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Contents

Authors of the Papers in This Record

Ahlin, Frank J., Operations Research, Toronto Transit Commission, 1900 Yonge Street, Toronto, Ontario, Canada M4S 1Z2

Alfieri, F.A., Transportation Development Centre, Transport Canada, 1000 Sherbrooke St. W., Suite 2421, Montreal, Quebec, Canada H3A 2R3

Bookbinder, J.H., Department of Management Sciences, University of Waterloo, Waterloo, Ontario, Canada N2L 3G1

Fleming, M.S., Research Branch, Canadian Transport Commission, 15 Eddy Street, Hull, Quebec, Canada K1A 0M9

Heron, Ruth M., Transportation Development Centre, Transport Canada, 1000 Sherbrooke St. W., Suite 2421, Montreal, Quebec, Canada H3A 2R3

Knapp, Sue F., Ecosometrics Incorporated, 4715 Cordell Avenue, Bethesda, Md. 20814

Lago, Armando M., Ecosometrics Incorporated, 4715 Cordell Avenue, Bethesda, Md. 20814

Lovely, Mary E., 1670 Sheridon Drive, Ann Arbor, Mich. 48104; formerly with Charles River Associates

McKnight, Claire E., Urban Transportation Center, University of Illinois at Chicago, P.O. Box 4348, Chicago, Ill. 60680

Miller, Eric J., Department of Civil Engineering, University of Toronto, Toronto, Ontario, Canada M5S 2E4; formerly with the University of Toronto/York University Joint Program in Transportation

Pagano, Anthony M., Urban Transportation Center, University of Illinois at Chicago, P.O. Box 4348, Chicago, Ill. 60680

Silverstone, D.B., Legal Services, Canadian Transport Commission, 15 Eddy Street, Hull, Quebec, Canada K1A 0M9

Smith, Barbara A., Transportation Development Centre, Transport Canada, 1000 Sherbrooke St. W., Suite 2421, Montreal, Quebec, Canada H3A 2R3

Stopnicki, Roberto, Metropolitan Planning Department, Municipality of Metropolitan Toronto, City Hall, East Tower, 11th Floor, Toronto, Ontario, Canada M5H 2N1

Suen, Ling, Transportation Development Centre, Transport Canada, 1000 Sherbrooke St. W., Suite 2421, Montreal, Quebec, Canada H3A 2R3

Wallace, Jim, Transportation Programs Branch, Manitoba Department of Highways and Transportation, 215 Garry Street, Winnipeg, Manitoba, Canada R3C 3Z1

Wolfe, Robert A., University of Toronto/York University Joint Program in Transportation, University of Toronto, 42 St. George Street, Toronto, Ontario, Canada M5S 2E4

Results of a Parametric Cost Analysis of Differences Between Urban and Rural Transportation Services for Transportation-Disadvantaged Persons

SUE F. KNAPP AND ARMANDO M. LAGO

It has been difficult in the past for local transportation service providers serving transportation-disadvantaged persons to accurately understand what their services should or will cost. This information is important for localities that contemplate the initiation, expansion, or evaluation of transportation services. In addition, information on the cost of services that differentiates among the various types and levels of service is important for federal, state, and local program managers because many use this information to apportion and distribute funds among local projects. A portion of the results from a study conducted by Ecosometrics, Inc., for the Administration on Aging, U.S. Department of Health and Human Services, is presented. The differences in costs of transportation services for the elderly in urban and rural areas are evaluated. Nevertheless, many of the services included in the study serve other transportation-disadvantaged groups; thus the results are applicable to multi-client services as well. Further, the parametric cost analysis performed in the study has analytical value beyond the differences in costs in urban and rural areas. The findings presented in the paper include (a) a brief review of the literature on the differences in costs between urban and rural transportation services for the elderly, and (b) a report on the results of the parametric cost analysis performed during the study by using secondary data.

One of the most important issues facing providers of transportation to transportation-disadvantaged persons involves estimating and evaluating the cost of those services. Not only have costs risen steadily during the past few years, but availability of funding for those services has been declining.

For many reasons it has been difficult to examine a particular transportation service for transportation-disadvantaged persons (either existing or under consideration) and to have an accurate understanding of some general guidelines for what those services should or will cost. First, costs in localities are different; what costs a certain amount in one locality may cost twice as much in another. Second, it is often difficult to find cost information that is current because inflation may seriously affect cost comparisons. Third, there is little published material that synthesizes information that cuts across more than a few projects. Finally, many agencies account for costs and services in different ways.

These observations are disheartening because accurate information on the costs of providing services is important to federal, state, and local program managers. Accurate cost information is important for localities that consider initiating or expanding a service because their estimate of costs should be as realistic as possible for the analysis of project feasibility and the preparation of a project budget. Accurate guidelines on what costs should be are also important for local areas evaluating their transportation services because these guidelines can act as benchmarks for determining how well the system is performing. Even more important, it is valuable for local system managers to have an understanding of their expenditures (relative to other services) for specific cost elements (such as drivers and gasoline) because this type of comparison gives managers data on what portions of the system are not as efficient as they might be.

Finally, an accurate estimation of the cost of providing services is important for federal, state, and local funding program managers. Many state and local governments have apportionment formulas for their funding programs that distribute available funds to local projects based on local conditions, quality of service, type of service, efficiency, and so on. In addition, the federal government has some program restrictions that affect the state or local apportionment of funds. For example, many programs have requirements for cost-effectiveness or they offer incentives for meeting cost-effectiveness standards. When these requirements are imposed, it can mean that systems that serve more severely disadvantaged persons or that operate in areas that inhibit efficiency will receive less money.

Another example is that of social service programs that apportion funds on a state or regional level based on factors such as total population or population density. When this is done, it often means that areas with less population receive less money. This result may be unfair to the more rural areas because more miles of service generally are required to provide one person trip in less densely populated areas. Both of these examples illustrate why it is important that federal, state, and local agencies have an understanding of the legitimate differences in costs among projects in different areas so that they can take these differences into account in their apportionment and distribution procedures.

The purpose of this paper is to present the findings of a portion of a study performed by Ecosometrics, Inc., for the Administration on Aging, U.S. Department of Health and Human Services. In this study the differences in needs and services of transportation programs for the elderly in rural and urban areas were evaluated. Although the study encompassed much more than is described herein, the discussion in this paper is confined to the subject of the cost of transportation services. The two topics explored in the study are as follows:

1. A brief review of the literature on the differences in costs between rural and urban transportation services for the elderly, and
2. A report on the results of the parametric cost analysis that was performed during the study by using secondary data.

It should be noted that many of the transportation services included in the study also serve other transportation-disadvantaged groups (such as the handicapped and low-income groups). Also note that the parametric cost analysis performed in the study has value beyond an analysis of the differences in cost in urban and rural areas. The cost analysis is structured to compare the cost of various elements among urban systems or rural systems (as well as between the two types).

CURRENT LITERATURE ON COMPARISON OF TRANSPORTATION COSTS IN RURAL AND URBAN AREAS

The literature review uncovered some sources that identified costs of transportation services to the elderly and other transportation-disadvantaged persons in urban and rural areas. Some of these sources

only identified costs in one of the areas, some provided costs in areas of urban and rural mix, and some either made no distinction between the areas or made different distinctions. Note that only a portion of the sources reviewed for the cost analysis can be considered truly literature sources, because much of the data contained in the analysis is actually drawn directly from report forms submitted to the Administration on Aging by states and local agencies on their projects.

Cost Analysis Limitations

Before discussing the literature on the cost of transportation services in urban and rural areas and their comparisons, it is important to note that these comparisons are of limited value. Although some general inferences can be made about possible differences in cost in urban and rural areas, it is not possible to make any definitive statements on the subject. There are five reasons for this.

1. The service costs in the literature are from different years: The years for the cost information available vary from 1972 to 1981.
2. The literature sources reviewed have varying definitions for the services provided: It is not clear from much of the literature what services are actually being provided. What one source calls by one name may be called something else by another source.
3. The measures for units of service used in the literature are inconsistent: Some of the literature uses units of service that measure output or production of service (e.g., number of bus miles, number of vehicle hours), whereas others use units that measure consumption (e.g., number of trips provided).
4. It is not clear from the literature which costs have been included: It is not clear from the literature reviewed whether all costs or only direct costs are included, and whether all costs or only costs allowable under government projects are included.
5. It is impossible from the available literature to control for local project service quality specifications: It is known that some projects provide a service that is superior in quality to other projects. In comparing the cost of service for projects, only the costs for projects with similar service quality should be compared. It is not possible to ascertain from the literature what the quality of service or the service specifications are in the projects for which cost information is available.

Unit Cost Comparisons for Transportation in Urban and Rural Areas

Data are not currently available in the literature for directly comparing the cost of transportation for the elderly in urban and rural areas. Nevertheless, given the caveats discussed previously, there are still some general inferences that can be made about cost differences. The data in Table 1 give the means and standard deviations for the cost per trip and cost per mile reported in the literature (all costs were converted to 1979 dollars by using the consumer price index).

Several problems make it difficult to derive a meaningful comparison of the costs of transportation for the elderly in rural and urban areas. The Institute for Public Administration (1), Nelson (2), and to a lesser extent Arrillaga et al. (3) attempt to make consistent cost comparisons between rural and urban areas. Their comparisons, although generally valid, suffer because the services compared in urban and rural areas differ significantly in their service specifications. For example, some services are fixed-route bus services whereas others are demand-responsive services.

Still, the comparisons are valid and based on common sense. The Institute for Public Administration (1) indicated that the cost per vehicle mile in rural areas ($0.60 in 1979) was significantly lower than the cost in urban areas, which ranged from $0.93 to $1.00. Nelson (2) indicated that the cost per one-way trip in rural areas ($1.39) was lower than in urban areas ($2.24). Similarly, Arrillaga et al. (3) indicated that the cost of demand-responsive transportation in small cities was $10.50 per vehicle hour, and these costs were in the lowest part of the range of $9.60 to $15.40 per vehicle hour, which characterizes larger urban areas. It is reasonable that costs should be lower in small cities because transportation projects for the elderly in large urban areas face much higher costs of labor and because the prevalence of volunteer labor services is greater in rural areas.

Although the costs per vehicle hour and per vehicle mile are larger in urban areas, the available literature presents costs per passenger trip, which are comparable for both areas. There is still great uncertainty about the comparisons of cost per passenger trip. First, the cost figures come from different researchers who differ in their methods of accounting for costs. Second, the cost comparisons are generally for services that vary significantly in their service specifications. Finally, the variance of costs per passenger trip arising from the literature is so high that the observed cost differences may be attributable more to service specifications than to whether the area is rural or urban. A final conclusion on the issue of rural versus urban cost differences in transportation services for the elderly has to wait for further work on the subject.

Table 1. Cost per trip and cost per mile from literature.

Cost Items	Costs ($)			
	Urban		Rural	
	Mean	Standard Deviation	Mean	Standard Deviation
Overall[a] (all modes)				
Cost per trip	2.94	2.16	2.96	3.50
Cost per mile	1.23	1.16	0.65	0.34
Demand responsive[b]				
Cost per trip	3.66	2.44	2.73	3.08
Cost per mile	1.43	1.26	0.70	0.48
Fixed route[c]				
Cost per trip	2.13	1.98	2.75	2.80
Cost per mile	0.97	0.99	0.55	0.32
Mixed demand responsive and fixed route[d]				
Cost per trip	2.25	0.83	3.10	2.58
Cost per mile	0.81	0.74	0.73	0.34

Note: Calculations by Ecosometrics, Inc.

[a]This category contains some cases that are not included in the analysis by mode because for these cases it was not known what type of service was being provided. The sample size for cost per trip is 106 in urban areas, 122 in rural areas; and the sample size for cost per mile is 112 in urban areas and 78 in rural areas.
[b]The sample size for cost per trip is 51 in urban areas and 14 in rural areas; and the sample size for cost per mile is 68 in urban areas and 12 in rural areas.
[c]The sample size for cost per trip is 31 in urban areas and 24 in rural areas; and the sample size for cost per mile is 32 in urban areas and 22 in rural areas.
[d]The sample size for cost per trip is 12 in urban areas and 19 in rural areas; and the sample size for cost per mile is 13 in urban areas and 19 in rural areas.

COMPARISON OF COST FOR TRANSPORTATION SERVICES FOR THE ELDERLY IN RURAL AREAS

In this section the outcomes of a parametric cost analysis of transportation services in rural and

urban areas, performed by using secondary data that were either readily available from secondary sources or available from the files at Ecosometrics, are presented. The analysis was based on data regarding the costs of resources, the relationships between the amount of each resource needed to produce a unit of transportation service, and information on service consumption rates. The results of this analysis are presented, which include (a) a description of the cost analysis methodology (both ideal and the one followed by using the secondary data), (b) a description of the secondary data sources used in the analysis, (c) a discussion of the parametric functions developed, and (d) the analysis results.

Cost Analysis

The objectives of the cost analysis are threefold. The first objective is to produce the information required to compare the cost of providing a basic unit of service in rural areas with the cost of providing that same unit of service in urban areas (the comparison of the cost per vehicle mile in urban areas with the cost per vehicle mile in rural areas). The issues examined here are (a) whether the cost of resources (vehicles, drivers, gasoline) are different in urban and rural areas, and (b) whether the amounts of these resources needed to produce a unit of service (a vehicle mile of operations) are different in urban and rural areas.

The second objective is to provide the information required to compare the cost of a unit of service consumed by the elderly (the comparison of the cost per one-way passenger trip provided in urban areas with the cost per trip for the same service in rural areas). This analysis answers the question of whether there is a difference in the cost for a local rural agency to provide a trip to an elderly person as compared with the cost for a local urban agency to provide a trip to an elderly person.

The third objective is to identify factors that could explain differences in cost. Although it is important to understand differences in costs to make decisions on how program funds should be allocated between urban and rural areas, it is also important to understand why these differences occur.

Secondary Data Used in the Analysis

Three groups of data were used to perform the analysis of transportation costs in urban and rural areas:

1. Information on the basic cost of resources in urban and rural areas;
2. Information on the relationships between the amount of each resource required to produce a unit (vehicle mile) of transportation service; and
3. Information on consumption rates to estimate the amount of service consumed in relation to the service provided (trips provided for every mile of service operated).

The literature review assessed the available literature on service costs. Unfortunately much of the information was not adequate on which to base a definite statement on the differences in service costs in urban and rural areas. There were some secondary data sources in the literature that either contained information on the basic cost of resources in urban and rural areas or on the amount of resources required to produce the service (4-13).

In addition, Ecosometrics had in-house a variety of local project reports and data collected either for, or in conjunction with, previous studies. These data included information on individual cost elements and services provided. This information was of considerable value in the cost analysis. This information included data on systems that dealt with transportation for the elderly and the handicapped in rural and urban areas throughout the country, and also Section 147 projects for FHWA. Finally, Ecosometrics has previously developed and was able to adapt for use in this study a parametric cost model to estimate the cost per mile of service (14).

Parametric Cost Models

Parametric cost analysis is an analytical tool that can estimate transportation unit costs with relatively simplified equations. It was used in this study to estimate and compare the cost of providing transportation services in urban and rural areas. These costs are expressed in the basic cost per vehicle mile in each area. The equations or models must be complete (in terms of containing all the pertinent cost categories) and give cost parameters that correspond to attributable characteristics or output measures (e.g., vehicle miles, passenger miles, vehicle hours, number of buses). By varying the value of the independent cost parameters and the independent output levels, the costs that result from transportation operations in rural and urban areas can be determined.

A cost-factor approach was used in this study to develop the parametric cost formulas. By using information on the basic cost of resources (i.e., cost of oil, gas, labor), cost factors have been developed for each cost parameter to explain the requirements for, or consumption of, resources in the production of service (i.e., miles per gallon of fuel, driver labor hours per vehicle mile of service). The cost factors were developed from the secondary data sources and represent cost as a multiplier of a known characteristic or output of the system. For example, overhead costs are expressed as a percentage of total operating costs.

The parametric cost formulas that were applied in the study are presented in the following sections. The cost formulas are discussed according to the four output variables of transportation costs: vehicle miles, vehicle hours, number of vehicles, and all other operating costs (overhead). In all cases costs are eventually converted to cost per mile regardless of whether they are dependent on vehicle miles, vehicle hours, or the number of vehicles operated.

Operating Costs Dependent on Vehicle Miles

There are four cost elements that are dependent on vehicle miles: fuel, oil, tubes and tires, and vehicle repairs and maintenance. The cost formulas are developed in a building-block fashion, as follows:

Cost Element	Cost Element Formula (per vehicle mile)
Fuel	$(PF_1)\,(1/MPG_i)$
Oil	$(OL_i)\,(PF_i)\,(1/MPG_i)$
Tubes and tires	T_i
Vehicle repairs and maintenance	RE_i

Adding these cost elements results in the following equation:

$$OCVM_i = [(1 + OL_i)\,(1/MPG_i)\,(PF_i)] + (T_i) + (RE_i) \quad (1)$$

where

$OCVM_i$ = operating costs per vehicle mile for costs that are dependent on vehicle miles for vans in area i;
MPG_i = miles per gallon for fuel for vans in area i;
PF_i = price per gallon for fuel in area i;
OL_i = proportion that oil and lubrication cost per mile are of fuel costs per mile in area i;
T_i = expenses for tubes and tires per vehicle mile for vans in area i; and
RE_i = expenses for vehicle repairs and maintenance per vehicle mile for vans in area i.

Operating Costs Dependent on Vehicle Hours

Operating costs influenced by vehicle hours include driver wages (volunteer and nonvolunteer) and dispatcher wages (also volunteer and nonvolunteer). The participation of volunteers in the provision of a service can reduce out-of-pocket costs considerably. Nevertheless, in the computation of true costs, comparable wages paid to volunters must be computed and included in the cost estimates. Thus two cost functions have been developed for driver and dispatcher wages, one accounting for true costs (including volunteer labor wages), and the other estimating out-of-pocket costs (not including volunteer labor wages).

Individual cost element formulas for driver and dispatcher wages include the following:

Cost Element	Cost Element Formula (per vehicle mile)
Driver wages	
Paid	$(1 + F_i)(DW_i)(1 - VD_i)(DH_i/RH_i)(RH_i \div VH_i)(1/MPH_i)$
Volunteer	$(1 + F_i)(DW_i)(VD_i)(DH_i/RH_i)(RH_i \div VH_i)(1/MPH_i)$
Dispatcher wages	
Paid	$(DR)(1 + F_i)(DPW_i/DW_i)(DW_i)(1 - VD_i)(DPH_i/DH_i)(DH_i/RH_i)(RH_i \div VH_i)(1/MPH_i)$
Volunteer	$(DR)(1 + F_i)(DPW_i/DW_i)(DW_i)(VD_i) \times (DPH_i/DH_i)(DH_i/RH_i)(RH_i/VH_i) \times (1/MPH_i)$

Adding these cost elements results in the following two equations (Equation 2 estimates real costs and Equation 3 estimates out-of-pocket costs):

$$OCVHT_i = (1 + F_i)(DW_i)(DH_i/RH_i)(RH_i/VH_i)(1/MPH_i)[1 + (DR) \times (DPW_i/DW_i)(DPH_i)/(DH_i)] \quad (2)$$

$$OCVHO_i = (1 + F_i)(DW_i)(1 - VD_i)(DH_i/RH_i)(RH_i/VH_i)(1/MPH_i) \times [1 + (DR)(DPW_i/DW_i)(DPH_i/DH_i)] \quad (3)$$

where

$OCVHT_i$ = total operating costs per vehicle mile for costs that are dependent on vehicles hours for vans in area i;
$OCVHO_i$ = out-of-pocket operating costs per vehicle mile for costs that are dependent on vehicle hours for vans in area i;
F_i = fringe benefit rate for area i (ratio of fringe benefits to wages);
DW_i = driver paid hourly rate and imputed driver volunteer rate in area i;
VD_i = proportion of volunteer driver hours or volunteer dispatcher hours to total driver or dispatcher hours in area i;
DH_i/RH_i = ratio of driver hours to revenue hours in area i;
RH_i/VH_i = ratio of revenue hours to total vehicle hours in area i;
MPH_i = miles per hour in area i;
DR = 1 if the system is demand responsive, 0 if it is not;
DPW_i/DW_i = ratio of dispatcher hourly wages to driver hourly wages in area i; and
DPH_i/DH_i = ratio of dispatcher hours to driver hours in area i.

Operating Costs Dependent on Number of Vehicles

Several costs are vehicle oriented, including insurance, vehicle storage, licenses and tags, and maintenance of dispatching equipment. For each computation, vehicle storage and licensing costs are included in the overhead. The individual cost formulas for insurance and maintenance of dispatching equipment follow.

Cost Element	Cost Element Formula (per vehicle mile)
Insurance	$(INS_i)(1/VMV_i)$
Maintenance of dispatching equipment	$(DR)(MR)[(DSC_i)(STAT_i) + (DMC_i) \times (N_i)][1/(N_i)(VMV_i)]$

The summation of these cost elements results in the following cost formula:

$$OCV_i = (1/VMV_i)\{(INS_i) + (DR)(MR)[(DSC_i)(STAT_i) + (DMC_i)(N_i)]\} \quad (4)$$

where

OCV_i = operating cost per vehicle mile for costs that are dependent on the number of vehicles in area i;
INS_i = annual insurance rate for a basic 10- to 12-passenger van in area i;
MR = proportion that annual maintenance costs of dispatching equipment is of the acquisition cost of dispatching equipment;
DSC_i = cost of acquisition and installation per dispatch base station in area i, including base, antenna, and repeaters;
$STAT_i$ = number of stations needed in area i;
DMC_i = cost of acquisition and installation of mobile radio units in area i;
N_i = number of vehicles in system in area i;
VMV_i = total vehicle miles per vehicle in area i; and
DR = 1 if the service is demand responsive, 0 if it is not.

General and Administrative Overhead

The overhead category includes all the personnel involved in general office administration, office rent and taxes, advertising, utilities and communications, office supplies, licenses, vehicle storage, and so on. The general administrative expenses are dominated by the personnel costs involved in general office administration. These personnel costs do not include the costs of the supervisors of vehicle repair or maintenance operations (whose costs are included among the repair costs) or the fringe benefits paid to the drivers, dispatchers, and mechanics.

The costs formula for this cost element is

$$OH_i = (OVRATE_F)[(OCVM_i) + (OCVH_i) + (OCV_i)] \quad (5)$$

where

OH_i = overhead expenses per vehicle mile in area i;
$OVRATE_F$ = overhead rate in area i, which varies according to firm type F; the two types of firms considered are social service agency and transit operators;
$OCVH_i$ = operating costs per mile for costs that are dependent on vehicle hours for vans in area i;
OCV_i = operating costs per mile for costs that are dependent on the number of vehicles in area i; and
$OCVM_i$ = operating costs per mile for costs that are dependent on vehicle miles for vans in area i.

Capital Costs

Capital costs include both depreciation and interest cost of capital equipment, including vehicle dispatching equipment. The estimation of capital costs in this study assumes that the vehicles and dispatching equipment have a negligible scrap or residual value at the end of their productive lives. All vehicle costs are estimated for a standard 10- to 12-passenger van for 1979. Cost formulas for capital items are as follows:

Cost Element	Cost Element Formula (per vehicle mile)
Vehicle capital costs	$(CRFV_{n,r,i})(VC_i)(TV_i)(1/VMV_i)$
Capital cost of dispatching equipment	$\{(DR)(TVD_i)[(DSC_i)(CRFS_i)(STAT_i) + (DMC_i)(CRFM_i)(N_i)]\}/[(N_i) \times (VMV_i)]$

The capital costs per vehicle mile are then computed by using the following equation:

$$CC_i = (1/VMV_i)\left[(CRFV_{n,r,i})(VC_i)(TV_i) + \{(DR)(TVD_i) \times [(DSC_i)(CRFS_{n,r,i})(STAT_i) + (DMC_i) \times (CRFM_{n,r,i})(N_i)]\}/N_i\right] \quad (6)$$

where

CC_i = capital cost per mile in area i;
VMV_i = annual vehicle miles per vehicle in area i;
$CRFV_{n,r,i}$ = capital recovery factor for vehicle for n years at rate of interest r in area i;
$CRFS_{n,r,i}$ = capital recovery factor for dispatch base station for n years and at rate of interest r in area i;
$CRFM_{n,r,i}$ = capital recovery factor for mobile dispatching units for n years and at rate of interest r in area i;
VC_i = vehicle acquisition cost for vans in area i;
TV_i = proportional terminal value for vans in area i (in this case terminal value is assumed to be negligible because service lives are used rather than economic life);
TVD_i = proportional terminal value for dispatching equipment in area i (as with vehicles, this is assumed to be negligible);
N_i = number of vehicles per system in area i;
DR = 1 if service is demand responsive, 0 if it is not;
DSC_i = cost of acquisition and installation per dispatch base station in area i, including base, antenna, and repeaters;
$STAT_i$ = number of stations required in area i; and
DMC_i = cost of acquisition and installation of mobile radio units in area i.

Total Costs

The total costs (TC) are computed by adding the five cost formulas presented earlier:

$$TC_i = OCVM_i + OCVH_i + OCV_i + OH_i + CC_i \quad (7)$$

Differences in Cost per Mile in Urban and Rural Areas: Results of Parametric Cost Models

In this section the end results of the parametric cost analysis are presented; detailed descriptions of the cost models are given in subsequent sections. As described previously, the total cost per vehicle mile is computed by adding the five types of costs: operating costs dependent on vehicle miles, operating costs dependent on vehicle hours, operating costs dependent on the number of vehicles, overhead costs, and capital costs. The data in Table 2 give the total costs per vehicle mile disaggregated by (a) whether the service was provided by a social service agency or a transit company, and (b) whether only out-of-pocket costs are considered. In all cases these costs have been computed for the year 1979 for areas on flat terrain and for the operation of 10- to 12-passenger vans.

The total costs per vehicle mile are approximately 2.4 times greater in urban areas than in rural areas. For demand-responsive services provided by social service agencies, the total true cost per vehicle mile is $3.15 in urban areas and $1.34 in rural areas. The corresponding cost per vehicle mile for demand-responsive services provided by transit companies is $2.80 in urban areas and $1.23 in rural areas. Fixed-route services cost slightly less than demand-responsive services (because of the necessity for dispatching equipment and personnel in demand-responsive systems). Fixed-route and scheduled services provided by social service agencies cost $2.49 per vehicle mile in urban areas and $0.97 per vehicle mile in rural areas. Fixed-route and scheduled services provided by transit companies cost $2.22 and $0.89 per vehicle mile in urban and rural areas, respectively.

Operating Costs Dependent on Vehicle Miles

In urban areas the operating costs dependent on vehicle miles are almost 1.5 times those in rural areas ($0.2499 in urban areas and $0.1718 in rural areas).

Fuel costs per mile are estimated based on the costs of fuel per gallon and on the rate of fuel consumption. The cost per gallon for fuel for vans in urban and rural areas is almost identical ($0.88 per gallon in urban areas and $0.89 per gallon in rural areas in 1979). However, the fuel-consumption rate (miles per gallon) is higher in urban areas (8.0 miles per gallon) than in rural areas (10.6 miles per gallon), which indicates that 32.5 percent more gallons of fuel are needed in urban areas to provide the same number of miles in rural areas (assuming fairly flat terrains in both areas). This is probably caused by the lower speeds and stop-and-go type of driving required in urban areas. Thus overall fuel costs per mile are $0.11 in urban areas and only $0.08 in rural areas.

Oil costs are expressed in terms of the proportion that oil and lubrication costs per mile are of fuel costs per mile. This proportion is higher in urban areas than in rural areas (0.0083 and 0.0076,

Table 2. Total costs per mile in 1981 costs for fixed-route and demand-responsive systems.

Cost Element	Symbol	Costs ($)			
		Urban		Rural	
		Fixed Route	Demand Responsive	Fixed Route	Demand Responsive
Operating cost per mile dependent on vehicle miles	$OCVM_i$	0.2499	0.2499	0.1718	0.1718
Total operating cost per mile dependent on vehicle hours	$OCVHT_i$	1.113	1.425	0.3309	0.4415
Out-of-pocket operating cost per mile dependent on vehicle hours	$OCVHO_i$	0.8912	1.141	0.2482	0.3311
Operating cost per mile dependent on number of vehicles	OCV_i	0.0652	0.1601	0.0276	0.1026
Overhead costs per vehicle mile[a]					
Social service agency	OH_i	0.843	1.083	0.244	0.329
Transit company		0.571	0.734	0.164	0.222
Capital costs per vehicle mile	CC_i	0.2178	0.2350	0.1986	0.2958
Total out-of-pocket costs per vehicle mile					
Social service agency		2.2671	2.869	0.8901	1.2306
Transit operator		1.9951	2.520	0.8106	1.189
Total costs per vehicle mile					
Social service agency		2.4889	3.153	0.9728	1.3410
Transit operator		2.2169	2.804	0.8933	1.234

[a] Assumes a flat terrain.

respectively). This results in an oil cost per mile of $0.0009 in urban areas and $0.0006 in rural areas (50 percent greater in urban areas).

Both tube and tire costs and vehicle repair and maintenance costs are expressed in a cost per vehicle mile. The cost per mile for tubes and tires is $0.020 in urban areas and $0.013 in rural areas (almost 50 percent greater in urban areas). Again, this is probably because of the stop-and-go nature of the driving in urban areas. Vehicle repair and maintenance costs include all expenses associated with repair shops, parts, labor, and equipment. Vehicle repair and maintenance costs per mile are almost 61 percent greater in urban areas than in rural areas ($0.119 and $0.074, respectively). This is probably caused by both higher labor costs in urban areas and also the stop-and-go, conjested traffic in these areas.

Operating Costs Dependent on Vehicle Hours

Driver and dispatcher wages and total labor expenses are the greatest factors that account for differences in costs in urban and rural areas. Considering real costs for demand-responsive services, total driver and dispatcher labor costs per vehicle mile are $1.43 in urban areas and $0.44 in rural areas (225 percent greater in urban areas). For fixed-route systems, driver wages per vehicle mile are $1.11 in urban areas and $0.33 in rural areas (236 percent greater in urban areas).

