal Business	41.9	40.7	40.5	35.8
Medical	11.0	4.7	7.9	13.4
Social-Recreational-Religious	25.3	37.2	26.6	32.8
Other	1.9	1.2	3.2	0

Source: Dayton Survey.

CHAPTER THREE

SERVICE PROVIDERS AND UNMET NEEDS

Step 2

Obtain Background Information on Existing Service Providers and Unmet Needs

DATA NEEDS

The following material presents some of the more important data items that are needed for adequate transportation handicapped planning. Care should be exercised in tailoring the data collection effort to the level of analysis required and availability of data previously collected in the local area. It is important that, whenever possible, a planner make maximum use of local data rather than the generalized data presented or default values. Locally derived data are especially important when developing specific programs and budgets. As a minimum, it is recommended that planners consider conducting the following two inventories:

1. Inventory of Existing Providers. A survey can be conducted by a local planner to define the present levels of transportation services being provided to the transportation handicapped. Depending on the analysis to be conducted, the survey can be brief, such as defining the number of transportation handicapped trips carrried per day in order to estimate the extent of unmet needs. Comparison of specific service characteristics between different providers, such as hours of service, client eligibility, area of service, etc., can be used to define specific gaps in service. If consideration is being given to selecting a particular operator to provide service under contract to a transit agency or to redefining service arrangements among existing providers, more detailed cost and operational data will be required.

2. Unmet Needs. A survey can be conducted by a local planner to ascertain the need for providing additional transportation handicapped services. The definition of need can help establish priorities for refining existing services or expanding services.

Only in unusual situations is it practical to develop a unique data set for the transportation handicapped in an urban area. If resources permit and if it is politically necessary to have a local data base, considerations can be given to collecting the information outlined in Table 8.

Table 8. Types of data to be collected to describe the handicapped travel market.

Information	Example	Potential Application	Presentation of Default Values in "User's Guide"
Socioeconomic data	• Residential location	• Location of transportation handicapped in the urban area	• Uniform Distribution
	• Transportation handicapped		• Table 3
	• Auto availability	• Availability of travel by auto	• Table 4
Ability to use various transportation modes	• Difficulty in using public transportation	• Defines market segments	• Table 2
Current travel characteristics	• Daily travel	• Trip rates	• Table 5
		• Current mode split	• Table 6
		• Percentage of travel by purpose	• Table 7
		• Service utilization rates	• Tables 16 and 17
	• Desire for additional travel	• Latent demand	• Chapter 5
Physical problems and mechanical aid requirements	• Use of wheelchair, walker, etc.	• Need for supporting training programs, etc.	• Table 3
		• Need to consider specific barriers such as curbs, sidewalks, etc.	

INVENTORY OF EXISTING PROVIDERS

Planning for transportation handicapped services should involve comparing the mobility needs of the transportation handicapped population with the available supply of transportation services. Since a community's present transportation resources might include combinations of human service agencies, taxi operators, volunteer organizations, and/ or public and private transit operators, it is important to define the role of each provider in meeting transportation handicapped mobility needs and to determine the extent to which transportation handicapped needs are being met.

A provider inventory can be approached as an estimation procedure to define the extent and magnitude of resources being devoted to handicapped mobility needs. The provider inventory can also present a rough appraisal of the number of transportation handicapped persons who seek additional travel not currently being provided by existing providers.

Table 9 outlines suggested data items to be collected as part of the inventory. Collection of a specific data item will depend on potential use and the information can be grouped into three analysis levels, noted as follows:

1. A general analysis defines data items required to describe the current level of transportation services being provided to the transportation handicapped. Information is used in defining current level of unmet needs and basic community transportation handicapped resources.
2. General characteristics of service providers define data items required to describe specific gaps in service due to trip restrictions, hours of service, geographic coverage, client eligibility definitions, lack of providers, etc. Some data items are also useful in a system design such as average hourly vehicle productivity for specialized services.
3. Specific characteristics of service providers define data items required to evaluate the potential for undertaking a study of coordinating or consolidating services.

UNMET NEEDS

Prior to initiating any new services, the planner should assess unmet needs. Ultimately, support for expanding or improving transportation handicapped services should come from an understanding of unmet needs. Unmet needs are not necessarily equated to specific trip-making activities; rather,

Table 9. Suggested data to be collected in a provider inventory.

General Analysis

1. Client eligibility definition.
2. Transportation handicapped ridership, by day, client group.
3. Number and type of vehicles operated. Other transportation arrangements such as backup volunteers, contracting services for others, etc.
4. Geographical service area and presence of ordinances or other restrictions limiting services to specific areas, operating patterns, or clients.

General Characteristics of Service Providers

1. Service area and location of services in relationship to major generators frequented by the transportation handicapped such as social service agencies, hospitals, medical complexes, major commercial and employment areas.
2. Type of service (door-to-door, fixed-route, etc.).
3. Method of user activation (demand-responsive, fixed-schedule).
4. Assistance on vehicles, availability of lifts.
5. Reservation time required, if any.
6. Special equipment on vehicles, such as lifts, radio, etc.
7. Service hours.
8. Extent of service refusals.
9. Fare levels.
10. Special services provided to transportation handicapped such as fare reductions, specialized training programs, and bus shelters.
11. General measures of service productivity such as average daily trips per vehicle-hour or average daily lift boardings per accessible bus.
12. Status of community facilities to support accessible bus service such as curb cuts.

Specific Characteristics of Service Providers

1. Type of service (routes can be displayed on a map). Scheduling, by area and/or day of week, where applicable. Hours and days of operation. It is especially useful to indicate periods of nonutilization or low utilization (e.g., midday slack for a sheltered workshop).
2. Vehicle condition, accumulated mileage, and age. Maintenance arrangements.
3. Number of drivers (part- and full-time). Funding source that pays them. Duties, including nontransportation ones. Training requirements. (i.e., chauffeur's license).
4. Transportation budget breakdown. Itemize annual operating expenses.

Source: Synthesis of planning studies for the transportation handicapped.

they are more of a perception of desires for travel by the transportation handicapped group that are currently not being served adequately. One means of collecting this information is through a systematic process interviewing human service agencies.

Unmet needs will be reflected by gaps and shortfalls existing in the provision of transportation handicapped services. Specific information should be obtained on the nature of the unmet needs such as: (1) services are not being provided to a particular client group; (2) hours of travel that do not overlap with service hours; or (3) trip demands extending beyond the service area. Unmet needs then help set priorities for refining existing services or establishing additional services.

Before considering the provision of new transportation options for improving the mobility of the transportation handicapped, it is desirable to determine approximately the number of unmet trips. First, the overall travel needs of the transportation handicapped can be defined from Worksheet A, in Appendix A. If desired, these can be stratified by degree of handicap. Based on default values, the percentage of these transportation handicapped trips accommodated by private vehicle, either as a driver or rider, can be calculated. Transportation handicap travel data, described in Table 6, suggest that between 61.5 and 88.3 percent of the transportation handicapped trips are accommodated by private vehicles. Subtracting vehicle driver and vehicle passenger trips from total trips determines the number of trips that should be made by bus, taxi, specialized service, and other means. Aggregate transportation handicapped ridership data collected from the provider inventory yield an approximate estimate of the number of these trips that are actually accounted for.

In developing this approximate comparison, it is important to make sure the records represent one-way trips and the ridership reflects an average day's conditions. The residual trips (i.e., total trips less private vehicle trips and those identified in the provider inventory) yield a rough estimate of the potential number of unmet trip needs. An analysis of unmet needs can help define critical gaps in the mobility provided to transportation handicapped persons and will then form a basis for selecting the transportation service options to be selected as described in Chapter Four. Unmet needs can also provide a check on the level of transportation handicapped trips identified in the social service provider inventory. Any large discrepancy means either underreporting or a deficiency in travel services. Discussions with social service agencies should provide clarification of which is a more reasonable interpretation if such discrepancies should appear.

EXAMPLE PROBLEM OF DETERMINING UNMET NEEDS

A town of 57,100 population provides specialized services for its elderly and handicapped citizens. The city operates two hightop mini-vans approximately 6 hours per day, 5 days per week, with a daily ridership of 46 trips. Assume that 3.0 percent of the riders could be categorized as severely transportation handicapped and 5.0 percent could be categorized as moderately transportation handicapped. A recent inventory of transportation service providers indicates that transportation handicapped services are being provided only by the Cerebral Palsy Center, serving 24 daily trips for the severely transportation handicapped; the Mental Health Center, serving 5 daily trips for the severely transportation handicapped; the Senior Citizens Center, serving 30 daily trips for the moderately transportation handicapped; and RSVP serving 11 daily trips for the transportation handicapped, with 80 percent judged to be moderately transportation handicapped individuals. In addition, the taxicab companies operate 12 vehicles with a ridership of 250 daily trips; about 12 percent of the taxi users are considered to be transportation handicapped (2 percent severe, 10 percent moderate).

Define the extent of unmet needs by filling out Worksheet A. It is known from a recent phone survey that 40 percent of the transportation handicapped generally do not have an auto available.

Table 10 provides an estimate of unmet trips that can then be addressed by the service options discussed in Chapter Four. It is seen from Table 10 that the unmet trip needs of the severely transportation handicapped are approximately 42 trips per day and those of the moderately transportation handicapped are approximately 185 trips per day.

One now should investigate the service alternatives that would be candidates for serving these unmet trip needs.

Table 10. Estimation of unmet needs.

WORKSHEET A--ESTIMATION OF UNMET NEEDS

1. Estimated Population in Service Area: 57,100

		Severely Transportation Handicapped	Moderately Transportation Handicapped
2.	Incidence Rates (Table 2)	.19 x .05	.30 x .05
3.	No. of Individuals (1 x 2)	542	857
4.	Auto Available*	60%	60%
5.	Trip Rate** (see Table 5)[a]	.78	1.2
6.	Estimated Total Needs Trips (3 x 5)	423	1,028
7.	Trips Taken as Auto Driver/Passenger* (see Table 6)[b]	344	777
8.	Estimated Trips Not Made By Auto** [6 - 7][a]	79	251
9.	No. of Estimated Trips by*		
	a. Regular Bus	1	2
	b. Taxi	5	25
	c. Social Service	31	39
10.	Total Additional Trips Needed (unmet needs) [8 - (9a + 9b + 9c)]	42	185

*Based on local knowledge and provider inventory.

**Weighted average of auto available and auto not available trip rates.

[a]For example, the average trip rate for severely transportation handicapped from Table 5 was .9 for "auto usually available" and .6 for "auto usually not available." Since 60 percent of the severely transportation handicapped were found to have an auto available, the weighted average trip rate was .78 trips.

[b]Without local data, default values of Table 6 were applied since 88.3 percent and 71.0 percent of the trips made by the severely transportation handicapped "with an auto" and "without an auto," respectively, are made by auto. The weighted average of percent trips taken by auto is .883(.60) + .710(.40) or .812.

CHAPTER FOUR

ALTERNATIVE PUBLIC TRANSPORTATION SERVICES FOR THE HANDICAPPED

Step 3

Select Alternative Transportation Service to be Evaluated

- Accessible Fixed-Route, Fixed-Schedule Bus
- Specialized Door-to-Door Services
- User-Side Subsidies
- Hybrid Designs and Combination

Several general approaches to solving the transportation problems of transportation handicapped people are available to local communities. The more common approaches taken include the following:

- Fixed-route, fixed-schedule transit services made accessible to handicapped people.
- Special, fully accessible, specialized transportation services.
- Individual subsidies to transportation handicapped persons to help them pay for transportation services such as taxis.
- Various combinations of the foregoing approaches.

In considering the various service options, the planner should be cognizant of the specific attributes of each service option as well as the characteristics of the different market segments. Some of the more important attributes of various service options are provided in the following discussion.

ACCESSIBLE FIXED-ROUTE, FIXED-SCHEDULE BUS SYSTEMS

The concept of an accessible fixed-route, fixed-schedule bus system often brings to mind the image of buses with wheelchair lifts. Lift-equipped vehicles, however, are only one component of an accessible bus service. Other elements of an accessible bus system include:

- Accessible bus stops.
- Transit facilities intended for the use of the general public.
- Parking areas at park-and-ride lots.
- Transit marketing and information systems.
- Appropriate vehicle operating policies and procedures.
- Driver training.
- User training.
- Marketing programs.
- Other transit service programs, policies, and practices such as maintenance of the lifts and other special equipment.

If any of these elements make it impossible for some transportation handicapped people to use the bus system, the system is inaccessible to those individuals. Furthermore, an accessible bus system may not be fully accessible to all transportation handicapped people because of numerous other physical, economic, and psychological barriers beyond the control of the transit operator.

Approximately 30 percent of the severely transportation handicapped market can access a fixed-route, fixed-schedule bus if the bus is lift-equipped. These individuals would be able to get on and off a bus, walk more than two or three blocks, and stand and wait for more than 10 minutes. Moderately transportation handicapped persons can normally access a fixed-route, fixed-schedule bus with minor modifications such as handrails, grab bars, nonslip floors, and/or kneeling features. Through specialized training, approximately 89 percent of all mentally retarded persons should be able to learn how to use existing transit services.

SPECIALIZED TRANSPORTATION SERVICES

Specialized transportation services have been defined as those forms of intraurban passenger transportation that:

- Can accommodate or are specifically designed for handicapped people.
- Are distinct from conventional fixed-route, fixed-schedule bus service.
- Can operate over existing streets and highways.

They usually provide door-to-door transportation, thereby mitigating or eliminating the problems of getting to the vehicle from the trip origin and from the vehicle to the trip destination. Specialized services are often called demand-responsive transportation services because, unlike conventional fixed-route, fixed-schedule bus systems, they usually operate by responding to requests for service.

There are many alternative forms of specialized transportation services and many alternative ways of providing them. The following list suggests some of the more important ways in which existing specialized transportation services differ from each other:

- Routing.
- Trip reservation and scheduling.
- Types of trips served.
- Persons eligible for service.
- Size of service area.
- Fleet size and composition.
- Personal assistance.
- Fares.
- Service management.

All members of the moderately and severely transportation handicapped markets can use specialized services providing the vehicle is lift-equipped and personal assistance is available in certain instances.

USER-SIDE SUBSIDY PROGRAMS

The third major alternative way of improving the mobility of transportation handicapped people is to provide them with individual subsidies that allow them to purchase available transportation, usually from private carriers, at reduced fares. Because the users, rather than the providers of transportation, are subsidized under this approach, this form of subsidy is referred to as a user-side subsidy. Persons eligible for the subsidy pay only a portion of the full fare for the trips they take via the participating transportation providers. The latter are then reimbursed for the remainder of the fare by the subsidizing agency. In most cases to date, the carriers have consisted of taxicab companies, although in a few instances other types of private transportation service providers have also been involved.

One of the chief advantages of user-side subsidies over the more traditional method of subsidizing transit providers is that the subsidizing agency does not spend any funds for unused capacity or service. The total subsidy depends on the demand for the available transportation services. If the demand is low, the cost of subsidizing the travel of eligible persons will also be low.

User-side subsidies can be beneficial for both the users and the participating service providers. They can lower the cost of travel to handicapped people, thereby enabling these people to travel more often. To the extent that the subsidies generate trips that otherwise might not have been taken, they can increase the revenues of the participating private carriers.

Like specialized transportation services, user-side subsidy programs have many variations. Various aspects of the user-side subsidy alternative are:

- Subsidy mechanism.
- Fares and amount of subsidy.
- Group riding policies.
- Restrictions on use.
- Advance reservations requirements.
- Service area.
- Persons eligible for service.
- Accommodation of wheelchair users.
- Personal assistance.
- Availability of administration agencies.
- Availability of service providers.

One of the drawbacks of many user-side subsidy programs has been their inability to accommodate all

wheelchair users. Some wheelchair users are physically unable to transfer from their wheelchairs and, therefore, cannot travel in taxicabs. Many user-side subsidy programs have not made special provisions for these people. Nevertheless, there are a few exceptions. To provide service effectively to all market segments, a supplemental lift-equipped vehicle must be available. Even without lift-equipped vehicles, 80 percent of the severely transportation handicapped, and all of the moderately transportation handicapped, markets can use taxis.

SUMMARY

Not everyone with a physical disability or a health condition has trouble using public transportation. Planners, therefore, need to segment the transportation handicapped population from the handicapped population in general. The transportation handicapped population consists of people who have difficulty using public transportation because of a physical disability or limitation. These people are not always easy to identify. Criteria have had to be established for determining whether or not a person is transportation handicapped and, therefore, eligible for a specialized transportation service or for a reduced fare on either the buses or the private provider services. Some agencies have established more elaborate criteria than others. Many of them require a physician's certification, although some transit agencies will also accept the certification of a social service agency.

It is important for planners to recognize that transportation handicapped people differ considerably in their ability to use public transportation. In evaluating alternative transportation services, planners should consider the characteristics and mobility limitations of the various market segments. Various relatively inexpensive improvements to the transit system (i.e., vehicles, operation, and user training) may greatly benefit many moderately transportation handicapped individuals, while a specialized transportation service may prove to be more cost-effective for the severely transportation handicapped.

CHAPTER FIVE

DEMAND FOR ALTERNATIVE TRANSPORTATION SERVICES

Step 4

Estimate Demand for Alternative Transportation Services Selected

ESTIMATING THE DEMAND FOR TRANSPORTATION

Planners can estimate the demand for alternative transportation services by transportation handicapped persons in one of two ways. The first approach is based on an analysis of the latent demand for transportation. The latent demand is the potential number of trips that could be made by transportation handicapped people who cannot now travel as frequently as they desire because existing modes of transportation are either inconvenient or unavailable to them or because they are physically unable to use existing modes of transportation. The second analytical approach is based on an analysis of the use of existing transportation services designed for transportation handicapped people.

Statistics on the use of various transportation services for transportation handicapped people may give planners a good indication of the amount of ridership that can be expected, based on past and current experience. Past and current utilization has generally been quite low. This does not mean, however, that all existing transportation services for transportation handicapped people have reached their potential levels of ridership. Many existing transportation services are still fairly new, and ridership is still growing. Service providers may also be able to achieve higher levels of ridership through better marketing, management, and levels of service. Planners, therefore, can use existing utilization statistics to determine the amount of ridership that can reasonably be achieved but cannot necessarily determine the maximum ridership attainable.

Planners may use one or both approaches to determine the demand for alternative transportation services. Because the latent demand analysis is more theoretical, it should be used in conjunction with utilization statistics. The two techniques combined can indicate the upper and lower limits of the demand.

The two methods of travel demand estimation are described as follows.

LATENT DEMAND ANALYSIS

Some of the proposed solutions to the transportation problems of transportation handicapped people involve existing transportation services, while other solutions involve entirely new services. Therefore, the trips made by transportation handicapped people on a new or modified service must be divided into three types:

- Current trips, or trips that were already being made via the transportation service.
- New trips, or trips that were not made by any mode of transportation before the transportation solution was implemented.
- Diverted trips, or previously made trips that were diverted to the new or improved transportation service from other modes.

The total trips taken on a transportation service for transportation handicapped people are the sum of the current trips, the new trips (i.e, latent demand), and the diverted trips. Procedures for estimating the numbers of current, new, and diverted trips are described next.

Current Trips

The estimation of current trips per person per day by market segment is given in Table 5.

New Trips

Table 11 can be used to estimate the number of new trips that would be made if various transportation solutions were implemented. It shows, for example, that a severely transportation handicapped person who usually does not have an auto available would increase his or her tripmaking by 0.042 trips per day if the local fixed-route, fixed-schedule bus system was made accessible. The same individual would make 0.09 additional trips per day if a new specialized transportation service were provided and 0.136 additional trips per day if subsidies were provided for travel by taxi. In an urban area with 2,000 severely transportation handicapped people who usually do not have autos available, an accessible fixed-route bus system would therefore generate 84 new trips a day (2,000 x 0.042 = 84). A new specialized transportation service would generate 180 additional daily trips in this market segment (2,000 x 0.09 = 180). User-side taxi subsidies would produce 272 new trips per day (2,000 x 0.136 = 272).

Diverted Trips

In addition to inducing new travel, a transportation solution may attract some of the trips that transportation handicapped people currently make by some other mode. Table 12 provides a way of estimating how many trips would be diverted from other modes to an accessible fixed-route bus system, a specialized transportation service, or reduced-fare taxis.

As an example of how to apply Table 12, consider an urbanized area with 2,000 severely transportation handicapped people who usually do not have an auto available. Table 12 indicates that, if the local bus system were made accessible, people in this market segment would switch 14 percent of their current trips from some other mode to the accessible bus system. According to Table 5, these people as a group currently make 1,200 trips a day (2,000 x 0.6 = 1,200). Table 12 indicates that 14 percent of these trips, or 168 trips a day (1,200 x 0.14 = 168), would be diverted to the local bus system if it were made accessible. These 168 diverted trips are in addition to the 84 new or previously unmade trips generated by the accessible bus system, as was determined in the previous example.

Example Problem

Tables 13, 14, and 15 consist of completed worksheets illustrating a latent demand analysis for a particular market segment of the transportation

Table 11. New one-way trips per person per day generated by alternative transportation solutions by market segment.

Alternative Transportation Solution	Severely Transportation Handicapped		Moderately Transportation Handicapped	
	Auto Usually Available	Auto Usually Not Available	Auto Usually Available	Auto Usually Not Available
Accessible Fixed-Route Bus System	0.006	0.042	0.008	0.054
Specialized Door-to-Door Transportation System	0.013	0.090	0.017	0.115
User-Side Subsidies for Taxi Use	0.020	0.136	0.025	0.174

Source: Derived data.

Table 12. Percent of current trips diverted from other modes to alternative transportation solutions, by market segment.

Alternative Transportation Solution	Market Segment	Percent of Current Trips Diverted From Other Modes		
		Low	High	Average
Accessible Fixed-Route Bus System	Severely Transportation Handicapped			
	• Auto Usually Available	1.3	1.6	1.4
	• Auto Usually Not Available	14.0	16.3	14.0
	Moderately Transportation Handicapped			
	• Auto Usually Available	1.2	1.9	1.4
	• Auto Usually Not Available	12.6	15.8	14.0
Specialized Door-to-Door Transportation System	Severely Transportation Handicapped			
	• Auto Usually Available	1.7	4.1	2.4
	• Auto Usually Not Available	19.8	33.3	25.2
	Moderately Transportation Handicapped			
	• Auto Usually Available	1.4	3.2	2.0
	• Auto Usually Not Available	16.9	28.4	21.5
User-Side Subsidies for Taxi Usage	Severely Transportation Handicapped			
	• Auto Usually Available	0.2	1.5	0.8
	• Auto Usually Not Available	1.8	12.6	7.6
	Moderately Transportation Handicapped			
	• Auto Usually Available	0.1	1.0	0.5
	• Auto Usually Not Available	1.4	10.3	6.2

Source: Derived data.

Table 13. Estimation of the demand for accessible fixed-route bus service.

WORKSHEET B--ESTIMATION OF DEMAND: ACCESSIBLE FIXED-ROUTE BUS SERVICE

Market Segment: Severely Transportation Handicapped with Auto Usually not Available[a]

1.	Estimated number of people in the market segment	1,940
	CURRENT BUS TRIPS	
2.	Current trips per person per day (from Table 5)	0.6
3.	Total current trips per day (Line 1 x Line 2)	1,164
4.	Percent of current trips by bus (from Table 6)	0.081
5.	CURRENT BUS TRIPS PER DAY (Line 3 x Line 4 ÷ 100)	94
	NEW BUS TRIPS	
6.	New trips per person per day generated by the accessible fixed-route bus system (from Table 11)	0.042
7.	NEW BUS TRIPS PER DAY (Line 1 x Line 6)	81
	TRIPS DIVERTED TO BUSES	
8.	Percent of current trips diverted from other modes to the accessible fixed-route bus system (from Table 12)	14.0%
9.	DIVERTED TRIPS PER DAY (line 3 x Line 8 ÷ 100)	163
10.	TOTAL TRIPS PER DAY on the accessible fixed-route bus system by persons in the market segment (Line 5 + Line 7 + Line 9)	338

[a]Total demand by the severely handicapped market segment needs to include the result of the "auto usually available" segment.

Table 14. Estimation of demand for specialized door-to-door transportation service.

WORKSHEET C--ESTIMATION OF DEMAND: SPECIALIZED DOOR-TO-DOOR TRANSPORTATION SERVICE

Market Segment: Severely Transportation Handicapped with Auto Usually not Available[a]

1.	Estimated number of people in the market segment	1,940
	NEW TRIPS	
2.	New trips per person per day generated by the specialized door-to-door transportation service (from Table 11)	0.090
3.	NEW TRIPS PER DAY (Line 1 x Line 2)	175
	TRIPS DIVERTED TO THE SPECIAL SERVICE	
4.	Current trips per person per day (from Table 5)	.6
5.	Total current trips per day (Line 1 x Line 4)	1,164
6.	Percent of current trips diverted from other modes to the specialized door-to-door trans portation service (from Table 12)	25.2%
7.	DIVERTED TRIPS PER DAY (Line 5 x Line 6 ÷ 100)	293
8.	TOTAL TRIPS PER DAY on the specialized door-to-door transportation service by persons in the market segment (Line 3 + Line 7)	468

[a]Total demand by the severely handicapped market segment needs to include the result of the "auto usually available" segment.

Table 15. Estimation of demand for user-side subsidies for travel by taxi.

WORKSHEET D--ESTIMATION OF DEMAND: USER-SIDE SUBSIDIES FOR TRAVEL BY TAXI

Market Segment: Severely Transportation Handicapped with Auto Usually not Available[a]

1.	Estimated number of people in the market segment	1,940
	CURRENT TAXI TRIPS	
2.	Current trips per person per day (from Table 5)	0.6
3.	Total current trips per day (Line 1 x Line 2)	1,164
4.	Percent of current trips by taxi (from Table 6)	4.7%
5.	CURRENT TAXI TRIPS PER DAY (Line 3 x Line 4 ÷ 100)	55
	NEW TAXI TRIPS	
6.	New trips per person per day generated by the subsidies (from Table 11)	0.136
7.	NEW TAXI TRIPS PER DAY (Line 1 x Line 6)	264
	TRIPS DIVERTED TO TAXIS	
8.	Percent of current trips diverted from other modes to taxis under a user-side subsidy program (from Table 12)	7.6%
9.	DIVERTED TRIPS PER DAY (Line 3 x Line 8 ÷ 100)	88
10.	TOTAL TAXI TRIPS PER DAY under a user-side subsidy program by persons in the market segment (Line 5 + Line 7 + Line 9)	407

[a]Total demand by the severely handicapped market segment needs to include the result of the "auto usually available" segment.

handicapped population. In this case, the market segment of interest consists of severely transportation handicapped persons who usually do not have an automobile available when they want to travel. Each worksheet is designed for a specific transportation solution. Blank worksheets are included in Appendix A.

ANALYSIS BASED ON UTILIZATION STATISTICS

Table 16 gives current ranges in the use of existing lift-equipped fixed-route, fixed-schedule bus systems by wheelchair users and other severely transportation handicapped persons. Utilization or ridership in this case is expressed as the number of lift boardings per day per lift-equipped bus. The average rate of use depends on the number of lift-equipped buses in the fleet. Thus, a fixed-route, fixed-schedule bus system with only 20 lift-equipped buses will carry, on the average, about 5 lift user trips a day (20 x 0.24 = 4.8).

The utilization rates in Table 17 can be used to estimate daily ridership on new, specialized transportation systems. These rates reflect the range of experience of a number of existing specialized transportation services. A special transportation system designed to serve 2,000 severely transportation handicapped people, for example, could attract as few as 20 riders a day (2,000 x 0.01 = 20) or as many as 260 passengers (2,000 x 0.13 = 260). Based on the average experience of existing services, it can be expected to carry 140 riders a day (2,000 x 0.07 = 140). It is assumed

that moderately transportation handicapped currently can utilize fixed-route bus service and, thus, they are not included in the demand analysis.

SELECTION OF DEMAND ESTIMATES

The latent demand estimate, based upon a theoretical analysis, and the utilization rates, based on actual operating experiences, will not agree. Generally, latent demand tends to provide higher demand estimates than utilizations observed by operating systems. Latent demand usually can be viewed as an ultimate or long-range potential, while utilization might give a better indication of what can be expected in the short run. Based upon local experiences, a planner should select the most appropriate demand estimate for the area. For example, the inventory of service providers might provide an indication of how the current transportation handicapped services are being used and of whether the high, low, or average utilization rate appears to reflect the local situation best. In making this determination, the planner must reflect on the size of unmet needs and the service levels provided.

