bus) must make 50 percent of the service they provide accessible to the handicapped by means of either bus lifts or ramps. The emphasis is on speedy compliance: 3 years from issuance of the final regulation. In the interim, some type of accessible service is to be provided, most likely a form of paratransit.

Urban and rural paratransit operators who receive UMTA funding will be required to provide accessible services within 3 years. Accessibility is defined as the ability to satisfy the needs of the handicapped in a manner that is approximately equivalent to service for the nonhandicapped. It does not mean that every vehicle in the fleet must be accessible, but it does mean that the wait time, the area coverage, and the other service features provided by the organization must be equivalent for both handicapped and nonhandicapped persons. The accessibility provisions apply to facilities as well as to vehicles. Exceptions would only be allowed if another provider were willing and able to handle all reasonable needs.

Other considerations associated with complying with Section 504 regulations include (a) safety and emergency handling procedures; (b) sensitivity training for drivers and other personnel; (c) escorts; (d) travel aids for the handicapped; (e) coordination among different types of operators, modes, and agencies; (f) marketing; (g) administration; (h) regulatory reform; and (i) insurance and labor agreements. The draft regulation also requires identification of barriers to serving the handicapped within the various systems and action on these as soon as possible.

What happens next? Public input has been solicited by DOT. The formal deadline for comments to the docket was October 20, 1978. Understanding the expected impacts of Section 504 regulations on rural and small-city systems is very important in the preparation of the final regulation by DOT.

Costs of Rural Public Transportation Services

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Typical costs for rural transportation operations and the factors that influence such costs are examined. Until now, few hard data have been available for the purpose of describing rural transportation costs. The data used in this research are taken from applications for funding and actual operations performed under Section 147 of the Federal-Aid Highway Act of 1973, the Rural Highway Public Transportation Demonstration Program. The following aspects of rural transportation costs are investigated: (a) general cost ranges and what constitutes average and "good" costs, (b) factors that affect the cost of operations, and (c) the characteristics of the most economical and most expensive hypothetical system designs.

There are relatively few references in the growing literature on rural transportation that describe the costs of these services. This subject has lagged behind others because there has been no standardized data-collection effort that covered the costs of rural paratransit operations. With the advent of the evaluation methodology for the Rural Highway Public Transportation Demonstration Program established in Section 147 of the Federal-Aid Highway Act of 1973, the lack of data will no longer be a problem. By using preliminary Section 147 data, it is possible to describe average costs for the initial operations of these systems. The figures now available should be refined through subsequent reports to the Federal Highway Administration.

This paper looks at several aspects of rural transportation costs. First, what general cost ranges are known to exist and what are average costs and "good" costs? Second, what factors influence the costs of operations? Finally, if we were to design systems with the objective of spending either as little or as much money as possible, what would such systems look like?

TYPICAL COSTS

Need for Caution

Before delving deeply into costs, we should restate the obvious disclaimer that cost is only one of many evaluation measures that should be used to assess rural transit operations. An evaluation that focused on cost alone—or on any other factor alone—would be deficient. Without service considerations, one could design a nearly costless system, but it probably would not serve enough people to warrant the name "system."

Thus, costs should be considered in conjunction with other evaluation measures. A complete evaluation would include assessments of efficiency (how well a transportation system uses available labor and capital resources) and effectiveness (how well a transportation system meets the goals and objectives set for it) (1). Such an evaluation would include at least the following factors:

1. Cost per one-way passenger trip—Total system costs (all operating expenses plus administrative costs plus capital costs on a depreciation schedule) divided by the number of passenger trips (costs and trips must be recorded over the same period of time);
2. Cost per vehicle kilometer—Total system costs divided by the total distance traveled by all vehicles in the system [the desirability of using passenger-kilometer rather than vehicle-kilometer statistics has been noted by Kidder and others, who have also pointed out the difficulty in obtaining these data (2)];
3. Cost per vehicle hour—Total system costs divided by the sum of the number of hours that each vehicle is operated;
4. Load factor—The sum of the distances for each

trip by each passenger divided by the sum of the seat kilometers provided by each vehicle (which is the product of the number of passenger seats times the kilometers the vehicle traveled);

5. Operating ratio—Total system costs divided by total system revenues;

6. Passengers per vehicle kilometer—The number of passenger trips divided by the number of vehicle kilometers provided by all vehicles;

7. Passengers per vehicle hour—The number of passenger trips divided by the sum of the number of hours that each vehicle is operated; and

8. Annual passengers per service-area population—The number of passenger trips taken per year divided by the population of the service area.

