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INNOVATIVE APPROACHES TO RURAL TRANSPORTATION

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This paper identifies innovative approaches to rural public transportation at federal, regional, state and local levels. There is no attempt to evaluate them. Examples include federal and regional task forces; state assistance with planning, management, funding and cash-flow, coordination, and insurance; and local level approaches to service provision, cost savings, revenue sources, coordination, user-side subsidies, maintenance, and promotion.

There are many innovative approaches to rural public transportation throughout the country. This paper identifies a variety of activities at the regional, state and local levels. It is hoped that the paper will suggest ways of solving common problems. There is no attempt to evaluate the effectiveness of each alternative.

Federal Region Activities

One innovative approach to rural transportation has been the creation of regional councils or rural transportation task forces at the regional (federal) level. The task force is composed of representatives from the regional offices of the Departments of Health, Education and Welfare; Transportation; Labor; and state representatives. The task force or regional council promotes the exchange of information among states and the coordination of programs at the regional, state and local levels.

One of the first federal regions to use the task force approach was Region IV (2). It began in 1972. The task force developed materials on rural public transportation and assisted states and projects in developing and stabilizing rural transportation services. It also reviewed Section 147 proposals and assisted in resolving coordination problems. Region VII's council is developing a standardized reporting system (3), and Region I will be sponsoring a conference and workshops(4).

State Activities: Examples

State legislatures, DOT's, and the Governors' offices often provide the major impetus for coordinating and stabilizing rural public transportation. Some states--e.g., California, Illinois, Iowa, Michigan, Minnesota, Oregon and Wisconsin--provide funds for capital and/or operating assistance. The Iowa legislature has divided the state into 16 regions, each of which has one agency to coordinate requests for, and allocate, federal and state funds for transportation(5). State DOT's provide planning and technical assistance to rural systems, and attempt to improve coordination through regulation and incentives. Some examples are discussed in more detail below.

Planning and Management Assistance

The Bureau of Urban and Public Transportation in Michigan has provided a combination of technical, planning and funding assistance to rural and small urban areas to develop dial-a-ride transportation (DART) systems(6). (Michigan's plan for funding these systems is discussed under "State Funding," below.)

Other examples of state involvement include Wisconsin's hiring a consultant to help rural systems(7). The consultant provides planning and management assistance to a number of small city systems.

Indiana provided funds to Indiana University's Institute for Urban Transportation, which developed management teams to assist places with less than 50,000 population in planning and managing rural and small urban systems(8).

In California, the state Department of Transportation (Caltrans) provides planning and management help to rural and small urban transportation systems(9). Caltrans has also offered seminars and conferences for local operators and planners.

State Funding

The level and stability of funding is important to any transportation system. State funding may be used as a match for federal funds for capital purchases; for operating assistance; for demonstrations, or to improve the cash-flow of local systems. States usually allocate their funds on the basis of the area population characteristics (e.g., total population or population density) or system operating characteristics (e.g., subsidy requirements, vehicle miles, passenger miles)(10).

For example, California allocates a percentage of the state sales tax back to the counties. New York allocates state dollars to systems according to the type of service (bus, subway or commuter rail) and the number of vehicle- and passenger-miles. The states of Wisconsin and Nebraska provide capital and operating assistance to rural systems based on a formula. Nebraska pays up to three-fourths of the costs the first year of service, then decreasing portions the second and third years.

As noted earlier, Michigan is initiating dial-a-ride systems in small urban and rural areas at the rate of almost one per month; forty-one systems have been started. The first year the state provides technical assistance and pays all the expenses except for $1,000, which is the local contribution. The second year the local government decides if it will continue to support the service. Thereafter the state provides one-third of the system's support. In our opinion, Michigan has been successful because it provides technical assistance and funds to cover initial or front-end costs, and continues to help support the systems. We believe this creates system stability, and encourages local people to vote "yes" on referendums because they know they are not alone in their efforts to establish a transportation system.

State funding may also be used to improve system cash flow. Despite good management, rural systems do not have sufficient cash on hand both to start up and to continue service. Cash shortages occur when federal funds arrive later than planned, or agency reimbursements take longer than a month. More coordination usually means more sources of funding, beginning and ending at different times.

The state of Tennessee assists Section 147 demonstrations by reimbursing the systems when needed(11). Ohio DOT also has a flexible reimbursement process which minimizes accounting and cash-flow problems for local systems(12).

Coordination at the State Level

States may also be effective in increasing coordination among agencies and all forms of transportation. Florida, California, Iowa, Pennsylvania, and North Carolina have state transit operators' organizations which increase communications among operators and between operators and the state DOT. Ohio DOT holds quarterly meetings for the Section 147 project managers as well as other transit operators. This is extremely beneficial to new operators, who can learn from the mistakes and solutions of other systems.

Ohio DOT also encourages coordination by allocating funds to public systems. Through the State Elderly Bus Fare Assistance program, thirty-five cents per capita (based on total area population) is passed through county governments to systems serving the public. This has encouraged a number of social service agencies to contract with, or lease their vehicles to, existing public transit systems.

Other states are actively pursuing coordination among state agencies, either through interagency agreements (e.g., California, Iowa, Kansas, Maine, Nebraska, Wisconsin), or with strong backing by the governor (e.g., Pennsylvania and North Carolina (13).

Insurance

Still another way that states may assist rural systems is to help obtain adequate and reasonably priced insurance. Insurance costs have increased tremendously. Premiums range from $70 to $3,000 per vehicle per year. The states of Vermont and South Carolina are considering assigned-risk pools. Some states have adopted no-fault insurance. Recently the Oregon DOT worked with the state Insurance Commission and helped form a consortium of special transportation operators that obtained insurance for about $700 per vehicle per year(14). The consortium has also developed hiring, training and vehicle standards for member agencies. This reduces risk and therefore should help keep insurance rates low.

Local Activities

In addition to innovative approaches to rural transit at the regional and state levels there have been numerous examples at the local level. Most of these are associated with the provision of service.