Without access to local experience, a judgment needs to be applied. If a comprehensive, well-funded, and extensively marketed system is to be deployed with widespread local support, the latent demand or high utilization rate might be applied. Likewise, a partial service with many travel restrictions, poorly organized service, or service being added to an area that is already served well by other transportation providers, a low utilization rate might be most appropriate. Lacking any definitive insight, the planner could use the average utilization rate as a default estimate.

In the examples just completed, it was estimated that the latent demand for specialized door-to-door services by 1,940 severely transportation handicapped individuals with autos usually not available was 468 new trips per day. If the analysis was repeated for 1,940 severely transportation handicapped individuals with autos usually available, the total latent demand would be 468 + 67 = 535 new trips per day. The equivalent low (3,880 x .01 = 39), high (3,880 x .13 = 504), and average (3,880 x .07 = 271) utilization rates would be 39, 504, and 271, respectively. While the selection of an appropriate demand value is the judgment of a local planner, the analysis does provide some limits on the range of ridership levels to be expected. In the demand analysis, no feedback was provided between ridership, fares or service levels.

Now that the demand has been estimated for a given alternative transportation service or combination of service options, unit cost data are provided in Chapter Six for use in conducting a costing analysis as described in Chapter Seven.

Table 16. Utilization of accessible fixed-route bus systems by wheelchair users and other severely transportation handicapped persons.

Number of Lift-Equipped Buses	Lift Boardings Per Day Per Lift-Equipped Bus		
	Low Estimate	High Estimate	Average Estimate
25 or less[a]	0.00	1.33	0.24
Greater than 25	0.01	0.33	0.20

[a]Data reported by smaller operators indicated different experiences with lift boardings. Use of 25 or less vehicles was based on clustering of data.

Source: Synthesis of experiences of existing specialized transportation services.

Table 17. Utilization of new, door-to-door specialized transportation services and user-side subsidies for use of taxi services.

Market Segment	Special Service Trips Per Person Per Day		
	Low Estimate	High Estimate	Average Estimate
Severely Transportation Handicapped	0.01	0.13	0.07
Moderately Transportation Handicapped	0.002	0.10	0.02

Source: Synthesis of experiences of existing specialized transportation services.

CHAPTER SIX

UNIT COST DATA

Step 5

Determine Unit Cost of Operating a Particular Transportation Service

PROBABLE COST

This chapter presents decision variables that will enable the planner to predict probable costs for providing transportation service to the transportation handicapped. The cost estimator is expected to provide an estimate of the probable cost of providing specialized services and/or the incremental cost of providing accessible fixed-route, fixed-schedule transit service as tailored to the characteristics of a local area. The term probable cost should include general management and staffing of the dispatching function as well as drivers, maintenance workers, and support personnel for vehicle operation for all transportation services. The establishment of certification criteria and the processing of candidates for service are not included as cost items.

ACCESSIBLE BUSES

The incremental costs of providing transportation services to the handicapped by existing bus systems include the following categories of cost:

1. Unit cost of lift and modifications to aid the mobility impaired.
2. Lift annual maintenance and inspection.
3. Additional operating costs--training, advertising and promotion, insurance, additional equipment, and road service (optional).

Unit Cost of Lift and Modifications to Aid the Mobility Impaired

Though the cost of providing lifts and auxiliary modifications is not generally specified separately by the supplier of new equipment, recent telephone contacts with manufacturers have indicated a highly competitive pricing policy. A suggested $13,000 initial cost is a realistic value in today's (1982) market. If the alternatives under consideration involve ordering buses with or without lifts, a planner could obtain current values directly from the suppliers (see Table 18).

Table 18. Unit cost for lift equipment--1982.

Manufacturer:	General Motors	$10,000
	Grumman Flxible	13,000
Retrofit:[a]	EEC Retrofit	$12,000
	TDT Retrofit	10,000
	Lift U	11,500

ANNUAL UNIT COST

Low	Best Value	High
1,000	1,300	1,300

Note: These values are based on 10-year estimated life and zero salvage value.

[a]Few buses will be retrofitted in the future. It is expected that new equipment with and without lifts will be the alternative choice.

Source: Lift manufacturers.

The range of values for retrofitting existing buses was found to be much wider than that for similarly equipping new units. However, two of the four suppliers with established reputations for reliability of lift units are in the suggested best value range. If more precise input pricing information is desired, suppliers will provide current information on being furnished the make and model of the equipment to be retrofitted, the proposed location of the lift, and a list of other mobility aid devices to be added.

Lift Annual Maintenance and Inspection

Reported costs vary from a low of $427 per bus per year in Seattle to a high in excess of $4,000 per bus per year in San Diego. The units supplied to early lift-equipped transit systems were not reliable. They required frequent enroute service and daily inspection. Both manufacturers and maintenance personnel have experienced a learning curve. The most recent reported comparable experiences range from $162 to $840 per vehicle per year. The Champaign-Urbana experience (rounded to the nearest $50) is suggested as a best value (see Table 19).

Additional Operating Costs

No evidence was found to indicate widespread driver wage increases attributable to incorporation of lift operation into the driver job duties. However, all systems have recognized the need to train drivers in the operation of lifts and kneeling features when they drive buses so equipped. In addition, some systems have provided sensitivity training for drivers. The suggested value of $250 per vehicle should provide at least 5 hours per year of instruction per driver, including both training personnel and driver time (based on two drivers per vehicle at $10/hr each, i.e., $100 for wages and $150 for training personnel and materials).

Advertising and promotion of the routes on which accessible buses are operating can involve either only the publishing of schedules or extensive public relations programs. Actual costs have ranged from $15 to $89 per lift. The selection of $50 per bus as the appropriate value for advertising and promotion should be tempered with the planner's judgment and the experience of the system in introducing other new service features.

The incidence of lift-related injuries is insufficient to establish an insurance cost increase increment for the addition of the lift. However, there have been several suits and personal injury awards. Premiums have not isolated the cost for lift liability insurance. Furthermore, the safety of lifts has improved along with the improvement in design, ease of operation, and level of maintenance required. The nominal value of $25 per lift-equipped vehicle seems appropriate for the level of risk involved (see Table 20).

The need for additional equipment as a result of extending schedules to compensate for the increased boarding time of mobility handicapped and wheelchair-bound bus riders is a cost that many transit operators expected to be formidable. However, the low level of ridership by this submarket of the transportation handicapped has resulted to date in little impact on route schedules. Should this potential cost item deserve attention,

Table 19. Lift maintenance and inspection costs of individual accessible fixed-route bus systems.

System	Annual Maintenance Cost per Lift
Champaign-Urbana, Illinois	$ 669
Connecticut Transit	552
Palm Beach County, Florida	840
St. Louis	
8/77-8/78	2,016
9/78-6/79	2,268
Seattle	427
Detroit	162
Los Angeles	
200 lift-equipped buses	6,100
1,370 lift-equipped buses	4,015
San Diego	4,200
Denver	260

Source: Spear et al. [1981]; Rosenbloom [1981]; Urbanik and Soegaad [1981]

Table 20. Annual additional operating cost bus.

Cost Element	Low	Best Value	High
Training	$30	$250	$350
Advertising and Promotion	15	50	89
Insurance	0	25	100
Total		$325	

Source: Spear et al. (training) [1981] and Casey (advertising) [1981]

current Section 15 data available from UMTA for the appropriate urban area population size would seem useful as base data in evaluating the effect of boarding time (as in Table 21). Similarly, the increased frequency of service calls occasioned by lift failure has not represented a noticeable increase in cost for most transit operators because the frequency of lift use has been low; therefore, the necessity of repairing lifts en route has been encountered only infrequently. Service call cost is computed at one-third hour of bus operating cost from available Section 15 bus operating cost data. Maintenance labor and material are presumed to be included in maintenance values (Table 22).

Each of these elements of additional operating cost should be discussed with the local transit operator in order to obtain more area-specific costs. If no cost experience is available from the local operator, the national transit management organizations may be able to supply useful cost values and experience for a similar area.

Table 21. Transit bus operating cost.

Population	Operating Cost/Hour		
	Low	Medium	High
Over 500,000	$21.20	$24.90	$29.20
250,000 to 500,000	13.90	15.20	21.50
100,000 to 250,000	11.30	18.90	29.90
Less than 100,000	10.90	16.00	21.10

Source: Section 15 data, 1978-1979; add 21% to bring to 1982 level.

Table 22. Service call estimated cost.

Population	$/Call[a]		
	Low	Medium	High
Over 500,000	$7.10	$8.30	$9.70
250,000 to 500,000	4.60	5.10	7.20
100,000 to 250,000	3.80	6.30	10.00
Less than 100,000	2.70	5.30	7.00
Best Value:		10.00	

[a]Average call requires one-third hour substitute bus operation. Mechanic time included in maintenance.

Source: Section 15 data, 1978-1979; add 21% to bring to 1982 level.

SPECIALIZED TRANSPORTATION SERVICES

The operating cost elements of providing demand-responsive, prescheduled, or subscription specialized transportation services for the handicapped may be designated as follows:

1. Vehicle and Equipment (Capital cost)
2. Direct Operating Costs:
   a. Direct labor
   b. Fuel
   c. Lubricants, oil, and supplies
   d. Tires
   e. Maintenance
   f. Insurance
3. Indirect Costs:
   a. General and administrative salaries (include dispatching)
   b. Office supplies and services
   c. Telephone, postage, and freight
   d. Fringe benefits (including both those required by law and others provided)
   e. Rents and/or maintenance of facilities

The choice of management organization for operating and/or lead agency may make a significant difference in the cost of providing transportation service for the handicapped. As an example, the following groupings have been identified:

1. Transit agency/authority serves as both lead and operating agency.
2. Transit agency/authority serves as lead agency only.
3. City/county agency serves as lead and operating agency.
4. City/county agency serves as lead agency only.
5. Social service agency serves as lead and operating agency.

To this list one should add brokerage of transportation services by an independent private or public agency.

The cost may vary substantially depending on the lead agency and/or operating management organization. The foregoing list is in the order of descending costs found typical. Brokerage operations are most often found to be in the mid-range of the cost hierarchy (see Tables 23, 24, and 25).

Vehicle and Equipment

The opportunity for substantial variation in purchase cost exists unless specifications for vehicles and equipment are quite rigid. Available

Table 23. Cost of providing a specialized transportation service utilizing vans without lifts.

Cost Category	Low	Typical	High
Vehicle and equipment costs			
• Annualized cost	$3,760	$ 3,950	$ 4,150
• Average cost per vehicle-hour	$0.904	$ 0.950	$ 0.998
Direct operating costs (nonlabor)			
• Annual cost per vehicle			
• Fuel	$4,360	$ 4,800	$ 5,335
• Tires	480	600	680
• Oil, lubricants, and supplies	300	350	400
• Maintenance	500	600	700
• Insurance	600	710	1,200
Total	$6,240	$ 7,060	$ 8,315
• Average cost per vehicle-hour	$1.500	$1.697	$ 1.999
Direct operating cost (labor)			
• Average cost per vehicle-hour	$ 4.00	$ 6.00	$ 11.00
Indirect costs			
• Percent of total direct operating cost	25	40	50
• Average cost per vehicle-hour	$1.375	$ 3.079	$ 6.500
Total cost per vehicle-hour	$7.779	$11.726	$20.497

published data from existing operations have insufficient specificity to permit their use. In many cases operating costs do not include vehicle and equipment cost. To avoid these inconsistencies, bid specifications were developed for a 12-passenger van with heavy duty suspension, power brakes and steering, air conditioning outlets front and rear, automatic transmission, and V-8 engine. The resulting bids were averaged to obtain a purchase cost of $11,600. To this cost was added a similar bid cost for a mobile two-way radio of $900--total $12,500. For a lift-equipped van, a typical additional cost was determined to be $2,500. The resale value of the vehicle at the end of 3 years was estimated to be $3,000 (not including radio or lift), and the discount rate was 10 percent (PV = $3,355 x .7513 = 2,524). Net annualized cost is $3,950 for van alone and $4,160 for van with lift (see Appendix B for sample of this and other computations).

The range of options for small buses is much greater than for vans. As representative of the category, our bid specification was for a 10,000- to 12,000-ton gross vehicle weight truck unit of 176-in. or greater nominal wheel base, dual rear wheels, 400 $in.^3$ displacement or greater V-8 engine, power brakes, power steering, automatic transmission, air conditioning with front and rear vents, auxiliary heat in rear, 21-passenger capacity seated or 17 seated passengers plus two wheelchairs. Purchase cost was estimated at $24,100, plus mobile two-way radio at $900 and lift at $2,500. Estimated value at the end of 5 years was $5,000 (without radio and lift), and the discount rate is 10 percent. Net annualized cost was $4,520.

Table 24. Cost of providing a specialized transportation service utilizing lift-equipped vans.

Cost Category	Low	Typical	High
Vehicle and equipment costs			
• Annualized cost	$3,960	$ 4,160	$ 4,370
• Average cost per vehicle-hour	$0.952	$ 1.000	$ 1.050
Direct operating costs (nonlabor)			
• Annual cost per vehicle			
• Fuel	$4,360	$ 4,800	$ 5,335
• Tires	480	600	680
• Oil, lubricants, and supplies	300	350	400
• Maintenance	600	700	800
• Insurance	600	750	1,200
Total	$6,340	$ 7,200	$ 8,415
• Average cost per vehicle-hour	$1.524	$1.731	$ 2.023
Direct operating cost (labor)			
• Average cost per vehicle-hour	$ 4.00	$ 6.00	$ 11.00
Indirect costs			
• Percent of total Direct operating cost	25	40	50
• Average cost per vehicle-hour	$1.381	$ 3.092	$ 6.512
Total cost per vehicle-hour	$7.857	$11.823	$20.585

Table 25. Cost of providing a specialized transportation service utilizing small lift-equipped buses.

Cost Category	Low	Typical	High
Vehicle and equipment costs			
• Annualized cost	$4,305	$ 4,520	$ 4,745
• Average cost per vehicle-hour	$1.035	$ 1.087	$ 1.141
Direct operating costs (nonlabor)			
• Annual cost per vehicle			
• Fuel	$5,650	$ 6,400	$ 6,860
• Tires	700	800	900
• Oil, lubricants, and supplies	500	550	600
• Maintenance	1,000	1,300	1,500
• Insurance	1,000	1,250	1,800
Total	$8,850	$10,300	$11,660
• Average cost per vehicle-hour	$2.127	$2.476	$ 2.803
Direct operating cost (labor)			
• Average cost per vehicle-hour	$ 5.00	$ 6.00	$ 12.00
Indirect costs			
• Percent of total Direct operating cost	25%	40%	50%
• Average cost per vehicle-hour	$1.782	$ 3.390	$ 7.402
Total cost per vehicle-hour	$9.944	$12.953	$23.346

Direct Operating Costs

These costs are the readily visible day-to-day costs that are incurred to operate the vehicles.

Direct Labor

The wage rate paid the driver may vary from zero for the volunteer, to minimum wage or slightly above for many social service and/or city or county agencies, to $10 or more per hour for many urban transit agencies. Direct labor costs may be affected by work rules, especially those related to "spread time," part-time employees, or by level of assistance drivers may provide. The latter items primarily affect productivity and are, therefore, not considered as direct cost items. The tables included herewith provide data useful for a quick estimate of anticipated costs; a more precise cost analysis can be provided by ascertaining the prevailing wage rate paid by the operating agency under consideration. The high ratio of $11 per hour in Tables 23 and 24 reflects the average wage of urban transit properties managed by ATE Management and Service Company. The typical rate of $6 per hour is the average for local drivers reported by the Bureau of Labor Statistics in 1981.

Fuel Cost

The suggested value is based on a fuel purchase cost of $1.20/gal., with 40,000 miles and 4,160 hours of operation per year. Consumption for the best value is estimated at 10 miles per gallon for a 12- to 15-passenger van, and 8 miles per gallon for a small bus (based on a survey of 40 agencies). High and low values for the range are the result of consumption variances that occur as the result of driver skill, maintenance of vehicle, driving conditions, and terrain in which driven. Values obtained varied from a low of just under 8 miles per gallon to over 11 miles per gallon.

Lubrication, Oil, and Supplies

Numerous studies by the National Association of Van Pool Operators have placed this cost within a narrow range of .75 to .99 cents per mile for vans and only slightly higher for small buses. A nominal value of .875 cents per mile for a van and 1.5 cents per mile for the small bus is suggested for developing probable costs.

Tires

Current studies from an equipment manufacturer place the cost in the range of 1.2 to 1.7 cents per mile--1.5 cents per mile was selected as the best value. Since a small bus is usually equipped with dual wheels, the suggested nominal cost is 2 cents per mile.

Maintenance

Maintenance costs are largely a reflection of maintenance labor and fringe benefits that are driven by the wage scale. The annual costs from a wide range of maintenance costs for various types of operations obtained in a telephone survey of 40 van fleet operators have been averaged to develop the suggested annual values. These operations have included transit systems with union wage scales, city and county operated services, social service agency systems, and brokered systems. Mechanic wages, whether mechanics are a part of a collective bargaining unit or not, seem to settle at nearly the same level, but there is a wide difference in driver wages under similar circumstances. Though large transit operations should have an advantage in obtaining the best prices for parts and supplies, whatever advantage may accrue is offset by slightly higher labor and fringe benefit costs.

Insurance

The only insurance expense anticipated is liability insurance which protects the agency driver and other employees. State laws and regulations are a major determinant in establishing annual premiums. If the vehicle is operated as a common carrier serving the general public, the operating agency is more vulnerable to suit under the doctrine requiring the use of the highest standards of care. The seating capacity of the vehicle also affects the premium. Only recently have insurers collected accident and claim statistics on vans and small buses used in specialized services. A telephone call to the state Department of Insurance or comparable agency of the state in which the service is to be offered can provide accurate costs for the agency and equipment under consideration. The Insurance Services Office in New York City provided information for the range of insurance costs specified in the tables.

Indirect Operating Expense

These costs frequently are measured and/or reported inaccurately. However, these often-hidden costs are a necessary part of the costs of operating a transportation system.

General and Administrative Salaries

Little of the data reported specifically identifies the funds expended for managing and directing the transportation system. In many instances the cost is included in the overall management of the transit system or agency that operates the specialized service. Where social service agencies operate the system the cost is often included in the administrative functions of the agency. Where the cost is identified it varies from a low of 5 percent of total costs to a high of 25 percent of total costs. In some instances, dispatchers are included in the administrative staff, while in others they are included in direct labor.

Office Supplies and Services

Only in rare instances is this category of expense of great significance. It is typically 1 to 2 percent of total cost.

Telephone and Postage (Communications)

This expense is usually less than 1 percent of total cost. Operation of two-way radio is usually included, and the category is identified as communications.

Fringe Benefits

It is not unusual for fringe benefits to represent 25 to 30 percent of wages for unionized transit employees when the term is used in its broadest context to include benefits required by law as well as those provided through collective bargaining. The negotiated items likely to be involved include life, medical, and dental insurance; annual and sick leave; holidays; retirement; and reimbursement for educational expense. The legally required items will include the employer portion of social security, unemployment insurance, and workman's compensation insurance, all of which are tied to wage rates. Fringe benefits for social service agencies and brokerage contractors usually fall in the range of 5 to 25 percent, while those of county or municipal agencies are most often in the 25 to 35 percent range.

The size of the transportation operation in terms of driver personnel and vehicles will determine the size of the management staff, number of supervisors, and the clerical and supporting personnel requirements. After analyzing financial reports of 40 large, medium, and small operations to determine a pattern, it is apparent that the application of a percentage factor to direct labor to cover fringe benefits and overhead as well as a similar factor to all other direct costs provides a realistic estimate of these labor driven costs. Except in those rare instances where volunteers are used extensively as drivers, the 25 to 50 percent factor applied to all direct noncapital costs will provide a good estimate of total costs. See Appendix B for typical operating statements.

It is anticipated that transit agencies will achieve the lower range of nonlabor direct cost, while direct labor and indirect cost will be at the high end of the range.

Mobility Training

As an alternative to providing specialized transportation to the mentally handicapped, mobility training to enable this segment of the transportation handicapped to use fixed-route, fixed-schedule transit where available should be considered. The mentally retarded may comprise as much as 45 percent of the transportation handicapped population. Such mobility training programs have been reported to be highly successful training; up to about 90 percent of this group uses existing services. Reported

costs vary from a low of less than $200 per person to a high of $1,800 per person; recent experience indicates a likely training cost of approximately $500 per person as noted in Table 26.

Table 26. Mobility training of handicapped per person.

Low	Medium	High	
$288	$690	$1,800	
Best Value[a]			$ 500

[a]Abnormally high overhead eliminated from Sacramento Area Council of Governments costs.

Source: Values from forthcoming report on Sacramento Mobility Training Program.

TAXI WITH USER-SIDE SUBSIDY

The operating cost elements for the taxi operator are identical to those of specialized transportation service providers. Though the sponsor will be unlikely to know the cost of providing the service, knowledge of the likely range of cost elements may be helpful in negotiating the most cost-effective service contract. See Table 27 for expected range of hourly operating cost.

Vehicle and Equipment

The bid specification was for a compact sedan with heavy duty shocks, three-speed transmission, power brakes, factory air conditioning, and vinyl upholstery. Quotes averaged $7,450. Two-way radios added $900, with the total cost coming to $8,350. A salvage value was estimated at $2,980 at the end of 2 years. Discounted at 10 percent for 2.5 years yields a present value of $2,350.

Table 27. Taxi operating cost--compact sedan.

Cost Element	Range[a] Low	Best Value	High
Vehicle and equipment costs			
• Annualized cost	2,285	2,400	2,520
• Average hourly cost	0.549	0.576	0.606
Direct operating cost (nonlabor)			
• Annual cost per vehicle			
• Fuel	3,200	4,000	4,365
• Tires	460	500	550
• Oil, lubricants, and supplies	300	400	400
• Maintenance	500	600	700
• Insurance	1,000	1,200	1,500
Total	5,460	6,700	7,515
• Average cost per vehicle-hour	1.313	1.612	1.806
Direct operating cost (labor)			
• Average cost per vehicle-hour	4.750	6.100	9.000
Indirect costs			
• Percent of total direct operating costs	20	25	30
• Average cost per vehicle-hour	1.213	1.928	3.242
Total cost per vehicle-hour	7.825	10.216	14.654

[a]Ranges for direct operating costs and percentage relationship of indirect costs to direct costs are from data obtained from membership of the International Taxicab Association in Rockville, Maryland.

Direct Operating Cost

Fuel

Though some taxi fleet operators have reported a fuel economy of 15 mpg, the norm is closer to 12 mpg.

Lubricants, Oil

Consumption for 40,000 miles is regularly reported at $.02/mile. The range is likely to be similar of that reported for vans.

Tires

Tire cost would be expected to be 20 to 25 percent below that of vans in view of the lower weight of the vehicle and the lower cost of tires.

Maintenance

Maintenance costs are expected to be the same as for vans without lifts--about $400/year.

Insurance

Taxi companies have higher insurance premiums than transit agencies or social service agencies. This is alleged to be the result of around-the-clock operations.

Direct Labor

User-side subsidies employing the taxi as the principal mode were studied in Montgomery, Alabama; Kinston, North Carolina; and Lawrence, Massachusetts, in 1979. Reported hourly rates for drivers were $3.81 for Kinston, $5.01 for Montgomery, and $7.38 for Lawrence. Adjusting for inflation would bring those rates to nominal levels of $4.75, $6.10, and $9.00 as likely representations of low, medium, and high.

Indirect Costs

The indirect costs included in Table 27 are only those costs associated with operation of the taxi fleet per se. In addition to the general management and staff required for taxi operation included as indirect cost in Table 27, user-side subsidy programs involve other administrative costs. These costs, based on the experience for Service and Methods Demonstration Projects, can represent as much as 50 percent of the transportation costs. These administrative activities include establishing the level of subsidy, identification and development of selection criteria for eligible target groups, monitoring procedures to guard against fraud and abuse, and processing of the subsidy distribution. Table 28 indicates the allocation of staff resources at three locations.

Table 28. Allocation of staff time on service and methods demonstration projects.

Activity	Kinston	Montgomery	Lawrence
Coordination/Liaison	43	17	16
General Office Management		127	128
Promotion/Advertising	4	6.5	-
Client Registration	9	74	16
Subsidy Distribution and Redemption	195	141.5	142
Demonstration Evaluation	110	38	48
Total Monthly Staff Time	367 Hr	404 Hr	350 Hr

Source: Smith and Vernmark.

SUMMARY

The choices among modes and among operating agencies for providing specialized transit service are subject to a wide range of costs. Obviously all services do not offer the same levels of service or even, in many instances, the possibility of meeting the mobility needs of people with certain types of handicaps.

Since the number of cost elements are few and their range of values is small, the increased cost of providing accessible fixed-route transit service is relatively straightforward. Specialized transportation services have been widely acclaimed to provide the ultimate in accessibility, but the cost of providing this type of service can become prohibitive. The operating agency selected for providing the service often has a major impact on cost. Transit agencies providing the specialized services with transit-oriented wage rates, fringe benefits, and wage-driven indirect costs have a multiplier effect on hourly vehicle operating costs. City and/or county operated systems have somewhat lower wage rates, but operating efficiencies often suffer.

Some social service agencies (which traditionally have lower wage rates and fringe benefits) have reported very low hourly operating costs leading to speculation that indirect costs are buried in the cost of other activities. Private providers (some of which are nonprofit) have alleged that they can provide the service less expensively than other agencies, because private industry has a reputation for efficiency and cost control.

Tables 23, 24, and 25 for specialized services suggest a range of values for each of the elements of cost. It is incorrect to assume that transit operated systems will always be high cost in every element and that social service agency will be low in every element. Table 29 indicates the agency most frequently reporting cost in the low, medium, and high range for each element. A table of comparative estimated costs has been constructed using anticipated elemental values for four different operating agencies (Table 30). In many situations, development of a user-side subsidy program using taxis for a high percentage of trips can become an interesting alternative where labor rates fall in the low to medium range. However, detailed costs must be determined for each local situation to reflect local wage rates and resources.

Table 29. Specialized transportation service element comparative costs--system operators.

Cost Element	Low	Mid	High
Vehicle and Equipment	TC	P	S
Direct Operating Cost			
Fuel	TP	C	S
Tires	TP	C	S
Lubricants, etc.	S	P	TC
Maintenance	P	TC	S
Insurance	S	PC	T
Direct Labor	S	PC	T
Indirect Costs	SP	C	T

T = Transit Operator

C = City or County Operator

S = Social Service Operator

P = Private Provider

Example: Direct Labor--Social service agencies are likely to have wage rates on the low side of the range; private providers and city or county operators of specialized transportation services are likely to have wage rates near the mid range; and transit systems are likely to have wage rates at or near the high range. See Table 30 for sample of how one might compare cost of operating a van with lift for several operating agencies.

Table 30. Estimating the cost of operating a van with lift.

Cost Element	Social Service Agency	Private Provider	City/ County Agency	Transit Agency
Vehicle and equipment costs				
• Average cost per vehicle-hour	1.05	1.00	0.952	0.952
Direct operating cost (nonlabor)				
• Annual cost per vehicle				
• Fuel	5,336	4,360	4,800	4,360
• Tires	680	480	600	480
• Oil, lubricants, and supplies	300	400	400	400
• Maintenance	800	600	700	700
• Insurance	600	600	600	1,200
• Average cost per vehicle-hour	7,716	6,440	7,100	7,140
Direct operating cost (labor)				
• Average cost per	4.00	4.50	6.00	8.50
Indirect costs				
• Percent of total direct operating cost	20	25	30	45
• Average cost per vehicle-hour	1.171	1.512	3.242	3.494
Total cost per vehicle-hour	8.071	8.560	11.356	12.21

CHAPTER SEVEN

COSTING PROCEDURES FOR ALTERNATIVE SERVICE CONCEPTS

Step 6

Determine Cost of Providing Transportation Services

Once a decision has been reached on the geographical area and transportation handicapped market segments to be served, and estimates have been made of daily ridership either through latent demand analysis or current utilization rates, one should conduct a system design to determine the total cost of providing transportation handicapped services. Unit cost data developed in Chapter Six will be combined with the service levels and policies defined to estimate total annual cost. A series of worksheets have been provided to simplify the computations. The overall design process will be presented by service option: accessible bus, specialized services, user-side subsidy programs, and combinations of service options. No feedback has been provided in the analysis between fare, service levels, and ridership.