The proportionally greater costs in urban areas may be attributed to four factors. First, driver wages are considerably higher in urban areas ($6.57 per hour in urban areas versus $4.53 per hour in rural areas). Second, fringe benefit rates (ratio of fringe benefits to wages) are higher in urban areas. (The 27.2 percent fringe benefit rate in urban areas and the 16.0 percent rate in rural areas produce a wage plus fringe benefit rate of $8.36 in urban areas and $5.25 in rural areas.)

The third factor is the ratio of driver paid hours to vehicle hours. In urban areas this ratio is 1.32, whereas in rural areas it is approximately 1.0. This means that in urban areas more than 24 percent of the paid driver hours are not spent driving the vehicle. Nevertheless, because these costs are an expense of the service, the cost of these labor hours must be included, which increases the overall labor cost considerably.

Finally, labor cost per mile is higher in urban areas because average speeds are lower (9.9 mph in urban areas and 15.9 mph in rural areas). This means that for every vehicle hour, a rural vehicle covers 60 percent more miles than an urban vehicle.

Note that if only out-of-pocket costs are considered (if volunteer labor is considered free and therefore not included as an expense), costs are reduced in both urban and rural areas. Nevertheless, this reduction in labor cost is not equal between areas. Data indicate that although approximately 25 percent of driver and dispatcher labor is volunteer in rural areas, only 20 percent of this labor is volunteer in urban areas. This means that out-of-pocket costs in urban areas would be relatively higher than out-of-pocket costs in rural areas because of the higher degree of volunteerism in rural areas.

Operating Costs Dependent on Number of Vehicles

Overall, the operating costs per mile for insurance in urban areas are approximately 2.4 times those in rural areas. For demand-responsive systems in urban areas, the overall operating cost per mile for insurance and acquisition of vehicles and operation of dispatching equipment is approximately 60 percent greater than those costs in rural areas.

There are a number of factors that influence these cost differentials. First, annual insurance costs per vehicle are greater in urban areas ($1,060 in urban areas and $619 in rural areas), and second, urban vehicles operate for fewer annual miles than rural systems (16,260 annual miles per vehicle in urban areas and 22,416 annual miles per vehicle in rural areas). These two factors combine to create much higher insurance costs per vehicle mile in urban areas.

On the other hand, the maintenance costs of dispatching equipment are greater in rural areas because of the need for more equipment and, in some cases, more sophisticated equipment. The cost per base dispatching station in an area of flat terrain is slightly lower in rural areas than urban areas ($3,600 in rural areas for VHF and $4,200 in urban areas for UHF), but the cost per station in a mountainous rural areas is almost 4 times either of these costs ($15,000). In addition, rural areas need more base stations because of greater dis-

tances, and, because rural systems tend to have more vehicles, they need to have more mobile units.

General and Administrative Overhead

Overhead costs will be partly dependent on the type of agency operating the system. It has been noted that overhead rates for social service agencies are almost 50 percent greater than overhead rates for transit companies operating a transportation service. Overhead rates for social service agency systems are 46 percent in rural areas and 59 percent in urban areas. Overhead rates for transit company systems are 31 percent in rural areas and 40 percent in urban areas. Overall, in urban areas the overhead cost per vehicle mile is 3.5 times the overhead cost per vehicle mile in rural areas.

Capital Costs

Two concepts of vehicle life appear in the literature: service life and economic life. The service life is the total time that the equipment--through continued repair and rebuilding--is operational. Vehicle economic life ends at that certain point when a vehicle becomes more expensive to own and operate than to replace. This cost model makes extensive use of service lives and thereby assumes negligible terminal values of the equipment at the end of their service lives.

Capital recovery factors are used to convert one-time costs such as vehicle acquisitions into equivalent annual costs. Conceptually, the product of the capital recovery factors and the capital costs gives the constant end-of-year annual amount over the life of the equipment necessary to pay interest and to recover the capital costs in full.

Overall, the capital cost per vehicle mile for fixed-route systems is slightly (10 percent) higher in urban than in rural areas ($0.2178 in urban areas and $0.1986 in rural areas). However, the capital cost per vehilce mile for demand-responsive systems is 30 percent higher in rural areas than in urban areas.

The cost of acquiring vehicles (10- to 12-passenger vans) is approximately the same in the two areas. Thus the slight increase in capital costs for vehicles in urban areas is because vehicles in urban areas operate fewer vehicle miles over which to distribute costs. Nevertheless, the considerably higher costs for dispatching equipment in rural areas are because (a) in some cases (with mountainous terrain) dispatch base stations are more expensive for rural areas, (b) rural areas require more base stations per system because of the distances involved, and (c) rural areas tend to have more vehicles requiring more mobile units.

Summary

The comparison of the overall costs per vehicle mile in urban and rural areas concludes that the unit cost per mile is almost 2.5 times greater in urban areas than in rural areas. The greatest factor contributing to this difference is the hourly rate for labor and the amount of labor hours needed in urban areas as compared with rural areas. Although fuel, oil, tires, maintenance, insurance, and capital costs are all greater in urban areas, these cost elements do not affect the overall cost differential anywhere near as greatly as driver and dispatcher wages and the overhead costs associated with them. The only production cost that is higher in rural areas than in urban areas is the cost of acquisition, installation, and maintenance of dispatching equipment.

Service Consumption and Demand Rates

For the purpose of this study, service consumption or demand rates are expressed in terms of the number of one-way passenger trips provided per mile in the two areas. From the secondary data examined in this study, the number of trips per mile ranges from 0.40 to 0.45 in urban areas and from 0.15 to 0.20 in rural areas.

The accuracy of the values used for the number of trips per mile was verified by examining load factors and average trip lengths for the two areas. A load factor is a value expressed as a percentage, which indicates how full vehicles are (on average) over the total service period. Load factors are equal to the ratio of passenger miles to seat miles (seat miles equal number of seats on the vehicle times vehicle miles). Load factors can be used with the trip length to verify the accuracy of the value used for trips per mile, because load factors are calculated as follows:

$$\text{Load factors} = (\text{One-way passenger trips} \div \text{vehicle miles}) \times (\text{Trip length} \div \text{seats on vehicle}) \quad (8)$$

On the one hand, from the secondary data analyzed for this study, it appears that load factors are fairly comparable in urban and rural areas, with the vehicles approximately 14 to 23 percent full in both areas. On the other hand, trip lengths in urban areas are only one-third to one-half the distances of those in rural areas (4 to 6 miles in urban areas and 12 to 14 miles in rural areas). By using the empirical data discussed and Equation 8, trips per vehicle mile for urban and rural areas are calculated as approximately 0.45 and 0.15, respectively.

Differences in Cost per Trip in Urban and Rural Areas

The unit cost per service consumed is expressed in terms of the total cost per one-way trip provided to an elderly person. Unit costs per trip in urban and rural areas were calculated by dividing the cost per mile in the two areas by the number of trips per mile. Because trips per mile are expressed in terms of a range of values, costs per trip are also expressed as a range of costs. (It was not possible, using the secondary data available, to estimate a mean or median value for trips per mile in the two areas.)

The ranges of values for the cost per trip in urban and rural areas, disaggregated for fixed-route and demand-responsive services, are given in Table 3. The data in the table indicate that the estimated values for the cost per trip in urban areas fall within the range of values for the cost per trip in rural areas (with, in all cases, a wider range of values for rural areas). A tentative conclusion is that the costs per trip are comparable in urban and rural areas. Unfortunately, from the data available for the study, it is not possible to control for, or take into account, differences in the quality of service in the two types of areas. Nevertheless it is known that the quality of service is considerably lower in rural areas in terms of lower frequencies, longer reservation times, and fewer trips per service area population.

Without controlling for service quality, it is impossible to make definitive conclusions concerning differences in cost. Nevertheless, because it appears that service quality is lower in rural areas than in urban areas, service costs may be the same but for an inferior type of service in rural areas. It is cautioned that this conclusion cannot be fully substantiated without the collection and analysis of

Table 3. Total cost per one-way trip for fixed-route and demand-responsive systems.

Location and Operator	Total Cost ($)	
	Fixed Route	Demand Responsive
Urban		
Social service agency	5.44-6.12	7.00-7.88
Transit operator	4.93-5.54	6.23-7.01
Rural		
Social service agency	4.86-6.48	6.71-8.94
Transit operator	4.46-5.96	6.17-8.23

primary data designed to control for service quality specifications.

CONCLUSIONS

In the examination of the differences in costs to provide transportation services to the elderly in rural and urban areas, a number of conclusions can be drawn. First, the basic cost of resources needed to provide the service (i.e., labor, tires) is generally greater in urban areas. Second, the amount of resources needed to produce the service is generally greater in urban areas (i.e., miles per gallon for fuel is lower in urban areas, driver hours to vehicle hours is greater in urban areas). Finally, because of these characteristics, the cost per vehicle mile in urban areas is almost 2.5 times greater than the cost per vehicle mile in rural areas.

There was considerable variation in the consumption rates in both urban and rural areas. Consumption rates in terms of trips per mile ranged from 0.40 to 0.45 in urban areas and from 0.15 to 0.20 in rural areas. This represents a trip length of about 12 to 14 miles in rural areas and from 4 to 6 miles in urban areas.

The final consideration--differences in the unit cost per one-way trip in urban and rural areas--is less conclusive than the other areas of analysis. Indications are that the costs per trip in urban and rural areas are roughly comparable, with rural areas having a greater range of values for these unit costs. However, as explained previously, this conclusion does not take into account the quality of service being provided in the two areas. Because service quality is considerably lower in rural areas, the conclusion might be drawn that, although the cost per trip in rural areas is the same as for urban areas, it buys a lower quality of service. If this conclusion is true, and the quality of service was controlled, then the cost per one-way trip of comparable quality would probably be considerably more expensive in rural areas. (Again, the validity of this statement can only be verified by the collection and analysis of primary data designed to control for service quality.)

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Case Study of User-Side Subsidies for the Handicapped in Milwaukee County

MARY E. LOVELY

Milwaukee County, Wisconsin, instituted a user-side subsidy program in June 1978 for handicapped users of taxi and chair-car companies. Because of the unique features of the program, a case study was undertaken by the UMTA Service and Management Demonstration program. The Milwaukee County program is funded entirely by county and state contributions. Unlike other user-side subsidy programs that serve the elderly and the handicapped, the Milwaukee County program serves only handicapped persons. Eligibility for the program is limited to the legally blind and to persons who require the use of a wheelchair, a walker, or crutches. Door-to-door transportation is provided for eligible persons who use the services of private taxi and chair-car companies. By 1982 five taxi companies and three chair-car companies accepted program vouchers. Participants pay the first $1.50 cost of a trip. The remaining cost is subsidized by the program—up to a maximum of $9.50 per trip, depending on the individual's handicap classification. Simple administrative procedures for subsidy distribution have been devised for the program and approximately 12 percent of the 1980 budget of $1 million has been spent on administrative activities. The paratransit industry in the county has expanded since the institution of the program, and providers appear to be competing actively for program ridership. Enrollment in the program by the eligible population is high, with wheelchair users making the majority of program trips. The program offers a high level of service to the most severely handicapped residents of the county, and the Milwaukee County experience should help other area administrators anticipate and meet the demand of handicapped persons for low-cost accessible service.

Transportation subsidies for handicapped users of taxi and chair-car companies are provided by the Milwaukee County, Wisconsin, user-side subsidy program. The program was instituted by the county in June 1978 and is administered through the county Department of Public Works. The program is permanent and ongoing, and it receives no federal assistance. [Ed. note: A chair-car company provides demand-responsive transportation service by using specially equipped vans.]

Accessible transportation is provided to eligible persons by the program by using existing private paratransit providers. Currently, participants pay the first $1.50 cost of a trip, and the remaining cost is subsidized by the program through the use of trip vouchers, up to a maximum of $9.50 for wheelchair users and $6.50 for other users. There is also a $5.00 registration fee. Before January 1981 users paid a minimum fee of $1.00 per trip, and the program subsidized up to $10.00 for wheelchair users and $7.00 for other users.

A distinctive feature of the Milwaukee County program is that, unlike other user-side subsidy programs that serve both the elderly and the handicapped, it serves only handicapped persons. The program is available to four groups--those persons confined to a wheelchair, those who require a walker, those who require crutches, and the legally blind.

Milwaukee County instituted the user-side subsidy program when state funds became available for locally administered transportation assistance to the handicapped. Originally, the state provided 90 percent of program funding under its Section 85.08(5) funding program but, as the program has grown, the county has contributed an increasing share. In 1980 the county provided $611,809 for the program--62 percent of the total program costs.

The findings of a recent UMTA Service and Management Demonstration (SMD) program case study (1) are presented in this paper. The Milwaukee County user-side subsidy program was chosen because of the unique features of the program. First, the program currently receives no federal assistance yet provides user subsidies without imposing a limit on the number or type of trips that can be taken. In contrast to many user-side subsidy programs that place monthly limits on the amount of subsidy each participant receives, the Milwaukee County program limits the subsidy per trip, but not the total amount of subsidy accruing to any one individual (2).

Second, the Milwaukee County program serves only a limited target group--persons confined to wheelchairs, persons who use a walker or crutches, and those who are blind. Most user-side subsidy programs serve both the handicapped and the elderly, with the notable exception of the Port Authority of Allegheny County paratransit subsidy program for severely handicapped persons in Pittsburgh. Because only a small percentage of the elderly and the handicapped require special services, these programs experience low participation rates. Nevertheless, with a potentially large number of eligible people, these programs have generally instituted monthly purchase limits, as previously discussed, to restrain the total possible subsidy liability. Milwaukee County is of interest because it has developed an alternative to this model of broad eligibility and limited monthly subsidy.

Third, the Milwaukee County program tests the user-side concept on a large scale. The program serves the entire county, which covers 237 miles^2 and contains almost 1 million people. Thus the program cannot successfully use either jurisdictional boundaries or residency as devices for restricting the amount of program subsidies. Instead the county has developed other methods of restraining the amount of subsidy provided, and these methods are worth studying for potential application in other large cities.

Finally, the Milwaukee County program is of interest because the county allows free entry of taxi and chair-car providers into the program. As a result, seven carriers currently are able to accept program vouchers. This case study of the Milwaukee program attempts to evalute the effect that free entry into the subsidy program has had on the paratransit industry in the county and on the level of service it provides. Because increased competition among providers is one benefit often believed to result from user-side rather than provider-side subsidies, this examination of the Milwaukee County paratransit industry provides additional evidence about the merit of the user-side concept.

ADMINISTRATIVE PROCEDURES AND COST

Milwaukee County designed the program to be administratively simple. Participants generally register through the mail, and certification by a doctor or a social service agency establishes the participant's eligibility. Procedures for contracting with providers are also simple. The program does not set service requirements on providers; instead it relies on the requirements set by the state's Title XIX program in which most chair-car carriers participate. The program involves only a minimum of paperwork for carriers because trip vouchers are used

directly for carrier reimbursement. Because of these simple administrative procedures, administrative costs constitute approximately 12 percent of the program budget. Furthermore, the carriers do not believe they are unreasonably burdened by program bookkeeping.

The simple design of the program also exposes it to the possibility of unnecessary expenditures. Registrants are not given photo identification cards, which allows for possible fraudulent use. A more serious problem, however, is that the program has no administrative mechanism for ensuring that trips eligible for funding under other transportation assistance programs (i.e., Title XIX, Title XX, and Title III) are not paid for by the user-side subsidy program. The county recognizes this problem and has studied the cost and feasibility of some type of coordination or brokerage mechanism. The study determined that the cost of coordinating the major transportation funding sources in the county would be substantial and possibly outweigh any savings achieved.

EFFECTS ON PARATRANSIT INDUSTRY

The user-side subsidy program contracts with three chair-car companies and five taxi companies for receipt of program vouchers. Because the program controlled more than $110,000 worth of total trip revenue per month by mid-1981, it accounts for approximately one-third or more of participating chair-car company revenues and one-quarter of participating taxi company revenues. Chair-car companies serve about 45 percent and taxi companies serve about 55 percent of the total number of trips sponsored by the program. Nevertheless, because chair-car rates are higher than taxi rates, chair-car companies receive 57 percent of the total program billings whereas taxi companies receive 43 percent. The program pays an average subsidy of $4.81 for a taxi trip and $8.74 for a chair-car trip.

A provider can become a carrier in the program if appropriately licensed by the Common Council of the city of Milwaukee, which regulates the paratransit industry. The program has not rejected the application of any licensed provider to become an affiliated carrier. As of 1981 all chair-car companies and all major taxi companies in the county participated in the program. Only three small taxi companies were not participating.

Taxi companies have become an important part of the provider network in the user-side subsidy program. Taxis provide low-cost service that is immediately available to program participants. Because taxi companies have joined the network, the program can provide, with the same budget, about one-third more trips than it would be able to provide by using only chair-car companies.

Taxi companies benefit substantially from the user-side subsidy program. In 1981 the program provided more than $45,000 in revenues to taxi companies each month. For those companies participating, user-side subsidy trips are a significant portion of their business. Moreover, user-side subsidy customers represent a relatively stable market in an industry that has deep seasonal shifts in demand.

Taxi companies have adjusted to the demands placed on their operations by participation in the program. They have hired additional personnel to check and account for user-side subsidy vouchers. More relevant from the perspective of users, the companies have recognized the new importance of handicapped persons in the market for taxi service. Participating companies have improved the service they provide to persons confined to wheelchairs primarily because of the $3.00 surcharge allowed by the user-side subsidy program. Drivers interviewed for this case study indicated their willingness to aid persons in wheelchairs because of the surcharge.

The chair-car industry appears to be the type of provider that has been most affected by the program. Chair-car companies are dependent on government transportation assistance programs, many of which use fixed-bid contracts. The program has allowed the industry to reduce the extent of its reliance on these funding sources.

The chair-car industry has expanded because of the user-side subsidy program. In 1981 the program provided more than $63,000 in revenue to the chair-car industry each month, a significant increase in industry revenues since 1978. Before the program only one carrier remained in stable operation. Currently there are three. Although carriers that have initiated operations since the program began indicate that they would have entered the industry in any case, it is not clear if all three carriers would be able to maintain operations without the program.

The owners of the largest chair-car company in the county, drawing on their experiences in Minneapolis and Florida (where assistance is provided through supply-side subsidies), state that the Milwaukee County program, unlike other programs, fuels competition in the industry because of free entry into the program and because participants may call any carrier they want. All carriers agree that the form of the county subsidy program--allowing users to choose a carrier--fuels competition for customers. The result of an expanded industry and increased competition is evident in longer hours of operation by chair-car companies and greater flexibility in providing service. Carriers attempt to differentiate their services in some way, hoping to retain passengers as regular users.

The user-side subsidy program has had some effect on two other types of providers that serve handicapped persons in Milwaukee County. For the Milwaukee County Transit System (MCTS), the program has affected a relatively small but important portion of its operations. MCTS has been freed from the responsibility of providing accessible bus service because of the program. As indicated by the data in Table 1, which lists monthly one-way trips of persons confined to wheelchairs by lift-equipped buses and the user-side subsidy program, the program has become extremely popular and serves many people. Because of this development, those handicapped individuals whose original lawsuit forced the county in 1976 to purchase accessible buses have agreed to allow the lift equipment at issue to become permanently inoperative. The county, in exchange, has agreed to fund user-side subsidies by an amount equal to 2.2 percent of the MCTS operating budget.

The second type of provider affected by the program--social service agencies--has not benefited directly from user-side subsidies, but many of their clients have. The agencies may be able to transfer some of their transportation costs to the program because no system for screening user-side subsidy trips exists. Nevertheless, the county relies on the agencies not to engage in this type of behavior, and no evidence exists that they do transfer their costs.

PARTICIPATION BY THE HANDICAPPED

The Southeast Wisconsin Regional Planning Commission (SEWRPC) estimates that there are 34,800 transportation-handicapped persons residing in private households in Milwaukee County (3). The potential market for special transportation services includes those chronically and acutely disabled handicapped persons

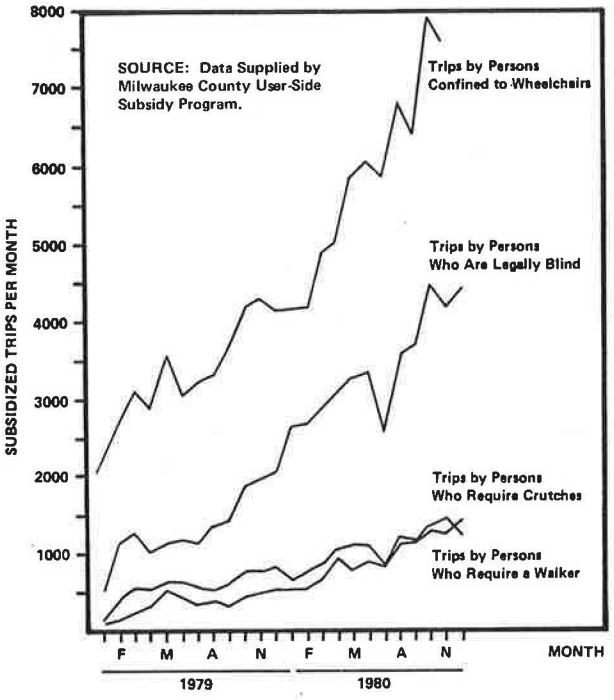
Table 1. Monthly one-way trips of persons confined to wheelchairs by lift-equipped buses and user-side subsidy program, 1979 and 1980.

Date	Total Trips by Lift-Equipped Buses[a]	Total Trips by User-Side Subsidy Program[a]
1979		
August	52	3,313
September	49	3,650
October	6	4,189
November	9	4,263
December	21	4,179
1980		
January	15	4,170
February	8	4,191
March	7	4,840
April	2	5,020
May	5	5,827
June	10	6,027
July	59	5,851
August	65	6,812
September	78	6,371
October	64	7,944
November	40	7,575

Note: Data are from MCTS and the Milwaukee County user-side subsidy program.

[a]Trips by persons confined to wheelchairs only.

Figure 1. Subsidized trips per month by user classification.



living in private households who cannot use public transit, with the exception of those individuals confined to their home. By this measure, 27,600 handicapped persons in Milwaukee County may require special transportation services. Considering the narrowly defined criteria for program eligibility, an estimated 12,018 county residents may be eligible for the user-side subsidy program.

The need for transportation assistance by Milwaukee County handicapped residents appears to have been substantial before the user-side subsidy program began. Although SEWRPC studies indicate that some handicapped persons in Milwaukee County are able to drive cars, the great majority of transportation-handicapped persons do not drive. Furthermore, many handicapped persons are not physically able to ride in an automobile. Of those who are, the majority do not have an automobile available to them when they wish to travel. In 1977 less than half of the handicapped believed that special services were available to them, and with 65 percent of the handicapped termed economically disadvantaged, it is unlikely that many could afford the cost of unsubsidized special services.

Between the initiation of the program in June 1978 and the end of December 1980, 7,045 handicapped persons registered for user-side subsidy identification cards. Dividing this number of registrants by the estimated number of persons eligible for the program results in a participation rate of 59 percent by the eligible population. Of the total registrants, approximately 68 percent were persons confined to wheelchairs, 10 percent used walkers, 6 percent required the use of crutches, and 16 percent were legally blind.

Enrolling in the program is a simple process, one that requires a minimum amount of effort by the registrant. Because all forms can be completed at home and no visit to either a doctor or other eligibility-testing site is required, the enrollment process is not considered a barrier to registration.

During 1979 and 1980 trips taken under the sponsorship of the program grew faster than enrollment. This growth in trips is the result of some individual registrants making more trips each month over time, probably because they have become accustomed to the service and to the trip-taking procedures. As of late 1980 and early 1981 the program subsidized approximately 14,000 trips monthly. The growth in subsidized trips per month for each category of users is shown in Figure 1.

Table 2. Distribution of trips, subsidies, and total cost among user classes, 1980.

Item	Distribution Values by User Classification				
	Wheelchair	Walker	Crutches	Blind	All Users
Total trips (%)	52.6	8.3	9.4	29.7	100
Total subsidy (%)	66.5	5.8	6.9	20.8	100
Total trip cost (%)	64.5	6.2	7.3	22.0	100
Cost per trip ($)	9.99	6.08	6.35	6.02	8.14
Subsidy per trip ($)	8.74	4.82	5.01	4.82	6.88
User payment per trip ($)	1.25	1.26	1.34	1.20	1.26

Note: Data are from Milwaukee County user-side subsidy program and Charles River Associates, Inc., 1981.

In 1979 the program provided $462,521 in subsidies for the use of taxis and chair-cars by registrants. In 1980 subsidies grew 103 percent to $940,976. In both 1979 and 1980 the average total cost per trip was essentially the same--$8.12 and $8.14, respectively. Of the total, the average program subsidy per trip was $6.81 in 1979 and $6.88 in 1980. Users paid an average of $1.31 per trip in 1979 and $1.26 per trip in 1980. Persons confined to wheelchairs received more than 65 percent of the subsidy in both years. This group received a larger percentage of subsidy funds than their percentage of total trips because of higher per-trip subsidies for nonambulatory participants. The distribution of trips, subsidies, and total costs among all four user groups for 1980 is given in Table 2.

Use rates, defined as the average percentage of total registrants who use the program in any month, vary among user groups. Those registered persons who use crutches and those who are legally blind participate more actively in the program than other groups. In these groups an average of 42 percent of

those who enroll in the program actually use it to travel. Among those who require a walker, 30 percent of those enrolled use the program in an average month. Among those who require a wheelchair, only 25 percent of those enrolled use the program.

Those persons who require crutches make the greatest number of trips per person--an average of 8.1 trips per active user per month. Persons who require a wheelchair and those who are legally blind make an average of 6.8 trips per person, and those who require a walker make significantly fewer--an average of 5.1 trips per person. Although the program does not systematically compile data on individual participation, it is believed that a small group of users makes more than 30 trips per month, which indicates the strong dependence of some users on the program.

Participating persons use the program to make trips for all purposes. No single trip purpose dominates. Medical trips (19 percent of all trips), recreational and social trips (17 percent), work trips (15 percent), and personal business trips (15 percent) are the purposes for which the program is most often used.

Program participants are eligible for hardship reimbursements if they pay more than $10.00 in excess of the maximum limits for medical, employment, or educational trips in a 2-week period. Use of hardship reimbursements has been limited, and only $10,795 has been reimbursed to participants in the 17-month period between August 1978 and December 1980.

ACHIEVEMENT OF PROGRAM GOALS

The Milwaukee user-side subsidy program offers substantial benefits to transportation-handicapped persons through its dramatic reduction in the per-trip cost of travel and its stimulation of a competitive environment among transportation providers. The program has reached a large percentage of the potential market for the service among those groups who are eligible. Response to the program has been particularly strong among those persons confined to wheelchairs, although many registrants do not use the program actively. The program is used for all trip purposes, with medical trips constituting the largest category, although far from the majority, of trips.

Although the county program offers substantial benefits to eligible groups, other transportation-handicapped persons in Milwaukee County remain without this type of assistance. The decision to limit eligibility to a few categories of disabilities as defined by the use of specific aids was an attempt to control the growth of the program until the demand for transportation subsidies could be assessed. After more than 3 years of experience with user-side subsidies, the county is now in a position to reconsider its earlier decision and to explore the needs of other transportation-handicapped persons. Serving these other groups will present a more complex challenge than serving currently eligible groups, particularly because determining eligibility may require more complicated and costly procedures.

The user-side subsidy program can be said to have met its own goal of providing transportation service to those confined to wheelchairs, those who require a walker or crutches, and those who are legally blind. Nevertheless, until the needs of remaining groups are addressed, the program does not completely meet the goals of the state's Section 85.08(5) funding program, which is intended to afford "the benefits of transportation to the elderly and handicapped who would not otherwise have an available or accessible mode of transportation." The next step for the county is to assess the costs of meeting this more broadly defined goal.

Many transportation analysts believe that user-side subsidies have a number of advantages when compared with provider-side subsidies. Because user-side subsidy programs retain the right of a consumer to choose a provider, these analysts believe user-side subsidies stimulate competition among providers and thereby improve service quality. Another advantage is that the subsidy can be targeted to specific individuals, thus minimizing the amount of funds given to those for whom no assistance is intended. Although these advantages, if realized, can be significant, it is also known that user-side subsidies may be costly to administer. Identifying and certifying eligible individuals may consume considerable administrative resources. The Milwaukee County experience provides additional evidence on the effects of user-side subsidy programs.

The Milwaukee County program appears to have stimulated competition among paratransit providers, particularly chair-car providers. Carriers are aware of program participants' ability to shop around, and they attempt to differentiate their services from those of other providers. Whereas new paratransit companies may have appeared under any type of assistance program simply as the result of the tremendous growth in industry revenues created by the program, it is unlikely that other forms of assistance would have fostered the service improvements that the user-side subsidy program has, including longer operating hours, stopping en route, and customer service evaluations. Furthermore, chair-car carriers hold their fares at the maximum subsidy level even for long-distance trips, for which they may currently charge a higher fare, in order to keep and attract program registrants. Although there was not a direct comparison of this program with a provider-side program, this evidence indicates a type of competition not present under a provider-side program, in which deficits usually are guaranteed to be made up by the subsidizing agency and a similar incentive for improved efficiency does not exist.

The user-side subsidy concept also allows subsidies to be targeted to specific groups. The Milwaukee County program targets its assistance on the basis of specific eligibility criteria. The program minimizes the amount of assistance funneled to other groups by requiring registrants' disabilities to be verified by a doctor or social service agency. Although this process is open to fraud, it does provide a mechanism for limiting access to assistance.

Milwaukee County has designed its program to obtain the desirable advantages of the user-side subsidy concept while remaining administratively simple. As mentioned previously, in 1980 only 12 percent of the program budget was spent for administrative activities. This percentage compares favorably to other user-side programs that have been instituted nationally. Administrative costs totaled 30 percent of program funds in the Seattle user-side subsidy program; 35 percent in the Kansas City, Missouri, program; 39 percent in the Lawrence, Massachusetts, program; 43 percent in the Kinston, North Carolina, program; 53 percent in the Montgomery, Alabama, program; and 16 percent in the Danville, Illinois, program (2, p. 11).