Hitchhiking

Hitchhiking is a feasible, low-cost alternative in rural areas. Clear Creek, Colorado, a Section 147 Rural Highway Public Transportation demonstration project, is building upon the characteristics of hitchhiking(15). It will attempt to overcome the disadvantages of hitchhiking by having riders and drivers use I.D.s, and by building shelters. It is hoped this will reduce fears about personal safety and provide comfortable places to wait for rides.

Carpooling and Vanpooling

In 1970, 40% of rural residents carpooled. Recently the Federal Highway Administration began encouraging car- and vanpooling, primarily in urban areas, providing capital funds for van pools. Minnesota is one of many states encouraging vanpooling in rural areas. North Dakota is also encouraging a friends-and-neighbors approach to meet some of its rural transportation needs(16).

Commuter Service

Most rural public transportation systems are used primarily by the transportation disadvantaged and serve the non-work trip purpose. Many of these specialized systems are attempting to broaden their base by serving work and school trips. The Area 15 System in Ottumwa, Iowa, is a Section 147 project and serves both work and non-work trips (17). The North Central Pennsylvania Regional Transportation Authority acts as a broker by contracting with taxi, school bus, and other transportation systems to serve both work and non-work trips(18). Other systems, such as the Pee Dee Regional Transportation Authority in Florence, South Carolina, contract with Headstart and community colleges(19). This broader base increases revenue and community support for the system.

Transfers

Another method of increasing service and decreasing costs is to arrange transfers between routes and systems. Transfers may be scheduled between rural systems and other rural systems, urban systems, or intercity systems. The Area 10 system in Cedar Rapids, Iowa, developed a system of transfers between county vehicles(20). The Michigan Upper Peninsula Section 147 demonstration and the TRIP system in West Virginia are developing rural-intercity transfers using tickets good on both rural and intercity systems, providing joint schedules and using common terminals(21). The AORTA system in Athens, Ohio uses Post Offices as terminals for its fixed-route system in rural Athens County(22).

Providers

In the past, rural transportation services have been provided predominantly by social services, taxi systems, and intercity carriers. Now, providers are changing their roles to meet demand and the requirements of funding programs. Social services are becoming more "public". Taxi operators are seeking more social service contracts and assuming other responsibilities. For example, in Woodbury, Iowa, a taxi operator provides back-up service as well as service during the peak hours for the social service programs(23). In Traverse City, Michigan, the taxi company manages and dispatches the dial-a-ride buses(24). In Orange City, California, the taxi systems have contracted with the city on a cost-plus-fee basis; the contractor keeps all the fares as an incentive(25). This concept is also being demonstrated in Westport, Connecticut. In southeast Tennessee, taxis will provide emergency service for the Progress for People Human Resource Agency(26).

There are also other providers in rural areas. School buses are being demonstrated, both as a vehicle type and as a transportation provider, in North Central Pennsylvania; Morehead, Kentucky; Lewiston, Idaho; and Hancock County, Tennessee(27). The Cape May County, New Jersey, system uses school buses to transport elderly persons for shopping trips(28). Both of these systems are testing the feasibility of using school buses for public transportation, and seeking ways to overcome legal and institutional barriers to such use.

Private cars are the most common form of rural transportation. The Chester County, Pennsylvania, Section 147 demonstration project has worked out a system by which drivers are reimbursed for service using their own cars(29).

Parcel Delivery

Another innovative approach to rural public transportation is to combine passenger service with package delivery. Examples of this include the Pine Ridge Reservation where parts for moccasins are cut at a central location, delivered by passenger van to individual homes where they are assembled, and then returned to the central location for packaging and distribution(30). This cottage industry seems to be working out very well.

West Virginia and California are also attempting to combine passenger and package delivery (mail and bank printouts). Each is negotiating with the postal service to deliver mail to the rural post offices. The vehicle could carry bags of mail, in the vehicle or in a small trailer, between the county seat and post offices in smaller places. (This is done in Scotland.) The Upper Peninsula system in Michigan has negotiated with Greyhound to be a collector and distributor of packages(31). Package delivery should increase system revenues and good will with very little additional cost.

Coordination at the Local Level

Coordination among federally funded transportation services and among the public and private sectors is receiving much attention. Increases in service and efficiency may result from coordination of resources such as:

- Drivers, dispatchers, and other operating and administrative personnel
- Vehicles
- Maintenance, repair and storage facilities and services
- Office space
- Fuel storage and distribution
- Promotional services and materials
- Technical assistance
- Information and referral services
- Computer services
- Radio equipment

Other aspects of rural transportation that could be coordinated include:

- Clientele
- Trip destinations
- Funding
- Bulk or volume purchasing of fuel, parts and supplies
- Insurance
- Tax exemptions

The Progress for People Human Resource Agency (PFP/HRA) in Southeast Tennessee has coordinated vehicles owned by other agencies. It has repainted the vehicles and applied the logo, "Rural Transportation," on each vehicle to give the system a unified public image(32). The PFP/HRA has also implemented a centralized radio dispatching system that has helped to increase its monthly ridership from 12,000 to 20,000.

Other examples of coordination are in planning and promotion. The Older Adults Transportation System (OATS) in Missouri uses volunteers to promote and coordinate service as well as to help in the central office(33).