ACCESSIBLE BUS

In situations where it is not possible to lift-equip an entire bus fleet, decisions have to be made on how best to deploy available equipment. The effectiveness of an accessible bus service is a result, in large part, of the policies adopted in deploying lift-equipped vehicles. Among the criteria used in deploying lift-equipped buses to selected routes are:

- Total ridership on route.
- Expected handicapped ridership.
- Sites served by route.
- Geographical area served.
- Transfer potential between high ridership lines.
- Possible headways and impact on overall schedule.
- Standing and seating capacity of available vehicles.

The cost to make an entire or a proportion of a bus fleet accessible represents the incremental costs associated with lift equipping a bus fleet as well as operating the lift equipment in regular route service. Because some of the costs associated with providing accessible bus service are controversial, three distinct levels of cost have been identified. First level (Level I) costs represent direct outlays by the bus company to purchase the lifts (depreciated over 10 years) and to maintain the lifts. Level I costs also include additional expenditures for insurance, promotion, and driver training. The second level (Level II) costs represent the more uncertain costs surrounding the need of the bus operator to increase schedule times because of the greater time required to load/unload lift users and the need to deploy extra vehicles because of potential lift malfunctions. In most operational situations, these costs have been found to be minor or nonexistent within the range of boardings currently experienced by accessible bus systems. The lost seating capacity attributed to providing wheelchair tie-downs in a bus is usually only an issue on peak-hour suburban runs where there is a policy against standees. It is conceivable, however, that Level II costs could become significant at future levels of boardings. Third level (Level III) costs represent delay cost to nonlift passengers due to increased trip time associated with the increased loading and unloading times and lift malfunctions. It is suggested that Level III costs not be included in the accessible bus cost analysis.

Figure 3 presents a quick estimate for annual Level I and Level II costs as a function of the number of accessible buses and daily lift boardings. The basic cost relationships are developed for a transit property operating at $20 per hour with an average delay of 3 minutes attributed to increased boarding and alighting time of lift users. As will be noted in the accessible bus example problem, these values can be adjusted to other lift boarding delays and hourly transit operating costs. If desired, a more detailed cost estimate can be prepared through use of the worksheets.

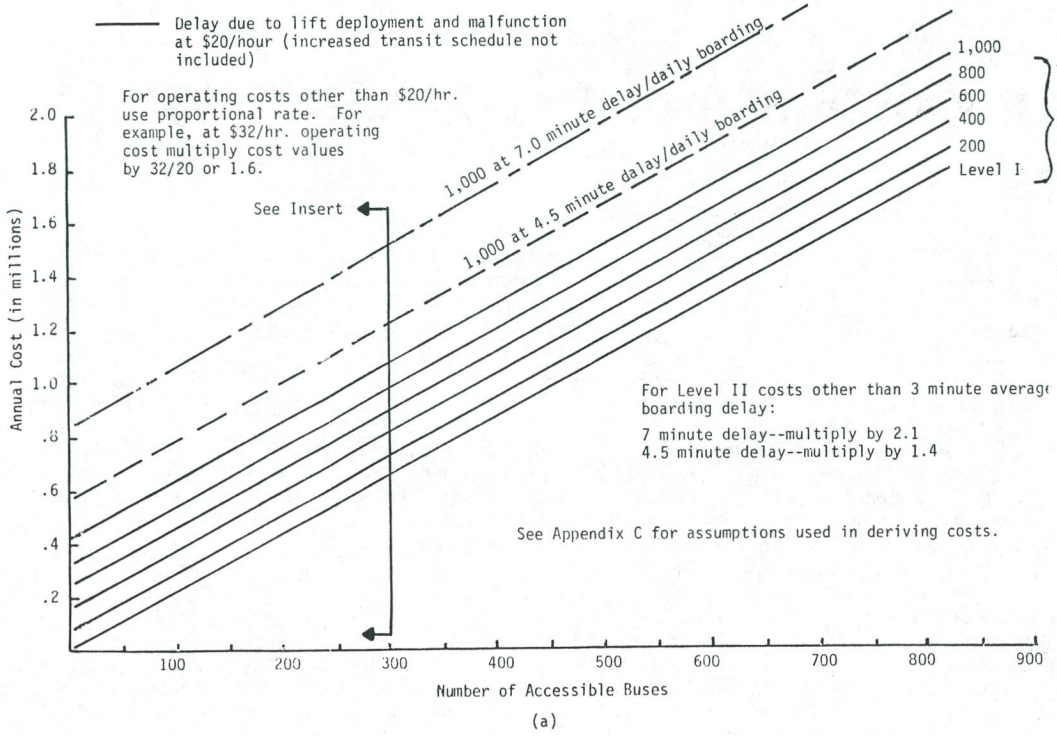
Worksheet E in Table 31 provides a convenient form for estimating Level I and Level II costs for making an entire or a proportion of a bus fleet accessible. An example worksheet is completed to estimate annual Level I and Level II costs for a bus operation of 41 lift-equipped vehicles and 88 drivers. The example problem assumes 8 daily lift boardings for the demand analysis outlined in Chapter Five, with each boarding having a delay of 4 minutes, 300 days per year, and a bus operating cost of $18.90 per hour. Best estimate unit costs presented in Chapter Six are used to complete the worksheet. A blank worksheet is provided in Appendix A.

Example Problem—Accessible Bus Quick Estimate of Cost

Problem: A local transit operator is studying the option of deploying 110 lift-equipped buses and is interested in making a quick estimate of Level I costs for the purchase, maintenance, and operation of the lifts. It is felt that the assumptions outlined in Appendix C are appropriate.

Solution: Reference to Figure 3 indicates annual Level I costs would be $240,000.

Problem: Concern has been voiced over the need to increase scheduled bus times because of the greater time required to board lift users and the need to deploy extra vehicles because of potential in-service lift malfunctions. The bus company assumes that the absolute highest boarding utilization would be .33 boarding per day per accessible bus (Table 16), and bus operating costs are $27.50 per hour. Further, an increased delay of 4.5 minutes per boarding is assumed. Calculate annual Level II costs for this condition.



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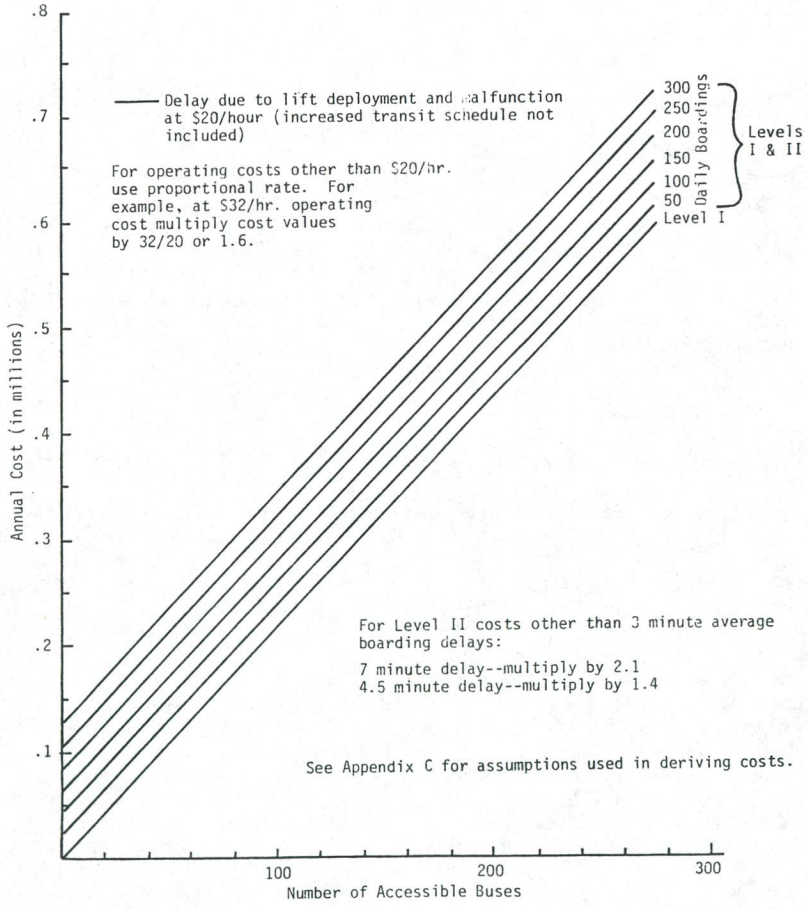


Source: Derived data.

(b)

Figure 3. Annual accessible bus cost versus daily boardings and accessible bus fleet size.

Table 31. Estimating the cost of making a bus fleet accessible.

WORKSHEET E--ACCESSIBLE FIXED-ROUTE BUS SERVICE

1.	TRANSPORTATION HANDICAPPED MARKET SEGMENT SERVED		
	a. Moderate Transportation Handicapped (lifts not required--modify buses)		
	b. Severe Transportation Handicapped (add lifts to buses)		X
2.	LIFT EQUIPMENT REQUIREMENTS		
	a. Buses in Fleet		100
	b. Percent of Fleet to be Lift-Equipped	x	41
	c. Lift-Equipped Buses Required		41
	d. Lift-Equipped Buses in Fleet	-	0
	e. Additional Lift-Equipped Buses Needed		41
3.	CAPITAL COSTS		
	a. Unit Cost of Lift-Equipment (see Chapter Six or use local values)		13,000
	b. Additional Lift-Equipped Buses Needed (2e)	x	41
	c. Total Cost to Purchase Lift Equipment		533,000
	d. Anticipated Life (8 to 12 years)	÷	10
	e. Total Annual Capital Cost		53,300
4.	MAINTENANCE COST		
	a. Additional Lift-Equipped Buses Needed		41
	b. Annual Maintenance Cost per Lift (see Chapter Six)	x	650
	c. Total Annual Maintenance Cost	=	26,650
5.	OPERATING COST		
	a. Drivers Utilized on Additional Lift-Equipped Buses		88
	b. Annual Driver Training Cost (Chapter Six)	x	250
	c. Annual Training Cost	=	22,000
	d. Promotion and Advertising Cost (Chapter Six)		50
	e. Additional Lift-Equipped Buses (2e)	x	41
	f. Annual Promotion and Advertising Cost	=	2,050
	g. Additional Insurance for Lift-Equipment		25
	h. Additional Lift-Equipped Buses (2e)	x	41
	i. Annual Increase in Insurance Cost	=	1,025
	j. Total Additional Operating Cost (5c + 5f + 5i)	=	25,075
6.	BOARDING TIME DELAY COST*		
	a. Estimated Daily Boardings Using Lift-Equipment (Table 16)		8
	b. Estimated Delay per Lift Boarding (4 minutes/60) (see Chapter 6--3 to 6 minutes suggested)	x	.0667
	c. Operating Days/Year (actual or 300 nominal)	x	300
	d. Hourly Bus Operating Cost (Chapter Six)	x	18.90
	e. Annual Increased Boarding Time Delay Cost	=	3,026
7.	LIFT SERVICE CALL COST*		
	a. Estimated Lift Failures En Route 1/36.6 x Lift Loadings/Day (8/36.6)		0.219
	b. Lift Failure Delay (Chapter Five) (20 minutes/60)	x	0.333
	c. Operating Days/Year (6c)	x	300
	d. Hourly Bus Operating Cost (Chapter Six)	x	18.90
	e. Annual Increased En Route Lift Failure Cost		413
8.	TOTAL ANNUAL LIFT COST		
	a. Capital Cost (3e)		53,300
	b. Maintenance Cost (4c)	+	26,650
	c. Operating Cost (5j)	+	25,075
	d. Boarding Time Delay Cost (6c)	+	3,026
	e. En Route Lift Failure Cost	+	413
	Total Annual Cost Assessable Fixed-Route Bus Service		108,464

*The inclusion of this cost category is controversial. Experience indicates little difficulty in maintaining schedules. If boardings increase, delays may occur. If these potential costs are not to be considered, skip to step 8.

Solution: Reference to Figure 3 indicates that for 36 accessible buses and a daily ridership of 110 lift boarding, annual Level I and Level II costs would be $250,000 at $20 per hour for an average 3-minute boarding delay. Adjustment of Level II costs to $27.50 per hour bus operating cost would represent: 27.50/20.00 (255,000 - 240,000) or $20,600. As noted by Figure 3, conversion of Level II costs to an average 4.5-minute boarding delay can be accomplished by multiplying $20,600 by a factor of 1.4 resulting in a cost of $28,800. The total annual Level I and II costs for 110 daily boardings, 4.5-minute average delay, and bus operating cost of $27.50/hour are then $240,000 + $28,800 ≅ $270,000.

SPECIALIZED SERVICES

Prior to initiating new specialized services, a review should be made of existing providers to explore opportunities for expanding available services. Also, current operational experience with average hourly vehicle productivity can be a good local indicator useful for system design. One complexity that is added to the planning and design of specialized transportation handicapped services is that various target groups are sometimes combined. For example, it is very common for the transportation handicapped and elderly to be combined as the market group for specialized services. The procedures outlined in the system design worksheets consider the transportation handicapped as an exclusive market. Some relationships describing system performance, however, are derived from specialized transportation programs transporting mixed client groups.

System Design Procedures

Two design approaches are introduced to determine the annual cost required to serve a given level of ridership by specialized services. One approach determines annual cost through selection of a representative vehicle productivity. Vehicle-hours of service are then determined as a function of the distribution of demand over the day and the number of vehicles required to serve the hourly demand for assumed values of average vehicle productivity, daily hours of service, and work rules. The second

approach relies on a simple relationship between ridership per square mile of service area and total fleet size per square mile of service area per hour, which was drawn from operational experience of a number of elderly and handicapped specialized services. The second approach provides a quicker assessment of fleet size where a planner may not wish to complete the more detailed costing analysis.

Vehicle Productivity Approach

The key question in system design is determining how many vehicles are required to serve a given area with a daily ridership level. General indications of fleet size requirements can be derived from estimates of average hourly vehicle productivities. Table 32 presents the influence of major operating policies on selecting appropriate vehicle productivity values.

By knowing the distribution of demand by time period, one can apply hourly productivities, estimated in Table 33, to determine number of vehicles operating within that time period. Typical daily distributions of demand are provided in Table 34 for different operating policies of hours and days of service. To a large extent, the temporal distribution of demand will depend on the relative proportion of trip purposes served. As noted by Figure 4, work and school trips tend to concentrate in the morning and evening peak time periods. A large number of such trips in relation to nutritional or social service agency trips will provide a traditional morning and evening double peaked demand pattern. On the other hand, a service dominated by shopping and/or social service trips will tend to have a midday peak. Evening hour and weekend services are usually provided to accommodate social-recreational trips. A knowledge of expected rider-

Table 32. Influence of operating policies and ridership on average hourly vehicle production specialized services.

Design Parameters	Affects	Relative Influence on Average Hourly Vehicle Productivity
Client eligibility	• Daily ridership • Vehicle productivity	• Exclusively transporting handicapped--lower productivities • Mixed markets such as handicapped, elderly, and/or general public--higher productivities
Service area	• Daily ridership • Vehicle productivity	• Small area such as 15-25 square miles--higher productivities • Large area such as 100-800 square miles--lower productivities unless specific actions are taken to affect the efficiency of serving a large geographical area such as operating inner/outer zones, encouraging group riding etc.
Service type	• Vehicle productivity	• Many-to-many--lower productivities • Many-to-one--moderate productivities • Many-to-few--moderate productivities • Subscription--higher productivities
Vehicle type	• Vehicle cost	• Minibus, Van } little impact on productivities
Trip prioritization	• Daily ridership	• Formal prioritization--exclude certain trip types such as social recreational trips, easier to get group ridership--higher productivities. • Informal prioritization--give preference to certain client groups or trip purposes and handle others as capacity permits--lower productivities.
Fleet equipment	• Vehicle cost • Vehicle productivity	• Lack of lifts or ramps restricts ability to accommodate wheelchair users and may lower vehicle productivites.
Scheduling	• Vehicle productivity	• Prescheduled--higher productivities • Subscription--higher productivities • Immediate response--lower productivities
Service hours	• Daily ridership • Daily vehicle-hours of service	• 8 am-2 pm--excludes work and school trips, less subscription trips--lower productivities • 7 am-5 pm--serves all purposes • 6 am-10 pm--evenings and weekends serve largely socioeconomic recreational trips without group riding--lower productivities.

Source: Derived data.

Table 33. Typical vehicle productivities--person trips/vehicle-hour.

Service (Specialized)	Market Segment: Severely Transportation Handicapped	Moderately Transportation Handicapped	Mixed
Many-to-Many			
Range	1.0-2.5	2.0-3.0	-
Default	1.5	2.5	2.0
Many-to-Few			
Range	1.5-3.5	2.5-4.0	-
Default	2.0	3.5	2.5
Group			
Range	-	-	3.4
Default	-	-	3.5
Subscription			
Range	-	-	10-12
Default	-	-	11
Nutritional			
Range	-	-	3.4
Default	-	-	3.5
RSVP			
Default	-	-	1.5
(Taxi)			
Range	2.0-3.0	2.5-5.0	-
Default	2.5	4.0	-
Variations			
Operator (Select from Range of Productivities)			
Human Service Agency = Low Value			
Taxi = High Value			
Contract Carrier = Mid Value			
Area (Select from Range of Productivities)			
Zones or Small Areas or Short Trip Lengths = High Value			
Large Areas or Long Trip Lengths = Low Value			
Scheduling (Select for Range of Productivities)			
on Call = Low Value			
48- to 24-Hour Reservation = Mid Value			

Table 34. Hourly distribution of transportation handicapped services by specialized services.

Typical Pattern	Hours		7am-10am	10am-3pm	3pm-6pm
Weekday					
1	7 am-6pm midday peak	% trips	13	79	8
		pk. hr. in time period as % of daily trips	6.7	27.1	5.6
2	7 am-6pm peak period	% trips	29.5	45.0	25.5
		pk. hr. in time period as % of daily trips	12.5	10.0	13.8
3	7 am-6 pm uniform	% trips	27.5	51.0	21.5
		pk. hr. in time period as % of daily trips	11.5	12.5	12.5

Typical Pattern	Hours		6am-10am	10am-3pm	3pm-6pm	6pm-12pm
4	6 am-12 pm midday peak	% trips	24.0	34.5	27.0	14.5
		pk. hr. in time period as % of daily trips	9	8	16	3
5	6 am-10 pm peak period	% trips	31.0	25.5	38.0	5.5
		pk. hr. in time period as % of daily trips	15	7.5	26	1.5

Saturday/Sunday			10am-3pm	3pm-6pm
6	10 am-6 pm	% trips	75	25
		pk. hr. in time period as % of daily trips	25	10

			8am-10am	10am-3pm	3-4pm
7	8 am-4 pm	% trips	25	60	15
		pk. hr. in period as % of daily trips	14	18	15

Sources: (Portland, Syracuse, Baton Rouge)

ship by trip purpose will allow estimation of the appropriate service hours per week and, in turn, identification of the appropriate hourly distribution.

Given a policy concerning hours and days of service, it is possible to determine total vehicle-hours of service. The decision on how to distribute service over the day will depend on work rules permitting either the ability to adjust revenue vehicles with fluctuations in demand or providing a constant level of service for the entire day. Work rules frequently can limit an organization's ability to tailor service to short-term fluctuations in demand.

Once operational fleet size is determined, adequate fleet reserves must be provided. A suggested fleet reserve policy is as follows:

- Up to 7 vehicles in fleet, add 1 vehicle.
- 8 to 20 vehicles in fleet, add 2 vehicles.
- 20+ vehicles in fleet, add 1 vehicle for every 10.

These design procedures can then be combined with unit costs presented in Chapter Six to determine the resources required to provide specialized transportation services. Worksheet F, in Table 35, provides an example application of the design principles for estimating annual cost required to operate a specialized service. The problem considers transporting 103 severely handicapped trips per day as estimated for the demand analysis in Chapter Five with uniform work hours, except during the evening hours. Vehicle productivity is three person trips per hour and a midday peak distribution is assumed. The number of vehicles required in the morning, midday, afternoon and evening periods is 3, 3, 5, and 1, respectively. Since 5 is the minimum number of vehicles, it is assumed that 5 vehicles will be operated in all time periods except the evening. Resulting, then, is 60 daily vehicle-hours of service. Given an estimate of operating 260 days per year and unit cost data as presented in Chapter Six, an annual cost of $219,407 is calculated. A blank worksheet is provided in Appendix A.

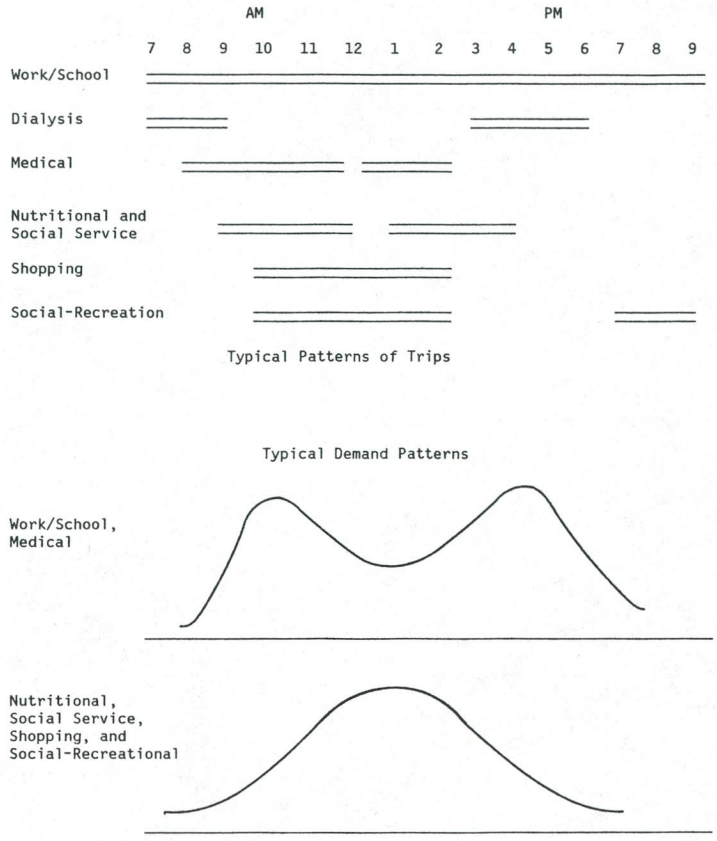


Figure 4. Typical trip purposes by times of day.

Determining Fleet Size from Ridership

Figure 5 can be used as an alternative means of relating trips per hour and total fleet size per square mile of service area. With an estimate of daily transportation handicapped and/or elderly ridership for a specialized service, either through a travel demand forecast or from utilization rates, it is possible to determine fleet size as a function of ridership and square miles of service area. In all cases the relationships are approximate, yielding generalized average values. Whenever localized experience is available it should be used to supplement the general empirical observations presented in this section. The generalized relationship, however, can be used to provide a quick estimate of fleet size as noted by an example problem.

In a community of 45,000, a demand-responsive service is to be instituted to mainly transport elderly and handicapped users. The service will operate 6 hours per day over a 33-square-mile area. With potential daily ridership of 45 trips as determined from a demand analysis as discussed in Chapter Five, there would be 0.23 trips per square mile of service area per hour. From Figure 5, it then can be estimated that the community needs approximately 0.075 vehicles per square mile as determined by the services typically provided by other elderly and handicapped services. This converts into a fleet size of 2.5 or 3 vehicles.

Comparison of Specialized Services with Accessible Bus

Although specific comparisons between transportation handicapped service options must consider localized situations such as the extent of unmet needs, in-place resources, organization and management skills, and prevailing labor rates, some general quick-assessment comparisons can be presented. These comparisons can help planners to assess quickly the adequacy of budget levels and the relative performance of different service options serving the same market segments. Table 36, based on Figure 6, indicates the approximate daily ridership required to have a specialized service equal in cost to lift equipping and operating a given number of accessible buses. The values can be computed against demand estimates to define the appropriateness of a particular service option.

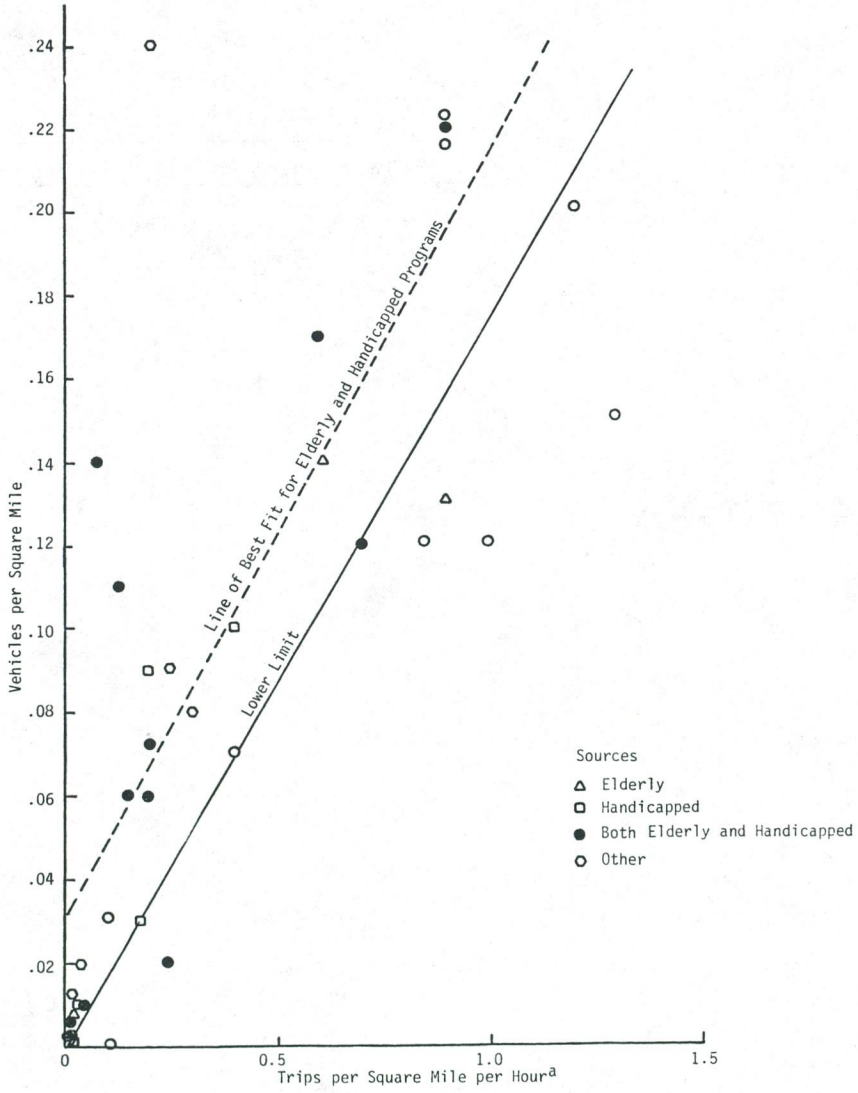
In applying these general relationships it must be noted that the comparisons are based on the assumptions that both service options are serving the same transportation handcapped market segment. It must be noted that accessible buses serve only those individuals residing or traveling to destinations within a few blocks of a bus route and that only 30 percent of the severely transportation handicapped are estimated to benefit from lift-equipped buses. It can be assumed that most moderately transportation handicapped persons already can use existing buses with only minor modifications to the vehicle. The generalized relationships presented in Figure 6 are based on the general high and low cost estimates of providing specialized services, assuming values of:

Low Cost

- Labor costs of $4/hour
- 11 hours of daily service
- Flexibility in adjusting service to demand
- Double-peak demand distribution

High Cost

- Labor cost of $8/hour
- 14 hours of daily service
- Little flexibility in adjusting service to demand
- Double-peak demand distribution



[a]Trips were estimated from the demand analysis in Chapter Five.

Source: Synthesis of experiences for transportation handicapped providers.