This administrative simplicity is possible because those groups currently eligible are not difficult to define or test for eligibility, and the criteria are largely self-enforcing. A social service agency can reasonably be relied on to certify that an individual uses specific aids or is legally blind. The criteria are self-enforcing in that eli-

gible disabilities are readily apparent and could be faked only with some discomfort. More complex definitions of eligibility would require more complicated testing and higher administrative expenses for such activities.

The administrative mechanisms of the program also minimize bookkeeping costs for providers. Program vouchers are sent back to the staff of the user-side subsidy program to serve as records of all trips provided. Other assistance programs, including Title XIX, require the carrier to complete a trip record and a payment request for each trip. The simplicity of the procedures of the user-side subsidy eases the accounting burden for providers. This should reduce any upward pressure that accounting costs could place on carrier rates. Unfortunately, the ease of user-side subsidy administrative procedures also gives carriers an incentive to allocate trips to the program that may be eligible for other funding.

In sum, the user-side subsidy concept as implemented by Milwaukee County appears to have realized the advantages often claimed for this form of assistance. Competition has stimulated improved service. Aid to unintended recipients is minimized while keeping administrative costs a small portion of the program budget. The possibility of higher administrative costs if coordination with other programs proved essential does not cloud the success of the program. Presumably, the combined benefits of improved target efficiency and coverage would outweigh the cost of additional administrative activity if such action were to be taken.

LESSONS FOR OTHER LOCALITIES

As noted earlier, eligibility for the Milwaukee County program is limited to a carefully defined target group. This group includes those members of the handicapped community who are most likely to need special services. Consequently, the participation rate for eligible persons in the program is comparatively high--an estimated 59 percent.

The majority of user-side subsidy programs nationally have extended eligibility to a far broader target group--the entire handicapped population and the elderly (2, pp. 2-3). Many handicapped and elderly individuals do not need special transportation services because they are automobile drivers, have someone to drive them, or are able to use fixed-route transit. Consequently, programs with broad eligibility exhibit low participation rates. In Seattle, 13 percent of the eligible population registered for the user-side subsidy program. In Lawrence, 26 percent registered. In Danville, 47 percent registered, and in Kansas City, 14 percent registered. At these sites the subsidy programs attracted those individuals most dependent on transit and most in need of subsidized services. Eligible individuals with other means of transportation took few, if any, subsidized trips (2, p. 19). Therefore, defining the target group for the services more narrowly at those sites may have increased measured participation without cutting off needy individuals.

Besides achieving the cosmetic goal of higher participation rates, narrowly defined program eligibility serves a useful purpose in Milwaukee County. Narrow eligibility focuses program resources on those people most likely to need special transportation services. As a result these people can be served more fully with few restrictions on their use of the program. For these people, the subsidy program offers many of the same characteristics of fixed-route transit: low user cost, no limit on frequency of use, and, for those who use taxis, no advance-reservation requirement.

Although the per-trip limit restrains the distance that can be traveled, these limits appear, on average, to have had little effect on actual trip-making by participants. In combination with a narrowly defined target group, per-trip limits can be successfully used to restrain program costs and liability while providing meaningful transportation assistance to severely mobility-restricted people. Monthly purchase limits, in contrast, can be used to provide transportation assistance to any group, but they are indiscriminate of those who need it most and who would, therefore, take maximum advantage of the assistance.

In conclusion, the Milwaukee County experience in providing user-side subsidies to transportation-handicapped citizens appears to be highly successful, as measured by the program's achievement of its goals. The program serves as a valuable case study for other localities based on the results of instituting various administrative mechanisms and procedures. Thus the Milwaukee County experience should help other administrators anticipate and meet the demand of handicapped residents for low-cost, accessible service.

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The findings of a study sponsored by the Transportation Systems Center under the UMTA SMD program are summarized in this paper. I wish to express my appreciation for the valuable insights and guidance provided by Bruce D. Spear of the Transportation Systems Center and Larry Bruno and Jim Bautz of UMTA. Thomas Knight of the Milwaukee Department of Public Works also contributed significantly to the study by providing essential information about the user-side subsidy program. I also acknowledge the helpful comments by Daniel Brand of Charles River Associates.

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Quality of Service in Special Service Paratransit: The Users' Perspective

ANTHONY M. PAGANO AND CLAIRE E. McKNIGHT

The purpose of this paper is to develop measures of quality of service in special service paratransit and to gauge the importance of various service attributes to users of these services. A set of service attributes was compiled, and the attributes were categorized into eight aspects of service quality. These eight aspects are reliability and on-time performance, comfort, convenience of making reservations, extent of service, vehicle access, safety, driver characteristics, and responsiveness to the individual. Questionnaires were mailed to elderly and handicapped users of these services; the respondents were asked to rank each aspect and its corresponding attributes as to importance in achieving service quality. The questionnaire results were analyzed by using psychometric scaling techniques. The results of the analysis indicate that not all types of users place the same importance on different characteristics of these services. Users younger than 65 years old place considerable emphasis on service reliability and extent of service. Wheelchair users believe that satisfactory vehicle access is extremely important. Users older than 65 years old believe that safety is of paramount importance. The most important attributes of service quality from the standpoint of all users are then developed.

During the past several years research in special service paratransit has grown substantially. This research has included in-depth analyses of coordination of services (1,2), studies of service innovations and the use of taxicabs for the transportation of the elderly and the handicapped (3,4), the costs of providing services under different organizational arrangements, and economies of scale in providing services (5,6).

Quality of service, however, is one aspect of research of special service paratransit that has not received equal and thorough attention in the literature. The studies of special services that have dealt with quality of service have done so only indirectly. Most researchers, providers, and policymakers rely on surrogate measures of quality, such as average trip distance, square miles of area served, and equipment available for wheelchair users. But these measures may not completely reflect the many ways in which service quality can vary. Except for a study by Falcocchio (7), no study has dealt with quality of service directly.

Detailed measures of quality of service are needed to answer a number of questions concerning special services. A complete evaluation of attempts to coordinate services requires ascertaining whether quality of service has changed and in what manner. Quality of service should be analyzed to gauge the effectiveness of the many federal, state, and local government programs that deal with special services. A measure of service quality could provide useful information to providers who are interested in improving quality in the most cost-efficient manner possible.

Efficient provision of special service transportation requires knowledge of the productivity of the various inputs used to provide these services. Productivity is most commonly measured as a ratio of output produced to inputs used. In paratransit services, output includes both quality and quantity dimensions. In order to adequately measure productivity, quality of service must be considered along with measures of the amount of service produced.

Questions such as these require a detailed understanding of the dimensions of quality of service in paratransit. The measures that have been used in previous studies are probably not adequate to gauge the full impact of service quality. Special service paratransit differs from conventional fixed-route transit in a variety of ways, including the nature and purposes of the services, the types of users, and trip purposes served. Thus quality-of-service measures developed for fixed-route service may not adequately capture all the dimensions of service quality inherent in the provision of special services.

The purpose of this paper is to develop measures of quality of service in special service paratransit. The various aspects that comprise service quality are examined. The importance of these various dimensions of quality of service is then presented based on the results of a questionnaire sent to users of these services.

QUALITY-OF-SERVICE MEASURES IN SPECIAL SERVICES

The development of quality-of-service measures for special service transportation requires the specification of the service attributes that comprise service quality and the weighting of these attributes by their importance. Measures of quality of service in fixed-route transit served as the starting point in the development of a quality-of-service index (8-12). The paratransit literature was also examined, and a list of service dimensions either implied or specifically used in research and demonstration studies was then compiled. Additional attributes based on the observations of the researchers were added to this list. The service attributes from the various sources were then categorized into eight service aspects, each representing a basic overall dimension of service quality:

1. Reliability and on-time performance--waiting time, delays, and variations from scheduled times;
2. Comfort--characteristics of the ride as well as comfort in waiting for the vehicle;
3. Convenience of making reservations--time needed to make reservations and accommodation to changes in reservations;
4. Extent of service--hours in which service is available and restrictions on locations served;
5. Vehicle access--ease of getting on and off the vehicle, assistance provided, and distance from the house or destination to the vehicle;
6. Safety--probability of having an accident while getting into or out of the vehicle, as well as traffic accidents;
7. Driver characteristics--courtesy, friendliness, neatness, and professionalism of the drivers; and
8. Responsiveness to the individual--relationship between the user and the provider's office.

A tentative list of service attributes included under each of the eight aspects of service quality was sent to a select panel of 22 experts drawn from academia, government, and providers. Each of the experts was chosen to serve on the panel based on his or her experience and expertise in transportation for the elderly and the handicapped. The experts were asked to rate each of the tentative set of attributes as to its importance in determining

the various aspects of service quality. They were also asked to add any additional attributes that they believed were important determinants of quality of service. The results of the questionnaire were then used to develop a final set of attributes under each of the eight service aspects. Attributes receiving a low rating by experts were not included in the final list. The refined set of aspects and attributes is shown in Figure 1.

USER EVALUATION OF QUALITY OF SERVICE

The list of attributes and aspects shown in Figure 1 does not indicate the relative importance of each characteristic in explaining service quality in transportation for the elderly and the handicapped. To ascertain the importance of each aspect and its corresponding attributes, a questionnaire was developed and mailed to users or potential users of these services. The respondents were asked to rank each aspect and its attributes as to importance in achieving service quality. A ranking rather than a rating of attributes was used to reduce the complexity of the questionnaire. Certain demographic questions were also included in the questionnaire.

Questionnaires were mailed to 659 people drawn from lists provided by five different organizations that deal with the elderly and the handicapped. Names were obtained mostly from providers of special services, but some names also came from lists of individuals attending a series of workshops on transportation for the elderly and the handicapped. Thus the sample was designed to be heavily oriented toward individuals who actually use these services. The sample of handicapped users does not include the most severely handicapped, who find it extremely difficult to use any form of transportation. In addition, excluded from the sample were the blind, deaf, and mentally retarded. Thus the sample was restricted to semiambulatory and wheelchair users younger than 65 years old and individuals 65 years old and older.

A total of 228 people returned the questionnaires. Of these, 155 questionnaires were usable. The questionnaires were classified into four categories: semiambulatory persons younger than 65, wheelchair users younger than 65, nonhandicapped persons older than 65, and handicapped persons older than 65 (6 percent of this last category were in wheelchairs). The breakdowns and descriptive statistics are given in Table 1. Twelve of the 155 respondents are not included in any of the categories either because the information needed to categorize them was missing or because they did not belong in any of the four categories. Thus the analysis was conducted based on the responses from 143 questionnaires.

Because the respondents were asked to rank attributes and aspects, the analysis of the results through traditional nonparametric statistical methods could yield information only on the order of importance of the dimensions of service quality. The degree of importance cannot be obtained by using these methods. To establish a degree of importance, the rankings were transformed to interval scales by using the psychometric methods set forth by Guilford (13).

Guilford's method is based on Thurstone's law of comparative judgment (case V), which assumes that the variances of the responses to different attributes are equal. The method converts an ordinal scale to an interval scale by assuming that each

Figure 1. Aspects and attributes of quality of service.

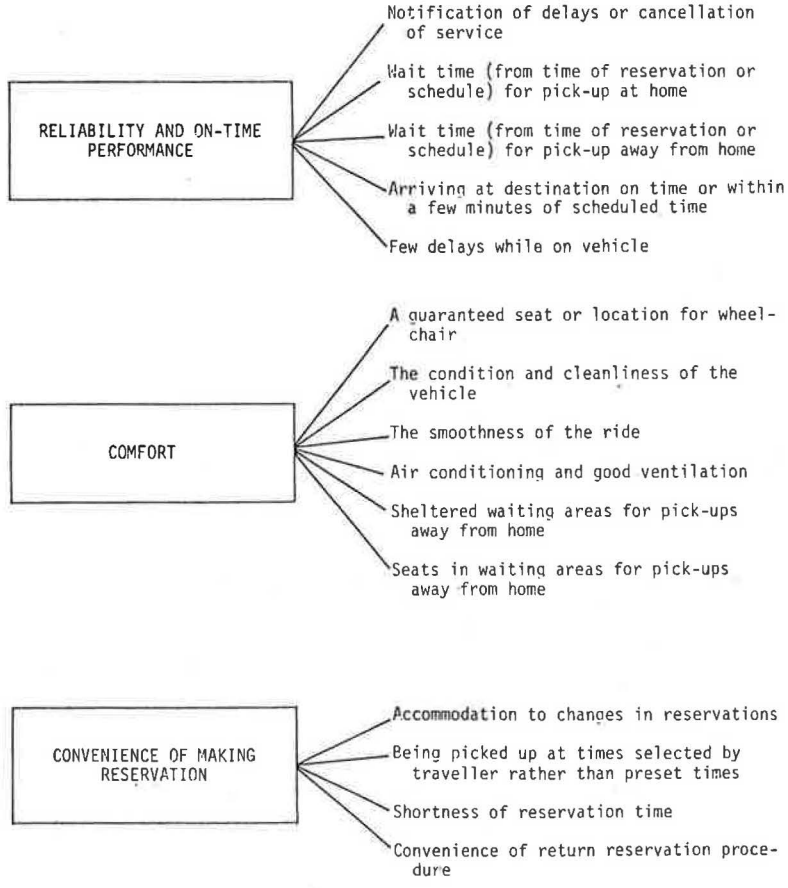
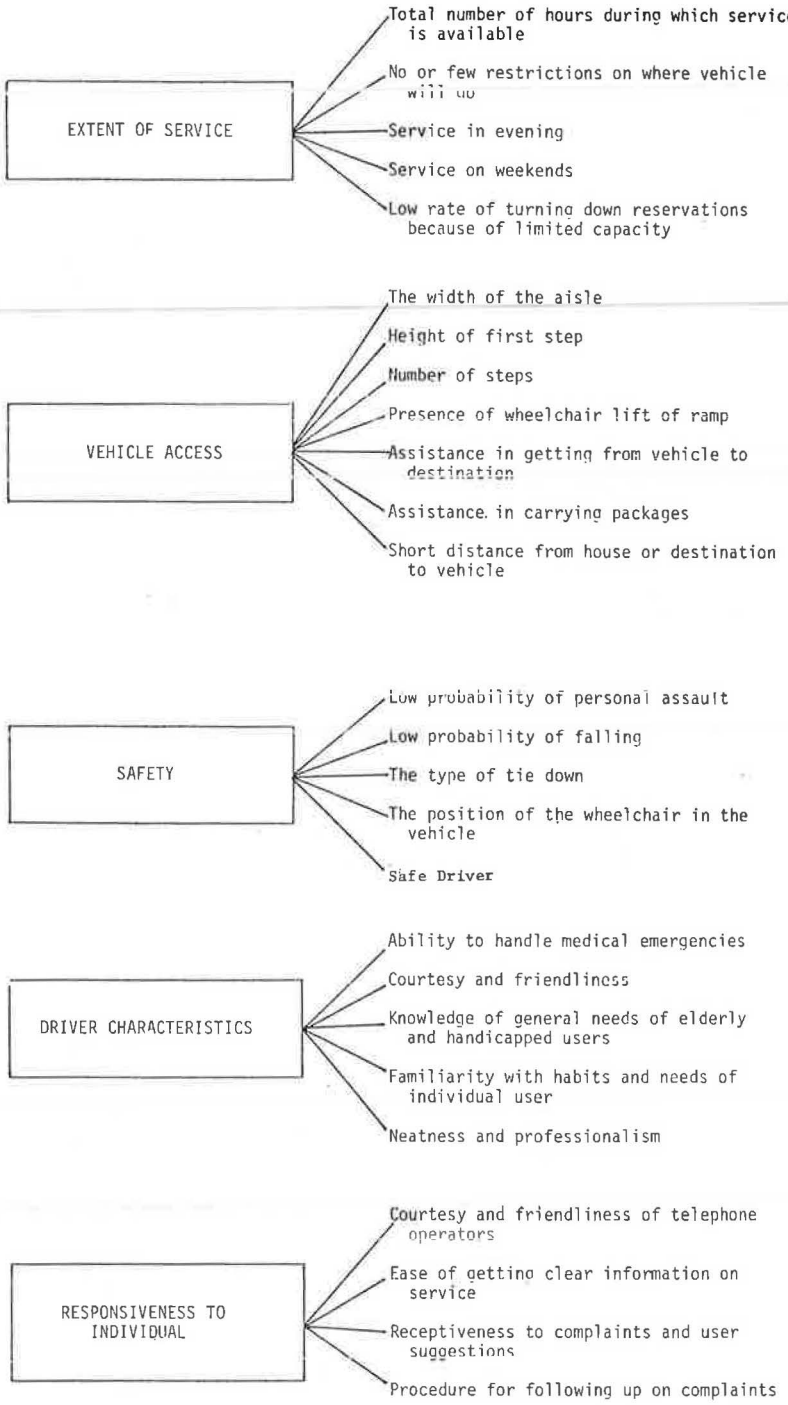


Figure 1. Continued.



respondent perceives the scaling of attributes that define a system, object, or situation differently. It can be shown that, for large samples, such differences can be represented by a normal distribution. This method assumes that there is a true scale relationship between the attributes (or aspects) that have been ranked, and that differences in rankings are caused by this normal dispersion characteristic of large populations.

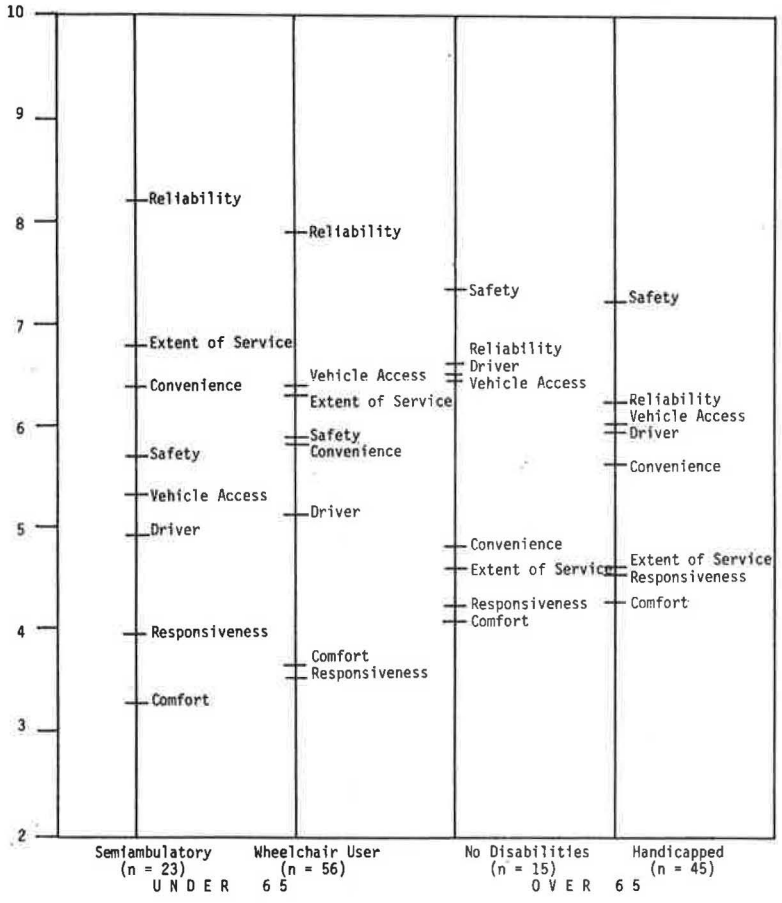
By applying this method to the survey sample, the aspects and attributes were placed on a dimensionless scale that indicates the degree of relative importance of each to service quality.

The scale values derived for the eight aspects for each of the four categories of respondents are shown in Figure 2. (The more important the aspect, the closer it is to the top of the figure.) For the younger-than-65 handicapped group, reliability is by the far the most important aspect. This may be partly because this group is much more likely to be employed. They also rank extent of service significantly higher than do the elderly. Wheelchair users ranked vehicle access as the second most important aspect, which probably reflects the greater frequency with which they encounter inaccessible transportation. The elderly rank safety as the most

Table 1. Characteristics of sample of elderly and handicapped respondents.

Item	All	Younger-than-65 Group		65 Yr and Older Group	
		Semiambulatory	Wheelchair User	No Disabilities	Handicapped
No.	155	23	57	17	46
Percentage of respondents who are					
Female	74	64	67	88	93
Employed full-time	25	26	45	0	2
Employed part-time	19	26	25	18	9
Not employed	56	48	30	82	89
Percentage of respondents whose income is					
<$7,000	39	39	21	50	67
$7,000-$10,000	16	13	10	36	18
$10,000-$15,000	15	9	21	14	10
>$15,000	30	39	47	0	5
Percentage of respondents who usually or often use special service transportation	42	30	40	53	59
Percentage of respondents who have never used special service transportation	88	74	91	94	91

Figure 2. Scale values of eight aspects.



important aspect, followed by reliability. The characteristics of the driver (including training and courtesy) are much more important to the elderly than to younger persons. Ease of dealing with the provider's office and comfort are both ranked low in comparison with other aspects by all categories of users.

An analysis of the attributes under each aspect also reveals similarities and differences among the categories of users. All four user groups ranked the attributes under the aspects of reliability and on-time performance in approximately the same order (Figure 3). Reaching the destination on time is most important, with notification of delays or cancellation second, and the other three attributes fall considerably lower. Nevertheless, those in the younger-than-65 groups ranked on-time performance significantly higher than did the elderly. The importance of on-time performance relative to waiting (either at home or away from home) appears to indicate that use of a window instead of exact pick-up times improves quality of service if the ability of the vehicles to keep to their schedule is increased.

All categories of users agree that the two most important attributes under extent of service (Figure 4) are the total hours during which the service operates and the lack of restrictions on trip desti-

Figure 3. Scale values of attributes of reliability and on-time performance.

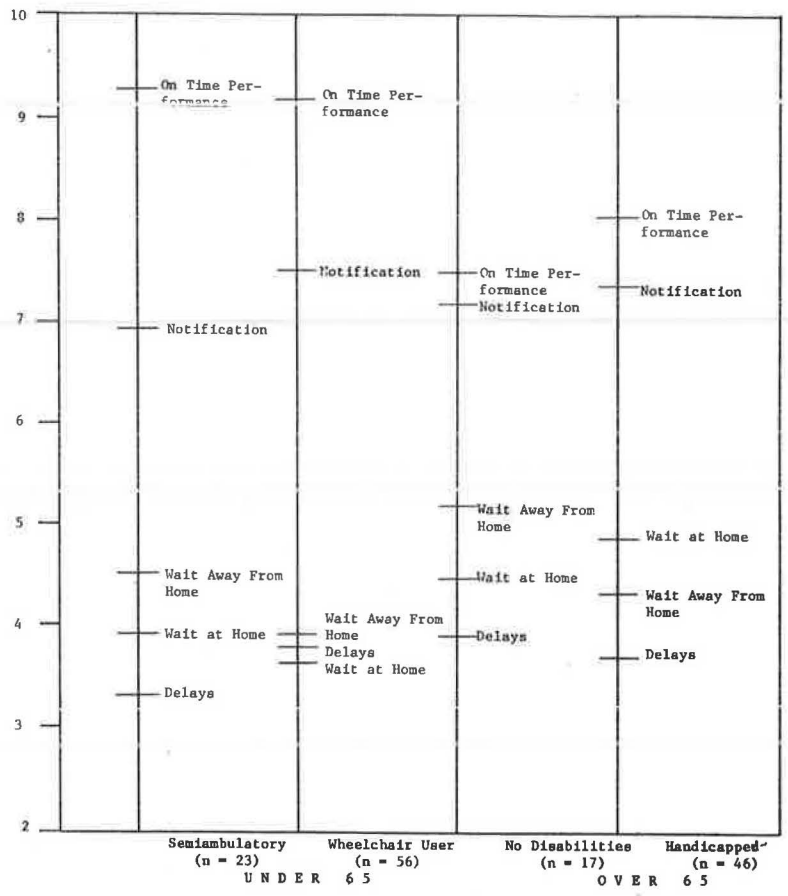
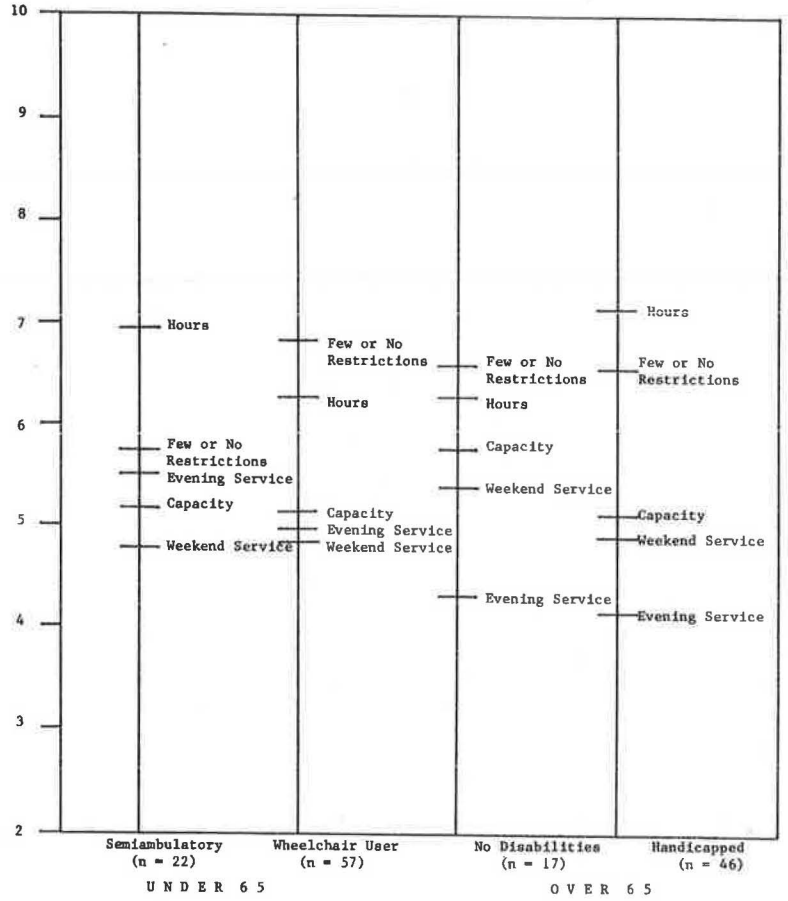


Figure 4. Scale values of attributes of extent of service.



nations. Because all users indicated that having few or no restrictions was more important than having enough capacity to prevent being turned down for service requests, this would indicate that restricting trip destinations or purposes to solve capacity problems will decrease quality of service significantly. The two age groups differ in that those in the younger-than-65 groups prefer evening to weekend service, whereas the elderly prefer weekend to evening service.

Three of the four user categories agree that a safe driver is the most important attribute of safety (Figure 5). Wheelchair users rate it a close second to the type of wheelchair tiedown. A small probability of falling is rated relatively higher by the two semiambulatory groups than by the other two, as might be expected. Low probability of assault while waiting for the vehicle is relatively more important to the elderly than to the younger groups.

Under the aspect of vehicle access (Figure 6), the most noticeable feature is that the importance of having a lift or ramp overwhelms all other attributes for wheelchair users. For all other groups, the height of the first step is most important. The distance between the vehicle and the house or destination is the second or close third most important attribute for all groups, and the number of steps is important to all ambulatory groups. Assistance from the drive is ranked below vehicle design access features; thus a higher quality of service is achieved by having an easily accessible vehicle than by providing assistance. All groups apparently prefer independence over assistance.

Under the aspect of convenience (Figure 7), the attributes are grouped relatively close together, which indicates that there are no strong preferences for one attribute over another. A short reservation time and being able to choose the pickup time tended to receive a higher rating. This indicates that demand-responsive service with a short reservation time is superior to fixed-route service. Accommodation to changes is ranked low, but if the reservation time is short, there is less need to make changes.

For the aspect of driver characteristics (Figure 8), all groups rank knowledge of the general needs of the elderly and the handicapped and courtesy and friendliness the most important attributes. The younger-than-65 groups rate knowledge of general needs the most important by a significant margin. The elderly groups put greater emphasis on courtesy and friendliness. The nonhandicapped elderly place the least importance on ability to handle medical emergencies. Familiarity with personal needs and habits is ranked lowest by all the groups.

The aspect of responsiveness to the individual (Figure 9) was partly meant to measure the degree to which passengers believe that the provider cares about their needs. The elderly indicated that the courtesy and friendliness of the telephone operators was the most important attribute, which is the strongest indication that the providers' responsiveness was important. The younger handicapped groups valued clear information more highly. Ease of making a complaint was rated higher than having a follow-up procedure by all four groups; there may be a feeling that if the agency is receptive to a complaint they will respond with or without a formal procedure.

Finally, under the aspect of comfort (Figure 10), a guaranteed seat or wheelchair position is the most important attribute by a significant margin. Wheelchair users put the greatest emphasis on a guaranteed position probably because a position is necessary in order for them to ride at all. A sheltered waiting area is ranked second highest by all groups, except the nonhandicapped elderly, who rank seats at the waiting area second. The younger handicapped groups ranked the condition and cleanliness of the vehicle lowest, and the elderly groups ranked air conditioning and good ventilation lowest.

CONCLUSIONS

The analysis indicates the relative importance of the different aspects and corresponding attributes of service quality from the perspective of the users of special services. It indicates that not all types of users place the same importance on different characteristics of these services. Thus high-quality services oriented toward one group of users may not be perceived as the highest quality by other groups of users. Unless economies of scale are an overriding consideration, this analysis suggests that, where resources are scarce, higher-quality service may be best obtained by having several providers, each oriented toward a specific user group.

The analysis indicates that users younger than 65 place a great deal of emphasis on service reliability and extent of service. Wheelchair users attach a great deal of importance to satisfactory vehicle access. Thus providers specializing in transportation for these groups should emphasize these aspects in order to produce high-quality service.

Users older than 65 believe that safety is of paramount importance. Reliability, driver characteristics, and vehicle access are also aspects that these users believe are important. Because these users are mostly retired, they can more easily schedule activities around the hours of service provided. Thus extent of service is not as important to these users it is to the younger groups.