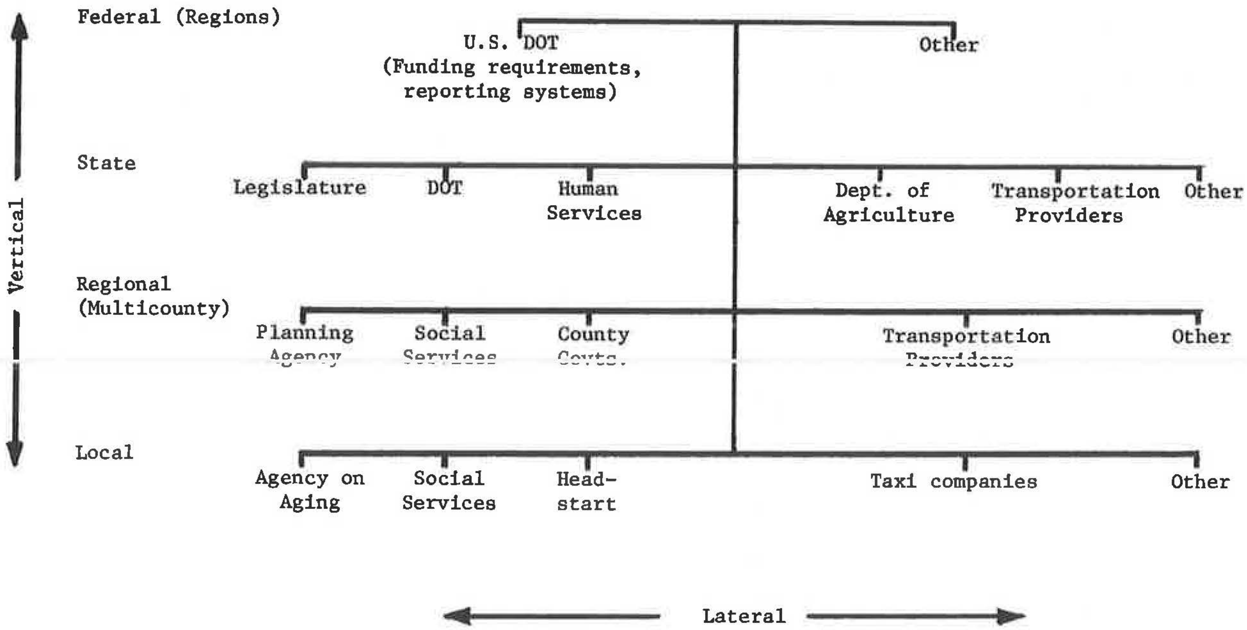
Other types of coordination, and the institutional barriers to coordination, are discussed in more detail in the Institute of Public Administration's report, Coordinating Transportation for the Elderly and Handicapped(34), and in Hindrances to Coordinating Transportation of People Participating in Federally Funded Grant Programs, published by the U.S. General Accounting Office(35). The Office of Human Development is also currently sponsoring five demonstrations of agency and service coordination(36).

One of the most important areas of coordination is in the area of funding. The HEW report, Transportation Authorities in Federal Human Services Programs(37), identified more than 100 federal programs directly or indirectly funding transportation, and drew attention to the need to coordinate these programs.

In summary, there are many different areas for coordination. However, the first step in any coordination is communication, both laterally and vertically (see Figure 1). More communication is needed. The most important criteria for deciding the type and extent of coordination should be:

1. Does it result in more mobility for those

Figure 1. Vertical and lateral communication for coordination.



without an alternative?

2. Does it increase the level of service?
3. Does it result in a system that is more stable financially?
4. Does it increase efficiency? (Sometimes costs, e.g., insurance, may increase)
5. Is it institutionally feasible?

User-Side Subsidy

Another innovative approach to rural transportation is to subsidize individuals rather than systems. This is called user-side subsidy(38). It permits the individual to choose the most convenient or appropriate of the available types of transportation. This can be less costly than operating a new and separate system, particularly in very low density areas, and the cost can be controlled. User-side subsidies are being demonstrated in the West Virginia TRIP program(39) and also in more populated areas such as Danville, Illinois(40). The latter is a demonstration project of the Service and Methods Program of the Urban Mass Transportation Administration.

Maintenance

Maintenance is another area where system managers have demonstrated new ways to reduce costs. One method is to write vehicle maintenance contracts. Such contracts have the advantage of allowing fixed amounts to be budgeted each year for maintenance. This avoids cost overruns and cash flow problems.

Most operators have reduced maintenance costs and down time by using local repair facilities. A few systems have their vehicles serviced at county garages or vocational training schools at substantial savings. The Qualla Public Transportation System in Cherokee, North Carolina, obtains vehicle service from a vocational training facility in Cherokee(41). The PFP/HRA system in southeast Tennessee tried having its maintenance done by a vocational school but routine maintenance was not satisfactory and major repairs were not expedited; local independent garages were better able to meet the system's needs.

Another innovative approach to maintenance has been to develop a computerized maintenance system. The computer prescribes a maintenance schedule for each vehicle and updates it based upon vehicle mileage. This is being done by the PFP/HRA (southeast Tennessee) system(42). It should result in lower costs and longer vehicle life.

Promotion

Advertising and promotion of service is frequently important to the success of a transportation system. Many promotional ideas have been summarized in reports by the Urban Mass Transportation Administration, and in the Georgia DOT's Handbook on Marketing and Promotion for Small Urban and Rural Systems.

AORTA in southeastern Ohio has used many methods and media for promotion of its service. One innovative idea was to have local Cub Scouts distribute system information door-to-door, in exchange for credit on a charter trip(43). OATS in Missouri promotes its service with a newspaper, slide presentations and billboards, and with the sale of coffee cups, caps and T-shirts, toy buses and books of poems, all bearing OATS' logo or promotional material(44). A system in Oregon is assessing the impact of the location of newspaper ads (on the front page, on inside pages, in the classified ads or near the obituaries)(45).

Promotion is an important element of good management. It requires manpower, dollars, imagination and training. However, the most effective promotion for a rural system is reliable, friendly service, and word-of-mouth promotion by satisfied patrons.

Conclusion

Innovation and coordination at the federal, state and local levels are important to the establishment of stable and effective rural public transportation systems. It is hoped that some of the ideas and innovations presented here will be transferable to other systems and other parts of the country.

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IMPACTS OF RURAL TRANSIT FUNDING OPTIONS

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This paper summarizes a study undertaken to assist the Urban Mass Transportation Administration (UMTA) in programming non-urban transit funds available through the National Mass Transportation Act of 1974. The study produced estimates of the amount of transportation provided and probable assistance levels under a variety of possible funding options. It was found that the supply of rural transportation services available in the next few years will vary significantly according to the type and amount of financial assistance available from UMTA, that assumptions about the useful life-span of vehicles significantly affect overall costs and administrative burdens, and that the transit assistance program with the most benefit to rural areas would be flexible depending on local conditions and would include some assistance for operating costs.