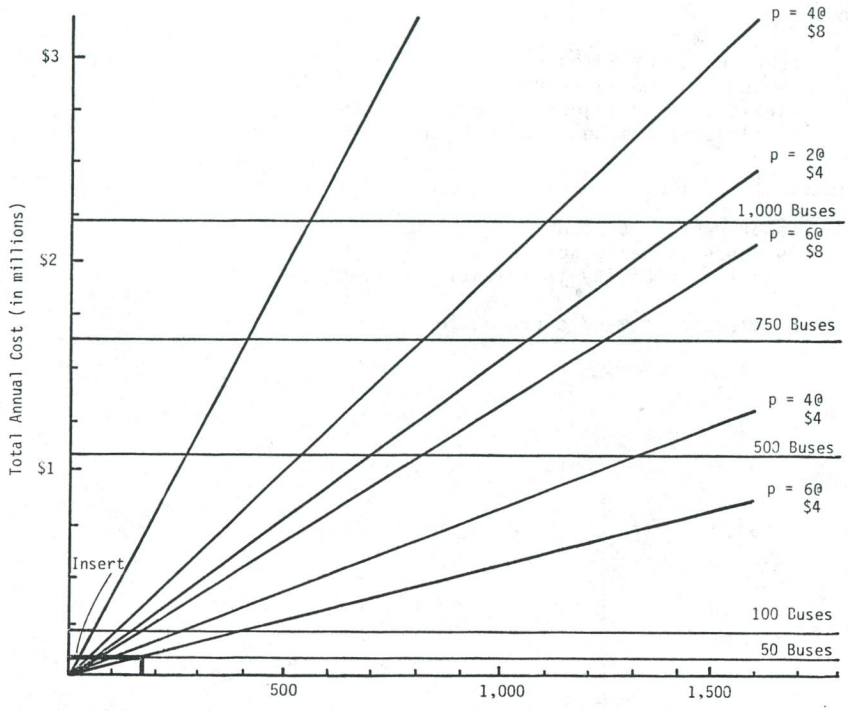
Figure 5. Vehicles per square mile versus trips per square mile per hour.

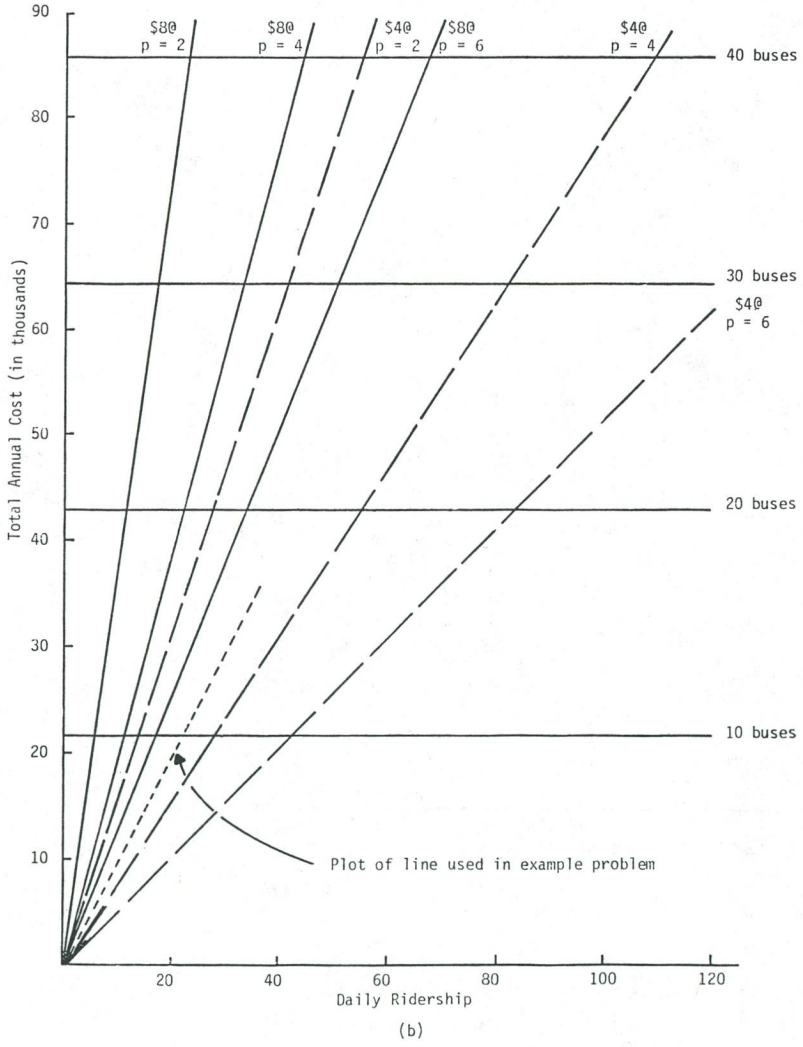
RANGE IN VAN COSTS

Typical Low Cost
$4 Labor (7am-6pm)
Variable Work Rules
Double Peak Distribution
Service Hours (7am-6pm)

See Table 24 for converting costs to other typical conditions.

Typical High Cost
$8 Labor
Uniform Work Rules
Double Peak Distribution
Service Hours (6am-10pm)
p = 2@
$8





Source: Dervied data.

Figure 6. Ridership break point--accessible bus and specialized van.

Table 35. Estimating the annual cost of a specialized transportation service.

WORKSHEET F--SPECIALIZED DOOR-TO-DOOR SERVICES

1. TRANSPORTATION HANDICAPPED MARKET SEGMENT SERVED

a.	Moderately Transportation Handicapped (lifts not required)	
b.	Severely Transportation Handicapped (vehicles lift-equipped)	X

2. VEHICLE TRIPS/DAY

a.	Person Trips per Day (Table 17)	103
b.	Person Trips/Vehicle Trip (Use 1.1 to 1.2)	÷ 1.2
c.	Vehicle Trips per Day	= 93

3. VEHICLES REQUIRED BY TIME PERIOD

	Time Period:	Morning	Midday	Afternoon	Evening	Night
b.	% Daily Trips Peak Hr	9	8	16	3	
c.	x__ Veh Trips/ Day (2c)	93	93	93	93	93
d.	Trips/Peak Hr	8	8	15	3	
e.	÷ Trips/Vehicle Hr	3.0	3.0	3.0	3.0	
f.	Required Vehicles	3	3	5	1	
g.	Work Rules Uniform	5	5	5	1	
h.	x Hours in Period	4	4	3	5	
i.	= Vehicle Hours	20	20	15	5	

j.	Total Hours Vehicle Service/Day (Σ of i)	60
k.	Days of Operation per Year	x 260
l.	Annual Hours of Service	= 15,600

4. COST ANALYSIS

a.	Driver Wage Rate	8.00 /hr
b.	Indirect Cost Factor (see Chapter Five)	x 1.40
c.	Driver Cost per Hour	= 11.20
d.	Operating Cost/Hour (Excluding Depreciation)	+ 2.42
e.	Total Out of Pocket Cost/Vehicle Hour	= 13.62
f.	Annual Hours of Service (3l)	x 15,600
g.	Annual Out of Pocket Cost	= 212,472
h.	Fleet Size (Vehicles, Including Reserves)	6
i.	Annual Cost Each Vehicle (see Chapter Five)	x 1,387
j.	Total Annual Vehicle Cost	= 8,322
k.	Total Cost per Year (g + k)	= 220,794

Given the general relationships for the high and low cost ranges, the annual cost to operate a specialized service can be estimated as a function of average hourly vehicle productivity. Typical productivities can be selected from Table 33 for different design considerations or through the analysis of existing providers. Table 37 can be consulted to adjust the low and high cost estimates to other labor costs, work rules, and service hour combinations. Table 36 indicates ridership levels where a specialized service would be less expensive to implement and operate than lift equipping a given

Table 36. Approximate ridership cost break points--specialized service versus accessible bus.[a]

Accessible Bus Fleet Total Vehicles to be Lift-Equipped and Operated in Accessible Bus Fleet Regular Route Service	Number of Daily Trips Before Specialized Van is Equivalent or Exceeds Level I Accessible Buses Costs[b] Labor = $4/hr Double Peak (7am-6pm) Prod[c] = 2	4	6	Labor = $8/hr Double Peak (6am-10pm) 2	4	6
10	10	25	40	5	10	15
50	75	125	200	25	25	75
100	150	275	425	50	100	150
500	750	1,400	[d]	275	550	850
750	1,075	[d]	[d]	425	850	1,250
1,000	1,450	[d]	[d]	550	1,025	1,700

[a] See Appendix C for assumptions.

[b] Numbers can be compared with demand estimates, as discussed in Chapter Five, to determine the appropriateness of a particular service option.

[c] Productivity = person trips/vehicle-hour.

[d] Greater than 1,800 daily trips.

Source: Derived data.

Table 37. Adjustment factors to estimate costs for other work rules, labor costs, hours of service, and demand distribution--specialized services.

Multiplier on $4 Base Case (see Figure 5)	Hourly Labor Cost ($)	Daily Hours of Service ($)	Demand Distribution	Labor Rules
1.15	4	11	Double-Peak	Uniform
1.45	4	11	Midday Peak	Variable
1.50	6	11	Midday Peak	Uniform
1.30	6	11	Double-Peak	Variable
1.85	6	16	Double-Peak	Variable
1.85	8	11	Double-Peak	Uniform
2.20	8	11	Midday	Variable
3.60	8	11	Midday	Uniform
2.30	8	16	Double-Peak	Variable

Note: All costs on 300 days/year service and van vehicles. For small buses multiply costs by a value of 1.15.

Source: Derived data.

number of buses. For example, if a community had the option of lift equipping and operating 100 accessible buses, and the local specialized service could serve an average of 4 trips per hour in the low cost range, for a ridership of up to 275 trips per day it would be less expensive to operate a specialized van. This value, derived from Table 36, can be verified approximately by consulting the insert to Figure 6 to determine ridership at the intersection of 100 accessible buses and specialized van services at $4 per hour and a productivity of 4 trips per hour. Likewise, selecting a specialized van cost in the high category at an hourly productivity of 2 trips per hour makes the accessible bus the low cost solution for in excess of 50 daily trips. If a daily ridership of 400 trips was anticipated and could be served by bus, the accessible bus would be the logical low cost choice in both cases, all other things being equal.

In all cases the ridership break points should be considered only as approximate indicators; local knowledge must be used to supplement these general relationships. In interpreting the data it is important for a planner to consider the anticipated level of ridership in the community. An example has been provided for application of these figures in a quick assessment format. Where time permits, the planner may desire to complete the worksheet and conduct a full system design analysis.

Example Problem—Specialized Services Quick Estimate of Cost

Problem: A city council budget work session is scheduled this evening and the planner has been asked to indicate the degree of mobility that can be provided to severely transportation handicapped individuals residing in the community with an annual budget of $25,000. The urban area has a population of 39,000 over the age of 5 years and a bus fleet of 10 vehicles. An estimated 60 percent of the population resides in the bus service area. Also, an existing social service agency is providing services equivalent to the low cost estimate at an average productivity of four trips/hour.

Solution:

a. Lift-Equipped Buses:
With reference to Figure 6, an annual budget of $25,000 would permit the city to lift-equip all of the buses. Using an "average utilization rate" from Table 16, the buses could be expected to serve about three lift boardings per day. This service would provide mobility to less than 30 percent of the severely transportation handicapped individuals residing in the transit service area.

b. Specialized Services:
Figure 6 indicates that $25,000 can provide about 30 daily trips by the existing human service agency.

Problem: Concern is voiced that the labor costs of the social service agency may increase to approximately $6 per hour. What influence will this have on the service provided for a $25,000 budget?

Solution: Reference to Table 37 indicates that the adjustment factor of 1.3 is used for a labor cost of $6 per hour, double-peak distribution, variable work rules, and 11 hours of daily service. Plotting this relationship on Figure 6 indicates that the revised labor cost would reduce service to approximately 25 daily trips.

Problem: Given the desire to serve mobility needs of all severely transportation handicapped persons with specialized services provided by the social service agency, what budget level should be considered by city council?

Solution: Using an "average utilization rate" from Table 17, the daily ridership would be approximately 26 trips (.07 x 39,000 x 0.05 x .19) which, as indicated by Figure 5, would require about $25,000 per year.

DESIGN OF USER-SIDE SUBSIDY PROGRAMS FOR TAXI USERS

Taxicab services can be found in urban areas of virtually every size and in many rural areas as well. In some places, taxicab services are the only form of public passenger transportation available. However, because taxi fares are generally much higher than public transit fares, many transportation handicapped people may not be able to afford to use taxi services very often or to rely on them for their transportation needs. By providing subsidies to the transportation handicapped, taxi services and other available carriers can be used to improve their mobility. Likewise, full use can be made of private nonprofit service providers and private for profit carriers that specialize in transporting wheelchair users where appropriate. Figure 7 provides a quick review of the factors to be considered in developing a user-side subsidy program for a community.

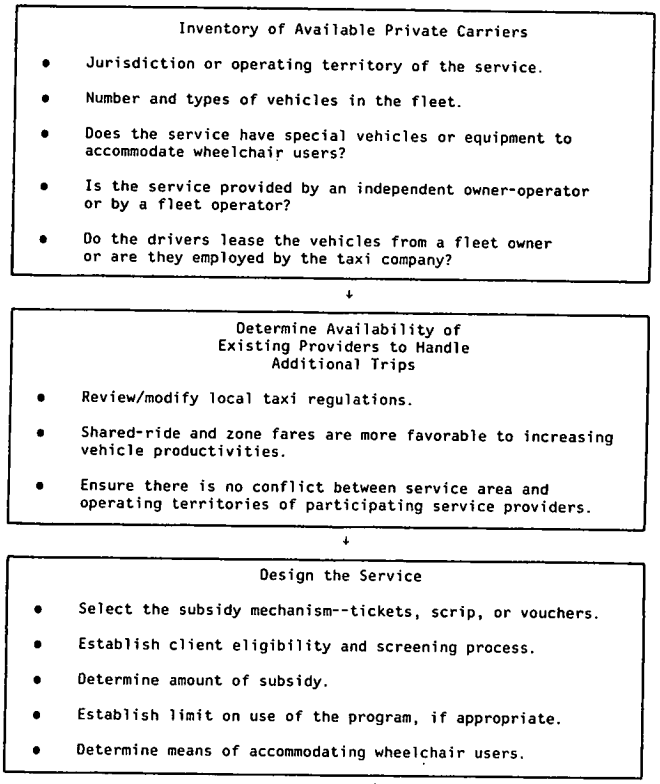


Figure 7. Design of user-side subsidy program.

Given information on the hourly distribution of taxicab demand as noted in Table 38 and incremental and maximum vehicle productivities as noted in Table 39, it is possible to compute the annual cost for a taxi-based user-side subsidy program. In conducting the analysis it must be considered that approximately 20 percent of severely transportation handicapped persons cannot enter a taxi vehicle. These individuals will require a specialized lift-equipped vehicle as a supplement to taxi service.

Worksheet G, in Table 40, provides a convenient format to estimate annual costs for transporting 166 severely handicapped trips per day.

Table 38. Typical hourly distribution of travel taxicab services.

Pattern			7am-10am	10am-3pm	3pm-6pm	6pm-12am	12am-7am
A	7am-7am (24 hr)	% trips peak hour in time period as % of daily trips	19.1	38.6	19.6	20.4	2.3
			8.0	6.9	6.9	5.7	1.0
				7am-10am	10am-4pm	4pm-7pm	
B	7am-7pm (12 hr)	% trips peak hour in time period as % of daily trips		23.8	59.1	17.1	
				8.0	10.0	5.7	

Source: Synthesis of operating experiences for taxi providers.

Table 39. Average hourly taxicab productivities.

Hour	Incremental Productivity (trips/hr)	Maximum Productivity (trips/hr)
High Trip Estimate		
7am-10am	2.3	5.0
10am-3pm	1.9	5.0
3pm-6pm	1.5	5.0
6pm-12am	3.0	5.0
12am-6am	3.0	5.0
Low Trip Estimate		
7am-10am	1.2	4.5
10am-3pm	1.0	4.5
3pm-6pm	.8	4.5
6pm-12am	1.5	4.5
12am-6am	1.5	4.5

Source: Synthesis of experiences of transportation handicapped providers.

Table 40. Estimating the annual costs for transporting 166 severely transportation trips per day.

WORKSHEET G--TAXI SERVICES

1. TRANSPORTATION HANDICAPPED MARKET SERVED
   - a. Moderate: x
   - b. Severe (typically 20% require lift-equipped vehicles):
2. DEMAND ANALYSIS (Chapter Five)
   - a. Person Trips/Day Moderately Handicapped: —
   - b. % Moderate Handicapped Trips by Taxi: x —
   - c. Person Trips by Taxi per Day by Moderately Handicapped: = —
   - d. Person Trips/Day Severely Handicapped: 166
   - e. % Severely Handicapped Trips by Taxi: x .80
   - f. Person Trips by Taxi per Day by Severely Handicapped: = 133
   - g. Anticipated Person Trips by Taxi per Day by Handicapped (c + f): = 133
   - h. % Severely Handicapped Trips by Lift-Equipped Van: .20
   - i. Person Trips by Lift-Equipped Van/Day (d x h): 33
3. VEHICLE TRIPS PER DAY
   - a. Anticipated Person Trips by Taxi by Handicapped (3g): 133
   - b. Anticipated Average Person Trips/Vehicle Trips: ÷ 1.2
   - c. Vehicle Trips/Day: = 111
4. VEHICLES REQUIRED BY TIME PERIOD

	Time Period:	Morning	Midday	Afternoon	Evening	Night
b.	% Trips Peak Hr.	8	6.9	6.9	5.7	1.0
c.	x Trips/Day (3c)	111	111	111	111	111
d.	Trips/Period Peak Hr.	9	8	8	7	2
e.	- Trips Currently Made	—	—	—	—	—
f.	= New Trips	9	8	8	7	2
g.	Vehicles In Service	66	58	58	47	9
h.	x Incremental Productivity	2.3	1.9	1.5	3.0	3.0
i.	New Trips Available	152	110	110	141	27
j.	(4f) - New Trips	- 9	- 8	- 8	- 7	- 2
k.	Sign of i - j	+	+	+	+	+

   If sign of i - j is positive, no added service required. If negative, proceed to 5 following.
5. COST SUMMARY--ADDITIONAL SERVICE
   - a. New Trips Required (4f):
   - b. New Trips Available: -
   - c. Additional Trips Required:
   - d. Productivity (Trips/Hours): ÷
   - e. Vehicle Hours Required: =
   - f. Operating Cost/Hours (see Chapter Five): x
   - g. Total Additional Operating Cost: =
   - h. Additional Vehicles Required:
   - i. Annual Depreciation/Vehicle: x
   - j. Annual Vehicle Cost: =
   - k. Total Cost (g + j):
6. USER-SIDE SUBSIDY COST
   - a. Average Taxi Fare: 2.50
   - b. User Share: - .50
   - c. Subsidy: 2.00
   - d. New Person Trips by Taxi Daily: x 133
   - e. User-Side Subsidy Cost Day: 266
   - f. Days of Operation: x 260
   - g. Annual Cost User-Side Subsidy: 69,160

WORKSHEET F--SPECIALIZED DOOR-TO-DOOR SERVICES

1. TRANSPORTATION HANDICAPPED MARKET SEGMENT SERVED
   - a. Moderately Transportation Handicapped (lifts not required):
   - b. Severely Transportation Handicapped (vehicles lift-equipped): x

2. VEHICLE TRIPS/DAY

a.	Person Trips per Day (Chapter Five)		33
b.	Person Trips/Vehicle Trip (Use 1.1 to 1.2)	÷	1.2
c.	Vehicle Trips per Day	=	28

3. VEHICLES REQUIRED BY TIME PERIOD

		Morning	Midday	Afternoon	Evening	Night
a.	Time Period:					
b.	% Daily Trips Peak Hr	12.5	10.0	12.5	–	–
c.	x__ Veh Trips/ Day (2c)	28	28	28	–	–
d.	Trips/Peak Hr	4	3	4	–	–
e.	÷ Trips/Vehicle Hr	2	2	2	–	–
f.	Required Vehicles	2	2	2	–	–
g.	Work Rules	–	–	–	–	–
h.	x Hours in Period	3	5	3	–	–
i.	= Vehicle Hours	6	10	6	–	–

j.	Total Hours Vehicle Service/Day (Σ of i)		22
k.	Days of Operation per Year	x	200
l.	Annual Hours of Service	=	4,400

4. COST ANALYSIS

a.	Driver Wage Rate		6.00 /hr
b.	Indirect Cost Factor (see Chapter Five)	x	1.4
c.	Driver Cost per Hour	=	8.40
d.	Operating Cost/Hour (Excluding Depreciation)	+	2.42
e.	Total Out of Pocket Cost/Vehicle Hour	=	10.82
f.	Annual Hours of Service (3l)	x	4,400
g.	Annual Out of Pocket Cost	=	47,608
h.	Fleet Size (Vehicles, Including Reserves)		3
i.	Annual Cost Each Vehicle (see Chapter Five)	x	1,387
j.	Total Annual Vehicle Cost	=	4,161
k.	Total Cost per Year (g + k)	=	51,769

Actually, two worksheets are completed--the taxi services sheet for a $2.50 taxi trip subsidy and the specialized services sheet for the 20 percent of the market segment requiring lift services. The total cost is then $119,542, the total of the specialized van and taxi subsidy. The specialized service assumed a labor cost of $6 per hour, variable work rules, peak hour distribution, and 11 hours of daily service. Default unit costs were derived from values presented in Chapter Six. Blank worksheets are provided in Appendix A.

Comparison with Accessible Bus

Table 41 indicates the approximate daily ridership required to have taxi-based user-side subsidy programs break even in annual cost with an accessible bus program. At riderships less than those indicated, taxi-based user-side subsidy programs would be less expensive to implement and operate than lift equipping a certain number of buses. The accessible bus program costs are based on Level I costs for a given number of lift-equipped buses.

Table 41. Approximate ridership cost break points--taxi-based user-side subsidy program versus accessible bus.[a]

Accessible Bus Fleet Total Vehicles to be Lift-Equipped and Operated in Regular Route Service	Number of Daily Trips Before Taxi-Based User-Side Subsidy is Equivalent or Exceeds Level I Accessible Bus Costs $1/trip User-Side Subsidy	$2.50/trip User-Side Subsidy[b]	$7.50/trip User-Side Subsidy
10	75	25	10
50	300	125	50
100	725	275	100
500	[c]	1,400	500
750	[c]	[c]	725
1,000	[c]	[c]	975

[a]See Appendix C for assumptions.

[b]Includes total of trip cost + overhead and administration costs.

[c]Greater than 1,800 daily trips.

Source: Derived data.

Since it is estimated that 20 percent of the severely transportation handicapped, such as persons in wheelchairs, would find it difficult and/or inconvenient to use a taxi vehicle, Table 42 has been prepared. These transportation handicapped individuals still require access to special lift-equipped vans, which, if desired, could be operated by a taxi service under contract to a public agency.

It is assumed that a user-side subsidy would be adequate to make the cost of a transportation handicapped trip comparable to an accessible bus or specialized van trip. To the extent that the user's payment for a taxi fare remains higher than that charged on accessible buses or specialized services, the transportation handicapped ridership may be less than that forecasted.

Table 42. Approximate ridership cost break points--taxi-based user-side subsidy with specialized lift-equipped van versus accessible bus.[a]

Total Vehicle to be Lift-Equipped and Operated in Regular Route Service	Number of Daily Trips Before Taxi-Based User-Side Subsidy with Supplemental Lift-Equipped Van is Equivalent or Exceeds Level I Accessible Buses Costs $1/trip User-Side Subsidy	$2.50/trip User-Side Subsidy[b]
10	25	20
50	200	100
100	400	225
500	1,425	1,125
750	[c]	1,675
1,000	[c]	[c]

[a]See Appendix B for Assumptions.

[b]Includes total of trip cost + overhead and administrative costs.

[c]Greater than 1,800 daily trips.

Source: Derived data.

Example Problem--User-Side Taxi Subsidy Quick Estimate of Cost

Problem: At the budget workshop the potential for operating a user-side subsidy program was raised. It was suggested a $2.50 per trip

user-side subsidy would be of greater assistance by allowing severely transportation handicapped persons to use the existing taxicab service than undertaking the expense of expanding the role of the human service agency. Is this alternative realistic?

For an annual $25,000 budget and a subsidy level of $2.50 per trip, about 30 daily trips could be served. In evaluating the user-side subsidy concept it must be recognized some transportation handicapped individuals are already using taxicabs. Also, a small portion of the $2.50 per trip may go directly to support administrative expenses associated with operating the program.

However, reflecting that only 80 percent of the users can utilize taxicab service, a supplemental lift-equipped van would have to be provided.

Solution: Reference to Table 42 notes that a $2.50 per user subsidy and operation of a supplemental lift-equipped van would be more economical than lift-equipping 10 buses up to a ridership of 20 daily trips.

SERVICE COMBINATIONS AND HYBRID DESIGNS

Mobility for the transportation handicapped individuals can be provided by a combination of service options. Specific service options can be designated to serve selected geographical areas or market segments. For example, lift users residing within the transit service area could use accessible buses for all destinations along the transit route. Specialized door-to-door services could be provided to transport all transportation handicapped individuals residing beyond the transit service area, while also feeding trips to the accessible buses for trip destinations within the transit service area. Likewise, different segments of the transportation handicapped population could obtain mobility from different service options.

The material presented in the user's guide permits consideration of three distinct segments: the severely transportation handicapped requiring lifts, the severely transportation handicapped not requiring lifts, and the moderately transportation handicapped. Given an estimate of ridership by market segment and/or geographical area it is possible to use the individual worksheets in combination to develop an estimate of annual cost. Table 43 provides a guide as to how the worksheets can be used in combination to develop an estimate of annual cost. Chapter Eight provides further examples of hybrid designs.

Now that the cost to provide different mobility options has been determined for estimated levels of ridership, it is possible to structure a cost-effectiveness analysis. Chapter Eight discusses the concept of cost-effectiveness analysis and how it can be applied to determining how to handle the mobility needs of the transportation handicapped.

Table 43. Combination designs for handicapped market segment.

Transportation Options	Moderate Transportation Handicapped	Severely Transportation Handicapped: Others	Severely Transportation Handicapped: Wheelchair Users and Others Who Require Lift
Accessible Bus Only	Retrofit bus to ease boarding by transportation handicapped.	Lift-equipped buses are usually not accessible unless special training, etc., is utilized.	Lift-equip buses for transit service are used--Worksheet E. Need to consider provision of services beyond transit area.
Accessible Bus and Specialized	Require transportation handicapped to use bus in the bus service area and use specialized services for trip origins/destinations outside bus service area. Fill out Worksheet F for area beyond transit service area.	Provide specialized services. Fill out Worksheet F.	Require transportation handicapped to use bus in the bus service area and use specialized services for trips with origins/destinations outside bus service area. Lift-equipped bus and specialized vehicles. Fill out Worksheet E and F.
Accessible Bus and Taxi	Require transportation handicapped to use bus in the bus service area and use taxi for trip origins/destinations outside bus service area. Because of high taxi costs consider shared ride taxi with user-side subsidy. Worksheet G.	Approx. 80% of severely transportation handicapped can use taxi. Fill out Worksheet G for 80% of handicapped market with origins/destinations outside bus service area + lift-equipped bus. Worksheet E.	Taxi not recommended for wheelchair users--consider only specialized services with lift-equipped vehicles Worksheet F.
Feeder to Bus	Require handicapped service for transfer to bus origins/destinations outside bus service area. Fill out Worksheet F.	Provide specialized services. Worksheet F.	Require handicapped to service for transfer to accessible bus for origins/destinations outside bus service area. Fill out Worksheets F and E.
Feeder Taxi to Bus	Require handicapped to call specialized service for transfer to bus for origins/destinations outside bus service area. Fill out Worksheet F.	Provide specialized services. Worksheet F.	Require handicapped to call specialized service for transfer to accessible bus for origins/destinations outside bus service area. Fill out Worksheets G and E.
Specialized Service Only	Transportation handicapped use specialized service throughout area. Worksheet F.	Transportation handicapped use lift-equipped specialized service throughout area. Worksheet F.	Transportation handicapped use lift-equipped specialized service throughout area. Worksheet F.
Taxi Only	Transportation handicapped use taxi service throughout area. Worksheet G. Consider user-side subsidy.	Approx. 80% of severely transportation handicapped use taxi. Fill out Worksheet F for 80% of transportation handicapped.	Taxi not recommended for wheelchair users--consider only specialized service with lift equipment. Worksheet F.

Source: Derived data.

CHAPTER EIGHT

APPLICATION OF COST-EFFECTIVENESS ANALYSIS

Step 7

Perform a Cost-Effectiveness Analysis

The approach taken in these guidelines is based on an evaluative technique known as cost-effectiveness analysis. This technique provides a multidimensional and flexible framework for evaluating solutions to complex problems. Cost-effectiveness analysis enables the decision-maker to compare the tradeoffs and compromises entailed by the adoption of one alternative over another and provides information to support the selection of a given alternative. Thus, it provides a strategy or an approach to reaching a decision. The results of a cost-effectiveness analysis do not make the decision for the analyst or the decision-maker. Given the information on the costs and effectiveness of various alternatives, decision-makers must ultimately choose the alternative that seems the best, using the objectives that have been established.