The most important attributes of service quality from the standpoint of all types of users can also be obtained from this analysis. These attributes are as follows:

1. Arriving at destinations on time or within a few minutes of scheduled times;
2. Notification of delays or cancellation of service;
3. Many hours during which service is available;
4. Few or no restrictions on where the vehicle will go;
5. Safe drivers;
6. Safe tiedowns for wheelchairs;
7. Short step height;
8. Short distance from house or destination to vehicle;
9. Short reservation time;
10. Being picked up at times selected by the traveler rather than at preset times;
11. Courteous, friendly drivers;
12. Drivers who have knowledge of the general needs of elderly and handicapped users;
13. Easily obtainable and clear information on how to use the service;
14. Courteous and friendly telephone operators; and
15. A guaranteed seat or location for a wheelchair.

High-quality services from this perspective would be those that arrive on time, notify users of delays, are available many hours during the week, and have few restrictions on destinations. Providers of high-quality services should hire or train drivers who are safe, courteous, friendly, and who have knowledge of the general needs of the users. The vehicles should be easily accessible because users prefer independence over assistance.

High-quality special services should have short

Figure 5. Scale values of attributes of safety.

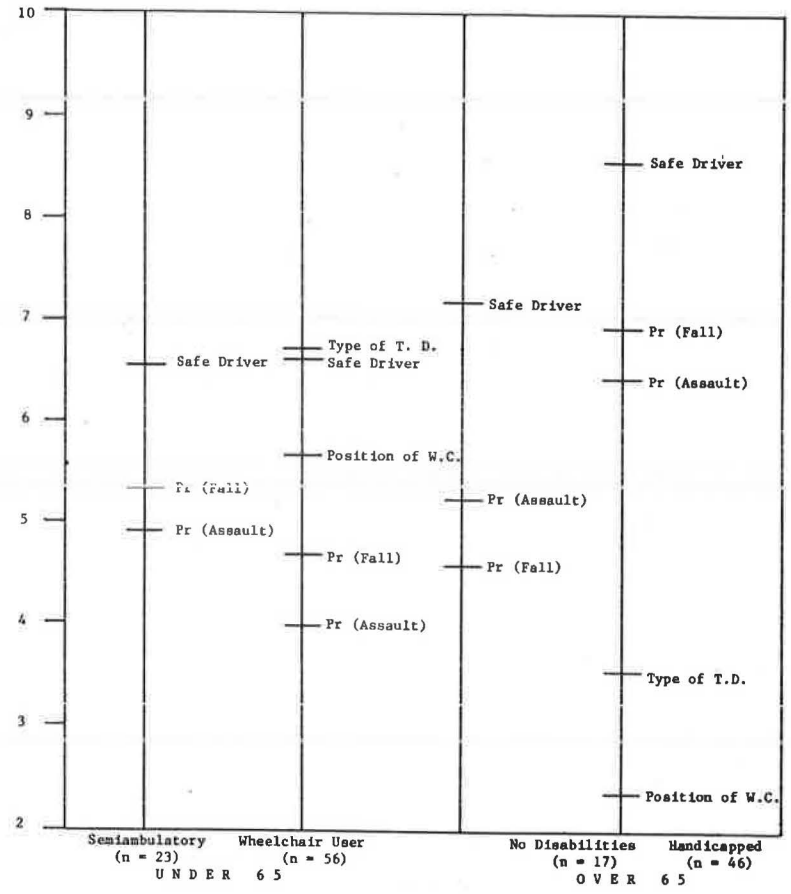
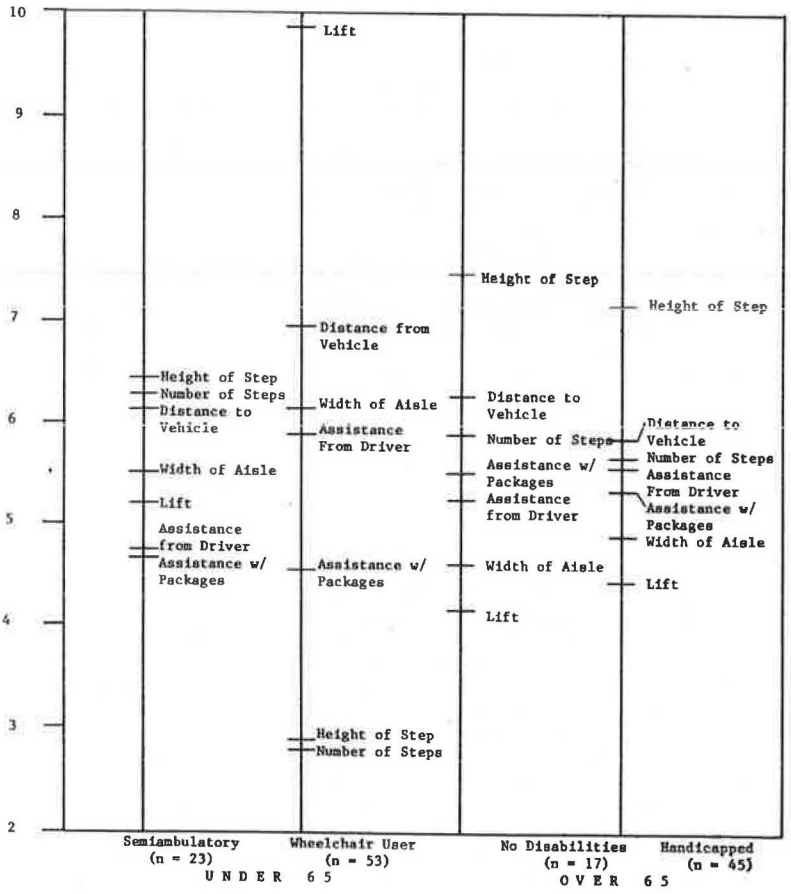


Figure 6. Scale values of attributes of vehicle access.



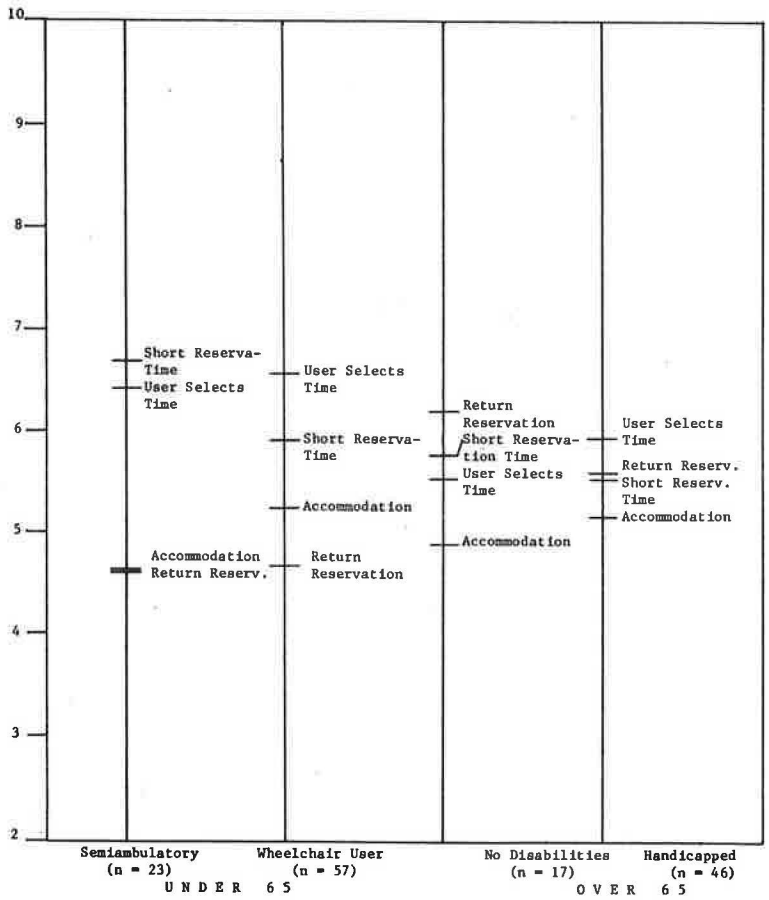


Figure 7. Scale values of attributes of convenience of making reservations.

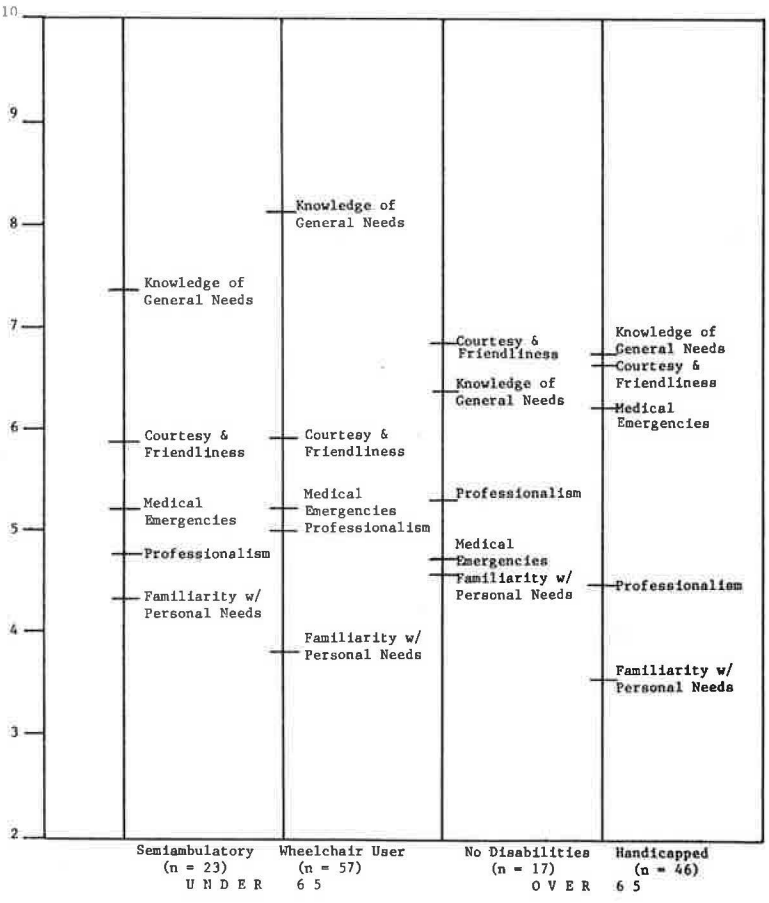


Figure 8. Scale values of attributes of driver characteristics.

Figure 9. Scale values of attributes of responsiveness to individual.

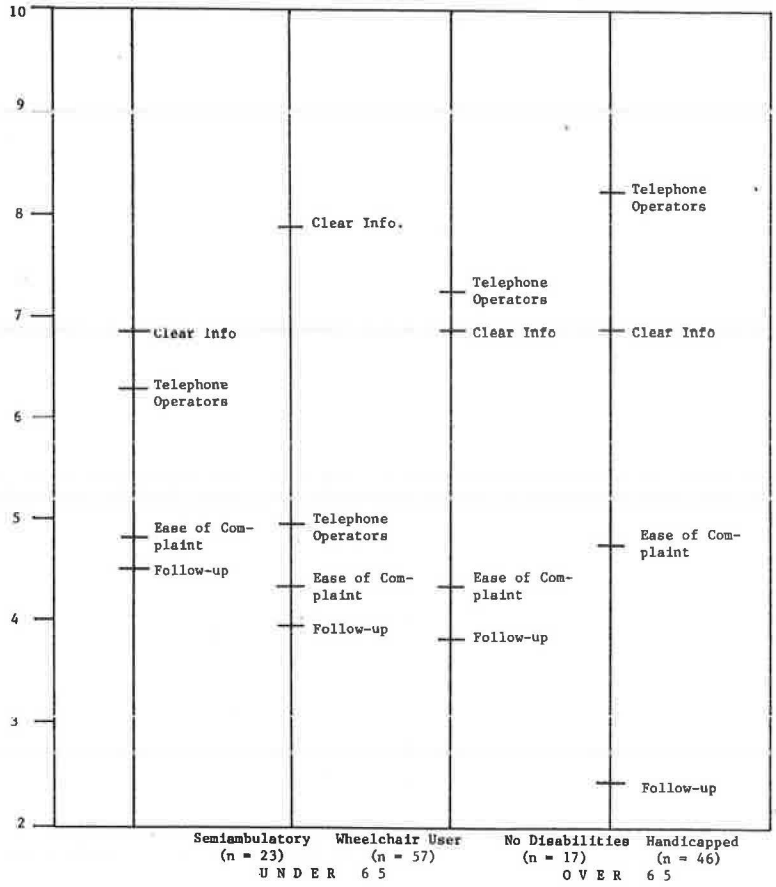
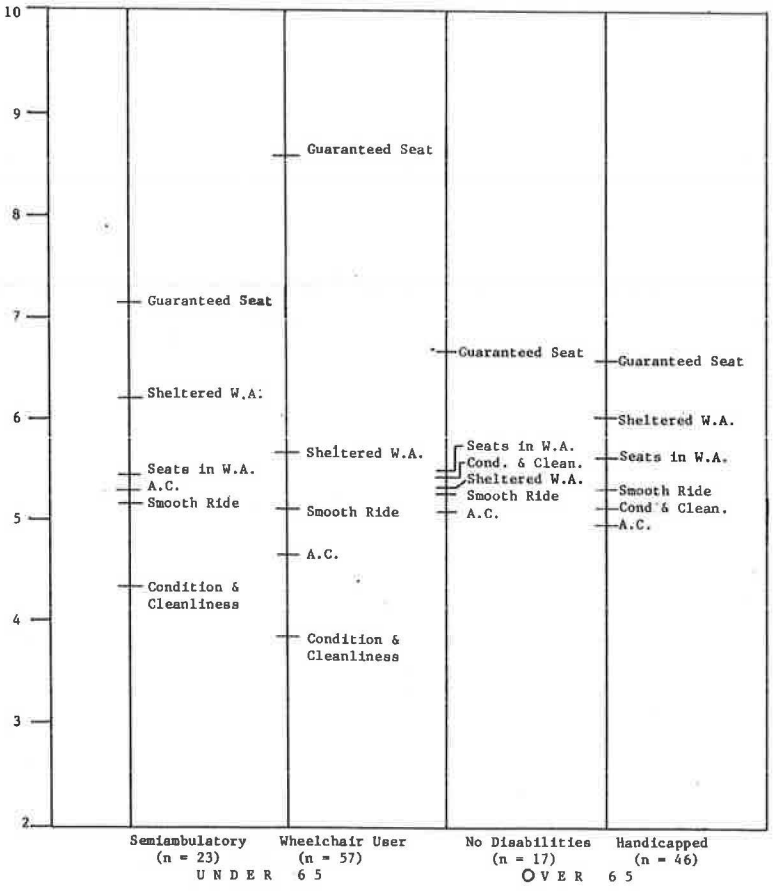


Figure 10. Scale values of attributes of comfort.



reservation times, require users to negotitate short distances from the house or destination to the vehicle, and have pickup times selected by the user rather than at preset times. These attributes describe demand-responsive service and imply that, from the users' perspective, such service is of superior quality to fixed-route service. Route-deviation service would also rank higher than fixed-route service by the sample of users.

The analysis of attributes also indicates that high-quality services ensure that users can obtain clear information on how to use the service, that the telephone operators are courteous and friendly, and that all users have a guaranteed seat or location for a wheelchair.

This analysis implies that the provision of high-quality transportation services for the elderly and the handicapped is complex and involves careful management of a variety of service attributes. Much planning, organization, and control are needed to ensure that high-quality services result.

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Inquiry of the Canadian Transport Commission into Intercity Bus Travel for Disabled Persons in Newfoundland

M.S. FLEMING AND D.B. SILVERSTONE

The objective of the paper is to (a) demonstrate how the Canadian government, acting through a regulatory body [the Canadian Transport Commission (CTC)], approached one particular issue under federal jurisdiction concerning transportation of the handicapped, and (b) present the results of its action. The issue discussed is the intercity bus service for disabled persons on the Island of Newfoundland, which is located off the eastern coast of the Canadian mainland. The Island has a population of approximately 536,000 and is the most densely populated part of the province. The intercity service currently is provided by CN Roadcruiser, a crown agency. The inquiry (the approach chosen to investigate the issue) is described, and the findings, along with the subsequent action taken by the CTC, are given. Terms of reference of the inquiry included consideration of the most efficient service for able-bodied and disabled persons alike. The primary finding was that the use of lift-equipped buses in the regular Roadcruiser service was not the appropriate course of action. Recommendations made in the report of the inquiry were adopted by the Motor Vehicle Transport Committee. In the Committee's decision, Roadcruiser was ordered to take specific courses of action that would lead to improvements for disabled travelers on the existing service, and it was recommended that the federal government finance a 3-year experiment to develop a new transportation service that would be an integrated service, but focused on the transportation requirements of disabled persons.

The accessibility of intercity bus service for disabled travelers appears to be an issue of higher profile in Canada than in the United States. The interest in Canada may be attributed, at least in part, to the interaction of two mutually exclusive events that have taken place or are taking place in the field of transportation in Canada.

The first event is the increasing reliance on bus service as a substitute for passenger train service for relatively short-distance intercity travel. In the province of Newfoundland, bus service replaced passenger train service in 1968.

The second event is an increasing effort on the part of the rail mode to accommodate nonambulatory persons and to encourage them to travel independently without an attendant. This effort commenced in earnest after a decision in March 1980 by the Railway Transport Committee (RTC), a modal committee of the Canadian Transport Commission (CTC). The

decision (1) ruled that, in effect, the railways had to accept the nonambulatory disabled person's judgment as to whether or not he was self-reliant and, therefore, whether or not he required an attendant. At the same time the RTC ordered manual lifting at 11 major stations across Canada and other measures to make rail travel more accessible. Thus this case set a precedent by the Canadian government to take an active part in removing physical barriers to travel by disabled persons.

The focus of this paper is on the intercity bus service for disabled persons on the Island of Newfoundland, which constitutes the most populated area of the province of Newfoundland. CN Roadcruiser, which is regulated by the CTC through its modal committee--the Motor Vehicle Transport Committee (MVTC)--provides a cross-Island intercity bus service. The procedure that the CTC chose to study the service was by inquiry; included in the paper is a description of the inquiry as well as its findings and recommendations (2).

PARLIAMENTARY COMMITTEE AND THE INVOLVEMENT OF THE CTC

The involvement by the CTC in the issue of accessible buses was activated by a report on disabled and handicapped persons produced by the Special Parliamentary Committee. The Committee was formed in 1980 and was made up of seven members of Parliament. They held hearings across Canada in order to "identify key obstacles faced by disabled persons in Canada, and to outline practical actions which will help overcome these obstacles."

In February 1981 the Parliamentary Committee's report "Obstacles" was issued (3). Their recommendations covered virtually all aspects of goods, services, and facilities provided to the public, and focused principally on matters falling within federal jurisdiction.

With regard to intercity bus services, the Parliamentary Committee addressed itself to the Roadcruiser service, in that it is the only service within federal jurisdiction. Insofar as the service is not accessible to disabled persons in wheelchairs, the Committee's Recommendation 86 was to the effect that, as a first objective, disabled persons in Newfoundland should be ensured access to at least one regularly scheduled bus each way, traveling both east and west. In their report the Committee requested that the CTC require CN Roadcruiser in Newfoundland to provide a mechanical facility or a service for lifting people in wheelchairs on and off the vehicles. It was also stated in the report that, "these recommendations, which apply specifically to Roadcruiser buses in Newfoundland, should also be applied to other inter-city buses travelling major routes across Canada, which fall under federal jurisdiction" (3).

THE CTC: ITS ROLE AND FUNCTIONS

The CTC came into existence in 1967 through the enactment of the National Transportation Act (4). It is an independent regulatory federal agency, and it shares with Transport Canada (the Canadian department of transportation) the regulation of all modes of transport under federal jurisdiction. The CTC operates through six modal committees: Railway Transport Committee (RTC), Air Transport Committee (ATC), MVTC, Water Transport Committee (WTC), Commodity Pipeline Transport Committee (CPTC), International Transport Policy Committee (ITPC), and a review committee. In 1980 the CTC also appointed a Special Advisory Panel on Transportation of the Handicapped.

In general, the focus of the modal committees is on economic regulation, such as rate regulation and service, on carriers under federal jurisdiction. Specifically, the RTC regulates safety, service, and rates on all interprovincial rail lines; the ATC regulates rates, service, and licensing on all air carriers (Transport Canada regulates safety); the MVTC regulates rates, service, and safety on the CN Roadcruiser bus service in Newfoundland (the provinces regulate service, rates, and safety on all other intercity bus services); and the WTC regulates service and safety on some inland vessels on certain inland waterways. As the name implies, the Special Advisory Panel focuses its attention on transportation service for the handicapped and the extent to which disabled persons might be better accommodated on the various modes under CTC jurisdiction within the principles set out in national transportation policy. As an advisory body, the Special Advisory Panel has multimodal jurisdiction and provides services to all committees. Its power is limited to carrying out investigations and submitting recommendations to the modal committees for action.

The CTC is a court of record with all the powers of a superior court with respect to the calling of witnesses, the production and inspection of documents, the enforcement of its orders, and the entry and inspection of property. It can act on complaint or on its own motion. Before ruling on a particular issue it may decide to hold (and in some cases must hold) a public hearing. Nevertheless, the Commission is not required to act only through the hearing process. The National Transportation Act provides for more informal channels for obtaining information. For example, the Commission may appoint inquiry officers to investigate any matter on which it has jurisdiction. This was the route chosen by the MVTC when faced with Recommendation 86 of the Parliamentary Committee report.

ENVIRONMENT OF NEWFOUNDLAND AND NATURE OF INTERCITY BUS SERVICE

Newfoundland is an island located at the mouth of the St. Lawrence River in the Atlantic Ocean off the eastern coast of the Canadian mainland. The province of Newfoundland includes the Island plus a portion on the mainland known as Labrador. The inquiry, however, was limited to the intercity bus service on the Island.

In 1981 the population of the Island was 536,363, nearly 45 percent of whom lived in the southeastern corner in the Avalon Peninsula. More than 60 percent of the population of the Avalon Peninsula, in turn, lived in the center or suburbs of the province's capital city, St. John's (population 154,820). The next city of any size is Cornerbrook (32,264), which is located on the west-central coast of the Island. The distribution pattern of the Island's population is shown in Figure 1, which relates specifically to the distribution pattern of disabled persons.

The terrain of the Island is picturesque but rugged. The coastline is hilly, and there are innumerable inlets along the 6,000 miles of coastline, with each inlet separated from its neighbor by a steep ravine. Much of the interior is barren with vast expanses of bogland intermixed with hard rock. The climate is unpredictable because of the Island's exposure to midlatitude storms moving across Canada and up the Atlantic seaboard. The south and southeastern portions of the Island experience periods of dense fog caused by the mixing of the cool air associated with the Labrador current and the warmer air of the Gulf Stream.

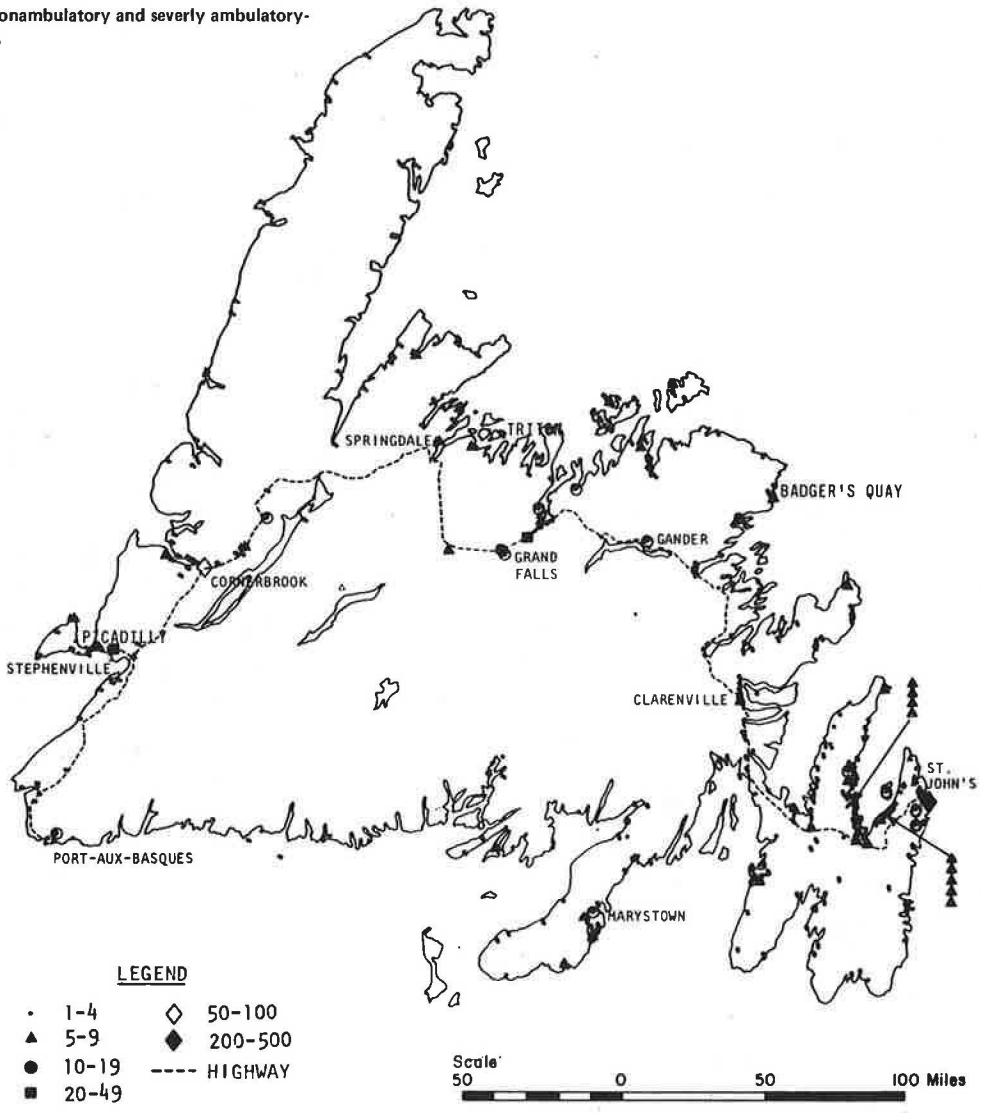
Characteristic of the settlement pattern is the location of a small independent fishing village or

outport at the head of an inlet. Many of the roads that link these outports with other outports and with the Trans-Canada Highway are narrow and rough. The intercity bus service operates only on the Trans-Canada Highway, which crosses the center of the Island, extending from Port-aux-Basques in the southwest corner to St. John's in the Avalon Peninsula in the southeast. This intercity service is operated by Roadcruiser, a subdivision of Terratransport, which is a subsidiary of Canadian National Railways (CN), a crown agency.

The Roadcruiser service connects the major centers across the Island. An element of the bus operation, and indeed of most intercity bus travel, is the use of numerous drop-off locations (there are 34 stops on the trans-island route, two of which are meal stops of 30 min each, and the rest a maximum of 10 min). Many of these stops are without extensive facilities. In fact, most station stops do not belong to Terratransport; rather, they consist of small stores and restaurants. The service is run on several schedules, with slight deviations in some areas and on some routes. Keeping to the schedule is essential to Roadcruiser's operations, especially the trans-island schedule, which already takes 15 hr. An important consideration is that the driver of the Roadcruiser is not permitted to make up for time lost at station stops by increasing the driving speed above the speed limit between stops. The time, including the time spent at station stops, is automatically recorded on a card that is submitted at the end of the trip.

The service in question is seen by many as a replacement for rail passenger service that, as mentioned previously, was ordered discontinued in 1968. Because of this, intercity bus operations in Newfoundland are often compared with intercity rail services. However, rail has certain advantages inherent in its operation that make it more adaptable to providing access to nonambulatory and severely ambulatory-impaired persons. Railway stations can be equipped with station-based lifts at many locations, something not feasible in many bus operations, given the nature of the drop-off points involved. Bus operations, however, have the flexibility inherent in their equipment to deviate from the route, and such flexibility increases with smaller buses.

Figure 1. Distribution pattern of nonambulatory and severly ambulatory-impaired persons in Newfoundland.



SOURCE - Children's Rehabilitation Centre, St. John's, Newfoundland, July, 1981.

INQUIRY INTO INTERCITY BUS SERVICE IN NEWFOUNDLAND

There are no specific provisions in the National Transportation Act and other legislation that the CTC is authorized to administer respecting service to the handicapped. Under the National Transportation Act, however, the MVTC is responsible for regulating service on the Roadcruiser to the public. As such, the MVTC, as well as the Commission's Special Advisory Panel, was interested in Recommendation 86. Both the Committee and the Special Advisory Panel agreed in principle that disabled persons should have access to regular bus service, but it was believed that an investigation was required to examine the extent to which the installation of mechanical lifts on the Roadcruiser buses would serve the needs of disabled persons for intercity travel in Newfoundland. An in-depth examination of other, more appropriate types of services or viable options and the cost implications of implementing them was believed to be a prerequisite to the ordering or institution of any service.

The MVTC and the Special Advisory Panel also agreed that the investigation should be carried out in an informal manner through public and private meetings as opposed to the more formal course of public hearings.

Accordingly, on the recommendation of the MVTC, the president of the CTC duly appointed on March 31, 1981, two inquiry officers, pursuant to Section 81 of the National Transportation Act. The terms of reference stated, inter alia, that the inquiry officers were to inquire into and report "on the relative merits of the various options available which would have the effect of rendering the Roadcruiser bus service in Newfoundland accessible to disabled travellers, with a view towards finding the service best suited to their needs, while taking into account the cost implications of all of the options under investigation."

Although the scope of Recommendation 86 was limited to persons in wheelchairs (i.e., nonambulatory persons), the inquiry included in its terms of reference persons who were able to walk but had some mobility problems, such that it was difficult, if not impossible, to board an intercity bus without assistance. The principal focus of the inquiry, therefore, was aimed at two groups: nonambulatory and severely ambulatory-impaired persons.

The inquiry also addressed the needs of ambulatory-disabled persons, including the deaf and the blind. These persons could board the bus with difficulty, but did not require the use of a lift.