Summary of Findings

This project was undertaken to assist the Urban Mass Transportation Administration (UMTA) to efficiently and effectively program the $500 million of rural (non-urbanized area) transit assistance funds available through the National Mass Transportation Act (UMTA) of 1974. The study produced estimates of the amount of transportation provided and probable assistance levels under a variety of possible funding options.

Major findings include:

1. The demand for rural transportation services will be highly sensitive to the amount and quality of services available.
2. The supply of transportation services will vary significantly according to the type and amount of financial assistance available from UMTA. Without UMTA assistance, service levels and patronage of rural transit systems will decline due to cost increases resulting from inflation, but with assistance equal to $77 million per year in 1985, a sixfold increase in passengers over the lowest probable UMTA funding level ($20 million) is likely.
3. The requirements for UMTA capital and operating assistance in rural areas will probably total $480 million from FY1977 through FY1985 under the most probable combination of funding options.
4. Approximately 55 percent of the $480 million would be devoted to capital assistance according to current vehicle life expectancies (three to five years in typical rural environments).
5. Because of the sensitivity of total costs, administrative costs, and the capital/operating ratio to vehicle life expectancy, techniques for expanding vehicle life should be studied.
6. There is a general need for operating assistance. Increases to the amount or share of operating assistance from UMTA will benefit smaller and poorer counties more than larger or richer counties. Ratios of 80 percent of capital expenses and 50 percent for operating deficits — the same assistance now available to urban areas — would result in only 41 percent of UMTA assistance devoted to counties with populations of less than 50,000 persons.
7. The number of counties applying for assistance (even if the smaller counties participate in larger multi-county systems) is likely to be high (from 500 to 1,000 counties applying, compared to only 278 urban MPO's), which coupled with short lives of vehicles now available, will impose significant administrative burdens on UMTA unless policies on vehicle replacement for easing the UMTA administrative burden would be the use of multi-year grants.)
8. The transportation requirements of rural (non-urbanized) areas, defined in terms of numbers and types of vehicles as well as operating assistance, differ so markedly depending on local conditions that a flexible program should be devised by UMTA. Attempts to develop standards for transportation in rural areas should emphasize the need for flexibility. In addition, funds for rural transit should be set aside solely for that use to encourage the growth of transit in smaller communities.
9. The most probable scenario would result, in 1985, in approximately 100 million annual one-way passenger trips, subsidy requirements (from Federal [non-UMTA] sources, State and local governments) of $25 million per year, $77 million from UMTA, and 41 percent of UMTA assistance devoted to counties with populations of less than 50,000 persons.

Background and Study Objectives

The National Mass Transportation Act of 1974 provided up to $500 million for exclusive use in non-urbanized areas during the six year period from 1975 through 1980. Such non-urbanized areas include cities, towns, and rural places with less than 50,000 population. Funds are available from the Urban Mass Transportation Administration (UMTA) for planning and program development activities, demonstration activities, vehicle acquisition, and the capital investments in support of general or special transit services, including those services provided for elderly, handicapped and other transit dependent persons. Legislation is pending in Congress to permit the use of some of the $500 million for operating assistance in non-urbanized areas. Growing public interest in UMTA programs is also revealed by an annual doubling of UMTA non-urbanized areas grants during the last three years.

UMTA quickly needs more information to help develop options for the non-urbanized area funds in an effective and efficient manner. This project was undertaken to assist UMTA in assessing:

o the demand for transit in non-urbanized counties through the nation, and

o the level of funding that these counties might request for UMTA capital and operating assistance programs.

Methodology

Because there is no operational experience for a program of rural transit assistance, a series of assumptions concerning key characteristics of demand and supply were necessary. The Section 147 Rural Public Highway Transportation Demonstration Program, (authorized by the Federal Aid Highway Act of 1973 for the purpose of carrying out demonstration projects for public transportation in rural areas and small urban areas, and currently funding 102 two-year projects in 48 states at a total cost of almost $25 million), administered by FHWA (the Federal Highway Administration) and UMTA, is the closest model to an operational rural transit program. Assumed values, based on actual experience, were given in terms of ranges for characteristics such as

- level of transit service to be provided,
- vehicle utilization ratios,
- costs of equipment, labor, and supplies,
- alternative fare policies,
- proportion of all counties in the U.S. that will apply for assistance,
- financial aid available from Federal, State and local governments, and
- vehicle replacement schedules.

Various combinations of these factors were devised to describe alternative funding options or scenarios. Analysis of all the relevant options was a complex task, involving more than 1,000 distinct combinations. Through computer-aided simulation modelling, feasible systems were identified and those with the lowest operating deficits were selected. The simulation exercises rely on econometric demand functions for the prediction of transportation demands at the county level and on parametric cost functions for the projections of costs for several regions of the nation. Also a discriminant analysis model of rural transit system feasibility was developed to ensure that the predictions of transit assistance requirements correspond to the requirements of feasible transportation systems.

An overview of the simulation model is presented in Figure 1 which shows the steps involved in conducting the simulation exercises. First, alternative levels of demand for each county type are estimated as a function of 3 alternative service levels for each county. (1, 2, 3, 4, 5) Cost estimates based on service characteristics are provided for each of four regions of the country. (6, 7, 8, 9, 10) The initial deficit of each applying county (costs minus revenues) is then reduced by both the UMTA transit assistance package (capital grants and operating subsidies) and the assumed levels of state and local aid. (11, 12) The three alternative systems are then evaluated in terms of their feasibility and one of these systems is selected for each county on the basis of which of the feasible systems leads to lower operating deficits. (13, 14) Finally, the transportation system selected for each county is contrasted with the existing inventory of vehicles in each county group (15, 16, 17, 18) and decision rules are developed on vehicle replacement schedules. (19, 20)

Out of the many possible combinations of factors influencing funding, three combinations of county application rates, UMTA program assistance, and other governmental aid were chosen as the scenarios for the simulation exercises. (Three other scenarios were also considered, none of which include any operating assistance at all from UMTA. These scenarios would decrease the overall demand for rural transit and would shift funds away from the smallest counties toward the largest.) These simulations have been classified as optimistic, moderate and pessimistic scenarios regarding the demands they create for UMTA transit assistance funds. These scenarios are displayed in Table 1.