The first five items above are efficiency measures, and the last three are measures of effectiveness. Other indicators have been proposed for urban transit systems (3), but these eight measures are probably the most appropriate for rural systems. They are not always available at the same time, but when they are one can be sure of getting a complete and accurate picture of the system.

Actual Costs

Tables 1 and 2 give data on recent operating experiences. Despite the fact that the two sets of data do not necessarily describe comparable systems, some similarities are evident.

The data for the Section 147 program (Table 1) are indicative of programs that are just starting: Although a fairly respectable cost per vehicle kilometer is achieved—$0.68 without capital costs or about $0.83 including capital costs—the cost per passenger trip is high, the load factor is low, and the operating ratio is very low. These statistics will presumably improve over time. On the other hand, as data given in Table 2 (11) show, what are referred to as rural 16b2 systems (Section 16b2 of the Urban Mass Transportation Act of 1964) operate at an unusually low cost—$0.25/vehicle-km ($0.41/vehicle mile)—which suggests that the reliance on volunteer drivers is high among systems in this group. According to data developed by Briggs (4), there is a strong negative correlation between the percentage of driver hours that represents volunteer labor and the cost per vehicle kilometer for various types of transportation systems. However, Briggs' data show that this relation is much stronger in urban than in rural areas.

Goals for Costs and Other Performance Measures

Although our ideas of what constitutes really fine performance—something much better than the ordinary—are not firmly developed at this point, it is not too early to begin to suggest some values as goals for program managers. Good or "exemplary" values are given in Table 3; it is anticipated that only about 20 percent of all systems will perform at levels equal to or better than these values, and so these values represent a "much better than average" standard.

These values should be used as guideposts by program operators. To the extent that such goals can be met or exceeded, a system is performing extremely well; if operations are quite far from these values, obvious improvements are required.

This list can obviously be refined, and some improvements should be possible in the near future. For example, fixed-route and demand-responsive systems should be further segmented to ensure that low-density operations are not compared with high-density systems (a system of "peer groups" is now being used to report the Section 147 data). Ranges could be given for quartile or quintile groups so that individual operators could obtain a precise understanding of their performance in comparison with similar systems. At the moment, the real usefulness of this list is the discussion it will generate among professionals.

But such indicators can never replace a firm understanding of how such costs are incurred. This subject is discussed below.

FACTORS THAT INFLUENCE COSTS

The majority of rural paratransit system costs are attributable to three factors: (a) driver wages and benefits, (b) overhead costs, and (c) vehicle capital costs. A breakdown of these costs is given in Table 4. The general agreement of the cost breakdowns from various sources is noteworthy. These three cost categories typically account for two-thirds of total system costs.

But how does the manager who wants to control costs know where to begin? Quite simply one begins to control costs by understanding which factors create or influence costs (5). Costs can be influenced by one or more of the following major factors:

1. Operating characteristics,
2. Regional characteristics,
3. Operating speeds and environment, and
4. Inflation.

Each of these factors is, in turn, influenced by a variety of other factors.

Operating Characteristics

Seventeen major cost elements are given in Table 5 (10). All 17 are significantly influenced by the operating characteristics of the system, namely, vehicle kilometers, vehicle hours, the number of vehicles, and all other operating costs (except overhead). Table 5 indicates which of these cost elements are affected by which of the four output measures or operating characteristics.

As an example of the details of such an analysis, Table 6 (10) shows how the elements of cost per vehicle kilometer vary according to type of vehicle. As can be seen from the table, the cost per vehicle kilometer increases with the size of the vehicle. However, a close inspection also shows that the cost per seat kilometer declines as vehicle size increases (6).

Regional Characteristics

Table 7 gives those cost elements that are highly sensitive to regional characteristics. Driver wages are the most sensitive item; insurance costs also show substantial variation. Driver wages will probably continue to vary substantially by region, but the within-region variation in insurance costs may soon be greater than the between-region variation (research on insurance costs is being done by Davis at the University of Tennessee). Except for wage ranges for dispatchers, the other cost factors are essentially unaffected by regional differences.

Operating Speeds and Environment

The way vehicles are operated and the environment in which they are operated has much to do with actual operating costs. Average operating speeds will probably range from 16 to 48 km/h (10 to 30 mph). The most recent statistics from the Section 147 program show average speeds of almost 26 km/h (16 mph) (7). The following guidelines should be noted:

1. Fuel consumption will increase as speeds increase,
2. Fuel consumption will increase as the quality of the road surface decreases,
3. Costs for engine oil, tires and tubes, vehicle repairs, and vehicle capital purchase will increase as the quality of the road surface decreases,
4. Fuel consumption will increase as the terrain becomes more hilly (8), and
5. Operating costs will increase as vehicle age increases (5).