In a cost-effectiveness analysis of alternative transportation services for handicapped people, the costs consist of all the resources needed to design, construct, operate, manage, and maintain transportation service. These costs are normally measured in dollars, but this is not always necessary or at times even appropriate. For example, the negative effects or consequences of an alternative can be quantified in any meaningful unit of measurement such as the expected number of passenger injuries.

Instead of measuring the dollar value of possible benefits, cost-effectiveness analysis measures the effectiveness of an alternative. The effectiveness is the degree to which an alternative achieves the intended objectives. Measures of effectiveness cannot be identified if the goals or objectives have not been first specified. Effectiveness can be expressed in any meaningful unit of measurement related to any particular objective such as the number of people served, the number of trips carried, or the number of new jobs created.

Utilization can be defined as the number of passengers or passenger trips served over a period of time such as a day, a week, a month, or a year. By itself, however, this measure can be misleading. High ridership can be the result of a large number of handicapped people making a few trips or a small number of handicapped people making a large number of trips. Thus, measures of utilization should also include, if at all possible, the percentage of eligible people who use the service and the frequency with which they use it.

The utilization of a transportation service by handicapped people is not a perfect measure of effectiveness. High ridership does not necessarily mean that the service is effective. Many of the handicapped riders may simply be using the service for trips previously made on other modes of transportation. If the goal of the service is to enable handicapped people to travel more often or to make trips that would otherwise be extremely difficult to make, a better indicator of effectiveness would be the increase in the trip rates of handicapped people due to the service or, alternatively, the number of previously unmade trips now being taken by handicapped persons on the new or improved transportation service.

Figure 8 illustrates the manner in which cost-effectiveness analysis can be used. The relationships drawn in Figure 8 are hypothetical but serve to illustrate the type of information that can be used for decision-making. The annual cost and trips per day that would be associated with three different alternative services have been plotted in Figure 8. The alternatives considered in this particular instance are specialized services, a user-side subsidy program, and the lift-equipped accessible bus system. The planner should recognize that, in addition to these three alternatives, one could also depict various combinations of the three types of services.

As indicated earlier, an objective must be established in order for a cost-effectivness analysis to be meaningful. In this particular example, one might presuppose that a fixed amount of money would be available to provide public transportation services for the handicapped. The objective would be to maximize the trips per day of handicapped people for three levels of annual resources that may be available. For an annual cost of Y_1 the alternative that would be most effective in serving the number of trips per day would be the user-side subsidy program. The trips per day from this alternative would be X_1. For that same amount of money, one would obtain only X_1' of trips per day if that money was used to support specialized services. One can also see from Figure 8 that if only Y_1 amount of money was available each year, one would not consider lift equipping the accessible buses to serve the handicapped.

If in the budget there were to be Y_2 resources available on a yearly basis, one could then look at which of the three alternatives would be more effective. The most effective alternative for a resource allocation of Y_2 would be the user-side subsidy program that would yield X_2 trips per day. As one will notice, for an annual expenditure of Y_2, there would be no differences in the effectiveness of the alternative specialized services or of lift-equipped accessible buses because both alternatives would be able to serve X_2' trips per day.

If there are Y_3 resources available each year, the most effective alternative would be lift-equipped accessible buses. This alternative would provide X_3 trips per day. As can be seen, Y_3 resources on an annual basis would provide for X_3' trips per day with specialized services and X_3'' trips per day if a user-side subsidy program was implemented.

Although the data in Figure 8 are hypothetical, they nevertheless illustrate the type of analysis that should be conducted when using cost-effectiveness procedures. Numerous relationships can be developed using the same concept as shown in Figure 8. This enables the decision-maker to look at a variety of relationships and compare them with any number of objectives that have been established for providing public transportation services for the handicapped.

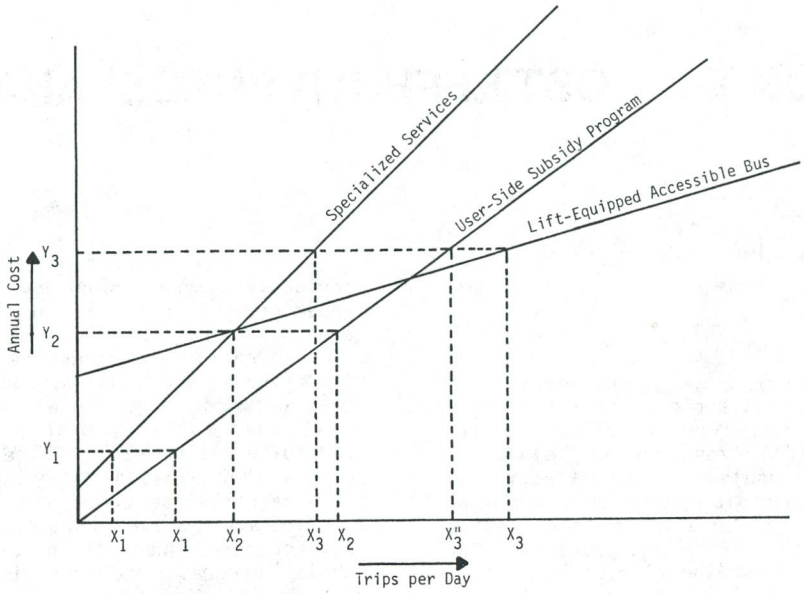
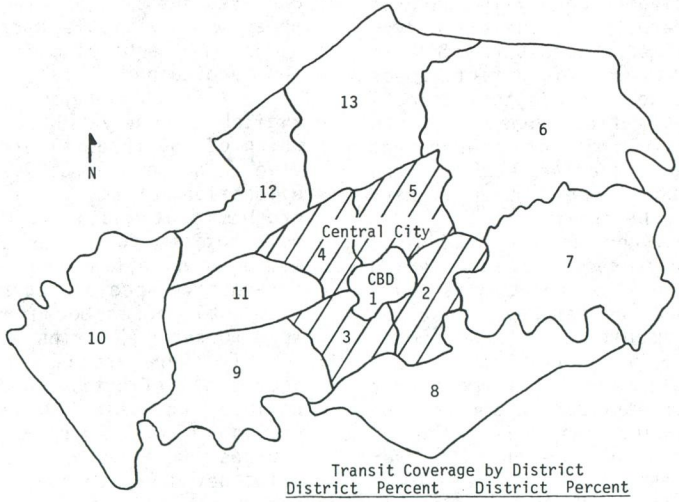


Figure 8. Hypothetical annual costs and trips per day for alternative services.

APPLICATION OF COST-EFFECTIVENESS ANALYSIS

An example problem has been prepared to highlight the application of the cost-effectiveness analysis to determine alternative means of addressing the mobility needs of the transportation handicapped. The study area has a 1980 population of 335,000 noninstitutionalized individuals over 5 years of age and has been subdivided into 13 districts (Fig. 9). The example problems highlight application of the transportation handicapped planning guidelines and include the following steps:

1. Location of transportation handicapped individuals by district, transit service area, and urbanized area.
2. Analyzing results from a service provider inventory to define unmet needs.
3. Defining transportation handicapped travel demand patterns.
4. Defining alternative service concepts.
5. Conducting a system design and costing procedure.
6. Performing a cost-effectiveness analysis.



Transit Coverage by District

District	Percent	District	Percent
1	100	8	--
2	85	9	20
3	100	10	--
4	75	11	25
5	70	12	--
6	--	13	--
7	5		

Figure 9. Planning districts in example problem.

LOCATION OF TRANSPORTATION HANDICAPPED PERSONS BY DISTRICT

Without the availability of a localized transportation handicapped data base, transferable parameters will be used. The analysis areas of interest will be the transit service area and urbanized area. Data for each of the 13 districts can be aggregated into the number of transportation handicapped residing in these two areas by severity of handicap and auto availability. In order to accomplish this it will be assumed:

1. Severely and moderately transportation handicapped will be located utilizing the incidence rates defined by the National Survey as noted in Chapter Two.
2. The transportation handicapped have the same residential location and transit accessibility characteristics as the general population.

Tables 44 and 45 present the number of transportation handicapped persons by district and transit service area, respectively. The number of transportation handicapped by auto availability are noted in Table 46.

Table 44. Number of transportation handicapped by district.

Population District	Population (1980)	Severely Transportation Handicapped (Pop. x .05 x .19)	Moderately Transportation Handicapped (Pop. x .05 x .30)
1	43,000	409	645
2	33,500	318	503
3	22,500	214	338
4	31,500	299	473
5	40,000	380	600
6	18,000	171	270
7	12,000	114	180
8	13,500	128	203
9	27,500	261	413
10	21,500	204	323
11	33,000	314	495
12	19,000	181	285
13	20,000	190	300
	Σ 335,000	Σ 3,183	Σ 5,028
		(955 are wheelchair bound)	

Source: Derived data.

Table 45. Number of transportation handicapped individuals by transit service area.

Zone	Percent of Population Residing in Transit Service Area	Number of Severely Transportation Handicapped	Number of Moderately Transportation Handicapped
1	100	409	645
2	85	270	428
3	100	214	338
4	75	224	355
5	70	266	420
6	0	-	-
7	5	6	9
8	0	-	-
9	20	53	83
10	0	-	-
11	25	79	124
12	0	-	-
13	0	-	-
		1,521	2,402
Percent Transit Service Area		48%	48%

Source: Derived data.

Table 46. Number of transportation handicapped individuals by transit service area and auto availability.

	Transit Service Area	Urbanized Area
Number of Severely Transportation Handicapped	1,481	3,183
a. Auto Usually Not Available[a]	533	1,146
b. Auto Usually Available	948	2,037
Number of Moderately Transportation Handicapped	2,402	5,028
a. Auto Usually Not Available[a]	721	1,508
b. Auto Usually Available	1,681	3,520

[a]Estimated value of 36 percent for severely transportation handicapped and 30 percent moderately transportation handicapped, based on local survey data.

Source: Derived data.

SERVICE PROVIDERS INVENTORY

Currently, approximately 48 percent of the population lives within a one-fourth mile of a bus route. The transit coverage, by district, is also noted in Figure 9. An analysis of current transportation handicapped service providers notes that the existing 80-vehicle fixed-route bus fleet is nonaccessible. However, 40 new vehicles, purchased in 1982, have kneeling features, nonslip floors, etc. These vehicles are candidates for being lift-equipped. Only 32 buses are assigned to regular route service, the remaining being used for express and charter service. A half-fare reduction for the transportation handicapped is maintained as is priority seating for the transportation handicapped. Table 47 provides a summary of the major human service agencies and taxi service providers. No special transportation handicapped programs are provided in conjunction with taxis, but shared riding is permitted.

Unmet needs can be estimated by comparing the number of trips currently carried by the service providers vs. those expected to be made.

Table 47. Transportation handicapped service provider inventory (Summary).

Agency	Type Passengers	Trip Type	Service Area	Hours Service Available	Service Frequency	Type and Number of Vehicle	Transportation Handicapped Ridership/Day
Community Dev Corp	Low Income 5-6 Transportation Handicapped	Medical Social Service	Public Housing in City	7 am-4 pm	M-F	6 Vans (1 lift-equipped)	1-2
Cerebral Palsy	Palsy	Social Services	Urban Area	7 am-5 pm	M-F	5 vans (all lift-equipped	57
Children Rehabilitation	Transportation Handicapped Children	Medical	Urban Area	As Needed	As Needed	1 van	2
Beta Houses	Residents	All	City	8-9 am & 2:30-3:30pm	M-F	2 Vans	1-6
Community Action Committee	County Elderly and Handicapped	All	Urban Area	7 am-5 pm	M-F	15 Vans (2 lift-equipped)	5
Association for the Blind	Visual Transportation Handicapped	All	Urban Area	As Needed	As Needed	1 Van 3 Autos (van lift-equipped)	20
Learning Center[a]	Mental Handicapped	Work Medical Group Rec	Areas in in City	6:30-8:30 am 3:00-5:00 pm	M-F	2 Bus, 6 Vans and 2 Autos	120
Easter Seals Society	Transportation Handicapped	Medical Education	City	6 am-6 pm	M-F	4 Vans (all lift-equipped)	80
City Schools[a]	Handicapped	Education	City	6:30 am-5:00 pm	M-F	15 buses (7 lift-equipped)	60
City Buses		All	Transit Area	6:00 am-12:00 pm	M-S	80 Buses	500 moderate 10 severely
Taxi		All	Urban Area	-	-	82 Vehicles	170

[a]School environment.

Source: Derived data.

UNMET NEEDS

Worksheet A, Table 48, indicates that approximately 8,500 transportation handicapped trips are expected to be made per day, with approximately 6,750 being made as an auto driver or passenger. Comparisons with the number of trips made by the transportation handicapped on the fixed-route buses, taxis, and specialized services indicate an approximate unmet need of 207 daily severely transportation handicapped trips and 543 moderately transportation handicapped trips throughout the urbanized area. Although these numbers are only approximate, they do highlight the desirability of considering transportation programs to meet transportation handicapped mobility needs.

If desired, alternative service options can be studied to provide additional transportation handicapped services and to reduce the unmet needs. This can be achieved by estimating ridership levels for new service options through utilization estimates or a latent demand analysis.

Table 48. Estimation of unmet needs.

WORKSHEET A--ESTIMATION OF UNMET NEEDS

		Severely Transportation Handicapped	Moderately Transportation Handicapped
1.	Estimated Population in Service Area	335,000	
2.	Incidence Rates (Table 2)	.19 x .05	.30 x .05
3.	No. of Individuals (1 x 2)	3,183	5,028
4.	Auto Available*	64%	70%
5.	Trip Rate** (see Table 5)	.8	1.2
6.	Estimated Total Needs Trips (3 x 5)	2,546	6,034
7.	Trips Taken as Auto Driver/Passenger* (see Table 6)	2,089	4,699
8.	Estimated Trips Not Made By Auto** [6 - 7]	457	1,335
9.	No. of Estimated Trips by*		
	a. Regular Bus	10	500
	b. Taxi	70	100
	c. Social Service	170	192
10.	Total Additional Trips Needed (unmet needs) [8 - (9a + 9b + 9c)]	207	543

*Based on local knowledge and provider inventory.

**Weighted average of auto available and auto not available trip rates.

DEMAND ANALYSIS

After assessing unmet needs, latent demand can be estimated for the various service options with the procedures outlined in Chapter Five. Table 49 provides an estimate of latent trip demand for: (1) accessible bus service if introduced into the transit service area; (2) specialized services if introduced into the transit service area or urbanized area; and (3) user-side subsidy for use of taxi if introduced into the transit service area or urbanized area. It was assumed that accessible buses would only serve the mobility needs of the severely transportation handicapped because moderately transportation handicapped persons can currently use the new buses. The other two service options could serve either the moderately and/or severely transportation handicapped.

To supplement the demand analysis, utilization values will be derived from experience observed with providing transportation handicapped services in other communities. Table 49 compares the utilization rates to the latent demand estimates.

The results indicate the magnitude of trip-making to be expected if an accessible bus or specialized van service were introduced. The various estimates of ridership then serves as input in the cost-effectiveness analysis discussed in the next section.

Table 49. Utilization rates and latent demand estimates.

Services	Estimate	Source Table[a]	Transit Service Area	Urbanized Area
Specialized				
Severely Transportation Handicapped Trips/Day	high utilization	17	198	414
	low utilization	17	15	32
	average utilization	17	106	222
	latent demand[b]	14	162	346
Severely Transportation Handicapped and Moderately Transportation Handicapped Trips/Day	high utilization	14	438	917
	low utilization	17	20	42
	average utilization	17	154	324
	latent demand[b]	14	461	981
User-Side Subsidies for Taxi				
Severely Transportation Handicapped Trips/Day	high utilization	17	198	414
	low utilization	17	15	32
	average utilization	17	106	222
	latent demand[b]	14	141	300
Severely Transportation Handicapped and Moderately Transportation Handicapped Trips/Day	high utilization	17	438	917
	low utilization	17	20	42
	average utilization	17	152	324
	latent demand[b]	15	382	813
Accessible Bus				
Severely Transportation Handicapped Trips/Day (need lift)	high utilization	16	14	-
	low utilization	16	1	-
	average utilization	16	8	-
	latent demand[b]	13	179	-

[a]Numbers are based on 3,183 severely transportation handicapped and 5,028 moderately transportation handicapped individuals. For example, 335,000 x .19 (from Table 2) x .05 (from Table 1) = 3,183 severely transportation handicapped individuals. The high utilization rate for the urban area is 3,183 x .13 (from Table 17) = 414 daily trips. Since the transit service area represents 48 percent of the population and without more specific data it is assumed the handicapped have the same residential destribution as the general population, the resulting transit service area trips are 3,183 x .13 x .48 = 198. All other values were derived similarly from tables in Chapter Five.

[b]Use of latent demand worksheet for auto available and auto not available.

Source: Derived data.

COST-EFFECTIVENESS ANALYSIS

Given the fact that unmet transportation handicapped needs exist, alternative services options can be studied for application to transportation handicapped individuals residing in the study community.

The options have been presented as a series of questions addressed to local decision-makers. Although the cost-effectiveness analyses pertain only to the characteristics of the community under investigation, they do highlight application of the system design and general approach to cost-effectiveness analysis.

The scenarios address the following issues:

Question 1 considers the cost-effectiveness of providing accessible bus or specialized services within the transit service area and how the decision is influenced by the market segment to be served, regional incidence rates, and projected level of ridership.

Question 2 considers the cost-effectiveness of providing specialized services with different labor rates, hourly vehicle productivities, trip restrictions, and service types to the severely transportation handicapped residing in the transit service area.

Question 3 considers expanding specialized and accessible bus services to the severely transportation handicapped residing throughout the urbanized area. Here, specialized services may serve as feeders to the accessible buses.

Question 4 considers the introduction of a user-side subsidy for taxis for the severely transportation handicapped residing in the urbanized area.

Question 5 considers the introduction of accessible buses on selected routes and specialized services in selected neighborhoods, with the specialized services feeding trips to the accessible buses for destinations in the transit service area.

Question 6 considers the issue of how much transportation handicapped mobility can be provided for a fixed budget.

Question 1

Issues

Local decision-makers wish to ascertain the cost-effectiveness of instituting specialized services provided by the transit company, or of making the fixed-route bus fleet fully accessible. Because of financial limitations, it is probably not possible to undertake both alternatives at this time. It is assumed that the specialized service would operate in an area roughly approximating the fixed-route transit service area.

Furthermore, a simple comparison between the two alternative transportation services is complicated because the service options address the mobility needs of different segments of the transportation handicapped population. A lift-equipped bus will serve to make buses accessible to only a segment of the severely transportation handicapped group. Likewise, many low-cost minor design changes, such as adding nonslip floors, providing extra handrails, etc., can be implemented to make the bus more accessible to the transportation handicapped population already able to use the bus. Because these changes are assumed to be relatively inexpensive and can benefit a large number of users, they will not be considered as a formal part of the cost-effectiveness analysis.

Without a clear definition of the eligibility requirements for specialized services, the absolute costs of providing the services can vary quite extensively. For example, local decision-makers must decide if the specialized services will serve only individuals who cannot use a bus without a lift (mainly to handicapped confined to wheelchairs), serve the entire severely transportation handicapped market, or even include those people defined as moderately transportation handicapped. The cost consequences of the eligibility decision can be determined by designing alternative specialized services to handle different ridership levels reflecting different eligibility definitions.

Approach

Little experience exists in providing specialized or accessible fixed-route bus service in this community, thereby a clear perspective of anticipated ridership is not known. Data will be transferred from national experience, and a range in utilization rates will be considered because of uncertainty surrounding the use of a new transportation handicapped service in this community.

The service and cost parameters will involve providing specialized services by the transit company for 260 days per year with restricted work rules, 16 hours of service per day which is comparable to regular fixed-route bus service hours. The transportation options will include the following:

Option a. Accessible bus (100% lift-equipped)
- Service Parameters:
  - Fleet size = 41
  - Number of drivers = 98
  - Number of potential lift failures/boarding = 1 lift failure per 36.6 loadings
  - Average delay due to lift failure = 20 min
  - Bus service area = 48% of population
- Cost Parameters:
  - Annual cost of lift = $1,300/lift
  - Annual lift maintenance = $650/lift
  - Annual driver training = $57/driver
  - Annual insurance promotion and marketing costs = $150/lift
  - Hourly bus operating cost = $20
  - Average lift delay = 3 min/boarding

Option b. Specialized Services
- Service Parameters:
  - Hourly productivity--moderately and severely transportation handicapped = 3.5
  - Hourly productivity--severely transportation handicapped only = 3.0
  - Hourly productivity--lift user only = 2.0
  - Service hours = 6 am to 10 pm
  - Trip restrictions = none (use midday demand distribution)
  - Work rules = restrictive (uniform distribution of service)
- Cost Parameters:
  - Annual cost of lift-equipped van = $4,163
  - Hourly labor cost = $8/hr
  - Operating cost/hr (excluding depreciation) = $2.42/hr
  - Indirect cost factors = 1.4 of wages

Results

Table 50 provides an estimate of eligible users and daily ridership. Figures 10, 11, and 12 show a comparison of annual costs, cost per trip, and cost per eligible user for the different service options.

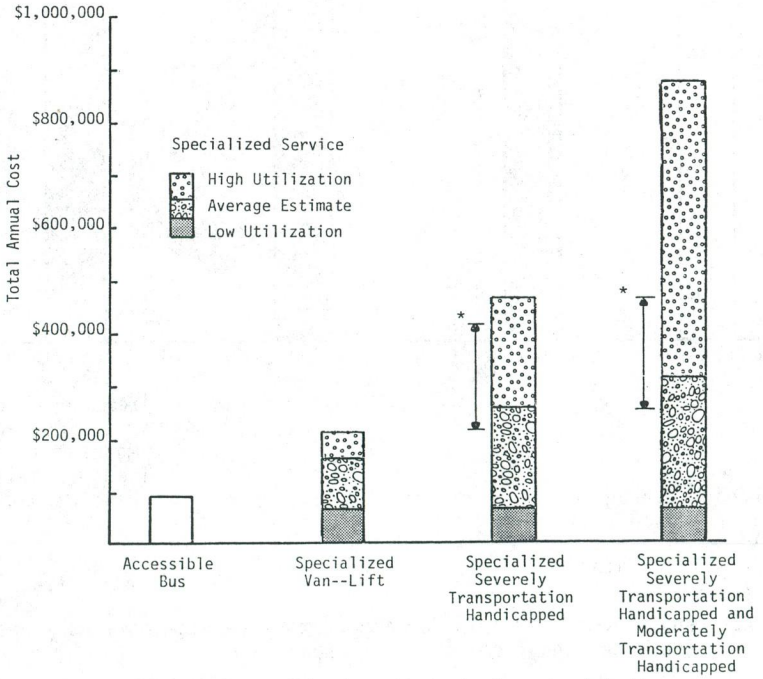
Given an uncertain ridership environment, the range in costs can be quite substantial. The combined specialized severely transportation handicapped and moderately transportation handicapped service provides the greatest variability between the high and low utilization estimates. The cost range is over tenfold between the high and low ridership estimate. For the severely transportation handicapped market there is almost a $400,000 annual cost variation in providing specialized services to meet the high versus low ridership estimate based on utilization rates.

Table 50. Results of analysis of question 1.

Number Of	Accessible Bus	Specialized Van: Severely Transportation Handicapped--Lift Users Only	Specialized Van: Severely Transportation Handicapped	Specialized Van: Severely Transportation Handicapped and Moderately Transportation Handicapped	Tables from Which Data were Derived
Eligible Users	456	456[a]	1,521	3,924	1,2
Daily Ridership Utilization (high)	14	59	198	438	16,17
Daily Ridership Utilization (low)	1	5	15	20	16,17
Average Estimate	8	32	106	154	16,17
Latent Demand	179	49	162	461	16,17
Range of Average Utilization Due to Regional Variation in Incidence Rates (low = 4.1%, high = 7.6%, avg. = 5.0%)		26-49	87-161	126-234	1

[a]Lift users represent 30 percent of the severely transportation handicapped market segment (see Table 3).

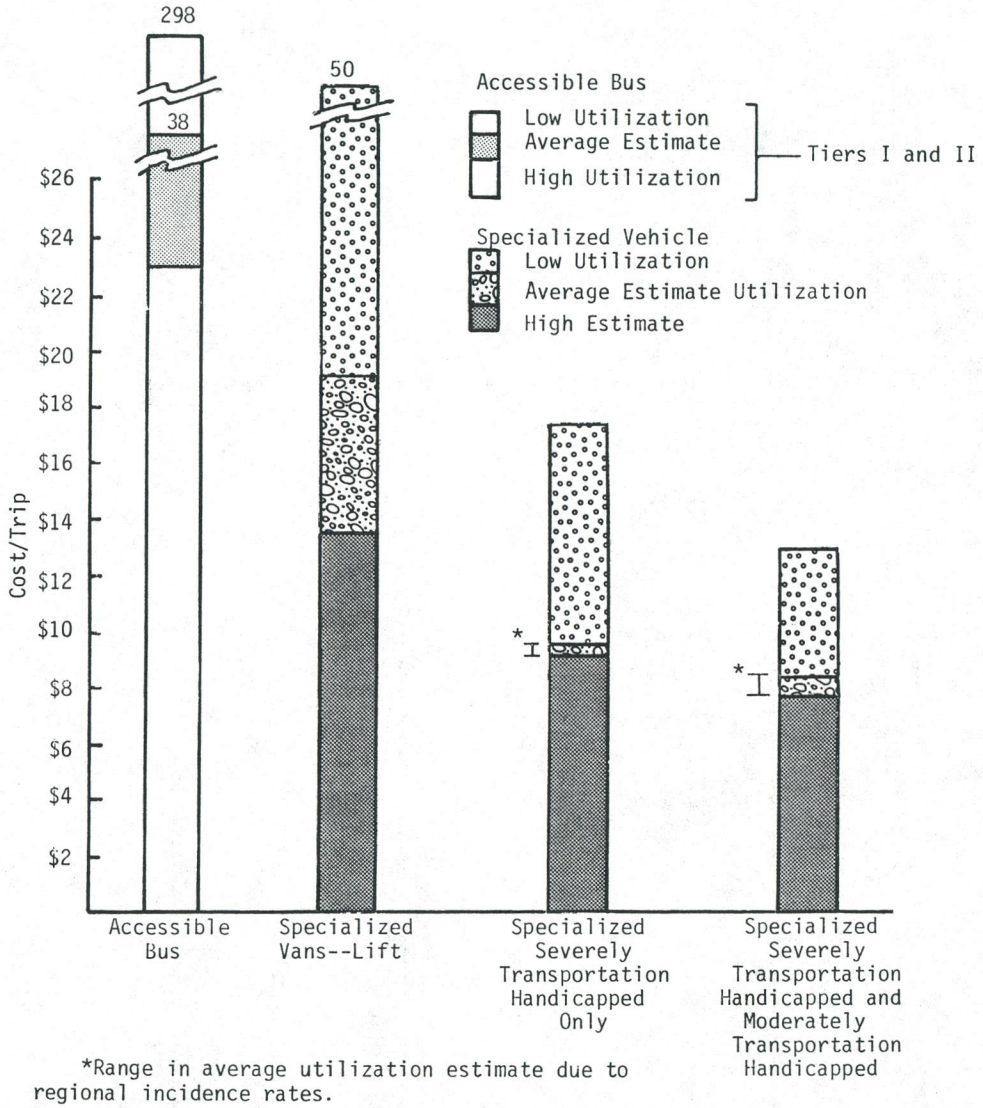
Source: Derived data.



*Range in average utilization estimate due to regional incidence rates.

Source: Derived data.