Findings

Range of Federal Financing

The "optimistic" scenario represents the maximum probable investment in rural transit. It assumes a high level of state, local and other non-UMTA federal aid (levels as high as $0.50 per bus mile in FY-1977) and the participation of 1,004 counties in the program (corresponding to application rates higher than the Section 147 application ranges). It assumes that UMTA pays 80 percent of capital costs and 50 percent of operating deficits. This scenario results in a requirement for UMTA funds of $724 million during the period FY1977-FY1985, with 51 percent of the funding devoted to capital grant assistance. (See Table 2).

The "moderate" scenario includes medium participation rates which correspond to the experience of the application rates in the Section 147 Demonstration program. Under this scenario, nearly 805 counties will participate in the program. This scenario assumes capital and operating assistance from UMTA and a medium level of other governmental funding. In our view, this is the most probable of the six scenarios. It results in total UMTA funding requirements of $480 million during the period FY-1977-1985. Fifty-five percent of the funds will be devoted to capital expenditures. (If no operating assistance were provided by UMTA, and other governments provided a medium level of support, the UMTA funds requested would drop to a total of $288 million for the study period.)

The pessimistic scenario is characterized by a low proportion of counties applying for assistance (50 percent less than the rate of applications to the Section 147 demonstration program). This scenario assumes capital and operating assistance from UMTA and a low level of non-UMTA governmental funding. Probable UMTA funding requirements under this scenario would total $146 million during FY1977-FY-1985. (If no operating assistance were provided by UMTA, and other governments provided a low level of support, the UMTA funds requested would drop to $38 million during FY1977 through FY1985).

Part of the explanation for the dominance of the capital assistance requirements lies in the rapid replacement assumed in the simulation exercises. By enabling the transit agencies to replace small buses every 5 years and paratransit vehicles every three years, as is the current experience (versus a normal replacement schedule of 12 years of large city buses (19, 20)), the replacement demand in these simulations grows rapidly, accounting for nearly half of the capital assistance requirements during the period. This is a subject which deserves more attention on the part of the policy makers; namely, the fact that the replacement demand may be excessive due to the very rapid vehicle replacement cycle now necessary.

On the basis of the above evidence, the statement can be made that a limitation that not more than 50 percent of all non-urbanized area grants from UMTA be devoted to operating assistance will not impair the growth of rural transportation, as long as this limitation is applied for the overall funding period FY1977-FY1985 (and not on year-to-year basis). However, if such a limitation is applied on a year-to-year basis, it will impair the ability of the systems to operate, since expenses for purchasing vehicles will probably not occur every year but operating expenses will occur each year. Since operating costs typically constitute about 70 percent of all costs for rural transit systems, any limitation on funds for operating assistance must be very carefully designed and administered. Substantial system to system variability suggests that UMTA might consider applying a restriction such as the 50 percent operating deficit limitation on a program-wide rather than system-specific basis.

The Demand for Funding Over Time

The time pattern of demand for UMTA rural transit assistance requirements is shown in Table 3. In general, there is an increasing demand for UMTA funds through time, with no levelling-off after a few years. This is due to substantial inflationary pressures on operating costs, particularly on fuel and wages. (8, 9) The operating assistance requirements will grow through time at annual rates which vary from 6 to 10 percent depending on the scenario analyzed. However, the need for operating funds will continue to grow regardless of what assistance is provided by UMTA. There will be no levelling-off in transit assistance requirements through time since the cost inflation that is already occurring will cancel whatever other effects (for example, scale economies in vehicle production or transit operations) that may tend to produce a levelling-off in demand. (If operating assistance were not provided, the demand for capital assistance would decline. The lack of operating assistance most severely affects smaller counties whose share of operating assistance is often double their share of capital assistance. However, the lack of operating assistance makes it necessary to curtail their operations. This contraction of rural transportation operations eventually results in a decreased demand for vehicles and thus for capital assistance.)

The growth in demand for funds is liable to be rapid — about 12 percent per year — because there will be a need to include new systems and because the gap between urban and rural transit costs will narrow. This rapid growth curve suggests that the program should start at a modest level — e.g., $30 million the first year — and grow substantially from year to year. The alternative — starting at a high funding level — may lead to overcapitalization of the first rural transit systems.

The Demand for Transportation Services Over Time

Table 4 presents the activity results which correspond to the scenarios described in Table 1. The number of vehicles in the fleet presented in Table 4 apply only to those UMTA-supported vehicles which are still providing services as part of the rural transit fleet. It is not the total number of vehicles bought within the period, since it excludes those vehicles replaced and eventually sold to other organizations.

Table 4 also presents an estimate of the state and local aid requirement under each scenario. These requirements were projected assuming that state, local and other federal aid would grow at the same rate as the Consumer Price Index during the study period. (11, 12)

The rural passengers generated by each scenario also appear in Table 4. Under the most optimistic scenario the ratio of passengers to bus miles is close to 0.8, while this ratio descends to 0.6 in the pessimistic scenario. (This rate declines even farther, to 0.35, if no operating assistance is available from UMTA.) (In urban areas, this ratio can be as high as 3.0, which is a reflection of higher densities and larger vehicles.) The behavior of this important ratio is in accordance with the rural transportation experience and itself vouches for the credibility of the simulation runs.