Table 1. Operating statistics for rural Section 147 projects.

Factor	Measure	October-December 1977[a]	January-March 1978[b]
Efficiency	Cost,[c] $		
	Per one-way passenger trip	3.16	2.47
	Per vehicle kilometer	0.42	
	Per vehicle hour	10.22	10.58
	Load factor, ⁒	14.7	17.1
	Operating ratio (revenues ÷ operating and administrative costs)	0.16	0.24
Effectiveness	Passengers per vehicle kilometer	0.14	0.23
	Passengers per vehicle hour	3.2	4.28
	Annual passengers per service-area population	NA	NA
Other	One-way passengers per month	449	536
	Monthly vehicle kilometers per vehicle	3330	3221

Notes: 1 km = 0.62 mile.
Data from Section 147 Rural Public Highway Transportation Demonstration Program tabulations; averages include both fixed-route and demand-responsive systems.

[a]National averages of 36 operating projects.
[b]National averages of 49 operating projects.
[c]Not including capital costs.

Table 2. Operating statistics for rural Section 16b2 projects in Pennsylvania.

Factor	Measure	High	Low	Mean
Efficiency	Cost, $			
	Per one-way passenger trip	13.29	0.29	1.19
	Per vehicle kilometer	1.61	0.025	0.25
	Per vehicle hour			NA
	Load factor, ⁒			NA
	Operating ratio	8.28	0.12	0.78
Effectiveness	Passengers per vehicle kilometer	0.74	0.05	0.21
	Passengers per vehicle hour			NA
	Annual passengers per service-area population			NA
Other	One-way passengers per month	9375	133	1830
	Monthly vehicle kilometers	30 721	726	8480

Notes: 1 km = 0.62 mile.
All systems are demand-responsive.

Table 3. Exemplary values for rural paratransit systems.

		Good Values	
Factor	Measure	Fixed-Route Systems	Demand-Responsive Systems
Efficiency	Cost, $		
	Per one-way trip	1.00	2.00
	Per vehicle kilometer	1.00	0.50
	Per vehicle hour	16.00	10.00
	Load factor, ⁒	35	25
	Operating ratio	0.75	1.0
Effectiveness	Passengers per vehicle kilometer	1.0	0.3
	Passengers per vehicle hour	16.0	6.0
	Annual passengers per service-area population	20.0	2.0

Note: 1 km = 0.62 mile.

Inflation

Inflation seems to have become a constant pressure for many industries, and public transit operators are a prime example. The American Public Transit Association has noted that unit operating costs for transit increased 108 percent from 1970 to 1976 (a real cost increase of 43 percent after adjusting for inflation). The largest portion of the increase was caused by inflation and the second largest by increased costs of labor (above and beyond increases attributable to cost-of-living adjustments). In those 7 years, the operating ratio declined from 90 to 56 percent (9).

Varying inflation factors might change the relative importance of the different cost factors. Actually, this is not expected to happen. The highest annual rates of real cost increases are projected to occur for driver and dispatcher wages and benefits (2.1 percent), administrative expenses (2.0 percent), and fuel and oil costs (1.7 percent). Vehicle capital costs are projected to grow at a relatively slow rate (0.5 percent), but dispatching equipment costs will increase fairly rapidly (1.5 percent) (10).

Table 4. Rural transit costs attributable to various factors.

	Percentage of Costs			
Cost Factor	Section 147 Systems[a]	12 Rural Systems[b]	Typical Fixed-Route Systems[c]	Typical Demand-Responsive Systems[c]
Drivers' wages and benefits	31	28	28	25
General and administrative expenses	24	38	20	20
Vehicle capital costs	15	6	16	14
All other costs	30	28	36	41
Total	100	100	100	100

[a]October through December 1977.
[b]From Chen, Saltzman, and Johnson (12).
[c]From Ceglowski, Lago, and Burkhardt (5).

Table 5. Cost elements for rural transportation systems and their relation to system operating characteristics.