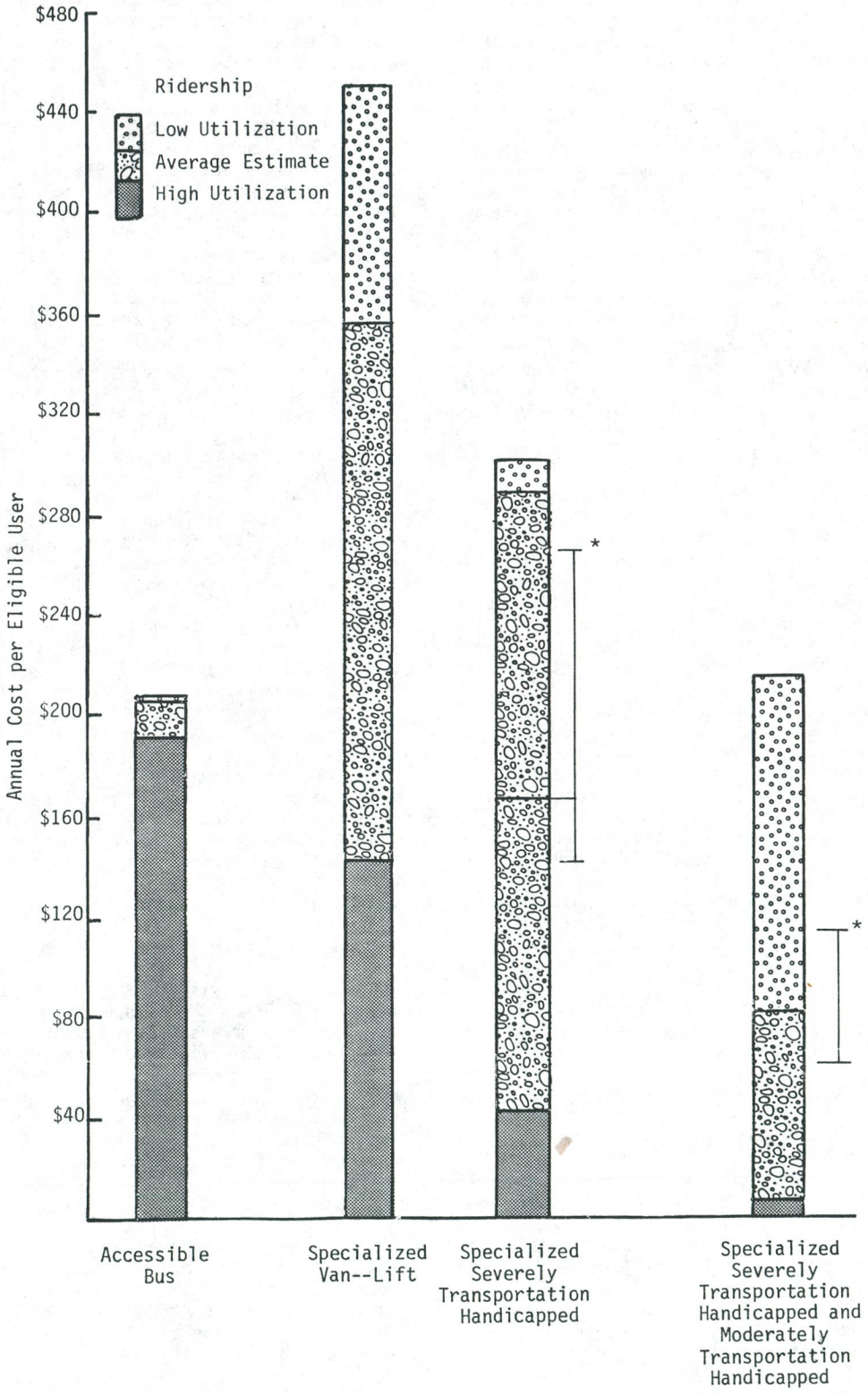
Figure 10. Total annual cost for service options identified in question 1 (costs derived from values in Appendic C).



*Range in average utilization estimate due to regional incidence rates.

Source: Derived data.

Figure 11. Annual cost per trip for alternative service options--question 1 (cost derived from values in Appendix C).



*Range in average utilization estimate due to regional incidence rates.

Source: Derived data.

Figure 12. Annual cost per eligible user for alternative service options--question 1 (cost derived from values in Appendix C).

Ridership levels generally tend to be low; for example, out of a population of over 150,000 individuals residing in the transit service area, the accessible bus system is estimated to handle 1 to 179 boardings per day. Specialized services, exclusively addressing the mobility needs of severely transportation handicapped individuals needing lift-equipped vehicles, expect only 5 to 59 trips per day. Correspondingly, the high utilization estimate for the severely transportation handicapped and combination of severely transportation handicapped and moderately transportation handicapped markets is only 198 and 438 trips per day, respectively.

A critical determinant in establishing annual costs is the market segment to be served with specialized services. As service is extended to more potential users the annual costs increase. In this example, the costs increase less than 20 percent to serve the moderately transportation handicapped in addition to the severely transportation handicapped, assuming the average level of ridership utilization. This relationship is grossly magnified if service is provided to satisfy the high estimate of utilization.

As eligibility definitions become more liberalized for specialized services, total annual costs increase, but the cost per trip remains relatively constant. For example, the cost per trip for the accessible bus ranges from $300 per trip for the low utilization to $23 per trip for the high utilization estimate. The specialized services cost in the range of $9 to $17 per trip, except for lift-equipped vans serving a more limited market size and operating at lower productivities. Here, the cost is in the range of $13 to $50 per trip.

The accessible bus costs annually $200 to $210 per eligible user for the high and low ridership utilization estimates. Over $195 per year per eligible user is invested in the purchase, maintenance, and operation of the lift-equipment (Level I). For specialized services, the annual cost per eligible user is $43 to over $300 for the severely transportation handicapped service and $17 to $220 for combined severely transportation handicapped and moderately transportation handicapped service.

Regional variations in the incidence rates of transportation handicapped persons can have a 50 percent affect on the cost to provide specialized services. The range in costs attributed to the range in regional incidence rates has been noted for the average estimate of utilization in Figures 9, 10, 11, and 12.

Decision-makers may be interested to note that an accessible bus could meet the mobility needs of 450 severely transportation handicapped at a cost of $89,000 per year ($195 per potential user). By using an "average estimate" of ridership level, and providing specialized services for an additional $165,000 per year, transportation services would be required to provide services to an additional 1,000 eligible, severely transportation handicapped persons ($165 per potential user). Likewise, for an additional $55,000 per year, specialized services could be provided to an additional 2,400 moderately transportation handicapped individuals at an incremental cost of $23 per eligible user. In a similar manner, again by using the average estimate of ridership, an $89,000 annual investment for accessible buses accommodates 8 trips per day ($37 per daily trip). For an additional $70,000 per year, an additional 24 transportation lift user/severely transportation handicapped trips per day ($10 per daily trip) could be served with specialized services.

The analysis highlights how local decision-makers can structure cost-effectiveness decisions on resources required to extend transportation services to people or to accommodate transportation handicapped travel. The decision as to which option to select must depend on local goals concerning improved mobility for the transportation handicapped. If the objective is to minimize total cost, the accessible bus is probably the favored option, but at a sacrifice in the mobility provided (the accessible bus high utilization estimate is only 14 daily trips, substantially lower than its latent demand estimate and comparable utilization rates for specialized services). As mobility is provided to more individuals through specialized services, the aggregate costs increase, but the cost per trip served and cost per eligible person to be served decreases. The specialized or accessible bus service can also be provided incrementally. If only 50 percent of the fleet were lift-equipped, the transit company could reduce expenditures, but at a reduction in service levels provided to transportation handicapped bus users requiring a lift. With a 30 percent transfer rate and off-peak headways of one hour or less on less used routes, the transportation handicapped would have extensive travel times. The cost estimates did not consider costs required to reduce architectural barriers in the community to make bus stops accessible to wheelchair users. Because of the trade-offs between mobility and resources, an indication of available resources and priorities for service (market segments to be served) must be clearly defined for the analysis. However, the planner can use the results of the first analysis to study the possibility of providing lower cost specialized services (question 2) using a user-side subsidy program (question 4) or deploying a hybrid service in a select area (question 6).

The decision-maker also must consider the anticipated level of trip-making presented within the range of high or low utilization rates and/or latent demand. Without additional information, the planner should use the average utilization rate.

Question 2

Issues

Concerned with the magnitude of resources required to provide specialized services, the decision-makers are willing to restrict specialized services to the severely transportation handicapped market, but are unwilling to define eligibility within this market segment. In order to reduce the cost of providing specialized services, the decision-makers are willing to consider options a, b, and c, described in the following discussion:

Approach

Option a. Operate the specialized services for a shorter time period (7 am to 6 pm), increase the reservation time, and limit service to a few destinations such as downtown, mall, major hospitals, and social service agencies. This will be called the increased productivity option.

Assumptions:
- Labor cost = $8/hr
- Work rules = restrictions (uniform distribution of service)
- Trip restrictions = none (use midday distribution)
- Service hours = 7 am to 6 pm
- Productivity = 4.0 trips/hr

Option b. Operate the specialized services for a shorter time period (7 am to 6 pm) and place restrictions on the number of trips, considering only medical and work trips. This will be called the trip restriction option.

Assumptions:
- Labor cost = $8/hr
- Work rules = restrictions (uniform distribution of service)
- Trip restrictions = medical/work (use double-peak hour distribution)
- Service hours = 7 am to 6 pm
- Productivity = 3.0 trips/hr

Option c. Subcontract transportation handicapped services to a human service agency who can operate service at a lower labor cost and use part-time labor. This will be called the contract carrier provider option.

Assumptions:
- Labor cost = $4/hr
- Work rules = flexible (variable distribution of service)
- Trip restrictions = none (use double-peak distribution)
- Service hours = 7 am to 6 pm
- Productivity = 2.5 trips/hr

Although the market being served is identical for all three options, the manner in which the service is provided will affect costs. Actions to increase productivity by restricting destinations, increasing reservations time from 24 to 48 or more hours, or imposing trip purpose restrictions or priorities serve to reduce the flexibility of specialized services in meeting the mobility needs of the transportation handicapped. However, these restrictions do provide opportunities to reduce costs, thereby ensuring that specialized services can be provided to a broad segment of the transportation handicapped market. Given the various degrees of service restrictions, it might be assumed that utilization levels could vary with the level of service provided as follows:

1. Increased productivity option: low estimate.
2. Trip restriction option: average estimate for medical/work trips only.
3. Contract carrier option: average estimate.

Results

Table 51 provides an estimate of the eligible users and daily ridership.

Table 51. Results of analysis of question 2.

Number Of	Option a Increased Productivity	Option b Trip Restrictions	Option c Contract Carrier	Source Tables
Eligible Users	1,521	1,521	1,521	1,2
Daily Ridership	15	32	106	17
Utilization Estimate	Low	Average	Average	
Trip Prioritization	None	Medical/Work Only[a]	None	

[a]30 percent of best estimate.

All four options presented can reduce total expenditures over the transit company's proposal to provide specialized door-to-door services for 16 hours per day. Actions, such as option a, to increase productivity by operating a many-to-few service rather than a many-to-many service, can reduce annual expenditures by 70 percent. The major cost savings result because the service hours are shortened and the service would attract fewer users (unless unmet transportation handicapped needs were extensive), thereby requiring fewer vehicles. Recognizing that fewer trips are handled, the cost per trip would exceed that of the base case.

Option b, focusing on trip restrictions, limits the transit company's financial commitment for providing specialized services, but at a sacrifice in the degree of mobility provided. Because of the lower number of trips, the cost per trip is almost equivalent to the increased productivity option.

A well-managed human service agency can provide cost efficiencies in relation to the transit company because these organizations sometimes have lower labor charges and more flexible work rules permitting the hiring of part-time workers. In this situation it was assumed that the human service agency would not be as well managed as the transit company with the hourly productivity being only 2.5 versus 3.0 for the transit company. As a result of this decline in productivity, the full efficiencies resulting for a lower labor cost and increased work rule flexibility are negated. However, the cost per trip is substantially less than the cost for the other options because the social service agency will be able to serve 106 trips per day.

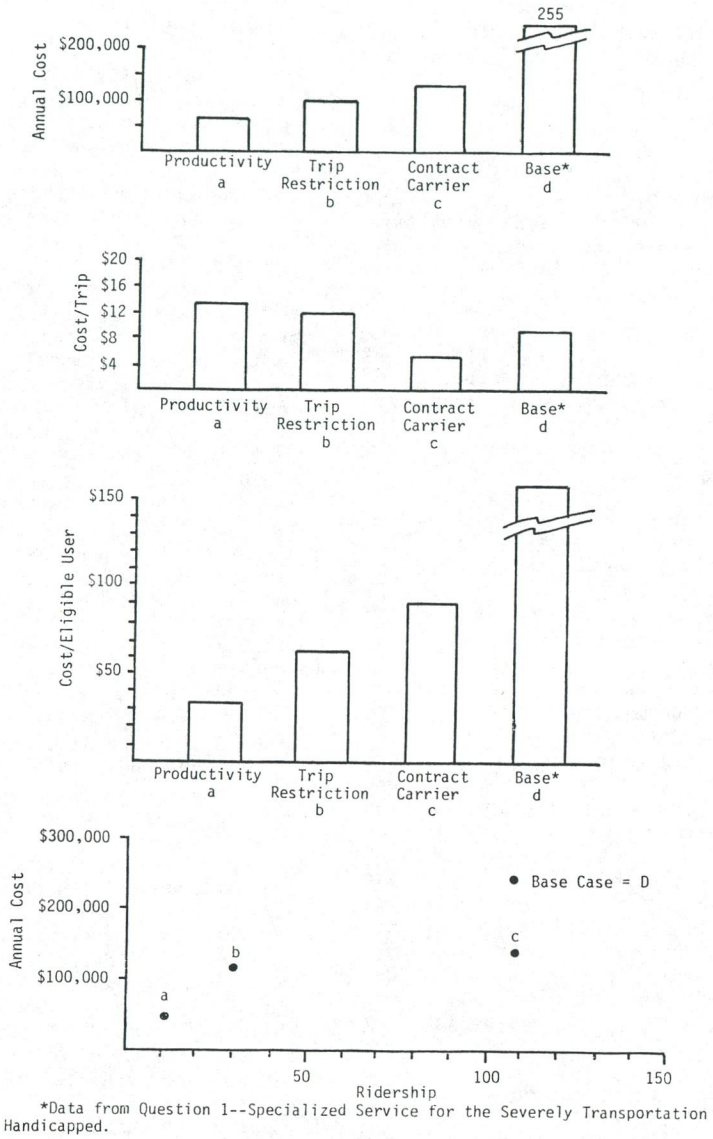
The cost per trip reflects the service provided to people, while cost per eligible user reflects the cost to make the service available to the transportation handicapped population. Option a, the increased productivity option, has the lowest cost per eligible user, but it is artificially influenced by the fact that transportation handicapped users will be limited in the destinations selected.

As suggested by Figure 13, the decision-maker must consider the trade-off between cost and ridership. As noted from Figure 13, option c is superior to the base case. The question then becomes comparing trade-offs between option c and options b and a, respectively. The planner must then address the question of whether or not it is worth an additional annual expenditure of $77,000 to provide an additional 91 trips (option c versus a) or $37,000 for an additional 74 trips with no trip restrictions (option c versus b). These trade-offs must be decided based on resources and transportation handicapped mobility needs at the local level. Obviously, if the option a service level was sufficient to attract an "average level" of ridership and service had to be expanded, option c would be more effective in minimizing annual cost, cost per trip, and cost per eligible user.

Question 3

Issues

Given the benefits of providing specialized services to the transportation handicapped, the decision-makers are interested in extending services to the entire urbanized area and not just to the transportation handicapped residing in the transit service area. The population density in this area will be lower than in the transit service area, thereby reducing the hourly vehicle productivity. Only the severely transportation handicapped will be served.



*Data from Question 1--Specialized Service for the Severely Transportation Handicapped.

Figure 13. Comparison of alternatives for question 1.

Approach

The transportation options include the following (see also Fig. 14):

Option a. Operate the specialized service for the severely transportation handicapped throughout the entire urbanized area through a contract with a social service agency.

Assumptions:
- Labor cost = $6/hr
- Work rules = flexible
- Trip restrictions = none (double-peak distribution)
- Service hours = 7 am to 6 pm
- Productivity = 2.5 trips/hr
- Ridership = best estimate

Option b. Provide a variation of option a where the severely transportation handicapped market segment able to board accessible buses will use the service for destinations within the transit service area and other segments of the severely transportation handicapped market not able to board accessible buses will be provided with specialized services.

Assumptions:
- Labor cost = $6/hr
- Work rules = flexible
- Trip restrictions = none (double-peak distribution)
- Service hours = 7 am to 6 pm
- Productivity = 3.0 trips/hr inside transit area; 2.5 trips/hr outside transit area
- Accessible fixed-route buses available in service area
- Ridership = average estimate

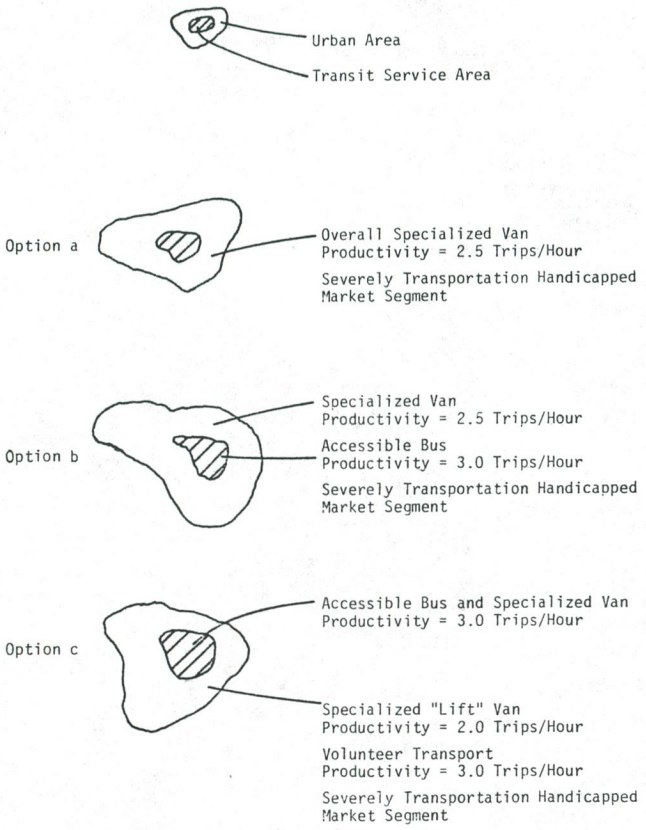


Figure 14. Question 3 transportation options.

Option c. Rely on volunteer organizations to provide services beyond the transit area for the severely transportation handicapped not requiring a lift; otherwise rely on option b.

Assumptions:
Labor cost = $4/hr
Productivity = 2.0 trips/hr

Of interest with these three options is the ability to integrate various service providers to extend services to an entire urbanized area. Feeder services to accessible buses encourage maximum use of buses in the transit service area, but also recognize that not all severely transportation handicapped persons benefit from the provision of accessible buses; these individuals will require supplemental services. Because the relative attractiveness of these services is unknown, they were all compared with a similar ridership level, the average estimate. With local knowledge, it might be desirable to reduce ridership estimates for the less attractive alternatives such as feeder services to buses that require transportation handicapped individuals to undertake an additional enroute transfer.

Results

Using a consistent ridership level of average estimate, the results given in Table 52 were achieved.

For the situation cited, cost comparisons indicate that an areawide specialized service would be less costly than a system attempting to integrate accessible buses with specialized services. Because approximately 70 percent of the severely transportation handicapped market segment may not be able to use accessible buses, a supplemental specialized service would need to be provided within the transit service area. An areawide specialized service can provide 222 daily trips at a cost of $5.90 per trip. The introduction of accessible buses and the need to provide a supplemental specialized service raise the cost to $6.10 per trip. If it is assumed that the accessible buses carry only 8 lift boardings per day rather than the 35 trips for the specialized service operated for lift users in the transit service area, the average cost per trip would approach $7. Reliance on volunteer transportation may serve to reduce hourly labor charges, but the availability of a publicly operated specialized lift service will still be required. If volunteers could take on the responsibility of implementing a specialized service for the entire area, annual cost could be reduced by approximately $30,000 per year. This would still require a trip cost of $5.40. As discussed in Appendix D, the operation of a volunteer program requires extensive dedication and management skills.

For question 3, the most cost-effective means of extending services to all severely transportation handicapped individuals residing in the urban area is through specialized services operated through a contract with a human service agency.

Question 4

Issues

Interest has developed in establishing a user-side subsidy program, and the local taxi operators have expressed an interest in participating in such a program. Currently, an average taxi fare is $2.50 for a 3.2-mile trip. The subsidy program would reduce the cost to the user to $0.50 per trip, or to a level approximating the transportation handicapped fare on transit and specialized services. It is assumed that the user-side taxi option will be available for the entire urbanized area.

Approach

Option a. Same as option a of question 3.

Option b. At a fare of $0.50 per trip, operate a user-side subsidy program for those members of the severely transportation handicapped able to enter a taxi. Further, it is assumed that 20 percent of the severely transportation handicapped will not be able to use a taxi and will require a special lift-equipped van leased to the taxi company or provided by a human service agency under contract.

Assumptions:
Taxi Service:
Number of taxi vehicles in fleet = 82
Fleet reserves = 20%
Maximum vehicle productivity = 5.0
Hours of service = 24 hrs/day
Trip restrictions = none
Incremental productivity with existing taxi vehicles
Morning = 2.3 trips/hr
Midday = 1.9 trips/hr
Afternoon = 1.5 trips/hr
Evening = 3.0 trips/hr
Night = 3.0 trips/hr
Fare for user = $0.50: Community subsidy = $2.50 ($2.00/trip taxi fare and $0.50/trip overhead and administration)

Table 52. Results of analysis of question 3.

			Option		
			a Specialized (All Severely Transportation Handicapped)	b Specialized + Accessible Bus (All Severely Transportation Handicapped)	c Volunteers + Accessible Bus (All Severely Transportation Handicapped)
Number of Eligible Transportation Handicapped	Within Transit		1,521	1,521	1,521
	Outside Transit		1,661	1,661	1,661
	Total		3,182	3,182	3,182
Number of Daily Trips	Within Transit	Bus	-	35[a]	35[a]
		Spec.	106	71[b]	71[b]
	Outside Transit	Spec.	116	116	38-lift[b] 77-Vol.
	Total		222	222	222
Annual Cost[c]	Within Transit	Bus	-	$90,000	$90,000
		Spec.	Yes	$94,500	$94,500
Annual Cost	Outside Transit	Spec.	Yes	$166,000	$125,000-Vol. $79,500-Lift
	Total		$340,000	$350,500	$389,000
Daily Cost/ Trip			$5.90	$6.10	$6.75
Yearly Cost/ Eligible User n = 260			$107.00	$110.00	$122.25

[a]Assume trips made on accessible bus. The average of bus use indicates only 8 trips.

[b]Specialized service ridership based on assumption that 30 percent of the severely transportation handicapped can use an accessible bus.

[c]All costs were derived from values in Appendix C.

Source: Derived data.

Specialized lift-equipped van:
Labor cost = $6/hr
Work rules = flexible
Service hours: 7 am to 6 pm
Productivity = 2.0
Trip restrictions = none
(double-peak distribution)

Of interest is the ability of the existing taxi service to expand its market and to provide severely transportation handicapped services by utilizing the idle time of the existing taxi fleet. In order to make taxi service affordable to the transportation handicapped, the fare level has to be reduced to a level comparable to that of bus or specialized services. However, a community might wish to recognize the premium nature of taxi service (immediate request) and charge a higher user fare that can affect ridership. Likewise, taxi vehicles cannot accommodate all members of the severely transportation handicapped market segment; supplemental lift-equipped van service will need to be provided.

Results

The ridership levels for the two options are noted in Table 53. Figure 15 presents total annual costs and cost per trip for the two options considered. As noted, the user-side subsidy program becomes the most cost-effective option. However, in this analysis, taxi revenues should become a consideration, as should the cost borne by the user versus the public via the subsidy level.

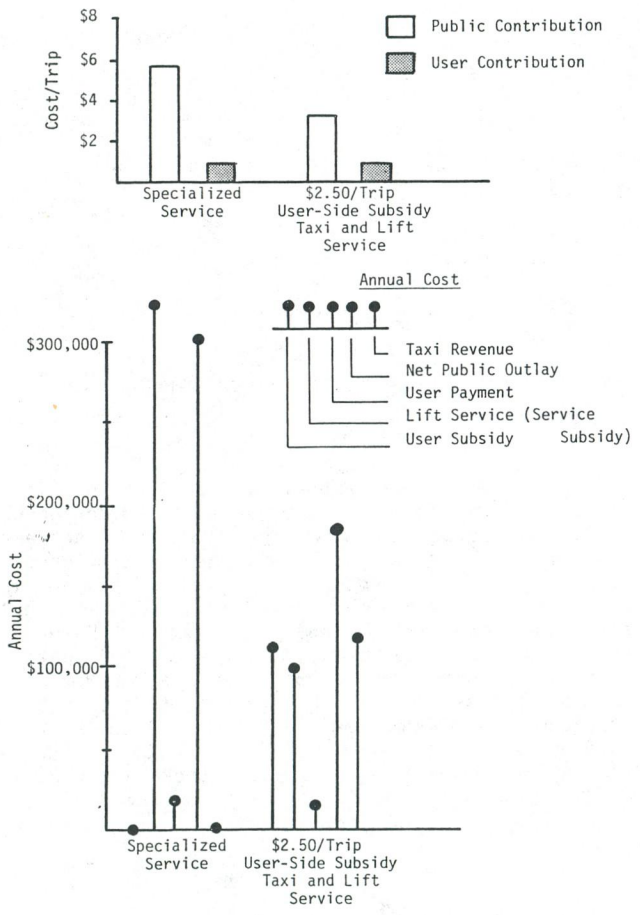
A user-side subsidy program relying on taxis can provide transportation handicapped services at less public expenditure than a specialized service. This scenario relies on the availability of cooperative and efficient taxi operators; such opportunities do exist in many cities. The taxi operator benefits by achieving greater use of existing resources through increased penetration of the transportation handicapped market. A user-side subsidy program must consider the need to operate supplemental lift-equipped vans to transport those members of the severely transportation handicapped market not able to use a taxi.

Taxi-based systems when combined with user-side subsidies have the opportunity to reduce total public costs over specialized services. However, some of the cost responsibilities may shift to the users.

Table 53. Ridership levels for question 4.

Number of	Option a Contract Carrier Specialized	Option b User-Side Subsidy Taxi and Van--50¢/ride
Eligible Users	3,182	3,182
Daily Ridership	222	222
Taxi	-	178
Specialized Lift	222	44

Source: Derived data.



Source: Derived data.

Figure 15. Service options for question 4.

Question 5

Issues and Approach

Because of the high incidence of transportation handicapped persons residing in Districts 1, 2, and 5 (see Fig. 9), the two bus routes serving these areas were selected for implementation of accessible bus service. Also, because many of the destinations frequenced by the transportation handicapped are located in this area, it is expected that 60 percent of systemwide accessible bus lift boardings will be generated by these two bus routes. Because not all residents will be served by accessible buses, a specialized service will be provided. The specialized service will act as a feeder to the accessible buses for origins/destinations located along the bus routes in Districts 1, 2, and 5 and will also be extended to District 13. Specialized service will be restricted to severely transportation handicapped persons who require use of a lift. It is estimated that 65 percent of the trips will have either an origin or destination in the transit service area.

Results

Table 54 gives the ridership estimates for the combined accessible bus-specialized service alternative.

Eighteen daily bus lift boardings were estimated considering trips that have both an origin and destination within the transit service area or involve transferring lift users to and from the specialized service. Also, the specialized service would involve 15 trips that could be handled by one van at an average vehicle productivity of 2 trips per hour. The cost of the hybrid service would then involve approximately $18,000 per year to lift-equip and operate 8 buses (Level I costs only) operating on the two routes and $37,000 per year for the operation of a specialized van operated by the transit service (option described in question 1, but only operated for 8 hours per day). The cost per trip would be $10.50 per trip and $141 per eligible user. As noted in this example, a hybrid design can then be a cost-effective means of providing transportation handicapped services to a select area having a high incidence of transportation handicapped individuals.

Question 6

Issues and Approach

At times, the decision to provide transportation handicapped services has to be influenced by available budgets. For example, it might be assumed that the local transit agency has an available budget of $100,000 to extend services to the maximum number of transportation handicapped. Assuming the transit company's labor costs are $8 per hour, with restrictive work rules, and 7 am to 6 pm service, determine the range of services that could be provided for the $100,000 budget.

Results

For $100,000 per yr. the transit company could:

1. Operate a lift-equipped bus fleet of 40 vehicles with an estimate of 8 daily lift boardings.
2. Operate 12 hours per day specialized services (productivity = 3.0) to provide 55 daily specialized trips to the severely transportation handicapped residing in the transit service area.
3. Operate 12 hours per day specialized services (productivity = 3.5) to provide 65 daily medical/work trips to severely transportation handicapped and moderately transportation handicapped residing throughout the urbanized area.
4. Contract with a human service agency to provide 125 severely transportation handicapped and moderately transportation handicapped daily trips (productivity = 3.5) in transit service area.
5. Initiate a taxi-based user-side subsidy program providing a subsidy level of $2.00 per trip (taxi cost plus administrative fees) for 190 daily severely transportation handicapped trips.

Table 54. Ridership estimate for question 5.