The differential effects of inflation from 1977 to 1985 were calculated for each of the major cost elements. The major inflationary forces are fuel and wages (including fringe benefits). (8, 9) Costs due to inflation will not be balanced by the growth of fares or state/local aid (11, 12) or even by population growth. (4, 5) These forces have the effect of decreasing the efficient size of the larger transit systems (13), which is why the number of UMTA-supported vehicles in system fleets will decrease if systems continue to minimize their total deficits. (If systems do not attempt to minimize deficits, but maintain constant fleet sizes instead, this will substantially increase the demands for funding.) A decrease in passengers and vehicle miles from 1977 to 1985 follows this decrease in number of vehicles. Without UMTA assistance, the decline in service provided would be much more severe.

Who Will Get the Money?

Table 5 summarizes the allocation of UMTA transit assistance requirements per county size group. The counties with population above 50,000 receive in all cases the majority of the funds, ranging from 44.6 percent of all funds in the most optimistic scenario to as high as 61.8 percent in the most pessimistic scenario.

Focusing on the allocation of the operating assistance funds, it was found that the counties with more than 50,000 residents receive 45 percent of the operating assistance funds in the optimistic scenario, 51 percent in the moderate and 63 percent in the pessimistic scenario. Thus, a curtailment in local and state aid tends to concentrate the operating assistance on the larger counties. However, in contrast to the capital grant program, the operating assistance funding is more targeted on the smaller communities. (The effect of allowing no funds for operating assistance is to shift the funds for capital expenses to the larger counties which have a greater ability to support transit operations. The same is true of the sensitivity of the county allocations to the level of state and local aid. A reduction in the level of state and local aid shifts the available UMTA funds to the larger counties, since the smaller counties are forced to more drastically curtail their operations in response to the reduction in aid levels.)

Conclusion: Major Influences on Rural Transit Funding Options

The total demand for financial assistance from UMTA from rural communities for transit operations is highly sensitive to a number of factors that have been discussed above. Several of these factors are worthy of further comment.

The type of assistance available from UMTA significantly affects the amount of transportation that will be provided and who will get the transportation services. The National Mass Transportation Act of 1974 does not now allow any portion of the $500 million set aside for non-urbanized areas to be used for paying operating deficits, although operating subsidy funds are now available to urbanized areas. If this restriction continues, it will significantly curtail the amount of transportation provided and will tend to shift funding toward the larger communities.

The second point deserving further emphasis is the sensitivity of the cost conclusions to vehicle life expectancy. The life cycle costing performed under this project covered several vehicle lives during the study period of FY1977-FY1985. In addition to the costs that could be directly attributed to short vehicle lives, there are significantly large indirect costs that we could not estimate. The most significant of these is the administrative burden — on UMTA and on transit operators as well — involved in capital grant applications. Because of the length of time and the amount of work involved in preparing and processing grant applications, all parties in the process would be better off if such applications were not often necessary. However, given the current vehicle life expectancy of three to five years for those vehicles typically used in rural transit operations, the administrative burden will be large. Thus, UMTA and other Federal agencies could create substantial administrative savings and some capital cost savings by insisting on better product standards. A Federal role is necessary in this instance because of the inability of the purchasers of the vehicles — local transit organizations — to have an impact on manufacturing decisions and standards.

Finally, the demand for funds for rural transit can be expected to grow steadily for the foreseeable future. No levelling-off in the demand for funding is projected due to inflationary pressures on operating costs, particularly on fuel and wages. These inflationary forces are beyond the control of UMTA policies. The alternative to at least keeping pace with rising costs is to see a decline in the volume and quality of rural transit services. Increases of about 12 percent per year in program funding from an initial appropriation of $30 million would best serve the projected rate of increase in the demand for funding.

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The contents of this paper reflect the views of the authors who are responsible for the facts and accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of UMTA, the U.S. Department of Transportation, or any other agency.

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Figure 1: OVERVIEW OF SIMULATION MODEL OF UMTA RURAL TRANSIT ASSISTANCE PACKAGES