Cost Category	Operating Characteristics	Cost Element
Operating costs	Vehicle kilometers	Fuel
		Oil
		Tires and tubes
		Vehicle repairs and maintenance
		Parts
		Nonvolunteer labor
		Volunteer labor
	Vehicle hours	Driver wages
		Nonvolunteer labor
		Volunteer labor
		Dispatcher wages
		Nonvolunteer labor
		Volunteer labor
	Number of vehicles	Insurance
		Maintenance of dispatching equipment (base and mobile equipment)
		Driver examination, training, license, and tags
		Vehicle storage costs (including covered storage and shelters)
	All other operating costs	General and administrative overhead expenses
Capital costs (including depreciation and interest charges)	Vehicle kilometers and number of vehicles	Vehicle capital costs
		Dispatching equipment capital costs (including dispatching base, repeaters, and mobile equipment)

Table 6. Typical costs per vehicle kilometer for fixed-route rural transportation in the northeast and mid-Atlantic regions (FY 1977).

Category	Automobile or Station Wagon	Van	Transit Bus Small	Transit Bus Medium	Transit Bus Large	School Bus
Number of adult seats	8	12	20	30	50	44
Operating speed, km/h	30	25	18	18	15	15
Cost per vehicle kilometer, $						
Fuel	0.032	0.043	0.057	0.050	0.060	0.057
Oil	0.002	0.002	0.0025	0.0025	0.003	0.0025
Tires and tubes	0.004	0.006	0.012	0.014	0.031	0.025
Vehicle repairs and maintenance	0.028	0.043	0.056	0.077	0.093	0.087
Driver wages and fringe benefits	0.085	0.102	0.142	0.142	0.170	0.170
Dispatcher wages and fringe benefits	-	-	-	-	-	-
Insurance	0.018	0.025	0.037	0.049	0.062	0.049
Maintenance of dispatching equipment	-	-	-	-	-	-
Driver examination, training, licenses, and tags	0.002	0.0025	0.005	0.007	0.012	0.012
Vehicle storage costs	0.012	0.012	0.012	0.012	0.012	0.012
General and administrative expenses	0.057	0.074	0.102	0.111	0.139	0.130
Vehicle capital costs	0.039	0.065	0.079	0.120	0.189	0.053
Dispatching equipment capital costs	-	-	-	-	-	-
Total costs	0.281	0.375	0.505	0.587	0.772	0.599

Notes: 1 km = 0.62 mile.
Fleet size: five vehicles, 40 322 km (25 000 miles) of annual operation per vehicle, 10 percent discount rates.

Table 7. Cost factors and their dependence on regional characteristics (FY 1977).

Cost Factor	Range of Estimates	Cost by Region ($) South	Northeast and Mid-Atlantic	Midwest and Mountain	Pacific
Driver hourly wage rate	Low	2.10	2.40	2.30	2.65
	Mean	2.50	3.50	3.22	4.26
	High	2.90	4.30	4.20	5.72
	Highest[a]	3.54	6.00	4.90	7.00[b]
Fringe-benefit rate	Mean	0.15	0.18	0.15	0.18
Annual insurance costs per 10- to 12-seat van	Low	350	450	300	410
	Mean	695	1000	450	730
	High	1200	1200	1200	1200

Note: Tabulations by Ecosometrics from applications for Section 147 Rural Public Highway Transportation Demonstration funds.

[a]The highest cost figures represent wage conditions typical of unionized labor and wages paid in nonurbanized areas of metropolitan counties.

[b]Driver wage rates of $10/h characterize applications from Alaska.

SOME HYPOTHETICAL RURAL TRANSIT SYSTEMS

In light of the above discussion, what would be the difference between extremely low-cost and high-cost rural transportation services? What would be the characteristics of idealized systems at either end of the spectrum?

A very low-cost system would almost exclusively use volunteer drivers who supplied their own vehicles. Direct out-of-pocket expenses for gas and oil would be reimbursed for those who required it. Gasoline would be purchased through municipal or county depots. Trips would be made on a scheduled basis but only if a sufficient number of riders could be found. Administration and record keeping would be performed by agency personnel on a part-time basis as a part of their regular job (i.e., these services would be provided at no cost to the project). Insurance would be provided by the drivers themselves or as an add-on to the fleet policy of the local municipality, the county, or the state.

A program of this nature should operate at an extremely low cost, perhaps on the order of $0.04/vehicle-km ($0.06/vehicle mile) and about $0.15/passenger trip for trips that average 16 km (10 miles) one way, assuming four passengers in the vehicle. If you asked riders for a contribution of $0.25/trip, you could make a profit of more than 50 percent (not everyone will contribute)!