Zone	Severely Transportation Handicapped Individuals Requiring Lift Service: Total	Percent Residing in Transit Area	Lift Users in Transit Area
1	123	100	123
2	95	85	81
5	114	70	80
13	57	-	-
	389		284

Zone	Specialized Service at Average Ridership[a]: Daily Trips Originating in Transit Area and Transferring from Bus to Van for Area Beyond Transit Service Area[b]	Daily Trips Originating Outside Transit Area and Transferring from Van to Accessible Bus[c]	Trips with Origin and Destination Outside Transit Area	Trips with Origin and Destination Served by Accessible Bus in in Transit Service Area[d]	Total
1	3	-	-	-	-
2	2	1	-	-	-
5	2	2	1	-	-
13	-	3	1	-	-
Daily Bus Lift Boardings	7	6	-	5	18
Specialized Services Trips	7	6	2	-	15

[a].07 daily trips (Table 17).

[b]35 percent transfer bus to specialized van.

[c]65 percent transfer van to bus.

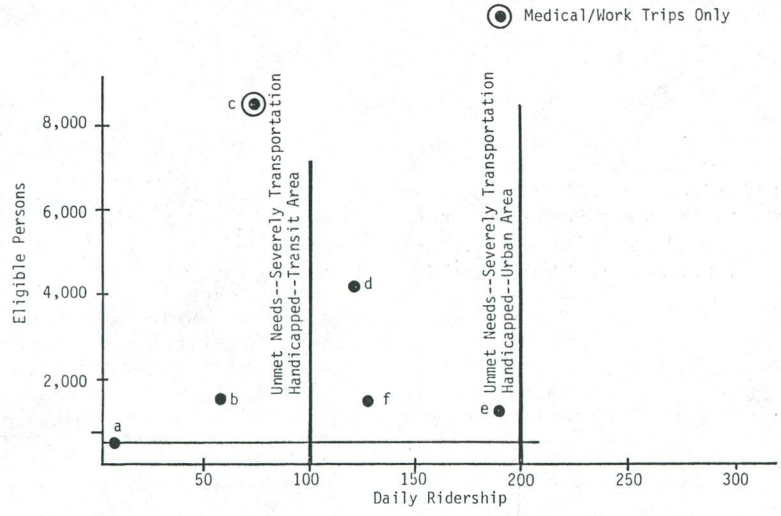
[d]60 percent of 8 daily lift boardings (Table 16).

Source: Derived data.

6. Initiate a taxi-based user-side subsidy program providing a subsidy level of $2.00 per trip with lift service provided to those individuals not able to access a taxi for a total of 135 daily trips.

Many additional transportation handicapped service options could be considered, but for a fixed annual level of resources, the decision-makers may wish to consider trade-offs between mobility provided (transportation handicapped trips served per day) and persons served (transportation handicapped individuals' eligible for the service).

Using an average estimate of daily trip utilization, a decision as to the most advantageous option to pursue is based on trade-offs between economics and the goals of the transportation handicapped program, as noted in Figure 16. If it is desired to maximize ridership, option e, the user-side taxi program, is most attractive. However, this option does not serve the severely transportation handicapped who cannot access a taxicab, or leaves 304 of the 1,521 severely transportation handicapped without service. Modification of this option (option f noted on Fig. 16) to include a specialized lift-equipped van for these individuals



Source: Derived data.

Figure 16. Eligible persons versus daily ridership for annual budget of $100,000.

would then provide 135 daily trips. The accessible bus can serve any number of trips (particularly if Level II costs are excluded), but this option serves only 456 severely transportation handicapped residing in the transit service area who can access a bus if a lift is provided. Option c can provide service to both severely and moderately handicapped residents of the entire urban area, but because of the trip prioritization requirements will only be able to serve 65 daily trips. If service was to be extended to the severely and moderately transportation handicapped residing in the transit area, alternative d would be preferred.

For a fixed budget, trade-offs then exist between persons served and trips served. One way to determine appropriate options is to consult community goals and unmet needs. Worksheet A identified an unmet need of about 200 daily severely transportation handicapped trips throughout the urbanized area or about 100 severely transportation handicapped trips in the transit service area. Likewise, Table 46 indicates that 1,146 and 533 severely transportation handicapped individuals are "without access" to an automobile in the urban area and transit area, respectively. Consideration of these parameters might then help bound the needs and define the appropriate service. In the example, it appears more vital to service trips for those without access to autos than to provide service to eligible individuals, many of whom rely on the automobile for personal mobility. For the available budget, the greatest number of trips for the eligible, severely transportation handicapped population could be served by a taxi-based user-side subsidy with a specialized lift-equipped van. In reaching a decision how best to utilize a fixed budget, eligibility standards and definition of the transportation handicapped market segment to be served (geographic area and type of transportation handicapped) are vital inputs. Without this understanding it is difficult to make a decision. There are, of course, numerous other options. For example, if it is assumed that 20 percent of the riders in option d are mentally retarded and could be trained to use existing bus service for trips within the transit service area, an annual net savings of $7,500 could be realized. This estimate is based on annual training costs of $500 per person for 25 persons or $12,500 versus the annual cost of $20,000 to transport these individuals by specialized services.

SUMMARY

Although the example issues reflect only a sample of alternative transportation service options that can be considered by a local community, they do highlight the application of the cost-effectiveness guidelines to typical problems. The central focus of the examples is that there is no simple answer that suggests that one alternative is always superior to others. Rather, the decision-maker should conduct a detailed analysis tailored to the local situation--demand levels, spatial concentration of transportation handicapped individuals, service providers, labor rates, etc.

In all the example issues, typical costs and performance values were selected, using as input the operational experiences of agencies currently providing transportation handicapped services. Wherever possible, the planner should select cost and utilization values best reflecting local conditions. Because many aspects of the analysis, such as ridership, service levels, etc., are subjected to variability, it is important for the planner to consider a range in values. The guidelines are presented to aid local planners and decision-makers in an understanding of the mobility needs of the transportation handicapped population and means to address needs within the scope of public resources and desires of the local community.

BIBLIOGRAPHY

Abt Associates, Inc., Accessibility of the Metropolitan Washington, D.C., Public Transportation System to the Handicapped and Elderly. Cambridge, Massachusetts: Abt Associates, Inc., 1972.

Abt Associates, Inc., Transportation Needs of the Handicapped: Travel Barriers. Cambridge, Massachusetts: Abt Associates, Inc., 1969.

Abt Associates, Inc., Travel Barriers. Washington, D.C.: U.S. Department of Transportation, 1970.

AM General Corporation, A Study of Wheelchair Access to the Current Transit Bus Design. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, April 1977.

American Management Association, AMA Management Course, Unit No. 1. New York: American Management Association, 1952.

Applied Resources Integration, Ltd, Planning Guidelines for Coordinated Agency Transportation Services. Boston, Massachusetts: Applied Resources Integration, Inc., April 1980.

Barker, W.G., T.K. Ryden, and F.T. Watson, An Analysis of Transit and Paratransit Options for the Elderly and the Handicapped. Arlington, Texas: North Central Texas Council of Governments, January 1978.

Billheimer, J.W., R.E. Lave, P. Jones, C. Fratessa, D. Newman, M. Holoszyc, and G. Fondahl, "Paratransit Handbook, A Guide to Paratransit Implementation Volume 1--Parts 1-3." Final Report, Report No. UMTA-MA-06-0054-79-1. Washington, D.C.: Office of Technology Development and Deployment, U.S. Department of Transportation, January 1979.

Blennemann, F., and E. Pajonk, "Evaluation of Additional Costs for Making Public Transportation Accessible to the Handicapped." Transportation Planning and Technology, Vol. 5, No. 2, 1979, pp. 105-114.

Bloomfield, P. and S. Flynn, "Subsidized Taxi Programs for Elderly and Handicapped Persons in the San Francisco Bay Area." Final Report, Report No. UMTA-MA-06-0049-77-9. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, September 1977.

Booz, Allen & Hamilton, Inc, Provisions for the Elderly and Handicapped in Design of Transbus. Bethesda, Maryland: Booz, Allen & Hamilton, Inc., March 1973.

Booz, Allen & Hamilton, Inc., and Synergy Consulting Services, "Planning for the Phase-In of Fixed-Route Accessible Buses--Interim Report No.1: Review of Accessible Transit Services." Interim Report, Report No. UMTA-IT-09-9010-80-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, January 1980.

Booz, Allen & Hamilton, Inc., and Synergy Consulting Services, "Planning for the Phase-In of Fixed-Route Accessible Buses." Draft Final Report, Report No. UMTA-IT-09-9010-80-5. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, March 1981.

Brail, R.K., J.W. Hughes, and C.A. Arthur, Transportation Services for the Disabled and Elderly. New Brunswick, New Jersey: Center for Urban Policy Research, Rutgers University, 1976.

Bullard, D.L. and T. Urbanik, "Evaluation of Selected Home Services Transportation Providers in Texas." Report No. UMTA-TX-80-1065-1. College Station, Texas: Texas Transportation Institute, Texas A&M University, August 1980.

Bureau of the Census, U.S. Department of Commerce, Disability Data from the National Content Test and the National Content Test Reinterview. National Content Test, 1976. Results Memorandum No. 10. September 9, 1977.

Burkhardt, J.E. and C.L. Eby, "Need as a Criterion for Transportation Planning." Highway Research Record 435, 1973, pp. 32-41.

Casey, R.F, "The Accessible Fixed-Route Bus Service Experience." Report No. UMTA-MA-06-0049-81-7. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, May 1981.

Casey, R.F., "San Diego Wheelchair Accessible Bus Study." Interim Report, Report No. UMTA-MA-06-0049-77-8. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, September 1977.

Charles River Associates, Inc., User-Side Subsidies for Shared Ride Taxis in Kinston, North Carolina. Boston, Massachusetts: Charles River Associates, Inc., October 1980.

Charles River Associates, Inc., "User-Side Subsidy Demonstration Project: Montgomery, Alabama." Draft Final Evaluation Report. Boston, Massachusetts: Charles River Associates, Inc., April 1982.

Charles River Associates, Inc., "User-Side Subsidy Demonstration Project: Lawrence, Massachusetts." Draft Final Evaluation Report. Boston, Massachusetts: Charles River Associates, Inc., May 1982.

Chatterjee, A., A.M. McAdams and F.J. Wegmann, "Non-Commitment Bias in Public Opinion on Transit Usage." Working Paper, Department of Civil Engineering, The University of Tennessee, January 1982.

Congressional Budget Office, United States Congress, Urban Transportation for Handicapped Persons: Alternative Federal Approaches. Washington, D.C.: Government Printing Office, November 1979.

Cook, A.R., "The Dial-A-BAT Paratransit Service of Brockton, Massachusetts, Area Transit--Public Transit in Coordinated Human Services Transportation." Report No. UMTA-OK-11-0001-79-5. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1978.

Coons Manufacturing, Inc., Comparative Costs: Ford Super Vans Versus Diamond People Movers. Oswego, Kansas: Coons Manufacturing, Inc.

Cooper, T., P. Bloomfield, and S. Flynn, "The LIFT: Special Needs Transportation in Portland, Oregon." Final Report, Report No. DOT-TSC-1081. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, August 1979.

Couture, M.R. and T. Dooley, "Analyzing Traveler Attitudes to Resolve Intent and Actual Use of a New Transit Service." Transportation Research Record 794, 1981, pp. 27-33.

Crain and Associates, AC Transit Elderly and Handicapped Planning Study--Analysis of Needs and Alternatives. Oakland, California: Alameda-Contra Costa Transit District, September 1977.

Crain and Associates, "Transportation for Seniors and Handicapped Persons in St. Louis. Volume II. Appendices." Report No. UMTA-IT-09-0028-74-2. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, January 1974.

Crain and Associates, "Transportation Problems of the Transportation Handicapped. Volume I. The Transportation Handicapped Population, Definition and Counts." Final Report, Report No. UMTA-CA-06-0092-76-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, August 1976.

Crain and Associates, Transportation Problems of the Transportation Handicapped. Volume IV. Transportation Solutions for the Handicapped. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, August 1976.

Crain, J. and W. Courington, "Incident Rates and Travel Characteristics of the Transportation Handicapped in Portland, Oregon." Final Report, Report No. UMTA-OR-06-0004-77-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, April 1977.

Davis, F.W., Jr., D.A. Burkhalter, W.W. Dotterweich, and T. Cleary, "The Social Service Insurance Dilemma: Problems, Analysis, and Proposed Solutions." Report No. DOT/RSPA/DPB-50/78/20. Washington, D.C.: Office of University Research, U.S. Department of Transportation, March 1979.

Dorosin, E. and J. Phillips, "Share A Fare: A User-Side Subsidy Transportation Program for Elderly and Handicapped Persons in Kansas City, Missouri." Final Report, Report No. UMTA-MA-06-0049-79-11. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, July 1979.

Dougherty, E. and J.A. De Benedictus, FIRL Specifications for Making Mass Transit Accessible to the Elderly and Handicapped. Philadelphia, Pennsylvania: Franklin Institute Research Laboratories, undated.

Dougherty, E. and J.A. De Benedictus, A Study on Making Transportation Facilities Accessible to the Elderly and Handicapped. Philadelphia, Pennsylvania: Franklin Institute Research Laboratories, June 1976.

Dougherty, E.J. and J.A. De Benedictus, "A Study on Making Transportation Facilities Accessible to the Handicapped and Elderly." Report No. UMTA-PA-06-0031-75-2. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1975.

Eckmann, A., "Identifying and Serving the Elderly and Handicapped in Rural Areas." Transportation Research Record 696, 1978, pp. 87-88.

Edelstein, P., "Evaluation of the EASYRIDE Specialized Transportation Service." Final Report, Report No. UMTA-MA-06-0049-4. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, November 1979.

Einstein, N., "Special Paratransit Service for Elderly and Handicapped Persons: Operational Experience." Final Report, Report No. DOT-1-81-35. Washington, D.C.: Technology Sharing Program, U.S. Department of Transportation, November 1981.

Falcocchio, J.C., "An Assessment of Wheelchair Lift Buses in Westchester County, New York." Interim Report, Report No. UMTA-NY-11-0023-81-2. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, October 1980.

Falcocchio, J.C., "Development of Design Standards for Public Transportation Services for the Transportation Handicapped in Large Urban Areas." Transportation Research Record 784, 1980, pp. 13-21.

Falcocchio, J.C., Estimates of Travel Demand for the Disadvantaged: Large Urban Areas. Brooklyn, New York: Department of Transportation Planning and Engineering, Polytechnic Institute of New York, 1976.

Fitzgerald, P.G., "User-Side Subsidies for Shared Ride Taxi Service in Danville, Illinois: Phase I." Report No. UMTA-IL-06-0034-77-1. Menlo Park, California: Crain and Associates, June 1977.

Flynn, S., "Paratransit, Inc. Special Transportation Service in Sacramento." Final Report, Report No. UMTA-06-0049-81-6. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, July 1981.

Furniss, R.E., "The Westport Connecticut Integrated Transit System." Final Report, Report No. UMTA-CT-06-0007-79-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, July 1979.

Grey Advertising, Incorporated., Summary Report of a Survey of Transportation Handicapped Users and Non-Users of Special Transportation Systems in Four Cities. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, December 1980.

Grey Advertising, Incorporated., Summary Report of the National Survey of Handicapped People. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1978.

Grey Advertising, Incorporated, "Technical Report of the National Survey of Transportation Handicapped People." Report No. UMTA-NY-06-0065-78-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, September 1978.

Hartgen, D.T. and C.A. Keck, "Forecasting Dial-A-Bus Ridership in Small Urban Areas." Transportation Research Record 563, 1976, pp. 53-62.

Hartgen, D.T., M. Pasko and S.M. Howe, "Forecasting Non-Work Public Transit Demand by the Elderly and Handicapped." Preliminary Research Report 108. Albany, New York: Planning Division, New York State Department of Transportation, August 1976.

Hartgen, D. and D. Weiss, "Cost-Effective Bus Transit Barrier Removal Policies for Elderly and Handicapped." Preliminary Research Report 118. Albany, New York: New York State Department of Transportation, 1977.

Hoel, L.A., E.D. Perle, K.J. Kansky, A.A. Kuehn, E.S. Roszner, and H.P. Nesbitt, Latent Demand for Urban Transportation. Pittsburgh, Pennsylvania: Transportation Research Institute, Carnegie-Mellon University, May 1968.

Hood, T.C., T.L. Bell, C.A. Sovchen, and K.W. Heathington, "Market Opportunity Analysis for Short-Range Public Transportation Planning: Transportation Services for the Transportation Disadvantaged." National Cooperative Highway Research Program Report 209. Washington, D.C.: Transportation Research Board, 1979.

Institute of Public Administration, Improving Transportation Services for Older Americans. Albany, New York: Institute of Public Administration, September 1980.

Institute of Public Transportation, Statewide Study of the Feasibility of Coordinating or Consolidating Specialized Transportation Services. Albany, New York: New York State Department of Transportation, October 1978.

Karash, K.H., "Analysis of a Taxi-Operated Transportation Service for the Handicapped." Transportation Research Record 618, 1976, pp. 25-29.

Kates, Peat, Marwick & Co., Transportation for the Disabled. Prepared for the Toronto Transit Commission, Ontario Ministry of Transportation and Communications. Toronto, Ontario: Kates, Peat, Marwick & Co., 1974.

Kendall, D., "Comparison of Findings from Projects that Employ User-Side Subsidies for Taxi and Bus Travel." Transportation Research Record 784, 1980, pp. 45-52.

Knapp, S.F., H. Worthington and J.E. Burkhardt, Wisconsin Manual to Coordinate Handicapped Transportation Services in Rural and Small Urban Counties. Madison, Wisconsin: Bureau of Transit, Wisconsin Department of Transportation, December 1980.

Knighton, R.B. and D.T. Hartgen, "Incorporating Barrier Effects in Elderly and Handicapped Non-Work Transit Demand Forecasts." Research Report 116. Albany, New York: Planning Division, New York State Department of Transportation, April 1977.

Kocur, G., "The Valley Transit District: Specialized Transportation for the Elderly, Handicapped and Low-Income in the Lower Naugatuck Valley, Connecticut." Final Report, Report No. UMTA-CT-06-0003-79-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, February 1979.

Koffman, D., "Lift-Equipped Bus Service in Seattle, Washington." Final Report, Report No. UMTA-MA-06-0049-81-14. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, March 1982.

Koffman, D., "Mobility Impacts of Transportation Improvements for the Elderly and Handicapped." Transportation Research Record 688, 1978, pp. 11-17.

Koffman, D., "A Taxi Scrip Program in Seattle, Washington." Report No. UMTA-MA-06-0049-82-2. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1982.

Lewis, D., Equity in Urban Transportation for Disabled Persons, Draft. Washington, D.C.: Congressional Budget Office, undated.

Lewis, D., "Issues in Transportation of the Elderly and Handicapped," Recording of a presentation made at the 60th Annual Meeting of the Transportation Research Board, Session 195, January 15, 1981.

Levinson, H.S., "Urban Travel Characteristics," Transportation and Traffic Engineering Handbook, Second Edition. Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1982.

Lovely, M.E., "The Milwaukee County User-Side Subsidy Program: A Case Study." Report No. UMTA-MA-06-0049-82-4. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1982.

Manheim, M., "Principles of Transport Systems Analysis." Professional Paper P67-1, Department of Civil Engineering, Massachusetts Institute of Technology, 1967.

Mark Battle Associates, Inc., and Parsons, Brinckerhoff, Quade and Douglas, Inc., Transportation for Elderly and Handicapped Persons in the Washington Metropolitan Area. Washington, D.C.: Metropolitan Washington Council of Governments, December 1977.

Mark Battle Associates, Inc., and Parsons, Brinckerhoff, Quade and Douglas, Inc., "Transportation for the Elderly and the Handicapped." Final Report, Report No. UMTA-DC-06-0020-73-3. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, July 1973.

Mayer, H.M., "Milwaukee's Accessibility Program--A Lot of Work for a Little Mobility." Metropolitan, March/April 1980, pp. 35-37.

Meier, H., Accessible Public Transit: A History and Overview of Accessible Provisions in the United States. San Francisco: United Cerebral Palsy Association of San Francisco, 1981.

Michaels, R.M. and N.S. Weiler, Transportation Needs of the Mobility Limited. Evanston, Illinois: Transportation Center, Northwestern University, 1974.

Middendorf, D.P. and A.B. Hassam, "Data Collection Issues in Transportation Planning." Transportation for the Elderly and Handicapped: Programs and Problems 2. Washington, D.C. U.S. Department of Transportation, Transportation Systems Center, Technology Sharing Office, February 1981, pp. 102-115.

Miller, J.A., "Latent Travel Demands of the Handicapped and Elderly." Transportation Research Record 618, 1976, pp. 7-12.

Multisystems, Inc., "Evaluation of the Palm Beach County Accessible Bus Demonstration." Draft Report. Washington, D.C.: Urban Mass Transportation Administration and Transportation Systems Center, U.S. Department of Transportation, May 1982.

Multisystems, Inc., "Evaluation of the Washington, D.C., Accessible Bus Demonstration." Draft Report. Washington, D.C.: Urban Mass Transportation Administration and Transportation Systems Center, U.S. Department of Transportation, January 1982.

Navin, F.P.D., "Productivity of Vehicle Transport for the Elderly and Handicapped." Transportation Planning and Technology, Vol. 5, No. 2, 1979, pp. 99-104.

Nelson, D., M. Spann and S. Shepetin, "Fixed-Route Accessible Bus in Connecticut: A Case Study." Report No. UMTA-MA-06-0049-81-5. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, July 1981.

Neumann, L.A., J.A. Wojno and R.D. Juster, "Integrated Dial-A-Ride and Fixed-Route Transit in Ann Arbor, Michigan." Final Report, Report No. UMTA-MA-06-1083-77-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, March 1977.

Newman, D.A. and M. Holoszyc, "Evaluation of the Rochester, New York Community Transit Service Demonstration--Vol. 1: Executive Summary." Report No. UMTA-NY-06-0048-81-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, October 1980.

North Carolina Department of Transportation, Planning for Non Urbanized Areas--A Guide Book for Local Governments and Service Providers. Raleigh, North Carolina: Public Transportation Division, North Carolina Department of Transportation, January 1979.

Paul, G. and R. Casey, "Atlanta Wheelchair Accessible Bus Study." Final Report, Report No. UMTA-MA-06-0049-78-10. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, August 1978.

Peat, Marwick & Partners, Urban Transportation for the Disabled. Prepared for the Ontario Ministry of Transportation and Communications. Toronto, Ontario: Peat, Marwick & Partners, 1975.

Peat, Marwick, Mitchell and Company, Analyzing Transit Options for Small Urban Communities. Washington, D.C.: U.S. Department of Transportation, January 1978.

Peat, Marwick, Mitchell and Company, Classification of Transportation Handicaps and the Transportation Handicapped Population, Report No. 1, Phase I, Research on the Transportation Problems of the Transportation Handicapped. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, October 1975.

Peat, Marwick, Mitchell and Company, "Data Requirements for Elderly and Handicapped Transportation Planning." Interim Report No. 1, Elderly and Handicapped Data Collection Study. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, December 1979.

Przepioria, J., J. Clare, M. Holoszyc and R. Lave, "The Call-A-Bus Demonstration Project--Specialized Transportation for the Elderly and Handicapped in Syracuse, New York." Report No. UMTA-NY-06-0041-77-1. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, June 1977.

Public Technology, Inc., Elderly and Handicapped Transportation: Eight Case Studies. Washington, D.C.: U.S. Department of Transportation, September 1979.

Public Technology, Inc., Elderly and Handicapped Transportation: Local Government Approaches. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, March 1979.

Randall, A., H. Greenhalgh, and E. Samson, "Mode of Transportation and Personal Characteristics of Tripmaker." Report No. 9, Nationwide Personal Transportation Study. Washington, D.C.: Federal Highway Administration, U.S. Department of Transportation, November 1973.

Richards, B., "The User-Side Subsidy Taxi Program in the Harbor Area of Los Angeles, California." Final Report, Report No. UMTA-MA-06-0049-80-9. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, May 1980.

Spear, B., "User-Side Subsidies: Delivering Special Needs Transportation Through Private Providers." Transportation Research Record 850, 1982, pp. 13-18.

Spear, B.D. et al., "Service and Methods Demonstrations Program Report." Report No. UMTA-MA-06-0049-81-12. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, December 1981.

Spear, B.D., E.A. Page, H. Slavin, and C. Hendrickson. Recent Evidence from UMTA's Service and Methods Demonstration Program Concerning the Travel Behavior of the Elderly and the Handicapped. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, October 1978.

Starks, Jane K., "Two Options for Travel Needs of Mentally Retarded: Implications for Productivity and Cost Effectiveness." Transportation Research Record 850, 1982.

Technology Sharing Office, U.S. Department of Transportation, Paratransit: State of the Art Overview. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, September 1981.

Teixeira, D., "State-of-the-Art Demand-Responsive Systems for the Transportation Handicapped." In Mobility for the Elderly and Handicapped, edited by N. Ashford and W. Bell, Proceedings of the International Conference on Transport for Elderly and Handicapped Persons held in Cambridge, England, 1978. Loughborough, Leicestershire, England: Department of Transport Technology, Loughborough University of Technology, n.d., pp. 304-311.

Teixeira, D., F. Varker and R. Bowlin, "Accessible Bus Service in St. Louis." Final Report, Report No. UMTA-MA-06-0049-80-6. Cambridge, Massachusetts: Transportation Systems Center, U.S. Department of Transportation, February 1980.

Urbanik, T. and J.A. Soegaad, Cost Effectiveness of Accessible Buses in Texas. Austin, Texas: Texas Department of Highways and Public Transportation, 1979.

U.S. Department of Transportation, "Nondiscrimination on the Basis of Handicap in Federally Assisted Programs and Activities Receiving or Benefiting from Federal Financial Assistance." Federal Register, Vol. 44, No. 106, May 31, 1979, pp. 31442-31483.

U.S. Department of Transportation, Office of the Secretary, "Nondiscrimination on the Basis of Handicap: Interim Final Rule and Request for Comments," Federal Register, Vol. 46, No. 138, July 20, 1981.

U.S. Department of Transportation, Urban Mass Transportation Administration, Federal Highway Administration, "Transportation for Elderly and Handicapped Persons." Federal Register, Volume 41, No. 85, April 30, 1976, pp. 18234-18241.

Wachs, M., Transportation for the Elderly: Changing Lifestyles, Changing Needs. Berkeley, California: University of California Press, 1979.

Rivas, J., Planning Handbook: Transportation Services for the Elderly. Washington, D.C.: Administration on Aging, U.S. Department of Health, Education, and Welfare, November 1975.

Rosen, S.B., E. Burnworth, M.H. Chase and A. Schwartz, "Planning Factors for Specialized Transportation Services." Staff paper, Chase, Rosen and Wallance, Inc., Alexandria, Virginia, undated.

Rosenbloom, S., "Bus Transit Accessibility for the Handicapped in Urban Areas." National Cooperative Highway Research Program Synthesis of Highway Practice 83. Washington, D.C.: Transportation Research Board, October 1981.

Rosenbloom, S., "Local Responses to Meeting the Transportation Needs of the Handicapped: The Experience of Six Texas Cities." Transportation Research Record 784, 1980, pp. 39-45.

Rosenbloom, S., A. Pio, H. Dittman and C. Schlessinger, Cost Analysis for Social Service Agency Transportation Providers. Austin, Texas, Center for Transportation Research, The University of Texas at Austin, January 1981.

Rosenbloom, S. and D. Warren, "Comparison of Two Brokerages: Lessons to be Learned from Houston and Pittsburgh." Transportation Research Record 830, 1981, pp. 7-14.

RRC International, Inc., Small Transit Bus Requirements Study: Bus Characteristics Needed for Elderly and Handicapped in Urban Travel. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, March 1976.

Smith, R.L., and B. Vernmark, Elderly and Handicapped Transportation in Dane County: Survey, Development of Alternatives, and Preliminary Demand Analysis. Madison, Wisconsin: Department of Civil and Environmental Engineering, The University of Wisconsin-Madison, June 1980.

Smith, R.L. and B. Vernmark, Evaluation of Specialized Transportation Systems for the Elderly and Handicapped in Dane County. Madison, Wisconsin: The University of Wisconsin-Madison, 1981.

Sosslau, A.B., A.B. Hassam, M.M. Carter, and G.V. Wickstrom, "Quick-Response Urban Travel Estimation Techniques and Transferrable Parameters--User's Guide." National Cooperative Highway Research Program Report 187. Washington, D.C.: Transportation Research Board, 1978.