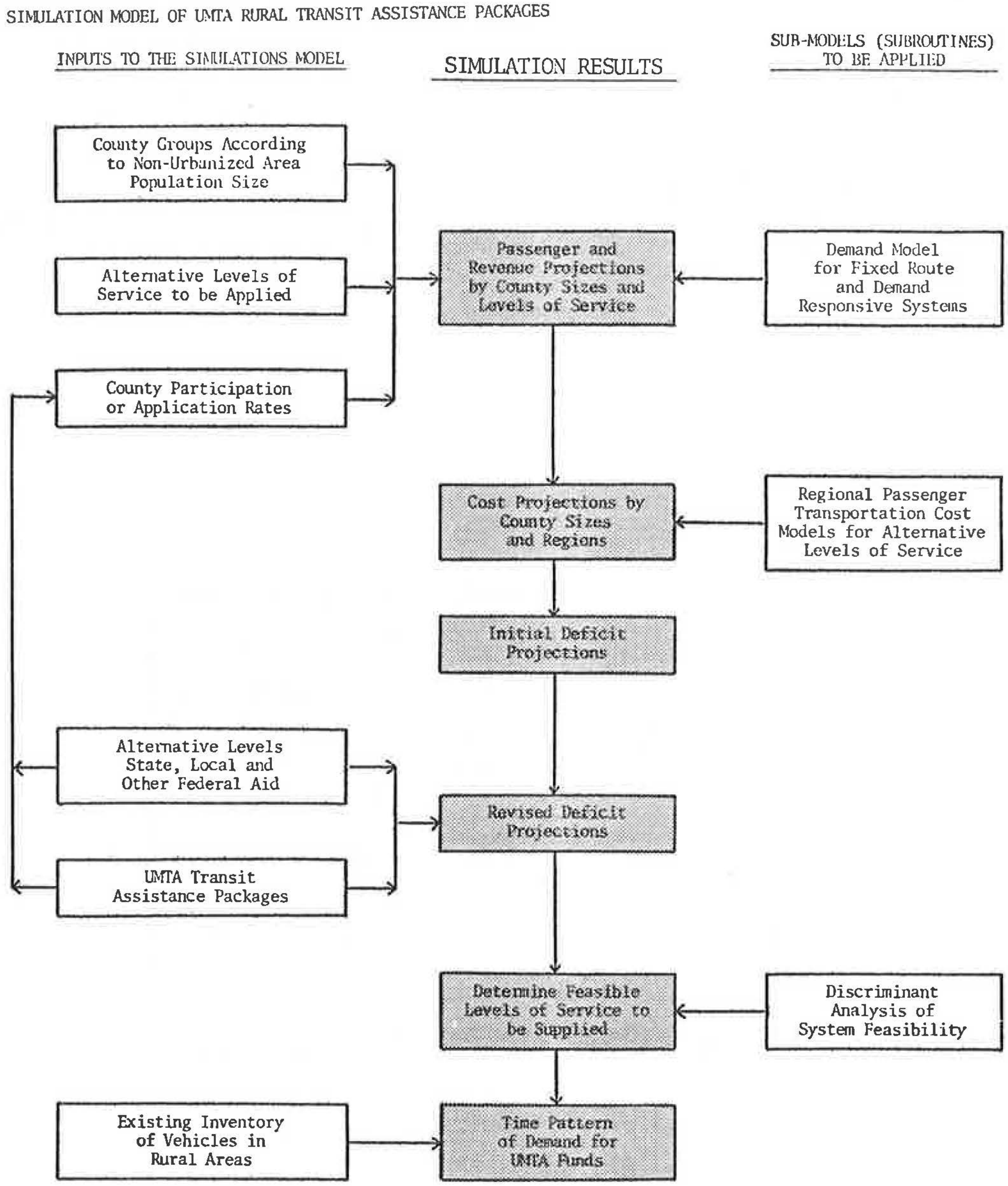

Table 1. Three Alternative Scenarios Resulting from Combinations of Factors Influencing Funding

Scenario Designation	VALUES OF INFLUENTIAL FACTORS: Percent of Counties in U.S. that apply for UMTA assistance*	UMTA Assistance Program: 80% Capital Grant Assistance	UMTA Assistance Program: 50% of Operating Deficits	Level of State, Local and Other Federal (Non-UMTA) Aid (subsidy per vehicle mile)
Optimistic	High (32%)	Yes	Yes	High ($0.50)
Moderate	Medium (26%)	Yes	Yes	Medium ($0.20)
Pessimistic	Low (16%)	Yes	Yes	Low ($0.10)

*There are 3,097 counties in the U.S. as of 1970, according to the U.S. Census. (The National Association of Counties lists 3,065 functional county governments. NACO has determined that, while only 11 counties in the nation are theoretically excluded from participation in the non-urbanized area funds of the 1974 National Mass Transportation Act, there are 442 other counties that contained urbanized areas in 1974, and, thus, are not as likely to apply or to receive funds as the remaining 2,612 counties.) The percent of counties applying is based on the U.S. Census total of 3,097 counties.

Table 2. Total Projected UMTA Expenditures for Non-Urbanized Area Transit Programs from NMTA Funds, FY1977-FY1985

Alternative Scenarios	FY1977-FY1985 UMTA Rural Transit Assistance Requirements (Millions of Current Dollars): Capital Grant Assistance	Operating Assistance	Total
Optimistic	$366	$358	$724
Moderate	$264	$216	$480
Pessimistic	$ 75	$ 71	$146

Table 3. Projected UMTA Non-Urbanized Area Transit Expenditures Over Time

Scenario	Time Period	FY1977-FY1985 UMTA Rural Transit Assistance Requirements* (Millions of Current Dollars) Capital Grant Assistance	Operating Assistance	Total
Optimistic	FY1977	$ 13.9	$ 30.5	$ 44.4
	FY1980	45.4	38.9	84.3
	FY1985	64.9	58.6	123.5
	FY77-FY85	366.0	358.2	724.2
Moderate	FY1977	9.4	20.5	29.9
	FY1980	36.8	23.9	60.7
	FY1985	44.1	33.2	77.3
	FY77-FY85	264.4	215.6	480.0
Pessimistic	FY1977	2.3	6.8	9.1
	FY1980	10.5	8.0	18.5
	FY1985	9.5	11.0	20.5
	FY77-FY85	74.6	71.3	145.9

*Based on matching ratios of 80 percent Federal share for capital expenses and 50 percent Federal share for operating deficits.

Table 4. Summary of Impacts of Selected Scenarios

Scenario Designation	Scenario Definition	Year	Transportation Activity Results: One-Way Passengers (millions)	Vehicle Miles (millions)	No. of UMTA Supported Vehicles in Fleet	State, Local and Other Federal Funding Assistance[a] (Millions of Current Dollars): State Govts	Local Govts	Other Non-UMTA Federal Aid[b]	UMTA Assistance (Millions of Current Dollars)
Optimistic:	High level of county participation (32%); High level of state and local aid ($0.50/vehicle mile); UMTA assistance: 80% capital; 50% operating deficits	FY77	143	185	7430	$20.4	$31.5	$22.2	$ 44.4
		FY85	150	185	7430	$32.5	$50.2	$35.4	$123.5
Moderate:	Medium level of co. participation (26%); Medium level of state & local aid ($0.20/vehicle mile); UMTA assistance: 80% capital; 50% operating deficits	FY77	106	131	5280	$ 3.9	$11.7	$ 2.6	$ 29.9
		FY85	100	113	4600	$ 5.4	$16.2	$ 3.6	$77.3
Pessimistic:	Low level of county participation (16%); Low level of state & local aid ($0.10/vehicle mile); UMTA assistance: 80% capital; 50% operating deficits	FY77	29	41	1665	$ 0.4	$ 2.0	$ 0.4	$ 9.1
		FY85	18	30	1220	$ 0.5	$ 2.4	$ 0.5	$20.5

Notes: a) Computed by using the state and local aid contributions as specified. These aid levels are all projected at an annual growth rate of six percent to FY1985.

b) "Other federal aid" refers primarily to funds and in-kind services from the Comprehensive Employment and Training Act of 1974 (administered by the Department of Labor), various programs sponsored by the Community Services Administration (formerly OEO), and the Administration on Aging of HEW. It is expected that other sources (such as Title XX of the Social Security Act of 1936, as amended) will also be used, but not to the extent of the first three sources.