Nature and Format of Inquiry

As previously noted, the inquiry was conducted on as informal a basis as possible, keeping in mind the methodology set out in the terms of reference that the inquiry would be conducted by discussions and meetings in order to solicit the views and obtain the facts from the appropriate persons, agencies, and governments concerned.

The largest part of the inquiry centered around public and private meetings with disabled persons in Newfoundland. Eight of the nine public meetings were held in major centers along the Roadcruiser route, and one public meeting was held off the route in the Burin Peninsula. The locations of the nine centers are shown in Figure 1; they include St. John's, Marystown (in the Burin Peninsula), Clarenville, Gander, Grand Falls, Sprindale Junction, Stephenville, Cornerbrook, and Port-aux-Basques.

Persons attending the public meetings included private individuals, groups and organizations representing disabled persons [such as the Consumer Organization of the Disabled People of Newfoundland (COD); the HUB, an organization of handicapped persons providing services; the Canadian Paraplegic Association (CPA); Group of Seven, and staff of the provincial Department of Social Services], and representatives from the Roadcruiser service. In addition, there was representation from ambulatory-disabled persons, including the deaf and the blind.

The private meetings were held in the homes of disabled persons. Persons visited there were so severely disabled that they were unable to attend the public meetings. The smaller communities where home visits were made included Badger's Quay, Triton, and Picadilly (see Figure 1 for their location).

Information obtained from the public and private meetings in Newfoundland was supplemented with information gained from the results of a questionnaire prepared within the CTC (see Figure 2). The questionnaire was distributed at the meetings and subsequently by the regional directors of the Newfoundland Department of Social Services on behalf of the CTC. Information from the questionnaire was the primary source for estimating the users and potential users of an intercity bus service for the disabled. Finally, to obtain as full an understanding as possible of how disabled persons viewed intercity bus travel, meetings were held with disabled persons living outside Newfoundland, some of whom had had experience riding on an intercity bus.

Summary of Views Expressed at Public Meetings by Organizations or Groups Representing Disabled Persons

Basically, the same position was put forth by the organizations and groups representing disabled persons at each of the public meetings that they attended. The essential points brought forward are summarized as follows.

1. The lift-equipped bus was seen as a concrete embodiment of the principle of integration and equality. Segregation by means of a special system was seen as a regressive step, even assuming the special system provided a superior service to that provided for able-bodied persons. The principle of integration was more important than the numbers of handicapped who would use the service. In fact, the question of numbers was seen by the groups representing disabled persons as irrelevant. The issue was not how many would use the service, but that disabled persons would have the same option as able-bodied persons to mass transportation. This was seen as the right of disabled persons.
2. The lift-equipped bus and the integration of disabled with able-bodied persons was seen as therapy for disabled persons. A comment was made to the effect that "handicapped people who were kept separate were kept handicapped."
3. It was believed that the lift-equipped bus could have special benefits for other groups, such as the aged, pregnant women, and the temporarily handicapped. The cost, therefore, would be offset by the number of people who would be helped.
4. The issue of costs, however, was seen as irrelevant by the groups in question. If the technology existed to adapt the intercity bus with a lift, it should be done regardless of costs.
5. A separate system was seen as a duplication of services, expensive, and "pie-in-the-sky".
6. Manual lifting was seen as a kindness rather than a responsibility and, in the opinion of the groups representing disabled persons, a manual lifting program did not make the bus accessible. The

point was made that manual lifting was unrealistic and dangerous and, moreover, it was degrading to the disabled person.

7. The issue of the accessibility of the feeder systems was seen as being irrelevant to the inquiry. It was pointed out that disabled persons had the same problem as able-bodied persons in getting to the terminal.

8. Incidental to equipping buses with lifts was the necessity to make terminals accessible.

Summary of Views Expressed by Disabled Persons at Public Meetings or Privately in Their Homes

The most striking aspect of the meetings with disabled persons, who expressed their individual concerns, was the diversity of disabilities and the obvious effects this would have on a person's choice of transport and on the operation of the service itself.

In some instances the severity of the disability was so great that it was evident that the person could never travel on a lift-equipped bus or otherwise. In other instances the needs of disabled persons were obviously different from the needs of able-bodied persons, inter alia, the need to stop more frequently because of tiring or to use toilet facilities and the requirement for a longer meal stop. At the same time some disabled persons could use the scheduled Roadcruiser service, requiring assistance only at the beginning and end of the trip. On the question of whether a lift or some manual assistance (apart from actual manual lifting) was necessary, there was a divergence of views. Some persons, even those in wheelchairs, could get on the bus by the stairs with some assistance and therefore

Figure 2. Questionnaire sent to disabled persons about the accessibility of the Roadcruiser service.

Commission canadienne des transports / Canadian Transport Commission
Ottawa, Ontario
K1A 0N9

Questionnaire on the Accessibility of the Roadcruiser Service to the Disabled

The purpose of this survey is to gather information about the transportation requirements of the disabled who have difficulty getting on and off the Roadcruiser.

PLEASE MARK THE APPROPRIATE BOX WITH AN ✓

NAME: _____
(optional)
ADDRESS: _____

_____

1. Which of the following mobility aids do you use?

- ☐ Wheelchair
- ☐ Crutches
- ☐ Other (please specify) _____
- ☐ None

2. Do you own or have access to a car?

- ☐ Yes
- ☐ No

3. If the answer to question 2 is yes, do you drive the car yourself?

- ☐ Yes
- ☐ No

4. How far do you live from a Roadcruiser Bus Terminal?

- ☐ Less than a mile
- ☐ 1 - 5 miles
- ☐ 5 - 10 miles
- ☐ More than 10 miles

5. Do you use the current Roadcruiser Service?

- ☐ Yes
- ☐ No

6. If the answer to question 5 is yes, how much difficulty do you encounter getting on and off the bus?

- ☐ None
- ☐ Slight
- ☐ Moderate
- ☐ Need Assistance
- ☐ Need Manual Lifting

7. If the answer to question 5 is no, please indicate the reasons by checking one or more of the following:

- ☐ Do not travel
- ☐ Have alternative means of transportation
- ☐ Bus journeys are too long
- ☐ Bathroom facilities are not accessible
- ☐ No transportation to terminal
- ☐ Inadequate facilities at terminal
- ☐ Other (please specify) _____

did not need the lift, but some of the persons preferred, or were required, to sit in their wheelchair while on board. In other cases parents preferred to carry their children on board. This diversity of disability is further emphasized by the answers received in many of the questionnaires.

The issue of integration appeared relatively unimportant when talking to disabled persons on an individual basis. Those individuals who were thoroughly integrated into the life of the community did not appear to have a need on a psychological level for an integrated transportation service; also they did not consider it a matter of principle. For them, access to a car was seen as being more important than access to the Roadcruiser. Where a car was available, many individuals pointed out that they would not use the Roadcruiser at all, with or without a lift. Nevertheless, others said that, even though they drove a car, they would prefer to use the Roadcruiser in winter when driving conditions were bad.

In many cases disabled persons preferred not to travel at all and, when they did, it was for medical trips only. Nevertheless, in one instance the wife of a person in a wheelchair believed it would be good therapy for her husband to travel, at least for short distances, on the Roadcruiser, although she pointed out that her husband was embarrassed by his

Figure 2. Continued.

8. Accessible Roadcruiser:

a roadcruiser bus (or buses) would have a lift installed presumably with wheelchair space and tie down available, as well as modifications to the arm rests.

Please indicate your usage of the current Roadcruiser service together with your anticipated usage of each of the suggested alternative services.

		Type of Bus Service: Current Roadcruiser	Type of Bus Service: Accessible Roadcruiser
Do you use or would you use these bus services?	Yes	☐	☐
	No	☐	☐
If yes; how frequently?			
	Once a week	☐	☐
	More than once a week	☐	☐
	Once a month	☐	☐
	More than once a month	☐	☐
	Once a year	☐	☐
	More than once a year	☐	☐
when?			
	During the week	☐	☐
	On weekends	☐	☐
	Both	☐	☐
where to?			
	St. Johns	☐	☐
	Marystown	☐	☐
	Clarenville	☐	☐
	Gander	☐	☐
	Grand Falls	☐	☐
	Springdale Jct.	☐	☐
	Cornerbrooke	☐	☐
	Stephenville	☐	☐
	Port-aux-Basques	☐	☐
	Elsewhere	☐	☐
Which type of service would you prefer?	None or	☐	☐

10. If you use or would use one of the above types of service please indicate, by checking one or more of the following, the primary purposes of your trips:

- Access to employment ☐
- Medical visits ☐
- Attendance at school ☐
- Shopping ☐
- Recreation ☐
- Other (please specify) _____ ☐

12. Please indicate any further comments, or make any suggestions as to other types of service, which you feel may assist the Inquiry Officers in their consideration of transportation needs for the disabled in Newfoundland.

_____

_____

_____

THANK YOU FOR YOUR COOPERATION

disability. Then again, one mother in Port-aux-Basques said that she believed it would be beneficial for her 12-year-old child to take the bus to Grand Falls. The person in question could board the bus without assistance.

Summary of Views Expressed by Users of an Intercity Charter Bus

Meetings with disabled individuals in Newfoundland did not provide much information on actual users of intercity bus; this is understandable in view of the inaccessibility of the service at the time. Nevertheless, it was considered important to talk to persons who had taken an intercity bus journey in a wheelchair and hear from them their capability to travel long distances in this manner, and any difficulties that may be encountered.

Accordingly, meetings were arranged with users of intercity charter buses in Windsor and Chatham in the province of Ontario. In Chatham the inquiry officers interviewed people who indicated the same diversity of disability as was found in Newfoundland. The diversity in disability gives rise to differences in capacity to endure long-distance travel. One woman with multiple sclerosis said that she could endure no more than 1.5 hr of travel. Nevertheless, what was seen as more important than the length of the journey was the ability of the bus driver to stop when he believed it was necessary, and his capability to judge when to make such stops. This involved, on the part of the operator, flexibility of schedule and, on the part of the driver, a thorough knowledge of, and sensitivity to, the disabilities of the individuals being transported.

The views expressed in Chatham were also borne out by representatives at Leboeuf Ltée., an operator of an intercity charter service exclusively for disabled persons between Montréal and Québec (a distance of 120 miles) and between Montréal and Rivière du Loup (a distance of about 290 miles). All three cities are located in the province of Québec. Leboeuf Ltée. has adapted an intercity bus especially for wheelchair use. There are six spaces for wheelchair tiedowns, an accessible toilet, and a Collins model lift in the back. The experience gained from the Leboeuf operation was that the driver's judgment on when to stop, rather than the number of stops, based on his knowledge of the disability of his clients, was a key factor in the operation of long-distance travel involving disabled persons. It was also pointed out by the driver of the Leboeuf charter bus that the bus had to be stopped every time someone had to use the accessible washroom because of the danger, not to mention the difficulty involved, in manipulating an unrestrained wheelchair on a moving bus.

CONCLUSIONS OF THE INQUIRY

In the first instance it was concluded that, inasmuch as the Roadcruiser service in Newfoundland was an intercity bus service for the general public, and inasmuch as disabled persons form part of the public, there was a duty on the part of Roadcruiser to accommodate disabled persons as far as it was practical to do so. Nevertheless, at the same time it was evident from the information gathered that the demand by disabled persons for travel on a lift-equipped Roadcruiser service would not be large. Although it was estimated that the number of nonambulatory and semiambulatory persons in Newfoundland might be as high as 7,500, this figure did not represent the number of users or potential users of the service. The distribution pattern of nonambulatory and severely ambulatory-impaired persons in Newfoundland is shown in Figure 1. Note from this map that many of the estimated 7,500 live in communities that are not on the Roadcruiser route and would depend on a feeder service, none of which are accessible nor do they conveniently coincide with the Roadcruiser schedule. Many others live in communities that had a local bus service or taxi-van service that was more convenient for both able-bodied and disabled persons. Again, many disabled persons would not use the Roadcruiser because of the nature of their disabilities; many preferred, or were required, to use a car, taxi, or other vehicle.

Given the physical and social environment peculiar to Newfoundland, it was concluded that a lift-equipped bus on the regular Roadcruiser service was not the most appropriate form of intercity transportation service for the disabled. This conclusion went against Recommendation 86 in the report of the Parliamentary Committee. The reasons given in support of this conclusion were as follows.

1. A lift-equipped bus(s) in the Roadcruiser service meant fixed-route accessibility; as the name implies, this means that the service lacks flexibility--an essential ingredient in developing a service for disabled persons. The lack of flexibility relates to schedules, routes, and types of vehicles. This flexibility is needed to determine the travel patterns of disabled persons and the location and possible development of the market. Experiences in the United States with urban mass transit systems were studied in this respect (5-7). Although there are important operational differences between intercity bus and urban systems, there were sufficient similarities to enable the inquiry to gain from the American experiences.
2. The most appropriate means of servicing the principle of integration would be to start with the disabled segment of the population; while developing a service in response to their requirements as to the type of vehicle, scheduling, and route, a service could be built at the same time that would include able-bodied persons.
3. Fixed-route accessibility ignores the wide diversity of disabilities and will not, therefore, provide mobility to a significant portion of the persons for whom the service is intended to benefit.
4. Maximum use of fixed-route accessibility depends, in part, on feeder services that are equally accessible; this is not the case in Newfoundland. Smaller buses with flexible routes and schedules can partly alleviate the problem of inaccessible feeder services. The experiences in the United States with regard to urban transit services supported this finding.
5. The need for intercity travel by disabled persons is more for short distances as opposed to trans-island service.
6. There is no regular-sized intercity bus currently manufactured that has a built-in lift. The installation of a lift on these buses is possible, but it would appear that other vehicles, which are suitable for intercity travel, are more suited to lift installations.
7. Both the smaller coach and the van-type bus appear to be a more appropriate vehicle for developing a service to meet the travel requirements of disabled persons. Both types of buses are suitable for use by able-bodied and disabled persons.

RECOMMENDATIONS OF THE INQUIRY AND CURRENT STATUS OF THEIR IMPLEMENTATION

The inquiry report was submitted to the MVTC in September 1981, and in December 1981 the MVTC issued

Table 1. Cost estimate for the introduction of a new service designed to meet the needs of disabled persons for public transportation.

Item	Cost ($)
Capital and operating cost of buses	
Capital	
1 medium-sized intercity bus (such as the Orion) at $160,000	160,000
3 van-type diesel buses (such as the Transette) at $30,000	90,000
Plus 11 percent provincial sales tax	27,500
Total	277,500
Incremental operating costs	
1 medium-sized intercity bus (such as the Orion)	78,980
3 van-type diesel buses (such as the Transette)	234,920
Total	313,900
Less revenue	
1 medium-sized intercity bus (such as the Orion)	44,000
3 van-type diesel buses (such as the Transette)	58,800
Total	102,800
Net cost of operating the buses	211,100
Net cost of air services[a]	21,800
Annual cost of experiment (less capital cost)	232,900
Total cost of operating experiment for 3 yr [i.e., 3 x 232,900 plus 277,500 (capital cost)]	976,200

Notes: Table gives 1982 cost figures. Data from Eastern Provincial Airways tariff, September 1981; Roadcruiser tariff 1981 (bus costs provided by Roadcruiser).

[a]Calculated on the basis of the regular air fare minus the Roadcruiser fare and 400 trans-island trips per year.

a decision that supported the inquiry recommendations (8).

As a first step, it was recommended that an advisory committee be formed that was made up of representatives from a number of groups, in particular disabled persons (who were potential users of the service), and personnel from CN Roadcruiser. Initially, this committee would investigate the potential for making improvements to the existing Roadcruiser bus, which would make it more accessible to many persons without the installation of a lift. This committee has been formed and is currently considering such modifications as the use of an extra mechanically operated step or a superimposed step to decrease the height of the steps; extra handrails that would be colored; removable armrests on some seats; and finally, for the deaf and visually impaired, flashing lights and mechanically operated rolling signs to clearly indicate and identify stops.

The report pointed out that a service that would appear to meet the terms of Section 3 of the National Transportation Act, which speaks generally of an "economic, efficient, and adequate transportation system making the best use of all available modes of transportation," was the combined use of the air and taxi modes. This service would be available to those persons who are unable, because of their disability, to use the Roadcruiser with manual lifting. Nevertheless, a major drawback to this option was that it did not seek out or develop the market or provide maximum mobility to disabled persons. It was estimated that the maximum cost for this type of operation would be less than $179,000 annually.

Therefore, an alternative recommendation was made that was endorsed by the MVTC. The recommendation was that there be a 3-year experiment to establish and develop the market with respect to disabled travelers through the use of an Orion bus and three smaller lift-equipped vehicles; for cross-island trips, the air mode would be used. Although this recommendation has approval in principle from the federal government, financial assistance is required from the government, and funds have not yet been provided. The capital cost for the experiment was estimated at $277,500, with an annual operating cost of $232,900. A breakdown of the cost estimates is given in Table 1.

OBSERVATIONS

The inquiry attempted to evaluate the option of fixed-route accessibility along with other options in the light of not only the civil rights aspect but also taking into account applicable Canadian legislation and transportation policy as well as the experiences of other countries. In this perspective, fixed-route accessibility was not seen as the most appropriate solution to the situation faced by the population in Newfoundland. Nevertheless, the concept was not discounted as a viable option in other contexts. In other parts of Canada or in other countries, depending on the population distribution, transportation service characteristics, and geographical features of the topography, fixed-route accessibility or some combination or permutation involving fixed-route accessibility may prove to be the more appropriate solution.

The recommendation in the inquiry report about the appointment of an advisory committee to monitor the implementation of the recommendations in the report (i.e., the improvements to the current Roadcruiser service and the experimental service) is seen as a particularly significant aspect of the report on the inquiry and crucial to the success of any service that would be adopted. The adoption of this recommendation and the spirit of cooperation and goodwill present in the meetings that have occurred to date can be considered as a positive step toward the advancement of better transportation service for disabled travelers.

Finally, the inquiry and the report, and its adoption by the MVTC, indicate that the CTC, while acting properly within its functions as a judicial and regulatory body, can play a significant role in the development of policy concerning transportation service for the handicapped.

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Canadian Overview of Technological and Systems Research and Development on Transportation for Disabled Persons

RUTH M. HERON, BARBARA A. SMITH, LING SUEN, AND F.A. ALFIERI

A general view of existing and planned innovations in technology and systems in Canada relating to the transportation of citizens with motor, hearing, sight, speech, or cognitive impairment is presented. Treatment of urban transportation highlights various advances in technology relevant to parallel modes. For example, the award-winning design of a wheelchair-securement/passenger-restraint system is described. Developments related to interurban systems are shown to be comprehensive because they cover problems experienced by special-needs travelers within air, rail, and surface modes, both at terminals and in transit. Canada's less-extensive applications in rural settings are also discussed.

Among the many recommendations made in 1981 by a Special Parliamentary Committee on the Disabled (1), those related to transportation were seen as key factors in guaranteeing the 1 million disabled citizens in Canada the right to independence and life satisfaction. Nevertheless, few people comprehend the enormous difficulties involved in conceptualizing, designing, developing, testing, and implementing the technological and systems innovations required to accomplish the objectives for transportation-disadvantaged persons. Numerous relevant projects had been undertaken before 1981, with the Transportation Development Centre (TDC) of Transport Canada spearheading the effort. Still, the Special Committee's announcements have alerted various government bodies and others concerned with transportation research and development to the need for greater activity in areas that affect the disabled. Hence funds for these purposes have been freed up to some extent, and the move toward new and creative technological and systems approaches to problems of transportation-disadvantaged persons has gained in momentum and coordination.

An overview of the state of the art of transportation for disabled persons in Canada is presented in this paper along with the technological and systems innovations that have already been accomplished and those planned or now in progress. An overall schema of urban, interurban, and rural transportation systems is adopted, and then the various types of subsystems and relevant technological developments are discussed within these three major contexts.

URBAN SYSTEMS

Public Transit

Only one Canadian city, Victoria in British Columbia, has attempted the adaptation of public transit for use by wheelchair occupants. In spring 1979 British Columbia Transit, working with the Capital Regional District, installed wheelchair lifts in four transit buses operating on a fixed route that served an area populated by elderly people (2). Manufactured by Transi-Lift Equipment in Calgary, the lift included several features that provided safety against operator error. Nevertheless, field evaluations, conducted during an 18-month period, were disappointing: equipment breakdowns were frequent after start-up but more importantly initial heavy use of the system eventually declined to zero because of the difficulty wheelchair users experienced in reaching bus stops. As a result, Victoria removed the lifts from the buses and shifted its effort to paratransit modes. This negative experience was scarcely an encouragement to other Canadian cities that were considering integrative transport for the disabled.

Modifications that would render public transport accessible to cognitively impaired persons, ambulatory elderly, and certain other special-need groups are somewhat less formidable than are those necessary to accommodate wheelchair passengers. For example, in the case of cognitive- or speech-impaired individuals, the barrier is largely one of communication and thus can be overcome with technical aid. Cooperating with the National Research Council, TDC is addressing part of the problem in a project that deals with the design and evaluation of remedial technology for cognitively impaired persons.

Apropos of the elderly, it is well known that declining strength impedes efforts of these citizens to mount the high first step on public transit vehicles, to get in and out of seats, to stand when no seat is available, or to ambulate when the vehicle is in motion. A recent report (3) indicates that the Toronto Transit Commission has been active in installing entrance grab bars and extra stanchions on certain seats in their vehicles, and communication with transit commission representatives in Montreal, Calgary, Edmonton, and Vancouver confirms that these major Canadian cities have followed suit. Nevertheless, lowering the first step to a point of easy access by the elderly is associated with engineering difficulties, not only because the suspension is not readily accommodated under the floor of the vehicle, but also because heavy snowfalls so common in Canadian winters interfere with clearance.

Flyer Industries has informed TDC that Toronto has obtained 10 air-conditioned buses with the

kneeling feature, whereby the driver can activate an electronic mechanism that releases air from the bellows and causes the front end of the bus to lower by 15 to 20 cm. W. McDiarmid of the Toronto Transit Commission reports that, after a month of testing on two routes where the population density of the elderly is high, no complaints from either passengers or drivers have been received about the kneeling feature. He adds that soon to be included in the tests is a door-closing delay mechanism that should allow elderly or slow-ambulating passengers to exit without fear of being caught in the door. Toronto's evaluations will determine whether the kneeling feature will be workable in other Canadian cities. Meanwhile, TDC is undertaking a comprehensive and detailed analysis of the problems that the elderly encounter with public transit so that a meaningful and holistic approach to remedially oriented systems and technological research and development can be mapped out.

Parallel Services

As is true in the United States, most cities in Canada have some type of door-to-door transit service in operation (4). In small city centers where demand is low, the service is likely to be provided through private donations from benevolent organizations. In major cities, however, the trend is for the relevant transit authority to take responsibility by either providing the service or contracting it out. Most systems require 1-day advance reservation and do not have the capability to handle on-demand scheduling. Only too familiar are the dispatch snags and snarls that occur as these many-to-many systems attempt to cope with peak loads and cancellations.

Auguring well for improvement in this respect is the success of a computerized dispatcher and driver communication system developed by Canada Systems Group and recently installed by Blue Line Taxi in Ottawa (5). On receiving keyed-in telephone taxi orders, the computer in this system allocates the order to a given district, relays the message to taxis in the area, and displays a one-line message to the driver. The message displays, as well as a small key pad used by the driver for responses, are interfaced through a digital adapter with the standard taxi radio; thus voice communication can be used in emergencies.

Another development of this kind is a TDC study being carried out by the Centre de recherche sur les transports, Université de Montréal, to construct a scheduling and routing algorithm to facilitate dispatching of transit vehicles for the disabled. To date, codified networks in Montreal, Sherbrooke, and Toronto are lacking only the 24-hr demand-responsive part of their respective algorithms. Ottawa will be included among the codified cities by the expected completion date of the project--December 1983.

Technological developments with respect to the vehicles used in these door-to-door systems usually refer to the modification of minibuses or standard vans such as the Ford Econoline or Dodge Maxivan (6). Many companies in Canada undertake modifications, and TDC has also explored the relevant technology in an early project (7). The Datsun 710 subcompact station wagon involved in this project underwent numerous adjustments, principal among them being lowering of the floor, raising of the roof, and provision of an aluminum nonslip ramp. The adapted vehicle is shown in Figure 1. Its evaluation by the Quebec Ministry of Transport revealed maneuverability to be excellent, occupancy per trip to be high, and fuel consumption to be low.

Figure 1. Datsun 710 subcompact station wagon modified by TDC for use by wheelchair passengers.

Figure 2. GSM taxi, which can carry one wheelchair passenger along with three ambulatory passengers.

Nevertheless, none of these modified vans is fully satisfactory in terms of operability, comfort, and safety. As a reaction to this reality, TDC initiated a project in coordination with the Canadian Urban Transit Association (CUTA) to fund the development of a specification and tender document for a prototype vehicle designed especially for the urban transportation of disabled persons (8). The specification guidelines for this vehicle have recently been produced (9). Critical to the concept of the prototype are the requirements that it be a heavy-duty bus with transit-type reliability, have a low floor and kneeling suspension for easy access, be able to accommodate four wheelchair and five seated passengers, be ergonomically suitable for such passengers in all respects, and be equipped with crash-tested wheelchair-securement/passenger-restraint systems.

Although expensive, the taxi does offer the disabled individual one-to-one service, which is often desirable and sometimes necessary. Yet getting the disabled person and the wheelchair in and out of the cab is burdensome for both driver and passenger. A vehicle that offers a solution is Canada's GSM (Guillon, Smith, Marquart) taxi shown in Figure 2. Designed and built by Guillon, Smith, Marquart &

Associates Ltd. with the support of TDC (10), this vehicle can adjust to accommodate either five ambulatory passengers or three ambulatory and one wheelchair passenger and, because of wide doors and a portable ramp, it is easily accessible to wheelchairs. In addition, because it has the same type of suspension, power train, and electrical parts as other automobiles built in North America, the vehicle is suitable for Canadian weather conditions.

Paratransit vehicles are associated with two accessories, i.e., lifts (or ramps) and securement devices, which are of particular technical concern in Canada. Lift manufacturers in Canada must try to find materials and develop mechanisms that guarantee operability during the cold and snowy conditions of winter. One of the most satisfactory lifts is manufactured by Para Industries (1978) Ltd. of Ontario (11). The two models of this lift, the Mark II and Mark III, are adapted for installation in vans with and without steps. Both are of the electrohydraulic platform type, and both have folding handrails, fixed side wheel stops, and an automatic safety flap that also acts as a boarding ramp. The platform is stowed vertically just inside the door of the van, where collected snow has a chance to melt away.

Of the many types of securement devices in use in Canada, one represents a unique technological accomplishment in the field of passenger safety. Designed by Uwe Rutenberg of Les Designers Douglas Ball Inc. of Ste Anne de Bellevue, Quebec, and developed by TDC, this multimodal wheelchair-securement/passenger-restraint system (12) received a Design Canada award in 1982. The unit consists of four modules: a wedge-shaped base, a lower back structure, an upper back structure with adjustable headrest, and an optional seat. The wheelchair is backed into place and secured with restraining arms that pull out telescopically from the base and fasten over the wheel rims. A lap and shoulder belt restrain the passenger. The wheelchair and ambulatory use of the unit are shown in Figures 3a and b. This system emerged from a 47 km/hr barrier crash test without structural damage to either unit or chair, and without disturbance of the position of the anthropometric dummy. These results confirm that the system meets its designer's aim of providing the wheelchair passenger the same level of safety enjoyed by any other passenger riding in a vehicle.

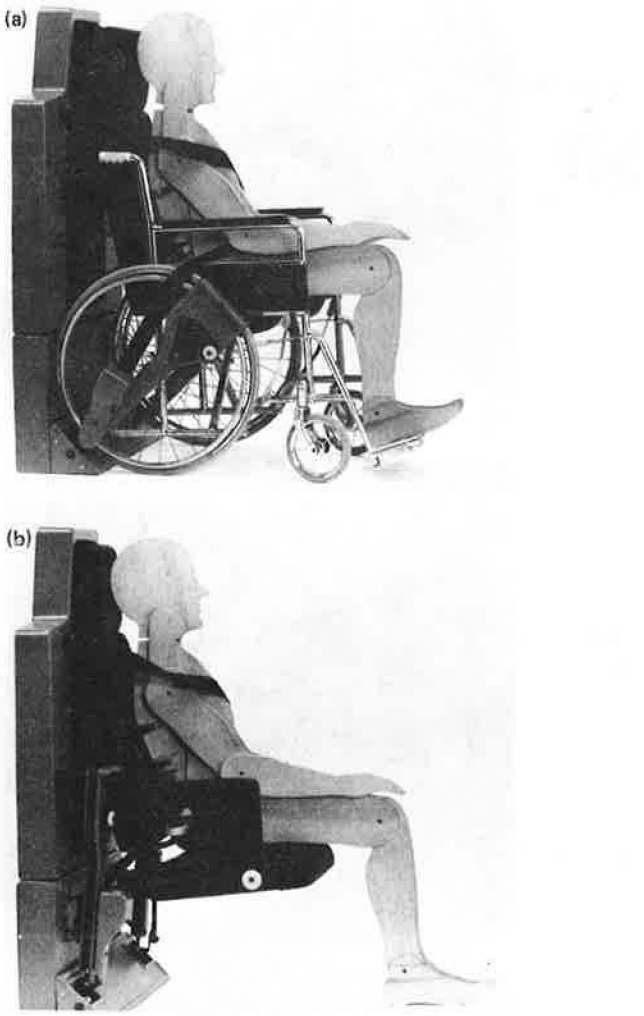
TDC's involvement in the development of the kinds of vehicles and equipment just described has enabled it to play a strong role in creating awareness of the need for relevant standards, and to become a useful representative on the Canadian Standards Association's Committee on Motor Vehicles for Transportation of Physically Disabled Persons. This committee, which is currently in the process of writing standards for relevant vehicles, is addressing issues of crash protection; interior head room; dimensions of ramps, lifts, and doors; type of lighting; and control of temperature and air quality.