Southeastern Wisconsin Regional Planning Commission, "A Regional Transportation Plan for the Transportation Handicapped in Southeastern Wisconsin: 1978-1982." Planning Report No. 31. Milwaukee, Wisconsin: Southeastern Wisconsin Regional Planning Commission, April 1978.

Spear, B., "Service and Methods Demonstration Program Summary Report." Report No. UMTA-MA-06-0049-81-11. Washington, D.C.: Urban Mass Transportation Administration, U.S. Department of Transportation, December 1981.

Wegmann, F.J., G.E. Byrne, A. Chatterjee, C.R. Bonilla, and K.W. Heathington, "Market Opportunity Analysis for Short-Range Public Transportation Planning: Procedures for Evaluating Alternative Service Concepts." National Cooperative Highway Research Program Report 208. Washington, D.C.: Transportation Research Board, October 1979.

Yukubousky, R. and A. Politano, "Latent Travel Demand of the Elderly, Youth and Low Income Population." Preliminary Report 63. Albany, New York: New York State Department of Transportation, August 1976.

GLOSSARY

Accessible fixed-route bus system--a system of buses of any size that serves the general public, operates on a network of fixed routes on a fixed schedule, and is able to be entered and used by some, not all, transportation handicapped persons.

Annual capital cost--the sum of the annual outlay for plant and equipment and the interest and taxes paid on capital items.

Cost-effectiveness analysis--an evaluative approach or technique that examines the relationships between the various costs of an alternative plan, strategy, service, or course of action and the various indicators or measures of the effectiveness of the alternative plan, strategy, service, or course of action.

Default value--a value that is based on experience or studied conclusions and is used as a substitute value when an actual value is not available.

Demand-responsive transportation system--a transportation service characterized by flexible routing and scheduling of relatively small vehicles to provide door-to-door or point-to-point transportation at the user's demand and that operates either on the street and highway system or on a guideway; taxicabs are a common example of a demand-responsive transportation service.

Depreciation--the decrease or loss in value of property through wear, deterioration, or obsolescence.

Door-to-door transportation--a mode or means of transportation that provides service between the exact origin and destination points without transfer or use of another mode.

Dwell time--the total time required for a vehicle to discharge and take on passengers at a stop, including the time for opening and closing doors and deploying a ramp or wheelchair lift as well as the time spent standing.

Effectiveness--the degree to which an alternative plan, strategy, service, or course of action meets or achieves an objective.

Feeder service--a local transportation service that picks up and delivers passengers to a rail rapid transit station or to a stop on a fixed-route bus system.

Fixed cost--an indirect cost that remains relatively constant irrespective of the level of operational activity (see also variable cost).

Latent travel demand--the potential number of additional trips that may be made by people who cannot now travel as frequently as they desire either because existing modes of transportation are either inconvenient or unavailable to them or because they are physically unable to use existing modes of transportation.

Level of service--multidimensional characteristics that indicate the quality and quantity of transportation service provided, including characteristics that are quantifiable (travel time, travel cost, number of transfers) and those that are difficult to quantify (comfort, modal image).

Many-to-few service--a transportation service that picks up passengers at many different origins and delivers them to a few specified destinations.

Many-to-many service--a transportation service that picks up passengers at many different origins and delivers them to many different destinations within the service area.

Many-to-one-service--a transportation service that collects passengers from many different origins and delivers them to a specific point, e.g., an office building, a hospital, a school, a social agency, or a bus stop.

Marginal cost--the incremental cost directly attributable to an incremental change in service.

Market--the potential consumers of a transportation product or service residing in a specified geographical area.

Market segments--a portion or group of the population that has similar characteristics and potentially similar travel behavior and transportation problems and needs.

Modal split--the proportional distribution of total person trips by mode(s) of transportation.

Mode of transportation--a means of travel; e.g., private automobile, taxi, bus, subway, walking.

Moderately transportation handicapped person--a transportation handicapped person who may have great difficulty performing one of the functions often required when a person attempts to use a conventional, fixed-route, fixed-schedule bus system (e.g., getting on and off a bus, walking more than two or three blocks, or standing and waiting for more than 10 minutes) but who is able to perform all other functions easily or with only some difficulty (see also severely transportation handicapped person and transportation handicapped person).

One-to-many-service--a transportation service that distributes passengers from one point of origin to many destinations; the reverse function of a many-to-one service.

Operating cost--the sum of all costs that can be associated with the operation and maintenance of a transportation service during the period under consideration, generally excluding depreciation on plant and equipment, interest paid for loans on capital equipment, and property taxes on capital items.

Passenger trip--a one-way trip made by a passenger on a mode of transportation (see also person trip, trip, and vehicle trip).

Peak hour--the hour during which the maximum amount of ridership on a transportation service occurs.

Person trip--a one-way trip made by a person by any mode or combination of modes for any purpose (see also passenger trip, trip, and vehicle trip).

Public transportation--transportation by bus, rail, streetcar, taxi, van, or other conveyance, either publicly or privately owned, that is provided to the general public or to special categories of users on a regular or continuing basis.

Ridership--the number of persons using a public transportation service within any given period.

Round trip--the movement of a person or a vehicle from a point of origin to a destination and then back to the same point of origin (see also trip).

Severely transportation handicapped person--a transportation handicapped person who cannot perform one or more of the functions often required when a person attempts to use a conventional, fixed-route, fixed-schedule bus system (e.g., getting on and off a bus, walking more than two or three blocks, or standing and waiting for more than ten minutes) or who has great difficulty performing more than one of these functions (see also moderately transportation handicapped person and transportation handicapped person).

Shared-ride service--a public transportation service other than a fixed-route, fixed-schedule bus or rail transit service that allows passengers having different origins and destinations to use the same vehicle at the same time.

Specialized transportation service--any passenger transportation service that is specifically designed for the exclusive use of transportation handicapped people or other special categories of users and is distinct from conventional, fixed-route, fixed-schedule bus and rail transit service.

Street furniture--equipment placed on the street, e.g., lights, benches, signs, bus shelters, kiosks, and plants.

Subscription service--a transportation service in which routes and schedules are prearranged to meet the travel needs of riders who sign up for the service in advance; the level of service is generally higher than that of regular transit service (fewer stops, shorter travel time, and greater comfort); the service is usually requested only once and thereafter is automatically provided at the prearranged time and place.

Total cost--the sum of the operating and capital costs of a transportation service.

Transportation handicapped person--any individual who by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability is unable without special facilities or special planning or design to use public transit facilities and services as effectively as persons who are not so affected (see also moderately transportation handicapped person and severely transportation handicapped person).

Trip--a one-way movement of a person or vehicle between two points for a specific purpose (see also passenger trip, person trip, round trip, and vehicle trip).

Trip purpose--the primary reason for making a trip; e.g., work, shopping, medical appointment, recreation.

Urbanized area--a city or twin cities that have a population of 50,000 or more (central city) and surrounding incorporated and unincorporated areas that meet certain criteria of population size or density specified by the Bureau of the Census.

User-side subsidy--a method by which designated people are allowed to travel at reduced user costs on certain modes of transportation; the transportation provider accepts tickets, vouchers, or some other evidence of trips taken by the user, and redeems them at the subsidizing agency for a value which has been negotiated in advance; this value represents the difference between the fare paid by the user and the full-fare value of the trip.

Variable cost--a cost that varies in some relation to the level of operational activity (see also fixed cost).

Vehicle capital cost--the sum of the periodic cost of the vehicle, including depreciation, interest payments, excess damage or loss, and property taxes.

Vehicle trip--the one-way movement of a vehicle between two points (see also passenger trip, person trip, and trip).

APPENDIX A

WORKSHEETS

This appendix presents sample worksheets that basically parallel, and aid in carrying out, the major steps in the cost-effectiveness analysis process.

WORKSHEET A--ESTIMATION OF UNMET NEEDS

1. Estimated Population in Service Area _____

	Severely Transportation Handicapped	Moderately Transportation Handicapped
2. Incidence Rates (Table 2)	_____	_____
3. No. of Individuals (1 x 2)	_____	_____
4. Auto Available*	_____	_____
5. Trip Rate** (see Table 5)	_____	_____
6. Estimated Total Needs Trips (3 x 5)	_____	_____
7. Trips Taken as Auto Driver/Passenger* (see Table 6)	_____	_____
8. Estimated Trips Not Made By Auto** [6 - 7]	_____	_____
9. No. of Estimated Trips by*		
a. Regular Bus	_____	_____
b. Taxi	_____	_____
c. Social Service	_____	_____
10. Total Additional Trips Needed (unmet needs) [8 - (9a + 9b + 9c)]	_____	_____

*Based on local knowledge and provider inventory.

**Weighted average of auto available and auto not available trip rates.

WORKSHEET B--ESTIMATION OF DEMAND: ACCESSIBLE FIXED-ROUTE BUS SERVICE

Market Segment _____

1. Estimated number of people in the market segment . . . . . _____

CURRENT BUS TRIPS

2. Current trips per person per day from Table 5) . . . . . _____

3. Total current trips per day (Line 1 x Line 2) . . . . . _____

4. Percent of current trips by bus (from Table 6) . . . . . _____

5. CURRENT BUS TRIPS PER DAY (Line 3 x Line 4 ÷ 100) . . . . . _____

NEW BUS TRIPS

6. New trips per person per day generated by the accessible fixed-route bus system (from Table 11) . . . . . _____

7. NEW BUS TRIPS PER DAY (Line 1 x Line 6) . . . . . _____

TRIPS DIVERTED TO BUSES

8. Percent of current trips diverted from other modes to the accessible fixed-route bus system (from Table 12) . . . . . _____

9. DIVERTED TRIPS PER DAY (line 3 x Line 8 ÷ 100) . . . . . _____

10. TOTAL TRIPS PER DAY on the accessible fixed-route bus system by persons in the market segment (Line 5 + Line 7 + Line 9) . . . . . _____

WORKSHEET C--ESTIMATION OF DEMAND: SPECIALIZED DOOR-TO-DOOR TRANSPORTATION SERVICE

Market Segment _____

1. Estimated number of people in the market segment . . . . . _____

NEW TRIPS

2. New trips per person per day generated by the specialized door-to-door transportation service (from Table 11) . . . . . _____

3. NEW TRIPS PER DAY (Line 1 x Line 2) . . . . . _____

TRIPS DIVERTED TO THE SPECIAL SERVICE

4. Current trips per person per day (from Table 5) . . . . . _____

5. Total current trips per day (Line 1 x Line 4) . . . . . _____

6. Percent of current trips diverted from other modes to the specialized door-to-door transportation service (from Table 12) . . . . . _____

7. DIVERTED TRIPS PER DAY (Line 5 x Line 6 ÷ 100) . . . . . _____

8. TOTAL TRIPS PER DAY on the specialized door-to-door transportation service by persons in the market segment (Line 3 + Line 7) . . . . . _____

WORKSHEET D--ESTIMATION OF DEMAND: USER-SIDE SUBSIDIES FOR TRAVEL BY TAXI

Market Segment _____

1. Estimated number of people in the market segment . . . . . _____

CURRENT TAXI TRIPS

2. Current trips per person per day (from Table 5) . . . . . _____

3. Total current trips per day (Line 1 x Line 2) . . . . . _____

4. Percent of current trips by taxi (from Table 6) . . . . . _____

5. CURRENT TAXI TRIPS PER DAY (Line 3 x Line 4 ÷ 100) . . . . . _____

NEW TAXI TRIPS

6. New trips per person per day generated by the subsidies (from Table 11) . . . . . _____

7. NEW TAXI TRIPS PER DAY (Line 1 x Line 6) . . . . _____

TRIPS DIVERTED TO TAXIS

8. Percent of current trips diverted from other modes to taxis under a user-side subsidy program (from Table 12) . . . . . _____

9. DIVERTED TRIPS PER DAY (Line 3 x Line 8 ÷ 100) . . . . . _____

10. TOTAL TAXI TRIPS PER DAY under a user-side subsidy program by persons in the market segment (Line 5 + Line 7 + Line 9) . . . . . _____

WORKSHEET E--ACCESSIBLE FIXED-ROUTE BUS SERVICE

1. TRANSPORTATION HANDICAPPED MARKET SEGMENT SERVED

   a. Moderate Transportation Handicapped (lifts not required--modify buses) _____

   b. Severe Transportation Handicapped (add lifts to buses) _____

2. LIFT EQUIPMENT REQUIREMENTS

   a. Buses in Fleet _____

   b. Percent of Fleet to be Lift-Equipped x _____

   c. Lift-Equipped Buses Required _____

   d. Lift-Equipped Buses in Fleet - _____

   e. Additional Lift-Equipped Buses Needed _____

3. CAPITAL COSTS

   a. Unit Cost of Lift-Equipment (see Chapter Six or use local values) _____

   b. Additional Lift-Equipped Buses Needed (2e) x _____

   c. Total Cost to Purchase Lift Equipment _____

   d. Anticipated Life (8 to 12 years) ÷ _____

   e. Total Annual Capital Cost _____

4. MAINTENANCE COST

   a. Additional Lift-Equipped Buses Needed _____

   b. Annual Maintenance Cost per Lift (see Chapter Six) x _____

   c. Total Annual Maintenance Cost = _____

5. OPERATING COST

a.	Drivers Utilized on Additional Lift-Equipped Buses	_____
b.	Annual Driver Training Cost (Chapter Six)	x_____
c.	Annual Training Cost	=_____
d.	Promotion and Advertising Cost (Chapter Six)	_____
e.	Additional Lift-Equipped Buses (2e)	x_____
f.	Annual Promotion and Advertising Cost	=_____
g.	Additional Insurance for Lift-Equipment	_____
h.	Additional Lift-Equipped Buses (2e)	x_____
i.	Annual Increase in Insurance Cost	=_____
j.	Total Additional Operating Cost (5c + 5f + 5i)	=_____

6. BOARDING TIME DELAY COST*

a.	Estimated Daily Boardings Using Lift-Equipment (Table 16)	_____
b.	Estimated Delay per Lift Boarding (___ minutes/60) (see Chapter 6-- 3 to 6 minutes suggested)	x_____
c.	Operating Days/Year (actual or 300 nominal)	x_____
d.	Hourly Bus Operating Cost (Chapter Six)	x_____
e.	Annual Increased Boarding Time Delay Cost	=_____

7. LIFT SERVICE CALL COST*

a.	Estimated Lift Failures En Route 1/36.6 x Lift Loadings/Day	_____

b. Lift Failure Delay (Chapter Five) (____ minutes/60) x_____

c. Operating Days/Year (6c) x_____

d. Hourly Bus Operating Cost (Chapter Six) x_____

e. Annual Increased En Route Lift Failure Cost _____

8. TOTAL ANNUAL LIFT COST

a. Capital Cost (3e) _____

b. Maintenance Cost (4c) +_____

c. Operating Cost (5j) +_____

d. Boarding Time Delay Cost (6c) +_____

e. En Route Lift Failure Cost +_____

Total Annual Cost Assessable Fixed-Route Bus Service _____

*The inclusion of this cost category is controversial. Experience indicates little difficulty in maintaining schedules. If boardings increase, delays may occur. If these potential costs are not to be considered, skip to step 8.

WORKSHEET F--SPECIALIZED DOOR-TO-DOOR SERVICES

1. TRANSPORTATION HANDICAPPED MARKET SEGMENT SERVED

   a. Moderately Transportation Handicapped (lifts not required) _____

   b. Severely Transportation Handicapped (vehicles lift-equipped) _____

2. VEHICLE TRIPS/DAY

   a. Person Trips per Day _____

   b. Person Trips/Vehicle Trip (Use 1.1 to 1.2) ÷_____

   c. Vehicle Trips per Day =_____

3. VEHICLES REQUIRED BY TIME PERIOD

	Time Period:	Morning	Midday	Afternoon	Evening	Night
b.	% Daily Trips Peak Hr	_____	_____	_____	_____	_____
c.	x__ Veh Trips/ Day (2c)	_____	_____	_____	_____	_____
d.	Trips/Peak Hr	_____	_____	_____	_____	_____
e.	÷ Trips/Vehicle Hr	_____	_____	_____	_____	_____
f.	Required Vehicles	_____	_____	_____	_____	_____
g.	Work Rules	_____	_____	_____	_____	_____
h.	x Hours in Period	_____	_____	_____	_____	_____
i.	= Vehicle Hours	_____	_____	_____	_____	_____

   j. Total Hours Vehicle Service/Day (Σ of i) _____

   k. Days of Operation per Year x_____

   l. Annual Hours of Service =_____

4. COST ANALYSIS

a.	Driver Wage Rate	_____/hr
b.	Indirect Cost Factor (see Chapter Five)	x_____
c.	Driver Cost per Hour	=_____
d.	Operating Cost/Hour (Excluding Depreciation)	+_____
e.	Total Out of Pocket Cost/Vehicle Hour	=_____
f.	Annual Hours of Service (31)	x_____
g.	Annual Out of Pocket Cost	=_____
h.	Fleet Size (Vehicles, Including Reserves)	_____
i.	Annual Cost Each Vehicle (see Chapter Five)	x_____
j.	Total Annual Vehicle Cost	=_____
k.	Total Cost per Year (g + k)	=_____

WORKSHEET G--TAXI SERVICES

1. TRANSPORTATION HANDICAPPED MARKET SERVED

   a. Moderate _____

   b. Severe (typically 20% require lift-equipped vehicles) _____

2. DEMAND ANALYSIS

   a. Person Trips/Day Moderately Handicapped _____

   b. % Moderate Handicapped Trips by Taxi x_____

   c. Person Trips by Taxi per Day by Moderately Handicapped =_____

   d. Person Trips/Day Severely Handicapped _____

   e. % Severely Handicapped Trips by Taxi x_____

   f. Person Trips by Taxi per Day by Severely Handicapped =_____

   g. Anticipated Person Trips by Taxi per Day by Handicapped (c + f) =_____

   h. % Severely Handicapped Trips by Lift-Equipped Van _____

   i. Person Trips by Lift-Equipped Van/Day (d x h) _____

3. VEHICLE TRIPS PER DAY

   a. Anticipated Person Trips by Taxi by Handicapped (3g) _____

   b. Anticipated Average Person Trips/Vehicle Trips ÷_____

   c. Vehicle Trips/Day =_____

4. VEHICLES REQUIRED BY TIME PERIOD

		Morning	Midday	Afternoon	Evening	Night
a.	Time Period:					
b.	% Trips Peak Hr.	____	____	____	____	____
c.	x__ Trips/Day (3c)	____	____	____	____	____
d.	Trips/Period Peak Hr.	____	____	____	____	____
e.	- Trips Currently Made	____	____	____	____	____
f.	= New Trips	____	____	____	____	____
g.	Vehicles In Service	____	____	____	____	____
h.	x Incremental Productivity	____	____	____	____	____
i.	New Trips Available	____	____	____	____	____
j.	(4f) - New Trips	-____	-____	-____	-____	-____
k.	Sign of i - j	____	____	____	____	____

If sign of i - j is positive, no added service required.
If negative, proceed to 5 following.

5. COST SUMMARY--ADDITIONAL SERVICE

a.	New Trips Required (4f)	____
b.	New Trips Available	-____
c.	Additional Trips Required	____
d.	Productivity (Trips/Hours)	÷____
e.	Vehicle Hours Required	=____
f.	Operating Cost/Hours (see Chapter Five)	x____
g.	Total Additional Operating Cost	=____
h.	Additional Vehicles Required	____
i.	Annual Depreciation/Vehicle	x____

j. Annual Vehicle Cost =_____

k. Total Cost (g + j) _____

6. USER-SIDE SUBSIDY COST

a. Average Taxi Fare _____

b. User Share -_____

c. Subsidy _____

d. New Person Trips by Taxi Daily x_____

e. User-Side Subsidy Cost Day _____

f. Days of Operation x_____

g. Annual Cost User-Side Subsidy _____

APPENDIX B

TYPICAL OPERATING STATEMENTS

Table B-1. Specialized transportation services sample computation[a] (van with lift--social service agency operation).

Vehicle and Equipment	
Purchase Cost Van	$15,000
Estimated Life 3 years--Salvage Value 3,355	
Net Present Value of Salvage @ 10% = 3355 x .7513 =	2,520
'Total Cost Over 3 years	$12,480
Average Cost Per Year = 12,480/3 =	$4,160
Hourly Cost--4,160/4,160 =	$1.00
Nonlabor Direct Operating Cost	
Fuel @ $1.20/gal 10 miles/gal and 40,000 miles/year = 1.20 x 40,000/10 =	$4,800
Tires--@ 0.015/mile--40,000 miles/year $0.015 x 40,000 =	600
Lubricants, oil & supplies @ 0.01/mile - 40,000 miles/year $0.00875 x 40,000 =	350
Maintenance (average of experience) =	700
Insurance--Social Service Operation =	750
TOTAL NONLABOR DIRECT ANNUAL COST	$7,200
Average Hourly Operating Cost 7,200/4,160 =	$1.731
Indirect Cost @ 40%	0.692
TOTAL NONLABOR DIRECT HOURLY COST	$2.423

[a]Based on 80 hours/week operation (4,160 hours/year), 40,000 miles per year and fuel cost of $1.20/gal.

Table B-2. Typical operating statement--specialized transportation service (comparable service area and ridership)

	Transit Operated ($)	Percent	Social Service Agency Operated ($)	Percent
DIRECT OPERATING COSTS:				
Driver Wages	70,251	44.6	39,990	38.6
Fuel	20,774	13.2	22,060	21.3
Oil, lubricants & supplies	623	0.4	803	0.8
Tires and Tubes	1,216	0.8	1,407	1.3
Maintenance	7,807	4.9	6,020	5.8
Vehicle Liability Ins.	4,910	3.1	2,408	2.3
TOTAL	105,581	67.0	72,688	70.1
INDIRECT OPERATING EXPENSE:				
Gen. & Admin. Salaries	23,325		19,000	
Office Supplies & Services	3,000	17.5	1,200	20.3
Telephone & Postage	1,200		800	
Fringe Benefits Employees:				
Group Insurance	8,969		3,220	
Unemployment Insurance	2,107	15.5	1,288	
Workman's Compensation	2,862		1,600	9.6
Social Security Tax Employer	6,382		3,892	
Annual Leave, Holidays, & Retirement	4,200		0	
Total	52,045	33.0	31,000	29.9
TOTAL	157,626	100.0	103,688	100.0

APPENDIX C

UNIT COST DATA USED IN BREAKEVEN ANALYSIS

ACCESSIBLE BUS	
Annual Capital Cost per Lift ($)	1,300.00
Annual Maintenance Cost per Lift ($)	650.00
Annual Training Cost per Driver ($)	57.38
Annual Marketing Cost per Lift ($)	150.00
Annual Marginal Insurance Cost per Lift ($)	2.50
Bus Operating Cost ($/veh-hr)	20.00
Average Delay from Getting a Wheelchair Passenger On and Off a Bus (minutes)	7.0
SPECIALIZED SERVICES	
Annual Capital Cost of a Taxicab ($)	2,400.00
Hourly Wage of Cab Drivers ($)	5.00
Factor Applied to Hourly Wage	1.25
Nonlabor Operating Cost per Cab-Hour, Excluding Depreciation ($)	2.02
Total Operating Cost per Cab-Hour, Excluding Depreciation ($)	8.27
TAXI SERVICES	
NonLabor Operating Cost/Vehicle-Hour Excluding Depreciation ($)	2.42
Hourly Wage of Driver ($)	4.00-8.00
Indirect Cost Factor	1.40
Annual Depreciation/Vehicle ($)	4,160.00

APPENDIX D

USE OF VOLUNTEER SERVICES IN PROVIDING TRANSPORTATION FOR THE HANDICAPPED

The use of volunteers in providing transportation for the handicapped can accomplish at least two objectives:

1. Provision of more personalized caring service for the handicapped transportation user.
2. The reduction of cost of the provision of the service to the handicapped.

The provision of personalized service is often a problem with the handicapped because drivers of specially equipped vehicles often hesitate to simply leave a handicapped person on the curb or not wait for a handicapped patient that does not appear at the pickup point for a return trip at an appointed time. This may result in a planned curb-to-curb service escalating to a door-through-door service with a consequent decline in productivity. Volunteer escorts may be a possible answer to this problem; a volunteer driver escort would be a definite answer since this would get the person off the

specially equipped van and into a schedule of a less costly trip.

The reduction of cost in volunteer programs is accomplished through savings in labor and through savings in the contribution of vehicle operation costs. Volunteers are defined as persons who contribute their labor to various aspects of the transportation task without compensation. Since labor costs are 75 to 90 percent of the cost of providing transportation to the handicapped, this can result in substantial savings. Often, persons who volunteer as drivers make an additional contribution in the form of the costs of operating their personal vehicle. This provides an additional savings for every trip that is subsidized in this fashion.

There are certain steps to be taken by local planners who wish to reduce costs by using volunteers in an effort to provide more cost-effective service to the handicapped. The following steps highlight the considerations that must be given in developing a volunteer program:

1. Assessing need and potential for volunteer transportation service.
2. Using volunteers in provision of transportation services.
3. Planning a volunteer transportation program.
4. Recruiting and training of volunteer transportation workers.
5. Maintaining a volunteer transportation program.

Table D-1 synthesizes the issues involved in these five steps. The planner should address each issue in Table D-1 if a volunteer program is being considered. A volunteer program requires substantial planning and organization, but can provide a very effective means for reducing costs in certain areas of public transportation services for the handicapped.

Table D-1. Issues to be addressed when considering a volunteer program

I. Assessing the need and potential for a volunteer transportation program for the handicapped.

- A. Assessing the need.
  - 1. What transportation programs (public, private and volunteer) provide services to the handicapped in this community?
  - 2. Do existing services reach all areas of the community in which the handicapped reside?
  - 3. Do existing services cover all trip purposes that the handicapped wish to have covered?
  - 4. Do existing services have a large number of unfilled requests and/or a long delay between request for service and provision of service?
- B. Assessing the potential for a volunteer program.
  - 1. Is there a volunteer bureau or similar agency in the community to help organize and recruit?
  - 2. How much volunteer support for the program can be obtained from voluntary associations and churches?
  - 3. What sources of continuing financial support can be found in the community?

II. Using volunteers in the provision of transportation services.

- A. Volunteer workers should be seen as working at their convenience rather than with the same reliability as paid staff. This means volunteers serve better in some tasks than in others.
- B. Provision must be made to ensure the actions of the volunteers in case of liability actions.
- C. Record keeping for volunteer service is an important part of the program that requires extra effort.
- D. Remember, volunteers are used best in situations requiring personal attention, nonrecurring trips from less dense areas of the community, for nonemergency trip purposes.

III. Planning a volunteer transportation program.

- A. Before beginning your planning, be sure to assemble a review team from agencies providing services to the handicapped. This team will enable you to review the potential effectiveness of your plan.
- B. Assemble planning team to include members of paid staff (if any) of sponsoring agency.
- C. Determine initial level of service, trip purposes, area, hours of operation that program will attempt to provide.
- D. Write job descriptions for each task for which volunteers will be recruited.
- E. Establish selection criteria for each position for which you will recruit. Selection criteria are very important for volunteer drivers.
- F. Establish training program of objectives and standards for all volunteers.
- G. Determine supervisory structure responsibility and line of report for volunteers.
- H. Establish policies for rewarding, reimbursing, insuring, and dismissing volunteers.
- I. Develop plans for promoting program and for obtaining initial funds to operate program.

IV. Recruiting and training of transportation volunteers.

- A. Recruiting.
  - 1. Contact local volunteer bureau, voluntary associations, and churches for assistance.
  - 2. Develop promotional brochure to give interested organizations and individuals.
  - 3. Studies have shown that programs using personal contact have most recruit success.
- B. Training of transportation volunteers.
  - 1. Develop orientation program for all volunteers.
  - 2. Set up some type of passenger assistance training for escorts and drivers.
  - 3. For volunteer drivers, provide special defensive driving, safe driving, or similar course.

V. Maintaining a volunteer transportation program.

- A. The most important aspect of maintaining a volunteer transportation program is promotion of the program among both potential clients and potential volunteers.
- B. Motivation of volunteers to continue participation in the program can be accomplished through recognition and reward programs.
- C. Development of local funding through United Way, foundations and/or other public or private sources of support will ensure a more stable existence.

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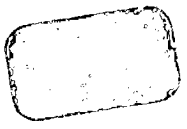

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JAMES W HILL
RESEARCH SUPERVISOR

IDAHO TRANS DEPT DIV OF HWYS
P O BOX 7129 3311 W STATE ST
BOISE ID 83707