But these costs are much lower than even the typical volunteer driver system, which often makes an attempt to reimburse the driver for the "true cost" of the transportation—gas and oil plus insurance plus depreciation plus other expenses. Such systems typically reimburse drivers at the rate of $0.09 to $0.10/km ($0.15 to $0.17/mile); most of the systems average between $0.06 and $0.13/km ($0.10 and $0.22/mile). At $0.09/km ($0.15/mile), an average trip of 16 km (10 miles) one way would cost $1.50, or $3.00 for the round trip. Thus, even for volunteer systems, methods for increasing vehicle use—that is, transporting more than one passenger at the same time—will obviously be required to create truly low-cost systems.

There are reasons to suspect that all-volunteer systems would probably serve few passengers. Total reliance on volunteers would decrease the reliability of service and increase the administrative time spent. The need to preschedule trips and travel only when others were traveling to similar destinations would seriously limit travel demand. Many volunteers have become discouraged by prohibitive clauses in their personal automobile insurance policies, and many fleet policies will not cover volunteers. Finally, the administrative costs of such a program may become more than can be "hidden" in someone else's budget.

On the other hand, a high-cost system would exclusively employ trained, professional drivers and use vehicles that are specially designed and equipped for serving the nonambulatory as well as the ambulatory. A full fringe-benefits package would be provided that would approximate 40 percent of salary costs. Services would be provided on a demand-responsive basis, with a guaranteed wait time of no more than 30 min from the call for service. Service would be provided on an exclusive-ride basis (one driver and one passenger). All general and administrative expenses would be directly charged to the system's accounts. Maximum liability insurance ($5 million with a cost-of-living escalator) would be carried to ensure full protection for drivers, passengers, and the corporation.

The cost per vehicle kilometer of such a system would be approximately $3, and passenger trips would probably cost at least $20 one way. Thus, the superlative quality of this service is more than offset by the exorbitant costs of providing the service.

Obviously, few systems operate at either of these extremes. The best values for cost-effective operations will be determined by a careful analysis of local conditions. Values for various evaluation measures that can be considered good (those given in Table 3) are now being achieved by some systems. These figures should be looked on as goals to guide improvements and system modifications.

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Nonfederal Funds for Public Transportation: Special Reference to Nonurban Areas

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From a sample of 25 states, it was observed that only 3 percent of the nonfederal funds for public transportation that serve the general public are expended in nonurban areas. Furthermore, the extent of support for public transportation in rural areas varies widely; the more affluent states are more likely to support programs for the nonurban sectors. Thus, the more wealthy sections are likely to benefit from a federal support program that requires substantial local contributions. Far more important from a dollar standpoint is the social service agency nonfederal support, which in many rural areas is the only source of funds for transportation, albeit client-oriented mobility. Evidently the need for mobility support for disadvantaged groups is recognized by state and local groups. However, there has been little coordination among social service funds for public transportation by state governments; congressional action to provide stronger incentives for such coordination would be advantageous.

There appears to be a growing financial commitment to public transportation on the part of state legislatures, as reflected in the dollar outlays for this purpose from nonfederal sources. However, unlike the federal level, the states for the most part do not distinguish between urban and nonurban areas in the formulas by which their transit funds are allocated. A recent study by the Transportation Institute of North Carolina A&T State University (1) explored the extent to which a random sample of 25 states contribute funds to public transit purposes, particularly in nonurban areas. It is the purpose of this paper to report the major findings of that study.

As of FY 1976, 13 of the sample 25 states were spending state funds on public transportation. Annual state funds from these sample areas totaled more than $400 000 000. Furthermore, in states for which there are data for FY 1974 through FY 1976, it is apparent that the trend in state expenditures has been upward. In California, the 3 years showed a growth index of 224 percent in the constant dollar value of the state contribution to public transportation. In Michigan, the growth index was 144 percent; in New York, 149 percent; and in Wisconsin, 157 percent. The largest growth index—419 percent—was recorded by Oregon. In three states—Indiana, Ohio, and Pennsylvania—state-paid transit programs were begun in those 3 years (see Tables 1 and 2).

In the overwhelming majority of cases, these funds are spent for travel in urban areas. Only $3/$100 of state assistance goes to nonurban areas. However, several states have significant expenditures for public transportation in nonurban areas. As indicated in Table 1, Michigan alone accounts for more than half of the funding going from sample state sources into general public transportation in nonurban areas. More than four-fifths of all the funds identified from these 25 sample states come from three states alone: Michigan, California, and Pennsylvania.