In addition, TDC is collaborating with the Roads and Transportation Association of Canada on the contracted preparation of a handbook of guidelines for taxi and paratransit vehicle technology, operation, and regulation. In Ontario legislation enforces regulations with respect to specifications for ramps, lift platforms, securement devices, and other features of paratransit vehicles, which have been set by the Program Development Branch, Transportation Regulation Division, of the Ontario Ministry of Transportation and Communications (13).

Personal Transport

Many disabled people drive their own cars and therefore do not need to avail themselves of either public or parallel transport services. Some of these drivers may, nevertheless, be aided by the hand controls shown in Figure 4. Developed by TDC (14), these controls can be installed in less than 3 min and removed in less than 1 min. This quick installation and release feature makes car rental for urban transport a much greater possibility for disabled drivers than was previously the case. An evaluation of the device, which focuses on user and installer ergonomics, is currently under way.

Figure 3. TDC modular multimodal wheelchair-securement/passenger-restraint system (designed by U. Rutenberg) (a) for the wheelchair passenger and (b) for the ambulatory passenger.



Because of the physically demanding and awkward nature of the operations of stowing the wheelchair and retrieving it from the vehicle, many wheelchair drivers would be well accommodated by a car such as the British Elswick Special Vehicle (15), which allows the individual to enter the car in the wheelchair and remain there while driving. The possibility of bringing this vehicle into Canada is being considered, but the outcome will rest on whether it complies with standards and regulations for all new vehicles in Canada, as set by the Road and Motor Vehicle Traffic Safety Branch of Transport Canada. In any case, some thought (albeit embryonic) is being given as well to the possibility of developing such a vehicle in Canada. Also in the germinal stage is consideration of the development of a car

Figure 4. TDC quick-release car hand controls.

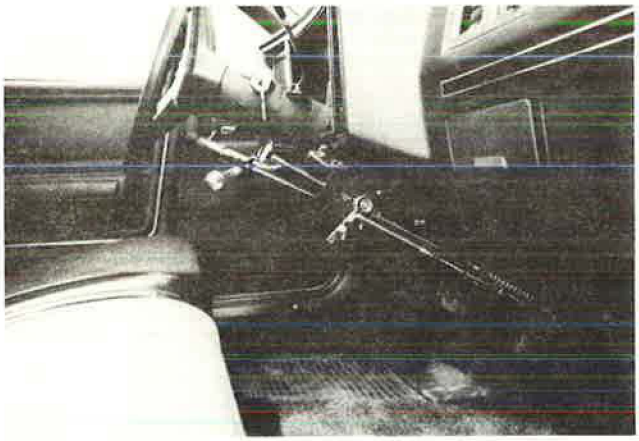
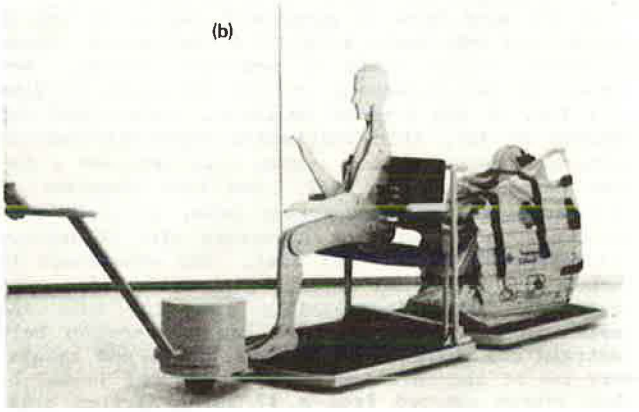


Figure 5. Curb-climbing electric wheelchair.

Figure 6. TDC modular transfer vehicle for use in terminals (a) for the wheelchair traveler and (b) for the ambulatory passenger, with second platform for luggage.



specially designed for elderly drivers. Easy entry and operability, in addition to expanded scanning capacity, would be desirable features of such a vehicle.

An estimated 5.6 percent of disabled people in Canada depend on the conventional wheelchair for mobility. Wheelchair occupants who use their wheelchairs to move about in small communities or in recreational areas commonly face barriers such as curbs, steep slopes, and rough terrain. An electric wheelchair, developed for TDC by Les Designers Douglas Ball, Inc. with a view to eliminating barriers of this kind, is shown in Figure 5. Notable here is the unique twin rear-axle feature, which provides the curb-climbing ability along with good traction and stability (16).

INTERURBAN SYSTEMS

Terminals

Intercity travel is often denied or made onerous for certain members of society because of various obstacles encountered at rail, air, and ferry terminals. To cover this aspect of technology and systems in its program on transportation for disabled persons, TDC has initiated a number of projects. For example, the possibility has been examined of developing communication technology that would have applications for speech-, sight-, and hearing-impaired individuals in terminals and in vehicles during transit (17). Deliberation will take account of results of a study designed to identify the human factors associated with use of various existing telecommunication aids and to generate new concepts in areas where further development is needed. Heretofore the only step toward accommodating this type of need in Canada has been the provision of safety information in Braille aboard Nordair aircraft (18). Another TDC project calls in part for preparation of terminal design guidelines to facilitate the handling of passengers with special needs (19). This work plan includes development of a conceptual design for a modular transfer vehicle for use by such travelers in various types of terminals (20). Preliminary versions of the vehicle are shown in Figures 6a and b.

The airports in Ottawa and Halifax are equipped with inclined stairway-mounted wheelchair elevating devices that overcome the problems of grade changes in transporting wheelchair travelers to the loading bridge. Two of these devices have recently been installed in the Kingston, Ontario, railway station. With cooperation from VIA Rail, TDC is now conducting ergonomic evaluations of all these lifts, the results of which will permit recommendations to be made with respect to possible use at other terminals. Apart from this effort, VIA Rail has developed an extensive program for making its major stations accessible in every way to disabled travelers (21).

Air Travel

Among the airlines in Canada, Air Canada appears to have been most active in developing and implementing technological change. W. Reeves of Air Canada reports that, in seeking a replacement for the awkward and uncomfortable Washington chair, the company has recently completed evaluation of a number of alternative passenger-loading models, namely, the Manten, Tark, Stowaway, and Wilshire Air Chair. The Wilshire Air Chair, shown in Figure 7, clearly outperformed the other models in terms of maneuverability, stowability, and other features. Its availability on request for all medium to long-range flights will aid disabled passengers because it permits them to be wheeled to the on-board washroom. According to R. Calhoun of Air Canada, the nonstowable Manten will be used for boarding to the seat.

W. Reeves also mentioned other features designed to facilitate travel by the disabled. All DC9 aircraft, for example, have removable armrests to permit easy transfer from wheelchair to seat. The airline's new Boeing 767s, six of which will be in operation by the end of 1983 and 12 by the end of 1984, will have removable armrests and special washroom facilities for disabled persons.

Air travelers in wheelchairs are frequently concerned about the condition of their chairs on arrival at destination and, if the chair is electric, about getting the wet-cell batteries transported. These concerns have been approached by TDC and some of the airlines. For example, the reusable reinforced-canvas container shown in Figure 8, which was developed by Davis Engineering under TDC sponsorship (22), was subjected to field tests by Air Canada and Canadian Pacific Air. The unique feature of this container is the light tubular stiffener ribs: on the one hand they allow easy entry and removal of the chair; more importantly, though, because the tightened sac fits snugly against all faces of the chair, the flex and spring properties of the ribs enable them to absorb shock from lateral roll maneuvers that otherwise would be transmitted to the chair.

A number of alternatives for handling wet-cell batteries were considered recently by TDC, the aim being to arrive at a packaging system that would not limit electric wheelchair occupants to riding only in the larger planes, which can accommodate the Air Transport Association's regulation that the chair be loaded upright in the cargo hold with the depowered battery secured to the battery tray. The packaging kit shown in Figure 9, developed by Air Canada (23) and approved by Transport Canada, will likely provide the solution for transporting wet-cell batteries for all airlines.

Rail Travel

Much has been accomplished in Canada through TDC's cooperative relationship with VIA Rail, which at an early date had indicated its interest in making its services and facilities available to transportation-disadvantaged persons. The testing of the stairway-mounted wheelchair lift has already been mentioned.

An earlier project involved the design of a coach to be included in the makeup of VIA's new LRC (light, rapid, comfortable) train and to be suitable in all respects for wheelchair passengers (24). This coach currently contains a widened entry space, an accessible washroom with well-placed grab bars, a wheelchair station, and a passenger chair with removable armrest for easy transfer from wheelchairs. The wheelchair station was designed to house a restraint system that was developed by TDC and is, actually, the forerunner of the multimodal model (25). When installed against the bulkhead and fas-

Figure 8. Reusable reinforced-canvas wheelchair container.

Figure 7. Wilshire Air Chair used by Air Canada on medium- to long-range flights.

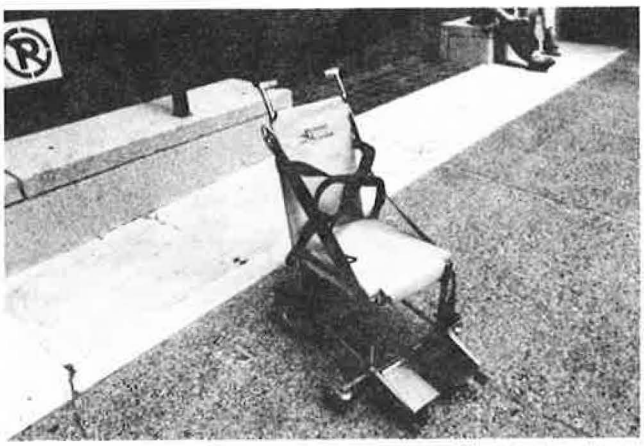
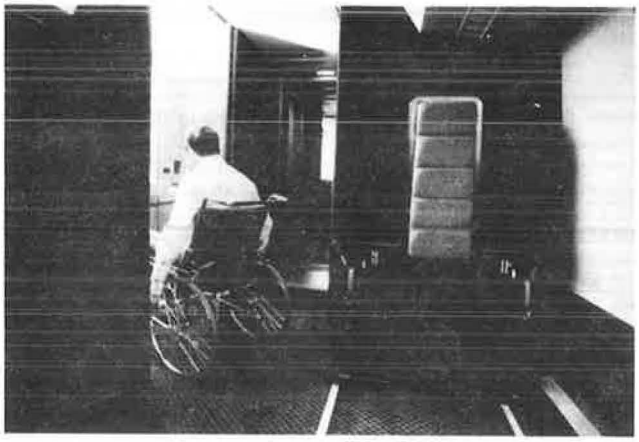


Figure 9. Air Canada wet-cell battery packaging kit.

Figure 10. TDC rail wheelchair securement system and accessible washroom on VIA Rail's LRC train.



tened to the floor, the unit secures the wheelchair by means of telescoping arms that pull out at an angle of 45° to the floor. Ergonomic evaluation proved the system to be fully operable by paraplegics. A view of the VIA Rail installations is shown in Figure 10.

Intercity Bus Travel

Recognizing that the intercity bus could represent an inexpensive and pleasurable means of travel for many Canadians in wheelchairs, the Special Parliamentary Committee on the Disabled recommended in 1981 that bus services under federal jurisdiction make their vehicles accessible to wheelchair passengers. Only one service is under federal jurisdiction--the Newfoundland CN Roadcruiser service; it objected to the recommended action on cost/benefit grounds.

For the subsequent inquiry held by the Canadian Transport Commission, TDC was asked by Transport Canada to provide a design for an accessible Roadcruiser bus. The resulting TDC project included consideration of general, technical, and safety requirements, particularly those related to lift and securement devices (26). Installation layouts and drawings clearly demonstrated the feasibility of modifications that would render the CN Roadcruiser fully accessible to passengers in wheelchairs. Nevertheless, the Canadian Transport Commission's ruling was that the implementation of the Parliamentary Committee's recommendation for an accessible fixed-route bus was unwarranted at this time because of the lack not only of accessible feeder services but also of flexibility of fixed-route services of the kind needed to accommodate the disabled (27). The Commission recommended (a) the use of smaller buses on a flexible schedule and route, phased in to correspond with market build-up; and (b) interim subsidies, amounting to the difference between bus and air fare, for wheelchair travelers making cross-island trips.

Other Intercity Travel Modes

It is true that the vehicles mentioned in the section on urban systems--the CUTA vehicle, the GSM taxi, and personal cars--also can be used for interurban transportation of disabled persons. A type of vehicle whose application is more distinctly for intercity travel is one conceived of as suitable for people living in institutions, or for others for whom outings are likely to be in groups and of a longer-haul recreational nature. Typical trips might be educational jaunts, camping excursions, shrine visits, and so on. As the travelers in these cases may be severely disabled, with some perhaps on stretchers, a suitable vehicle would require special loading, suspension, housing, and other features.

Somewhat similar in concept are the Van Hool articulated bus, which accommodates 12 stretchers along with seated passengers, and the Swedish Volvo mobile hospital vehicle. The aim of a current TDC project is to arrive at a full set of technological specifications for a vehicle of this genre that would be suitable for Canadian use; subsequently, and depending on the feasibility, prototype development may be undertaken.

Informational Requisites

The Canadian thrust toward technological and systems development with respect to interurban travel has not been without recognition of the need for complementary information by those either providing or receiving services. Transport Canada, for example, has published a resource handbook instructing transportation personnel on recognizing, understanding, and assisting travelers with disabilities (28). Moreover, responding to the need for attitudinal and procedural change, airlines such as Air Canada, Nordair, and Canadian Pacific Air either have or are considering audiovisual and practical training programs for their personnel (29). VIA Rail also has such a program in place.

For the travelers, TDC has prepared a national transportation guide that not only includes the floor plans of major Canadian terminals but also describes facilities, policies, and procedures of the railway, airlines, ferry operators, and bus companies (30). To date 10,000 copies of the guide have been distributed, the recipients comprising providers of service as well as disabled travelers. To complement this effort, TDC is currently compiling a compendium of boarding and on-board equipment for the disabled at air terminals around the world.

RURAL AND SMALL-CITY SYSTEMS

Taxi-Bus Concept

In Canada questions regarding special technology and systems for rural transportation of disabled persons have been given less attention than have those posed with similar orientation in urban and interurban contexts. Yet transportation problems exist in rural areas for all citizens, not just disabled persons. Travel within a small community is restricted because fixed-route bus systems are likely to be either absent or inadequate, thus forcing individuals to depend on either taxis or personal cars. A partial solution may lie in the taxi-bus concept implemented in the Battlefords, Saskatchewan (31).

Mobility-Club Concept

An intracommunity transportation alternative for the disabled is the mobility club, the concept for which calls for enlistment of services of volunteer drivers with access to private cars and, through centralized coordination, matching of driver trips with potential users. An exploratory mobility-club project was initiated in 1978 in Huron County, Ontario, with the aim of developing and testing the rural application of the concept (32).

During the 17-month project period attempts to create a centralized operation were unsuccessful. Nevertheless, about five individual mobility clubs related to specific local activities were spontaneously organized by small groups. Thus, although in one sense the project failed, it did provide an excellent opportunity to draw conclusions on the nature of transportation problems in rural areas, as well as on the potential of volunteer driver systems for meeting transportation requirements. The lesson learned is that the rural development process is one that is slow and strongly resistant to efforts of an external agent to impose schedules and deadlines for a demonstration project; moreover, to be workable the concept must be applied with an activity- or group-specific orientation rather than with one that uses a centralized dispatching agency.

External Travel

Options for travel outside small Canadian communities have been reduced because, for economic reasons, VIA Rail has withdrawn its services from such areas (33), thus leaving residents wholly dependent on buses. Although an appropriate lift represents a solution for wheelchair passengers in those cases in which both origin and destination have terminals, such is not the case when the town or village bus stop is merely some point on the highway. This difficulty appears to be beyond the range of means available to the transportation technologist and is instead within the realm of social application.

SUMMARY

On balance, Canada has taken many creative approaches to the multifaceted issue of how the rights of its disabled citizens to full transportation service can be satisfied through changes in technology and systems. As a consequence, numerous innovative devices and concepts have been developed and implemented within urban, interurban, and rural and small-city systems throughout the country. Moreover, the Special Parliamentary Committee's 1981 recommendations have produced an upsurge in relevant research and development.

Supplementing these efforts are various other efforts meant to address the informational needs of both transportation personnel and disabled travelers. In the first case, the aim has been to recognize the need for attitudinal and procedural changes; in the second, it has been to broaden the traveling scope of disabled persons through knowledge of the policies and procedures adopted by the various carriers, and of the facilities available to disabled persons.

While taking pride in these endeavours and achievements, Canada remains aware of the extent of work to be done before disabled persons can enjoy all the advantages that innovative transportation technology and systems can afford them.

ACKNOWLEDGMENT

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Transportation Service for the Physically Handicapped in Toronto—Its Structure and the Integration of Computer Aids

FRANK J. AHLIN, ROBERTO STOPNICKI, AND JAMES H. BOOKBINDER

The structure of Wheel-Trans—the Metropolitan Toronto transportation system for the physically handicapped—and the future operating options under consideration for Toronto are discussed, and the design and implementation process of a computer-aided reservation, scheduling, and dispatching system is reviewed. The growth of the service from 8 vehicles to 53 vans and 21 taxis during the past 7 years has created changes in the current operation to accommodate an increasing demand for service. Examples of these changes are the takeover by the Toronto Transit Commission of the reservation, scheduling, and dispatching functions from a private contractor; the investigation of new procedures such as demand-responsive systems; and the use of smaller vehicles. The increasing demand for service has resulted in a growing number of trip requests that need to be processed and an increased number of opportunities for misplacement of orders and generation of errors. The computer system is being implemented to improve the efficiency of control-office tasks and to provide a high level of service to the users.

In fall 1972 the Council of Metropolitan Toronto adopted a recommendation to establish a Technical Committee on Transportation of the Physically Handicapped to plan and implement a system to provide public transportation for the handicapped, who as a group was estimated at that time to constitute about 7 percent of the municipality's population of more than 2 million people spread over an area of 244 miles^2. About 20 percent of the handicapped were estimated to fulfill the eligibility criteria for the system.

The subsequent implementation of a pilot project was preceded by considerable controversy and debate on the type of public transportation that should be provided to the physically handicapped community of Metropolitan Toronto. Following this debate, the governments of the province of Ontario and Metropolitan Toronto and the Toronto Transit Commission (TTC) decided to support a parallel paratransit system rather than a fully accessible public transit system.

The commitment to such a policy was recently reinforced by two major events: (a) the rejection by the TTC of a proposal to provide fully accessible stations in the newest section of Toronto's rapid transit system (an intermediate capacity transit system operating on a 4.4-mile elevated guideway), and (b) the Metropolitan Council's decision to accept the TTC recommendation to take over the reservation, scheduling, and dispatching functions of Wheel-Trans from a private operator to improve the reliability of the service.

SERVICE HISTORY

On February 3, 1975, Wheel-Trans phase 1 was initiated in Metropolitan Toronto; it provided 46 users with a transportation service for work-oriented trips. The 2-year pilot project consisted of eight

vans operating during the morning and afternoon peak hours, Monday through Friday.

The TTC was responsible for the administration of the service, which was operated under contract by a private operator. Financial assistance for the operating deficits of the project were shared on an equal basis by the province of Ontario and Metropolitan Toronto. The success of the pilot project and the enthusiasm with which it was received by the handicapped community led to the decisions to continue the service and that major expansions to the service operation be incorporated.

In February 1977 Wheel-Trans phase 2 was initiated. The service consisted of 12 vehicles operating 12 hr per day, Monday through Friday. In addition to subscription work-oriented trips, service was introduced for nonsubscription trips for shopping, medical, and social purposes. The operating and financial arrangements of phase 1 were continued.

In anticipation of the commencement of phase 2 of the project, an advisory committee was established to assist the TTC with project evaluation and policy decisions. The committee consisted of representatives of the provincial government, various agencies representing the handicapped community, and the TTC. In addition, an eligibility subcommittee was formed, which consisted of representatives from the TTC, the physically handicapped community, and Public Health (who determined the eligibility of applicants for the service). The main criterion governing the decisions of the eligibility subcommittee was, and still is, the inability of the applicant to board regular transit vehicles.

A successful experiment with the use of taxicabs was initiated in August 1978, in which some ambulatory subscription riders were accommodated in taxis under contract to the TCC. The decision to establish the permanent service followed the provincial commitment to share the operating costs on a permanent basis.

EXISTING SERVICE

The permanent Wheel-Trans service commenced operations in November 1979 with an expanded fleet of 27 vehicles operated by a private contractor under a 3-year contract. The basic operating procedures and financial agreements under which the pilot project was administered and operated were maintained, with the exception of the nonsubscription fare, which was reduced to the equivalent of a single regular transit adult fare.

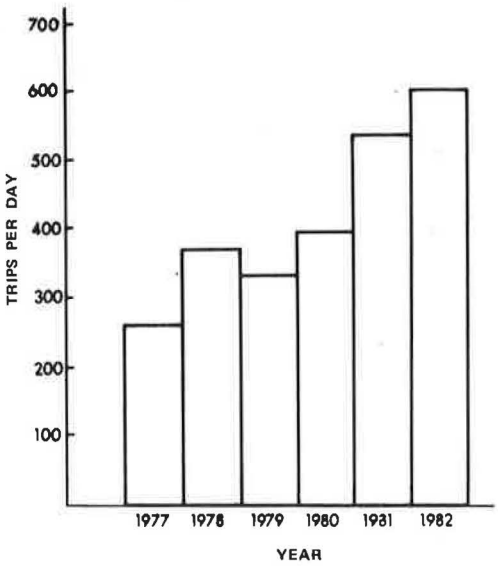
The major change from the pilot project occurred in the Wheel-Trans organization, in which the advisory committee, under its new mandate, took a more direct role in the decision-making process for the operation of the service and in reporting to the transportation committee of the Metropolitan Council. The advisory committee comprises representatives of various metropolitan departments, the TTC, and handicapped representatives from the six municipalities that form the metropolitan area. Three subcommittees were later formed to assist in the activities of the advisory committee: budget subcommittee, long-range planning subcommittee, and community relations subcommittee.

Operating Characteristics

Wheel-Trans offers four types of service.

1. Subscription: The subscription service is available for passengers traveling round trip between the same two points at the same time for at least 4 weekdays; typically these are work-oriented trips. The subscription routes are scheduled by the TTC and forwarded to the contractor. These trips are guaranteed, and the passenger does not have to book or confirm the trips on a regular basis. Taxicabs are also used on subscription routes for ambulatory passengers on a separate contract. Subscription riders buy a pass from the TTC equivalent to the number of monthly rides.
2. Prebook: Prebook services are similar to the subscription service for trips undertaken at least once a week. These trips are not guaranteed and are scheduled by the contractor on the basis of space availability.
3. Reservation: Reservation services are nonsubscription trips that can be reserved up to 7 days in advance. The trip reservation and confirmation occurs strictly between the private operator and the passenger.
4. Demand-responsive service: Demand-responsive service, which gives passengers the opportunity of requesting a ride on a short-notice (i.e., same-day) basis, is provided to Wheel-Trans users. However, because of the high demand for the service, the probability of obtaining a demand-responsive ride is low.

Figure 1. Average daily ridership.



On a typical weekday about 40 percent of the rides taken by Wheel-Trans users are subscription related, which requires that more than 50 percent of the mini-bus fleet be used for subscription service during peak hours. In addition, 20 taxicab routes are active for ambulatory subscription riders. The growth of daily average ridership is shown in Figure 1. The service operates on a first-come, first-served basis, and no trip priorities are allowed for reservation or scheduling purposes.

Vehicle Characteristics

The vehicles used in the service are Thomas Might-Mite mini-buses configured to accommodate five wheelchair and five seated positions. In addition to the buses, Wheel-Trans operates two station wagons to transport ambulatory and nonambulatory passengers who can transfer from a wheelchair to the vehicle without difficulty. All vehicles are linked by two-way radio to a central dispatch facility.

Figure 2. Vehicles in service during an average weekday.

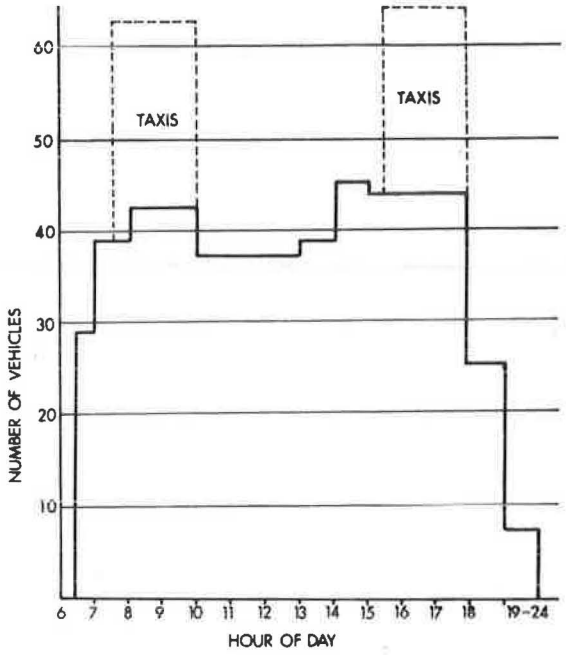


Figure 3. Cost deficit per trip.

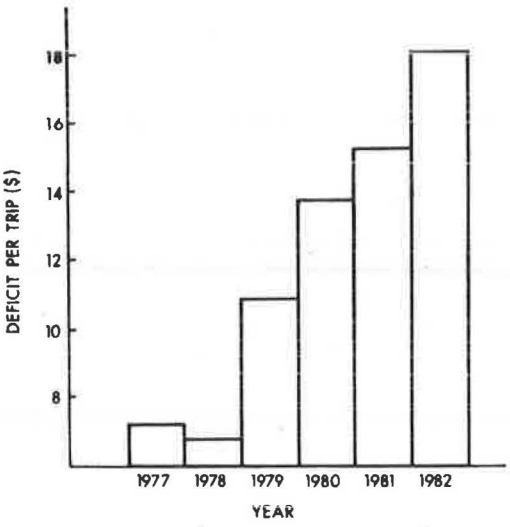
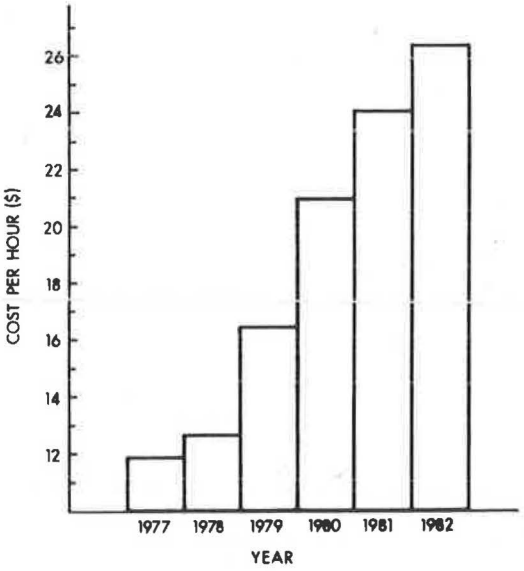


Figure 4. Average costs per vehicle hour.



Ridership Characteristics

On an average weekday in 1982 about 800 trips were carried on the bus service from 6:30 a.m. to 12:00 midnight, and about 180 trips were scheduled on the taxi service. On a typical weekend day about 250 users are carried from 9:00 a.m. to 12:00 midnight. Holiday service is also provided from 9:00 a.m. to 12:00 midnight and between 150 and 200 users a day are carried. The number of vehicles in operation during a typical weekday is shown in Figure 2.

A significant problem for the system has been the overall trip-cancellation and no-show rate of about 20 percent per month. This factor introduces an inefficiency in the system that is difficult to overcome because of the lead time required to schedule the daily routes. For example, the service currently rejects an average of 25 daily reservations and 25 daily demand-responsive bookings and, in addition, an average of about 65 people are on the subscription service waiting list. The resulting service productivity translates to an overall ratio of 1.5 riders per van hour and 2.0 riders per taxicab hour.

Funding Arrangements

The Wheel-Trans service is funded jointly by the province of Ontario through the Ministry of Transportation and Communications and by the Municipality of Metropolitan Toronto. The provincial government provides a subsidy equal to 50 percent of the total operating and capital costs, subject to a per capita ceiling based on the metropolitan population. Metropolitan Toronto funds the remaining 50 percent of the costs, less revenue from subscription service. The annual increase in costs per passenger trip and per vehicle hour are shown in Figures 3 and 4, respectively. It should be noted that revenues from nonsubscription users remain with the contractor as an incentive to increase the productivity of this segment of the service.

User Attitudes

Several surveys of Wheel-Trans users have indicated that the general attitude toward most aspects of the service is favorable. Complaints about the service have highlighted the need for improvement in the reservation, scheduling, and dispatching functions, and an increase in the amount of service provided.

PLANNING FOR THE FUTURE

The advisory committee has accepted a recommendation of the budget subcommittee to expand the service in increments to reach a mature state by 1986, according to the schedule given in Table 1, to accommodate the anticipated doubling of trips per week from the current 4,000 to 8,000.

A system evaluation study conducted in 1981 determined that the door-to-door service currently operated for nonambulatory persons is the only real option for that segment of Wheel-Trans users. Sev-

Table 1. Wheel-Trans service growth forecast.

Year	Bus Ridership	No. of Peak-Period Vehicles: Buses	No. of Peak-Period Vehicles: Taxis	Total Budget ($000,000s)
1982	250,000	53	21	4.8
1983	300,000	62	24	7.4
1984	350,000	71	28	9.3
1985	390,000	80	32	11.6
1986	430,000	85	34	14.1

eral alternatives were proposed for this service, such as the introduction of smaller vehicles, the operation of the service on a zone system, and the introduction of a reliable demand-responsive system.

The concept of a zone system was discarded because of the difficulty of establishing zone boundaries that would conform to the thinly dispersed pattern, in terms of geography and time, of trip origins and destinations.

The study recommended that the long-term goal toward which the service for nonambulatory persons should be directed would consist of a door-to-door demand-responsive service that operated predominantly smaller vehicles that had a capacity of four to five wheelchairs.

Various service options were considered for ambulatory users, such as a single-ride taxi, a shared-ride taxi serving only Wheel-Trans ambulatory passengers or sharing with the public at large, the inclusion of ambulatory users in areawide carpool and vanpool programs, and the establishment of policies that would encourage self-drive vehicles. Some of these options would require some form of legislative changes to either the licensing laws or the subsidy agreements under which the taxi industry or Wheel-Trans operate.

Further, in anticipation of the expiration of the existing Wheel-Trans contract in October 1983, the TTC reviewed the future operating alternatives of Wheel-Trans, which included full integration with the TTC, partial integration with the TTC, or continuation of a private-sector operation.

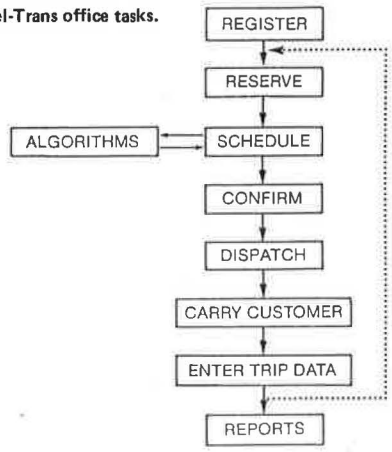
The partial integration of the service with the TTC was recommended and later approved by the Metropolitan Council. Under this alternative the TTC will take over the reservation, scheduling, and dispatching functions of the service. A more structured organization such as the TTC would provide better control of the areas that generate the most complaints, although the drivers and vehicles would still be operated by a private contractor.

INTEGRATION OF COMPUTER AIDS

There has been a constant increase in demand for Wheel-Trans service and in the size of the vehicle fleet. It is envisioned that during the next 4 years the demand will double, with a corresponding requirement for the doubling of the vehicle fleet. Accommodation of the extra order processing and an increase in the information flow will require additional office staff. Retention of the existing manual office procedures during this period of growth would be labor intensive and would also result in more staff errors because of the increased work load. It is expected that the implementation of the computer-aided system will provide a higher quality of service to the user through the reduction of errors and a more rapid processing of requests (1,2).

The system will accomplish these improvements by assisting the staff in performing various Wheel-Trans administrative functions, such as order taking, cancellation processing, handling of inquiries, production of schedule and driver run sheets, and recordkeeping.

Figure 5. Wheel-Trans office tasks.



Currently, the majority of the control-office staff work in the bus contractor's office. This staff is responsible for the processing of the prebook, reservation, and demand-responsive trips and the day-to-day operation of the mini-bus fleet. As an indication of the work load involved, there are 13 telephone operators, 6 schedulers, and 2 dispatchers on duty at the contractor's office during peak periods. The TTC employs two clerks and two schedulers to process the subscription trips. In addition, the taxi contractor handles the day-to-day operation of the peak-hour taxi service through his regular dispatcher. A simplified view of the sequential tasks carried out by the Wheel-Trans control office is shown in Figure 5.

Computer System Design Issues

The use of the computer is envisioned to be implemented in two phases (3). The first phase is to duplicate the current information flow and office tasks, but replace the current paper transfer and storage with the computer as the flow manager and storage medium. The computer has the advantage of quicker transfer of information, quicker retrieval of stored information, the ability to obtain information under a variety of keys, standardization of office procedures, elimination of transcription of written data, a decrease in the loss of orders, and a reduction in errors. There would be no attempt in the first phase to use the computer to accomplish any decision-making tasks; it would be used only for straightforward data processing tasks.

The second phase of the computerized information system, if implemented, would involve the expansion of the software to include automating some of the scheduling and decision-making tasks. Two tasks that are being considered are (a) determining the optimum number of vehicles and the hours of the vehicle runs to satisfy fluctuations in anticipated demand, and (b) scheduling requested trips onto the appropriate vehicles in the most effective manner.

The latter task is one that has been discussed and worked on by various researchers; one program--the Massachusetts Institute of Technology (MIT)/UMTA dial-a-ride package (4)--has been written and operationally tested. Nevertheless, this package has some deficiencies, and further work is required before it could be implemented for Wheel-Trans operations. There are currently also several research

efforts occurring to develop advanced-reservation scheduling algorithms (5-8), but further operational testing is required.

The first phase of the computer system, which in its design will incorporate expansion interfaces for the second phase, is described in this paper.

To give a brief perspective into the future environment that the Wheel-Trans computer system will be expected to operate, following are some of the issues that the computer system is being designed to accommodate:

1. Rider issues--(a) expansion to increase system capacity (proposal to double the current size of the vehicle fleet by 1986), and (b) reduction of time between request for service and actual delivery of service; and
2. Provider issues--(a) reduction in the cancellation rate, (b) improved productivity (passengers per hour), (c) possible increased use of shared-ride taxis to reduce costs and provide more flexible service, (d) possible operation of the mini-bus service by the TTC, (e) provision of control-office functions at efficient staffing levels, (f) minimization of misplaced orders and errors, and (g) good human factors interface.

Because the introduction of the management information system will have its most noticeable impact in the control office in which it is used, the system is being designed with the needs of the office staff in the forefront. The benefits that are derived by this group of personnel by having quicker access and more accurate and timely information will be extremely helpful in providing a higher level of service to customers. For the schedulers and dispatchers, the display of information in other formats and the provision of automatic sorting features should reduce the amount of information they have to consider. This would allow for a quicker production of schedules or the provision of additional time to optimize a schedule. In addition, the reports generated by the information system will prove valuable to managers and administrators who must make service-level and operational decisions.

A typical weekday distribution of trips delivered (by service category) is 47 percent subscription, 14 percent prebook, 37 percent reservation, and 2 percent demand-responsive service. Note that a major characteristic of the current Wheel-Trans system is that 98 percent of the delivered trips are scheduled by, at the latest, the day before the trip is required.

These figures provide an insight toward the impacts of implementing a possible policy of increased demand-responsive trips if the scheduling task can be reduced in time and staffing. Nevertheless, implementing a policy of demand-responsive scheduling also requires that additional vehicle resources be available to satisfy all trip requests, because clients would not have sufficient time to arrange for alternate transportation if they cannot be accommodated. The computer system is being designed from the outset to accommodate such a policy change.

Tasks

There are several types of tasks performed in the control office of the Wheel-Trans transportation system for the disabled. These tasks are performed by clerks, telephone operators, schedulers, dispatchers, and supervisors. These tasks or portions of the tasks are also currently split between three agencies: the TTC, the bus contractor, and the taxi contractor. This leads to a slightly more complex communications and coordinating structure than would otherwise be entailed if all functions were under the control of one organization.

The reservation, scheduling, confirmation, and to some extent the dispatching functions can be further broken down by the four trip-type categories: subscription, prebook, reservation, and demand-responsive service. The various trip categories allow a layered scheduling process to occur. In the case of a subscription or a prebook trip, there is a greater guarantee of service to the customer.

A number of common tasks exist in the dispatching environment of any shared-ride paratransit system. Several other items peculiar to transportation systems for the disabled, such as registration requirements and the wide range of handicaps, add an extra element of complexity to operating a door-to-door transportation system. Generally, though, the set of tasks that exist in the operation of transportation systems for disabled persons is common to all shared-ride paratransit systems.

These tasks are generally all processed in a sequential order. What does vary among the transportation systems for handicapped persons in various cities is the type and number of personnel who perform the various tasks and the time frame in which the various tasks are performed. The computer system is being designed to provide this flexibility.

Because the current control-office operation can be separated among the TTC, the bus operation, and the taxi operation, there exists a need for timely and accurate transfer of information between the various locations. The computer system is considered an ideal medium for coordinating the actions taken by staff at these locations.

Although the majority of the information-processing tasks are fairly straightforward information retrieval and storage tasks, two of the tasks--scheduling and dispatching--are crucial to the operation of any paratransit transportation system. The personnel involved in these two tasks have the difficult jobs of either efficiently allocating a large number of trips or of monitoring the real-time delivery of passengers by the vehicles and drivers. The adequacy with which the system is designed around these two tasks determines the successful implementation of the computer system.

The key to achieving high productivity in the Wheel-Trans shared-ride service is the ability to shift clients' desired pickup and delivery times within an allowable 1.5-hr time window to allow grouping with other fares. Scheduling is currently based on a combination of efficiency (i.e., accommodating the maximum number of riders within a fixed system capacity) and also first scheduling those who called earliest.

An example of another type of operation that the computer system is being designed to accommodate is a demand-responsive format with a strict first-come, first-served priority. Only a certain number of trips are accepted by the reservationist for each vehicle hour of service. Once this limit is reached, the trips are scheduled and new trips are rejected, or the client must choose an alternate time. Because there is no preselection of trips, demand-responsive systems have lower levels of productivity and must generally have adequate resources to service all the trips because people do not have time to arrange for alternative means of transportation.

Examples of two basic methodologies to display scheduling information in a paratransit operation are described in the following sections. Which system is used usually depends on the complexity of the scheduling task.

Scheduling Board

The scheduling board is one of the most common methods used to display information in shared-ride systems with advanced reservations. The board can be a physical board with slots to insert cards that contain information on trip origins and destinations, or it can be (as it is in the Wheel-Trans control office) a large sheet of paper in which information is transcribed from the call slips onto the large scheduling sheets.

In the Wheel-Trans office a 3 x 4-ft schedule will contain 144 rows, with each row representing 5-min intervals and 16 columns representing the vehicle runs. Thus four of these sheets are currently required to display all the vehicle runs during the peak periods. The scheduling process is initially one of standing back and assigning grouped rides to the free spaces on the scheduling board. The scheduler can determine the location of a vehicle by moving in closer to the board and subsequently reading the addresses or the geographic coordinates.

It is difficult to display on a computer terminal the large amount of information that is currently displayed on the paper schedules. Thus various methods of displaying these data by computer will be tested. Some procedures to display information would include the use of several terminals, the use of sorting procedures to allow the scheduler to quickly window-in on a particular schedule, or the continuation of the use of paper schedules and the generation of gummed labels for manual insertion onto paper schedules.

Map Display

The second major method of displaying information is by a map of the service area. Such a method is generally used in exclusive-ride demand-responsive systems.

Although such a display is excellent in determining spatial patterns, it is generally deficient in that it cannot display the time element that the scheduling board contains. For this reason, the use of such a display has generally been relegated to demand-responsive taxi and courier systems where pickup and delivery times are not generally of primary consideration. Nevertheless, such a display is beneficial to the dispatcher in determining the location of vehicles in real time.

Such a display also has potential for displaying the desire lines of trips. In the same way that a scheduler currently presorts trip requests by time, a mapping feature could be used to sort the trips by spatial distribution to indicate how the requested pickup times might be adjusted. The mapping display would use the coordinate information obtained from street address files to display desired trips to the scheduler.

Note that the phase 1 scheduling aids previously described do not involve any decision-making processes by the computer, but consist of displaying preorganized information to the scheduling staff. The development of sophisticated displays of information to the schedulers in this first phase is an important prerequisite to the second phase. This will avoid a common complaint of the previous work on automated scheduling that the algorithms appeared to be black-boxes from which it was difficult to determine their intermediate processes, sensitivity, and final results.

Expansion

Although not part of the first phase of this project, several options have been proposed as part of a possible phase 2 expansion program. These expansions can be categorized as two basic types: software and hardware expansions. The software expansions would be accommodated in the hardware acquired in phase 1. On the other hand, the hardware options involve additional specialized hardware devices that interface with devices outside the control office and generally have a high cost element associated with them.

The current software options consist of improving the precision of the location coordinate file and implementing both advanced-reservation and demand-responsive-type scheduling algorithms. This would allow the scheduler to predefine service standards and determine the most efficient number of vehicles required or to predefine the number of vehicles and hours of service and determine the most efficient service standards obtained.

The current hardware options consist of telephone dialing aids, voice synthesized or stored-message confirmations, and digital communications to the vehicles.

CONCLUSIONS

In 1983 the TTC initiated the detailed design and installation of the computer-aided system to serve the Toronto area. Such a system was designed from the outset to be adaptable to other smaller transit properties in Ontario.

The implementation time frame of this project will see this computer system introduced in a parallel mode with the current manual operations in early 1984. This will provide for an operational debugging period of several months before the final transfer of all paper files, records, and communications to the computer system occurs in mid-1984. During this time, evaluations will be initiated into the ongoing research on advanced-reservation and demand-responsive scheduling algorithms. A testing program of the various concepts and approaches will be developed to determine the most acceptable aids to the decision-intensive scheduling problem.

Such computer-aided systems are not justified for all installations because of their high initial costs and ongoing operating costs. Nevertheless, they are suitable for larger properties where savings in the administrative overheads or improvements in productivity will equal or exceed the implementation costs.

Although firmly established as a permanent public transportation service for the physically handicapped in Metropolitan Toronto, Wheel-Trans can still be considered a development project. It is hoped that the introduction of the computer management information system and the transfer of the reservation, scheduling, and dispatching functions to the TTC will provide an improvement in the areas that currently cause the largest number of complaints.

The anticipated doubling in growth during the next 4 years will continue to see major changes take place in the operation and structure of the Wheel-Trans service and an improvement in availability and the quality of service. Subject to funding constraints, it is expected that the future Wheel-Trans system will have increased system capacity and a reduction in the time between the request for and the delivery of service. This will be accompanied by higher user expectations and an increasing demand for service from a generally aging community.

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Long-Range Transportation Planning for the Elderly in Ontario

ROBERT A. WOLFE AND ERIC J. MILLER

In Canada few long-range planning studies have addressed the transportation needs of the rapidly growing proportion of elderly people in the general population. In this paper the characteristics of the elderly population are identified, and forecasts about this population to the year 2021 are discussed. Given these data, the elderly population is segmented into seven life-style groups, such that the group definitions are invariant through time, but the number of people in each group is allowed to change. Next technological, organizational, and service-related innovations that may be applied to five modes of transportation are enumerated. These innovations are briefly discussed, and how they might affect the seven life-style market segments is outlined. Finally, three scenarios for the future are developed to indicate which innovations are most likely to affect large groups of the elderly. Findings indicate that innovation in small-scale, locally oriented types of special transit appears to be able to increase the mobility of the largest number of elderly persons.

In Canada few long-range planning studies address the issues of transportation for elderly persons; it has been only recently that Canadian governments realized that the elderly will comprise a rapidly growing proportion of society. Various government ministries in Ontario have begun to address seriously the long-term issues of future housing, health care, and social requirements of the elderly population into the 21st century. The analysis reported in this paper was commissioned by the Ontario Ministry of Municipal Affairs and Housing because it was interested in how transportation plans could be blended with its own long-term housing plans.

The procedure adopted in this study was totally conceptual, and not statistical. Instead transportation demand was treated in terms of the needs and requirements of tomorrow's elderly population. The supply system was discussed in terms of innovations and changes to current supply that could affect future needs and requirements. Finally, a rough attempt was made at scenario development, so that supply changes could be somewhat related to the future quantity of demand.

The study was conducted in the absence of any reliable or thorough data; only the most simple demographic tabulations were available. Consequently, the results of the analysis, and certainly the methodology, could be applied to areas other than Ontario.

Given this context for the study, the population groups being discussed are first identified and then their needs and behavior are outlined as briefly as possible. Supply innovations are then discussed as they affect the needs of the elderly. Finally, the scenario results are briefly reported in a policy-making context.

THE ELDERLY IN ONTARIO

In this section the characteristics of the elderly are described only to the extent required to establish their travel behavior and needs. More complete treatments of the socioeconomic dimensions of the elderly population of Ontario may be found elsewhere (1,2).

The term elderly has a varied meaning but is generally taken to mean those people aged 65 years or older, although United Nations documents include people aged between 55 and 64 in this definition. Clearly, such a definition is problematic because many people aged 65 or older act much younger, and many younger people have patterns of behavior similar to much older people. Although this important point is recognized, in order to coincide with the census definition in Canada, as well as typical retirement ages, the elderly are defined in this paper as those people aged 65 and older.

Data based on the 1976 Canadian Census place 865.3 thousand people in this group in Ontario in 1981. A breakdown of the elderly population by age and sex, and a comparison of this breakdown to the population in Ontario as a whole, is given in Table 1 (1). The data in this table indicate that the elderly account for approximately 10 percent of

Table 1. Characteristics of the elderly in Ontario, 1981 (1).

Age (yr)	Male (000s)	Percentage of Male Elderly	Percentage of Ontario Total	Female (000s)	Percentage of Female Elderly	Percentage of Ontario Total	All Seniors (000s)	Percentage of Elderly	Percentage of Ontario Total
65-74	239.7	66.1	2.7	289.9	57.6	3.3	529.6	61.2	6.0
75-84	100.6	27.8	1.2	161.3	32.1	1.8	261.9	30.3	3.0
≤85	22.1	6.1	0.003	51.7	10.3	0.006	73.8	8.5	0.009
Total	362.4			502.9			865.3		
Ontario	4,320.5			4,410.4			8,730.9		

Ontario's 1981 population, and that the majority of them are in the so-called young-old group of ages, i.e., between 65 and 74. In addition, it is evident that there are more older women than men in the population (male-to-female ratio of 0.72), and that this difference is considerably greater than that for the population as a whole (which has a male-to-female ratio of 0.97). Finally, there are more women in the older categories, particularly aged 85 and older, where there are more than twice as many women as men.

Further data regarding the elderly are far more difficult to obtain. Based on the data that are available, the current elderly population in Ontario can be characterized as follows:

1. The proportion of the elderly that are married drops dramatically as age increases;
2. More than half of the elderly population live with relatives, and less than 10 percent live in some form of collective housing;
3. Mean incomes of young-old females are half those of males, but similar to each other for old-old persons; incomes are approximately half the mean figure for all ages in Ontario; and
4. Less than half the elderly have a driver's license, and probably even fewer own an automobile.

Several forecasts are available concerning the future population of the elderly, although these forecasts usually are categorized by age and sex only, thus providing little or no information regarding employment, automobile ownership, and living arrangements. For example, Figure 1 shows a forecast for three age groups in which it is projected that the elderly will constitute 26 percent of the population in Ontario by the year 2021. It is clear from the data in this figure that the number of young-old (aged 65 to 74) will increase at an extremely high rate, one that will be greater than that for the general population. This trend indicates that there will be an extremely large group of reasonably active older persons by the year 2000.

Other Statistics Canada data relate to male-to-female ratios and point to the rising proportion of females in the elderly population. Little data are available that project single-person households, but one report (2) provides indices of growth of nonmarried people older than age 65. In Ontario, by using 1971 as a base index of 100, the index will grow to 109 by 2001 and to 348 by 2021. No data are available to compare this to other age groups or to the general population. Similar data are available concerning nonfamily households (living alone, sharing, institutionalized) with the head of the family older than age 65. No data are available in comparison to other age groups, but it is apparent that there will be many households headed by elderly people who are single or who are living in institutional or shared quarters.

TRANSPORTATION NEEDS OF THE ELDERLY

A basic premise of this paper is that the needs of the elderly are no different from any other adult group in society. A fundamental right of all people in society is equal access to facilities (and this too is fundamental to the needs of the elderly).

Previous studies of the transportation needs of the elderly have adopted a life-style market-segmentation approach. For example, Wachs (3) divides the elderly population into seven groups based on empirical data and statistical analysis. No such analysis was possible in this study, as the data required were not available. Instead, a set of life-style groups was defined judgmentally, subject to the requirement that they be specifically transportation

Figure 1. Forecasts of the elderly population in Ontario.

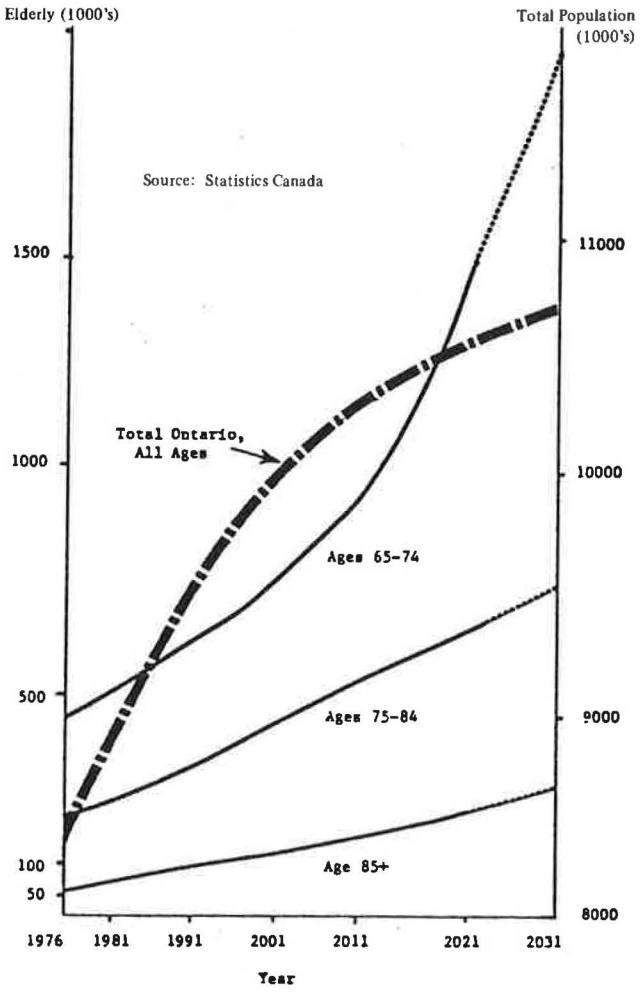
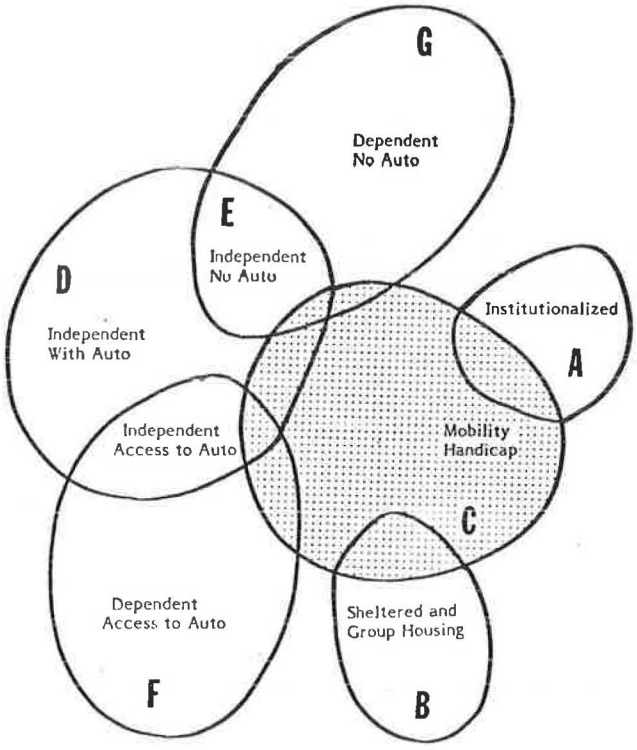


Figure 2. Life-style groups.



related and that they be invariant with time (the number of people within each group, though, will not necessarily be constant with time).

Figure 2 shows a typology of seven life-style groups:

1. Institutionalized, with severe mobility constraints;
2. Sheltered and group housing, with some degree of financial or physical dependence;
3. Handicapped, under any income level and living arrangement other than 1 or 2;
4. Independent, owns automobile, and has the financial means to drive it;
5. Independent, no automobile, but may have access to an automobile;
6. Dependent, access to automobile; and
7. Dependent, no automobile, or access to one.

The terminology used in these group definitions is as follows. The term institution is used to define any nursing home, hospital, or similar facility for residents who are not able to care for their own needs. Handicap is used to refer to physical mobility constraints caused by health problems or physical disability. Independent people are defined as those who are financially independent and do not require the aid of others in their living quarters. Therefore, independent people could be living alone or with a spouse, sibling, or friends by their own free choice. Those whose accommodation is determined by income constraints or require the financial aid of others are termed dependent.

The interdependence of these definitions is shown by the overlapping boundaries in Figure 2. Probably the greatest overlap occurs within the handicapped category, but in terms of transportation, independence, and automobile ownership this overlap is not that relevant, as the handicapped have special needs regardless of their living situation. Other potentially relevant characteristics, such as whether or not the person works and whether he lives in a rural, urban, or suburban setting, can be used to define subgroups within the seven major groups, although such subgroups will not be examined here.

Most analysts expect there to be major life-style differences in the future for the elderly. For example, Wachs (3) indicates that the elderly in the future will be a more heterogeneous group than today. This does not mean that there will be more life-style groups, but rather that the proportions of the population will be more evenly distributed.

Other expectations concerning the future elderly population include the following.

1. The elderly will be more affluent because of a larger proportion of people in the work force than today. More people working today means that more people will collect pensions and the like in the future. (The future value of pension income is another issue, but this will not be considered here.)
2. The elderly will be healthier as a group. This assumption is based on historically observed increasing survival rates. Such a conclusion must be viewed with caution, however, as most medical people believe that there is a upper limit on the life span, although people may be healthier as they approach this limit.
3. The elderly will be more independent in their living arrangements. With trends toward fewer nuclear families today, the elderly of the future will depend less on their children and attempt to be more independent in their activities. Today's independent women can be expected to continue their independence as they grow older. High divorce rates today may lead to fewer married elderly. Finally, because many of today's couples do not have children, they will by definition have no one to depend on in their old age.
4. The elderly will be more educated and have broader interests. This will have significant implications for their work force participation desires.
5. The elderly will have higher automobile ownership levels. The hypothesis here is that people dependent on the automobile today will act the same later in life.

These points do not indicate that the life-style groups change, but rather that as the elderly population evolves, the groups will still be relevant. Given this assumption, the transportation needs of each group may be briefly summarized. This discussion is not meant to be exhaustive, and details may be found in a report by Wolfe and Miller (4).

Institutionalized

The institutionalized proportion of the elderly population is small and is not expected to change significantly with time. An argument may be made that institutionalized people have no significant transportation needs, but this is not so. Therapeutically, the benefit gained from an outside trip may be immense, and, if medically able, the person should be encouraged to make trips to shopping centers, relatives, friends, and so on. Issues associated with being able to make such trips include the following.

1. For nonwalking trips, vehicles are needed that accept wheelchairs and people with severe mobility problems.
2. Most locations in modern cities (particularly residential locations) are not accessible by the physically disabled. Thus, even if a trip could be

made, the person might not be able to gain physical access to the building or activity that is the object of the trip.

3. Perhaps most important, the ability to make short trips by walking or with aid in a wheelchair is required. The need here is for a pleasant, exciting, and barrier-free environment with destinations that may be of interest to elderly persons.

Sheltered and Group Housing

Common needs of the elderly living in sheltered and group housing include the following.

1. An interesting and safe walking environment of about 100- to 200-m radius would be of value to handicapped and mobile elderly persons. They should be able to reach shopping, recreational, medical, and service (e.g., post office) destinations without crossing major barriers. Barriers include high-speed roads, multiple-lane roads, railway tracks, extreme natural features (hills), or dangerous land uses. In general, throughout the walking environment, street orientation of facilities and street furniture appears to be important to this population group.
2. Public transportation services that may be used to travel to dispersed locations must be readily available with a route structure that accounts for the dispersed nature of travel. Paratransit is included here. Reduced or subsidized fares are essential to encourage tripmaking among economically disadvantaged persons.
3. Special services for physically disabled persons are needed for equal access.

Physically Disabled (not in sheltered or group housing)

The physically disabled elderly who live on their own or with family have special transportation needs. They are few in number and are fairly independent if they are able to live under such conditions. Hence it is expected that they are able to use transportation facilities available to the general physically disabled population.

One problem is that some elderly people gradually become handicapped through arthritic or other ailments and have great difficulty adapting to their new situation. These people, if living independently, may have problems because of not knowing how to access special transportation services.

Physically disabled people who live with families or spouses need the same type of services that other handicapped people require. The problem here is often psychological, in that the spouse or family is not able to assist them adequately, and such assistance ultimately may become a severe burden. Thus members of this population may become captives by depending on others rather than on public transportation special services.

Independent, Owns Automobile

Independent elderly persons who own automobiles are fully capable of making nearly all of their trips by this mode, subject to several provisions.

1. The elderly must be able to afford to use the automobile. Currently, this is a constantly increasing cost, so some trips may not be made or may have to be made by other modes. In addition, the economic prospect of purchasing a new car today is difficult for most elderly persons. Thus, as the person and car age, members of this group may decide to use other modes.
2. The elderly may not all have the psychological or physiological stamina to endure heavy traffic or long stretches of highway travel, and hence some trips may be made on other modes.
3. Some automobile trips may not be possible because of medical problems such as night blindness.

Independent, No Automobile

The subgroup independent, no automobile must rely on nonautomobile modes to make trips of any nature. The problem of serving this group is exacerbated by their dispersion in space. That is, not all such people will be located near a public transit route. Those who do have normal bus access have the means to travel, providing the routes that are nearby actually serve their needs. For example, radial routes to a downtown area may not take the independent elderly to convenient shopping or medical locations. In addition, walking to bus stops in winter may be difficult even for healthy elderly persons, and waiting for buses in any weather can be onerous. Therefore, normal public transit modes are able to serve the needs of only some subset of this population and may not even be able to supply all of this subset's trip demands. Clearly, a fundamental need of this group is for some form of transportation that may serve their particular needs, which include access to dispersed trip origins and destinations, short walk trips to wait for the mode, short wait times, and reasonable cost.

Dependent, Automobile Access

The life-style group of dependent, automobile access leads an unusual existence when related to their transportation needs. They live with others and use their automobile or take rides with others when possible. Otherwise they depend on other transportation modes that may or may not supply their needs properly.

For those trips that are made by automobile, these people must rely on the schedules of others. If they wish to use the automobile themselves, it must be available, which may not be often. Typically, automobiles that are used for work are not available to those elderly persons for most of the day. Hence this population must either act like dependents with no automobile access or become captive to the limited automobile access that they have available.

If they desire to obtain rides with others, the other persons must be available along with the car--and be willing to drive the elderly person to a destination. This results in severe forms of dependency on the services of others.

Dependent, No Automobile

The group of dependent, no automobile forms a small proportion of the elderly population, but many of the group just discussed (dependent, automobile access) are often without automobile access. Those with no automobile access and dependent on others generally have financial constraints and hence become the most disadvantaged of all of the elderly. With no automobile access, they must depend on walking and transit for all tripmaking.

It is clear that walk trips may not supply all needs if this population is dispersed because not all origin locations are well located, close to destinations, or in a barrier-free environment. Similarly, transit is not ubiquitously available and can be costly for elderly persons with limited incomes. Taxis and similar expensive modes cannot be used for most trips. Hence portions of this group

Table 2. Trip purposes by the elderly.

Purpose	Percentage of All Trips		
	1979, Metropolitan Toronto	1978-1979, Durham Region	1977, Ottawa-Carleton
Home-based work	13.8	6.5	11.8
Home-based shopping	31.6	34.0	49.0
Home-based social, recreational, other	37.5	43.5	26.7
Non-home-based trips	11.6	10.5	12.2
School	5.6	5.5	0.4

Table 3. Modal choice by the elderly.

Mode	Percentage of All Trips		
	1979, Metropolitan Toronto	1978-1979, Durham Region	1977, Ottawa-Carleton
Driver	47.8	65.1	50.9
Passenger	15.9	25.3	18.7
Taxi	2.5	1.2	1.9
Transit	32.2	7.9	26.1
Walk (to work)	1.4	0	1.7
Other	0.3	0.5	0.8

become captive to the trips that they can make, not those that need to be made.

THE SUPPLY SYSTEM

Current Supply

Most Ontario cities with a population greater than 30,000 have some form of public transit service, even if it is of a limited nature. Of course, the major cities have extensive route networks and special services for the elderly and the handicapped, but the services are generally not specifically oriented for use by the elderly. Fixed-route public transit systems are typically radial in nature, bringing people from dispersed locations into city core locations. Special demand-responsive and other services almost all give priority treatment to people making work trips--something that is not always of benefit to elderly persons today.

Use of these and other modes by the elderly population is not well documented. Limited surveys in the Toronto and Ottawa areas were collected in the late 1970s; the basic results are given in Tables 2 and 3. These data indicate that most trips are home-based shopping or social-recreational in nature. In large cities about half the trips are made as automobile drivers, with public transit an important second. The less-urbanized Durham region, which possesses far less transit services than either Toronto or Ottawa, is, not unexpectedly, more automobile oriented.

Results from other surveys indicate that

1. Important barriers perceived by the elderly are uneven slopes, street crossings, bad weather, climbing steps, no seats on buses, and not enough time to sit down on buses (similar results are found for the general handicapped public);
2. There is a general fear of subways because of stairs, walking in long corridors, and loss of general orientation to the street;
3. Walk trips are severely hampered if packages must be carried;
4. Elderly people fear crime at night and in poorly traveled areas;
5. Inflexible transit routes are blamed for low use among elderly people; and
6. Taxi use is limited because of cost.

In summary, it appears that the elderly are severely disadvantaged in terms of transportation because the systems currently available are not suited to their needs.

Future Transportation Innovations

The purpose of this section is to explore possible transportation innovations that might occur over the next 50 years and that might affect transportation services for the elderly. In considering this highly speculative topic, the following basic assumptions were made about the future:

1. Petroleum will still be available 50 years from now in sufficient supply and will still constitute a major fuel source for economic activity (including, possibly, transportation), although the price of petroleum will be considerably higher than it is currently in real dollar terms;
2. The economic and social order will be approximately the same as it is at present;
3. No radically new transport modes will emerge during the next 50 years;
4. The relative roles of the public and private sectors in the supply of transportation services could change; and
5. As the elderly population increases in size it will be vocal in its concerns and may be able to wield considerable power.

To assess the range and types of transportation innovations that are possible, a typology of the subject was developed. Five modes of transportation and three types of innovation were considered. The modes are

1. Private automobile, including any future technological derivations that might emerge;
2. Fixed-route public (conventional) transit, regardless of type of vehicle and right-of-way used;
3. Special transit, which consists of all public and private transit and paratransit services other than fixed-route public transit;
4. Walking; and
5. Cycling.

The types of innovation are technological, organizational, and service related. Pricing innovations were not considered, as this is inherently a political issue that involves the role of transportation as a public good and the redistribution of wealth in society.

The possibilities to be considered exclude certain cases a priori. For example, it was believed that no organizational changes are possible that could affect the walking mode. Given this typology, each possibility was examined in detail. The findings are too lengthy to report here, but they are summarized in Table 4. Although the data in the table only outline a few innovations, details of more possibilities are given by Wolfe and Miller (4). Reported here are those innovations that appear to be most promising and feasible in their potential impacts on the elderly population. In order to elaborate on the table, each mode will be dealt with separately.

Table 4. Summary of promising innovations by type and mode.

Mode	Innovation		
	Technological	Organizational	Service Related
Automobile	Incremental improvements or new power plants Urban car	Elderly community rental fleets	NA
Fixed-route public transit	Vehicle improvements Customer information systems Improved security systems	NA	Well-lit, enclosed stop shelters Information displays at stops Coordination and integration with land uses and buildings
Special transit	Improved control systems Improved vehicles	Transportation brokerage systems Elderly transportation organizations	Range of paratransit service options
Walking	Limited applications of moving sidewalks, enclosed sidewalks, and so on	NA	Micro-design options for sidewalks and walkways Separation and protection of pedestrians from automobiles
Bicycle	Adult-sized mopeds Enclosed bikeways	NA	Open-air bikeways

Note: NA = not applicable.

Automobile

It is expected that changes to the automobile will occur during the next 50 years, regardless of the needs of the elderly population. Smaller cars are expected, possibly two-seater urban cars. Because a greater proportion of today's adults are drivers, tomorrow's elderly persons, particularly women, will be used to being able to use and drive automobiles. Only the price of the vehicle and fuel will be the strong controlling factor.

One interesting organizational innovation may be community car fleets, where the capital cost of a fleet of cars may be shared across many users, and individuals will pay for their use on some measured basis. This is a particularly good option for older persons living in group housing.

Fixed-Route Public Transit

Through technology, fixed-route transit vehicles may be slightly modified to be more accessible by the elderly. In addition, different vehicle sizes may be more appropriate for certain demand levels. Of major importance is the possibility of digital communication systems so that the elderly (and others) may be able to minimize their waiting time. Psychologically, this could increase transit access for the elderly.

In terms of service-related innovations, shelters, lighting, and proper snow removal are necessary. Information displays and access to information are important. A critical point is the integration of transit facilities with land use design. A great deal could be said here, but it may be sufficient to provide a statement that coordination of service and building design is important.

Special Transit

Through technology, control systems and vehicles could be changed and modified to aid the transportation needs of the elderly; for example, mini-buses could have lower floors and fewer steps.

Organizationally, brokerage systems and systems run by the elderly have the greatest possibilities of providing cost-effective service. The types of service are many, but they might revolve about a jitney-style service that runs in small loops to and from traffic generators and attractors.

Walking

Technologically, few improvements are possible, but enclosed and weather-protected walkways are possible. Proper snow removal is also critical. In terms of service, separation of traffic and pedestrians may be an appropriate goal.

Cycling

Vehicles suited to elderly persons may be designed that are both powered and nonpowered. Open-air and enclosed bikeways are also possible.

Summary

Although these innovations are only briefly described, how they might affect the various subgroups of elderly persons can be summarized. Figure 3 shows that special transit options have the strongest impact on the most groups, with automobile innovations a close second. In the next section how these impacts relate to the number of people in each group is described.

FUTURE SCENARIOS

The life-style groups that have been developed in this paper are designed to be invariant in time with respect to their definitions, although the proportion of the elderly in each category does indeed change. Therefore, the future transportation needs of any single life-style group remain exactly as earlier described, except that their relative importance changes as the general demographics of population evolve through time.

Referring to Figure 1, the 1981 ratio of elderly persons to total population is about 0.10. In the year 2021 it is forecasted to be 0.26. This means that an increasingly large proportion of society will have specialized needs, as previously described. To assess the magnitude of these needs, a set of scenarios was developed judgmentally to analyze how society might evolve, and then how transportation innovations would be required to service the future elderly population. A summary of these scenarios, and the percentage of each life-style group relative to the entire Ontario population, is given in Table 5.

The base scenario describes what would happen if

Figure 3. Distribution of innovation impacts.

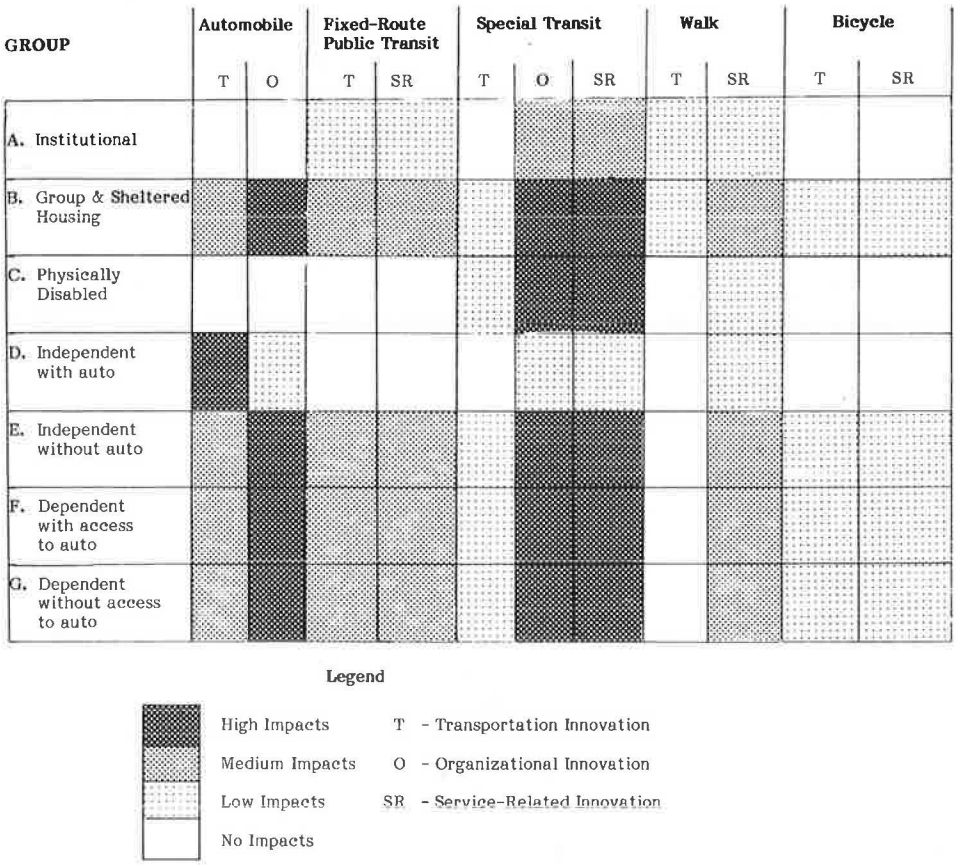


Table 5. Relative proportion of each life-style group for different scenarios.

Elderly Groups	1981	Percentage of Total Ontario Population in the Future		
		Base	Pessimistic Economy	Public Intervention
Institutionalized	1	3.9	3.9	5.2
Sheltered and group housing	1	5.2	10.4	11.7
Handicapped	0.5	1.3	1.3	1.3
Independent, with automobile	2	9.1	2.6	2.6
Independent, no automobile	1	1.3	2.6	1.3
Dependent, automobile access	4	3.9	2.6	2.6
Dependent, no automobile	0.5	1.3	2.6	1.3

all current trends were to continue unchecked and if no major economic changes were to occur in society. Given these assumptions, the data in Table 5 indicate that the elderly will make up a much larger proportion of society, that many of the elderly will be independent in terms of living arrangements, and that a large number of independent older persons will be automobile owners.

Under this scenario the transportation needs of the elderly will not actually change, as those who need nonautomobile transportation will constitute a proportion of society similar to current levels. The only difference that might occur is a gradual increase in the number of people in group housing. This implies the need for local transportation in the environment near the homes, and the need for easy access to distant destinations for work and other trip purposes.

In the pessimistic economic scenario, petroleum will become a scarce resource and automobile use (in any form) will be largely curtailed. Referring to the data in Table 5, nearly 11 percent of the total Ontario population will be elderly and living in group or sheltered housing under this scenario (this housing might be provided by the nonprofit and private sectors). It should be noted that this represents more than the entire proportion of all the elderly in 1981.

The significance of this change is that there will be large groups of healthy elderly persons living in areas that will require satisfactory transportation access and service. This change implies that land use planning will become as important as transport planning because the location of facilities and services will be critical. Another issue here is the spatial distribution of the population, specifically the problems of the population in the suburbs without automobiles. The proportion of the population in this situation could be as much as 25 percent of all elderly and 6 percent or more of the total population.

The changes in society that take place under the public-intervention scenario are expected to cause an arrangement of population similar to the pessimistic scenario, except that 65 percent of the elderly population will be in institutions or in sheltered or group housing. The implications of this are obvious in that needs will have to be supplied through a different form of service than exists today. Land use planning will become of overwhelming importance to ensure efficiency of movement. The other difference here is that a larger proportion of society will be employed,

thereby creating the need for special services for these people.

Referring to Figure 3, it becomes apparent that special transit innovations should be able to affect the greatest number of people in each scenario. For example, high impacts from special transit could affect 13, 19.5, and 18.2 percent of the entire population in Ontario in each of the scenarios, respectively. The probable number of people in sheltered and group housing could make community automobile fleets possible, and walking and cycling innovations will have widespread effects.

In a policymaking context these conclusions have the implication that considerable investment in modes other than fixed-route transit is required if no brokerage or other concepts develop. This is not in the Ontario government's current concept of the future, and authorities are only beginning to consider the implications of this conclusion.

SUMMARY AND FURTHER WORK

The major conclusion that can be drawn from this work is that the life-style group scenario approach appears to be a promising manner of looking to the future. If further work is to be done, quantification of the groups and projections could add firmer evidence to the conclusions. This work will be done in the future when detailed results from the 1981 national census of Canada are released.

ACKNOWLEDGMENT

The work carried out under contract to the Ontario Ministry of Municipal Affairs and Housing is summarized in this paper. A great deal of aid given by members of the Project Planning Office within the ministry is gratefully acknowledged.

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Transportation of the Elderly and the Handicapped in Rural Areas: The Manitoba Experience

JIM WALLACE

A transportation service for the elderly and the handicapped in small towns and rural municipalities is described. This service is supported by grants from the province of Manitoba and is administered at the community level. Actual operations are usually undertaken by a local organization that deals with the handicapped. Available ridership and cost data are discussed. Problems encountered in attempting to estimate the number of potential users are examined along with possible conflicts with local taxi and ambulance services. The advantages and disadvantages of working through local governments are outlined. It is concluded that it is possible to provide a satisfactory level of service at reasonable cost in areas where it is traditionally considered difficult, if not impossible, to provide such services.

A key element in bringing the elderly and the handicapped into the mainstream of community life is the provision of adequate transportation services. In recent years there have been a number of advances in this field, but they have been largely confined to urban areas or heavily populated rural areas, and little has been done in small towns and rural municipalities. Although the need for transportation of the elderly and the handicapped in urban areas in the provice of Manitoba has not been neglected, steps have been taken to provide service to those in lightly populated rural areas as well.

In its early years Manitoba was an agricultural province, with a majority of the population living on farms or in small rural towns. Since the turn of the century there has been a shift to urban living, until today about 70 percent of the population lives in a few large urban centers and the remainder on farms or in small communities. Outside the city of Winnipeg, which has more than half the province's population (578,000) and a few other small cities such as Brandon (34,901), Portage la Prairie (12,555), and Thompson (17,291), there are few public transportation facilities, and even local taxis are rare. Under such circumstances the elderly and the handicapped who cannot drive or do not own an automobile are dependent on friends and relatives or become virtual shut-ins.

At first glance the problems of providing an organized and effective transportation service for a small user group spread over a wide area appeared almost insurmountable. The initial impetus to do something came from handicapped persons. Their perseverance, coupled with the help of service clubs and other community-minded citizens, municipal governments, and the Department of Highways and Transportation, has resulted in a program designed to meet the unique needs of rural Manitoba.

BACKGROUND

The first organized attempts to provide transportation for the elderly and the handicapped in rural Manitoba came in the mid-1970s when a number of local programs were started with federal funding under Canada Works grants. These projects demonstrated the need for service tailored to the needs of the elderly and the handicapped and delivered through broad community involvement, in a financial and administrative sense. When Canada Works funding was terminated, the local municipalities and various charitable and service organizations that had par-

ticipated in the projects attempted to keep them going, but the withdrawal of federal support resulted in the eventual demise of several transportation services for the handicapped in the province.

Two of the stronger organizations managed to maintain services but were continually insolvent and on the verge of collapse. They appealed to the province for financial assistance, which was provided by the Department of Highways and Transportation on an ad hoc basis because no policy framework or guidelines existed and there was no assurance that the groups could be provided with ongoing assistance in the future.

In 1980 it was decided to rectify these shortcomings by the introduction of a formal program for the provision of assistance to transportation services for the handicapped. The program was to be in place by 1981, the International Year of the Disabled.

A committee, which included representatives from the Manitoba League of the Physically Handicapped, was formed to make policy recommendations to the Minister of Highways and Transportation. This committee operated under the following broad guidelines:

1. All handicapped persons have a right to public transportation services;
2. Public transportation services for the handicapped are a responsibility to be shared by provincial and municipal authorities;
3. The provision of services must be undertaken at a municipal level, with the municipalities responsible for the administration and partial funding of the services;
4. The province must contribute financial resources and treat the service as a transportation rather than a social welfare matter; and
5. The program goal is to ultimately ensure that all handicapped persons in Manitoba have access to reasonably priced transportation services, regardless of where they live in the province.

Among the first and most difficult tasks faced by the committee was that of defining the meaning of "transportation handicapped" and estimating the number of potential users falling within the definition. After careful consideration it was decided that in order to encompass a broad range of users, including both the elderly and the physically handicapped, the following definition of a handicapped person would apply:

> An individual who by reason of illness, injury, age, congenital malfunction, or other permanent or temporary incapacity or disability is unable, without special facility or special planning or design, to use available transportation facilities.

Considerable difficulty was experienced in establishing the population distribution of handicapped persons throughout Manitoba. Statistics were often unavailable, and when they were available there were conflicts in the figures obtained from different sources. Eventually use was made of a report by Transport Canada on the identification and quantification of transportation-handicapped persons in Canada. By using the total of 781,159 handicapped persons in Canada and the fact that Manitoba has approximately 4.5 percent of the total population, it was estimated that there were approximately 35,152 handicapped persons in Manitoba. When the proportion of this group estimated to live in the major urban areas was removed, it left a balance of 4,789 persons in this category scattered throughout the remainder of the province.

In an attempt to further pinpoint the location of potential users, a survey was made of the domicile of members of the Manitoba League of the Physically Handicapped. This resulted in the identification of eight communities in which there was sufficient potential demand to warrant their inclusion in the first stages of the program.

As a result of the work of the committee and some fine tuning within the Department of Highways and Transportation, a policy paper was passed by Cabinet, provision was made for funding, and the new program was introduced in September 1981.

THE PROGRAM

The "Program for Transportation of the Handicapped in Rural Manitoba" contains the following main elements.

1. The program is designed to assist communities that have taken the initiative in providing transportation services for handicapped persons in rural Manitoba.
2. To qualify for funding under the program, the communities concerned must demonstrate a serious commitment to keep a service in operation once it is established.
3. Grants are only made to municipalities. Two or more municipalities may work together, with one acting as the sponsor of the joint service for the purpose of receiving grants.
4. Municipalities may operate the service directly or enter into an agreement or contract with any other party for its operation.
5. Service will be provided to all eligible persons without regard to any group membership or affiliation.

The limited experience with the services operated under Canada Works grants had indicated that the main difficulties were financial hardship and cash flow problems, particularly during the first year of operation. To ameliorate these problems, three types of grants were included in the programs.

1. Start-up grants assist in defraying expenses incurred during the initial operating period. This is a one-time grant of $6,000 payable when the commitment to start the service is made.
2. Capital grants assist in the acquisition of capital assets such as vehicles. These grants, which must be approved in advance, are paid on proof of purchase of the asset. The grant is for 50 percent of the capital cost, up to a limit of $10,000.
3. Operating grants assist in defraying the cost of the ongoing operation of transportation services for the handicapped. These grants, which are paid annually, are based on 50 percent of the operating costs after user fees (estimated at 25 percent of gross costs) have been deducted. The maximum payable in any one year is $20,000.

To remove uncertainties and ensure continuity of service, municipalities entering the program will continue to receive annual operating grants, provided that their operation complies with provincial standards. These standards include a requirement that there be service for a minimum of 40 hr in any 7-day period and that the dispatcher be available by telephone from at least 0.5 hr before operation until at least 1 hr after service has been completed.

Service requests may be booked in advance or users can take their chances if they fail to call

ahead. Some daily runs such as trips to work or school at the same time each day can be set up as standing details. In cases where demand exceeds capacity, service is carried out on a priority system based on the following criteria:

1. Nature of transportation handicap--wheelchair, semiambulatory, vision impairments, or all other handicapped persons; and
2. Purpose of trip--employment; medical; education; or personal business, social, or recreation.

The vehicles and ancillary equipment must meet minimum specifications established by the province, including the provision of fire extinguishers and first-aid kits. For reasons of safety as well as ease of dispatch, all vehicles must be equipped with adequate two-way radio equipment.

User fees are established by the municipality. For purposes of calculating operating grants, this fee will be considered to cover 25 percent of gross operating expenses. Should a municipality choose to lower fees and make up the deficit, this is perfectly acceptable. The normal user fee is about $1.50.

THE MANITOBA EXPERIENCE

Because this program has only operated for slightly more than 1 year, it would be premature to draw exhaustive conclusions from the experience to date. There are, however, a number of interesting trends and a few lessons learned that may provide insight for other officials who are contemplating such a program.

There are now five services in full operation in rural Manitoba and six others at various stages of consideration of entry to the program. The five services currently in operation cover rural areas with a total population of 59,329, which is about 10 percent of the population of rural Manitoba.

Each of the services has unique characteristics that are a function of the area served, the local population, and the needs of transportation-handicapped persons in the area. The following examples illustrate this diversity.

The service based in The Pas serves the town of The Pas, the local government district of Consol, and the reservations of The Pas Indian Band and the Swampy Cree Tribal Council. The Pas is located north of the 53rd parallel in an area of precambrian shield, which is largely lakes and forests. The local population, which is largely involved in forestry and other resource-related industries, is estimated at 9,993.

The service of The Pas Handivan was one of those originally established under a Canada Works grant and kept in operation by ad hoc government funding; therefore, there is a longer operating history for this service than for the other services. Service is provided by a modified 12-passenger commercial van. An analysis of trip services for 1 year, expressed in person trips, is given in Table 1. Demand has now reached a point where approval has been given to add a second vehicle.

A second service in Neepawa is located in the southern agricultural area of the province; it serves the town of Neepawa and three contiguous rural municipalities with a total population of 7,231. The service was started by local initiative with a custom-modified van provided by the local Lion's Club. An analysis of trip services in Neepawa is given in Table 2.

The person trips reported by Neepawa are considerably fewer than in The Pas. This is because the Neepawa service has not contracted to transport handicapped children to school.

Table 1. The Pas Handivan, Inc., analysis of trip services.

Date	No. of Trips				
	Total	Schools	Medical	Recreational	Other
1981					
April	977	660	31	82	204
May	1,246	980	26	80	160
June	950	709	26	80	135
July	156	-	5	66	85
August	134	-	3	88	43
September	669	544	3	90	32
October	1,123	1,033	5	70	15
November	952	833	20	76	23
December	730	588	21	65	56
1982					
January	1,153	994	20	38	101
February	1,006	843	16	51	96
March	1,274	895	17	55	307
Total	10,370	8,079	193	841	1,257

Table 2. The Neepawa and district Handivan analysis of trip services.

Date	No. of Trips				
	Total	Schools	Medical	Recreational	Other
1981					
August	94	0	28	64	2
September	116	0	40	76	0
October	104	0	30	70	4
November	131	0	41	88	2
December	208	0	44	96	68
1982					
January	92	0	34	34	24
February	114	0	58	42	14
March	192	0	65	107	20
April	226	0	85	112	29
May	224	0	89	113	22
June	223	0	75	118	30
July	201	0	62	96	43
Total	1,925	0	651	1,016	258

The newest service in Selkirk is operated with a larger vehicle--a bus with a capacity of 16 passengers. The area served consists of the town of Selkirk and two adjacent rural municipalities with a population of 24,336 in close proximity to the city of Winnipeg. Where the other services are largely demand responsive, the Selkirk service operates some fixed-scheduled routes to small rural communities to bring groups into Selkirk for medical appointments, shopping, and recreational purposes. This mixture of demand-responsive and fixed-route operation appears to be highly successful.

Financial comparisons are difficult to make on an equitable basis after such short experience, but some interesting results are available. A match of the analysis of trip services for The Pas with the audited financial statements indicates a net cost of $2.53 per passenger. A comparison of this rate with other transit services in Manitoba is given in Table 3.

The data in Table 3 indicate that transportation-handicapped persons in rural Manitoba can be provided with door-to-door transportation service at a cost less than that of regular transit services on suburban routes. Rural transportation for the handicapped is now being provided in The Pas at a net cost per passenger that is 22.73 percent of the cost of similar service in urban Winnipeg. There is a lower cost because overheads are much lower due to volunteer help, lower driver wages, and no heavy overheads for infrastructure or administration.

Table 3. Comparative net cost per passenger.

Item	Cost ($)			
	Winnipeg Transit			
	System Total	Suburban Service	Handi Transit	The Pas Handivan
Total system cost per passenger	0.85	3.76	11.73	3.91
Avg revenue (from users)	0.39	0.39	0.60	1.38
Net cost per passenger	0.46	3.37	11.13	2.53

Note: Data are from Winnipeg Transit (1981 figures) and The Pas Handivan 1981 and 1982 financial statement.

When considering the direct cost to the taxpayer (i.e., grants from local or provincial governments), it is interesting to note that the net cost per passenger is $1.78, with the remainder being made up through donations and other nonuser fee revenue.

The experience has not been without its problems. Initially the amount of assistance required by local governments in getting a service organized was woefully underestimated. Originally it was perceived that all that would be necessary was one or two visits to the municipalities to discuss the program with interested parties. It is now known that a great deal more is involved. Fledgling services require a considerable amount of advice and assistance in getting organized, obtaining vehicles, training drivers, and starting operations. There is also a requirement for a considerable amount of moral support and encouragement during this period.

It is obvious that without local support the program is unlikely to succeed. By making grants payble only to municipalities and requiring that they be matched by local funds, the necessary commitment is usually assured. Leaving the detailed administration at the municipal level allows sufficient flexibility to meet local requirements, determine local priorities, and sort out any local conflicts. It also reduces bureaucratic intervention in matters better handled at the community level.

Although there is a firm belief in the need for involvement by local government, it has become apparent that there are broad differences in the attitudes of municipal councils. As a result, what was intended to be a universally available service to the handicapped has now become dependent on the degree of interest that can be engendered at the local government level. The reluctance of some municipalities to become involved may break down in time under pressure from potential user groups.

The program allows municipalities to operate the service directly or make an arrangement to have it operated under an agreement with some other organization. In actual practice no municipal government has yet opted to run the service itself. In every case the actual operator is an organization for handicapped individuals that is incorporated as a charitable organization for tax purposes. Such organizations have been effective at this job, and there is a fringe benefit because many local citizens make tax-exempt donations to this organization when they would never dream of contributing to the government.

Attempts to run services entirely by volunteers have not been successful, and there is some concern about the possible use of inadequately trained drivers. There is a place for volunteers in organizing and administering the service and in supporting full-time driver and dispatcher staffs. There is a need for more study and experience to determine the optimum use for volunteers in these services.

There has been an extremely positive response from user groups to the approach of treating the service as a transportation rather than a social welfare matter. In addition, the involvement of transportation planners from the inception of the program appears to have helped avoid a number of problems.

Previous mention was made of the problems of accurately estimating the number of potential users. Although estimates of the number of physically handicapped persons may be reasonably accurate, experience has indicated that the number of elderly users is usually grossly underestimated. After a service is introduced, new users appear steadily for several months. Providing service to an undefined user population can be fraught with difficulty, and successful budgeting for the first year or two often owes more to good guessing than it does to sound financial forecasts.

Where services have started because of local initiative, this has come from one of two groups--the physically handicapped or the elderly. The limited experience to date has revealed that the group that provides the initial impetus will form the major user group, whereas others appear somewhat reluctant to make full use of the facilities. New ways are being looked at to encourage all groups to make use of the service without it being identified as belonging to one particular organization.

Although the transportation service for the handicapped is designed to fill a unique role, there is some possibility of conflict with other services, such as a local taxi (where one exists). Although local taxi services are not common in rural Manitoba, there are some that have been providing service to many of the elderly and the handicapped. A decision by local government to participate in a rural transportation program for the handicapped may erode the revenues of the taxi service to an extent where it goes out of business or provides considerably reduced service. This requires a trade-off decision by the councils concerned and may mitigate against establishment of the service, thus leaving those who cannot use a taxi without any transportation.

At the other end of the scale there is possible conflict with rural ambulances if the respective roles are not clearly defined. Transportation for the handicapped should not be used where an ambulance is required, or an ambulance should not be used for nonemergency journeys that can be done more appropriately by the Handivan.

Because the transportation vehicles for the handicapped cross municipal boundaries and charge user fees, they are technically operating as an intermunicipal livery and thus come under the jurisdiction of the Motor Transport Board and would be subject to its regulatory process. Nevertheless, there is provision for the Board to issue exemptions, and application had been made to have any vehicle operated by a municipality under the program exempted from regulatory requirements.

CONCLUSIONS

The program for transportation of the handicapped in rural Manitoba is still in its infancy, but the success to date has been rewarding. The key ingredients appear to have been involving the users in the planning and operation of the program, obtaining commitment by local government, leaving maximum

flexibility in the operation at the local level, and having financial and technical support available from the province.

There is every indication that rural transportation services for the handicapped can be operated at costs approximating those of some regular urban transit systems.

Although the program may not be transferable in its entirety to other jurisdictions, there are a number of useful lessons to be learned from the experience to date. There has been a great deal of satisfaction in seeing the elderly and the handicapped residents of rural Manitoba offered an opportunity to join the mainstream of community life.