Table 5. Relative Assignment of UMTA Non-Urbanized Area Transit Assistance Funds from National Mass Transportation Act of 1974 According to County Size — FY1977-FY1985

Scenario Characteristics	SCENARIO DESIGNATIONS		
	Optimistic	Moderate	Pessimistic
County Application Rate (Percent of 3,097 U.S. counties)	High (32%)	Medium (26%)	Low (16%)
UMTA Assistance • for Capital Grants: 80% • for Operating Deficits: 50%	Yes Yes	Yes Yes	Yes Yes
Level of State, Local and Other Federal Aid per Vehicle Mile	High ($0.50)	Medium ($0.20)	Low ($0.10)
County Size Groups (By Population)	PERCENTAGE ALLOCATION OF UMTA TRANSIT ASSISTANCE FUNDS — FY1977 FY1985		
Less than 2,500	0.1%	0.0%	0.0 %
2,500 - 9,999	5.7	7.2	7.5
10,000 - 24,999	23.9	11.7	13.1
25,000 - 39,999	16.9	19.5	8.3
40,000 - 49,999	8.8	9.4	7.8
50,000 - 99,999	28.4	29.8	43.6
100,000 and over	16.2	22.4	19.7
TOTAL	100.0%	100.0%	100.0%
Total UMTA Non-Urbanized Transit Assistance (in millions of current--1977-dollars)	$724	$480	$146

RURAL TRANSPORTATION COSTS

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This paper presents a rural transportation cost model which was developed while determining potential future demand for UMTA capital and operating assistance in rural areas. The model is designed to account for all costs incurred in the operation of a rural transit system, with considerations given to regional location, firm size and public/private ownership characteristics. The bulk of the data used to develop this model came from the Section 147 Demonstration funded by FHWA and UMTA. By combining the cost information and the information available on operating characteristics, a standardized cost per vehicle mile can be calculated for a given vehicle type. Several conclusions regarding costs are noteworthy: 1) Total operating costs per vehicle mile are highest in the Northeast and Pacific coast states. 2) In rural transit operations, the bulk of the total system costs are directly attributable to drivers wages, overhead costs, and vehicle capital costs. 3) Economies of scale are not obvious in rural transportation operations.

This paper presents considerations designed to account for all costs incurred in the operation of a rural transit system. Included are considerations for geographic locations, firm size, use of volunteer services and public/private ownership considerations.

The majority of the data used to design this model was drawn from the Section 147 Rural Transit Demonstrations funded by FHWA and UMTA, and from the actual operating reports submitted by private transportation companies in the States of Pennsylvania and Washington. This data contained cost information on individual cost items and information on the relationships between related cost elements. Because the program is nationwide, information on regional characteristics was readily available. By combining the cost element information and some basic operating characteristics, a "standardized" system costing can be produced.

Cost Elements

Seventeen major cost elements are presented in Table 1. The elements are divided into two major categories: 1) operating costs and 2) capital costs.

The operating costs are the expenses incurred in actual transportation operations, while the capital costs represent costs of equipment depreciation and interest charges on the use of capital equipment. Capital costs can be divided among two types of equipment costs: vehicle costs and dispatching equipment costs. It is assumed that all other capital equipment and facilities are rented.

Table 1 displays the seventeen cost variables and the output variables which influence the cost factors. Four output variables are distinguished, namely: 1) vehicle miles, 2) vehicle hours, 3) number of vehicles, and 4) all other operating costs (except for overhead).

Total Costs

The total system costs are the summation of the five major cost categories: costs dependent on vehicle miles, costs dependent on vehicle hours, costs dependent on number (and type) of vehicles, capital costs, and overhead costs. It would be a long, but not impossible task, to determine total system cost by calculating each component and adding the parts to arrive at a grand total. The process is greatly simplified if all costs can be defined by a common denominator. By "standardizing" the cost elements, it is possible to quickly determine the proportion of total costs allocated to each cost category or cost element.

Cost Factors Dependent on Vehicle Types

Table 2 displays the cost elements which are dependent on the type of vehicle operated by the transit system. Table 2 also presents some average values for various cost items including vehicle acquisition costs, fuel costs, and the cost of tags and licenses for the various vehicle types. The operating speeds presented in this table are averages and will vary according to the road surface, topography, and population density in the service area.

Table 1. Cost Element Structure for Rural Transportation Systems

Overall Cost Category	Output Measures Driving Costs	Cost Elements
OPERATING COSTS	Per vehicle mile	1. Fuel 2. Oil 3. Tires and Tubes 4. Vehicle Repairs & Maintenance-Parts 5. Vehicle Repairs & Maintenance-Non Volunteer Labor 6. Vehicle Repairs & Maintenance-Volunteer Labor
	Per vehicle hours	7. Drivers Wages - Non Volunteer labor 8. Drivers Wages - Volunteer labor 9. Dispatcher Wages - Non Volunteer labor 10. Dispatcher Wages - Volunteer labor
	Per vehicle	11. Insurance 12. Maintenance of Dispatching Equipment (Base and Mobile Equipment) 13. Driver Examination & Training, Licence and Tags 14. Vehicle storage costs (including covered storage and shelters)
	Per all other operating costs	15. General and Administrative Overhead Expenses
CAPITAL COSTS (including depreciation & interest charges)	Per vehicle mile and per vehicle	16. Vehicle capital costs 17. Dispatching equipment capital costs (including dispatching base, repeaters and mobile equipment)

Table 2. Cost Factors Dependent on Vehicle Types — FY1977

Parametric Cost Factor Description	Vehicle Types (i)					
	Auto/ Station Wagon	Van	Small Transit Bus	Medium Transit Bus	Large Transit Bus	School Bus
Capacity (in adult seats)	5-9	10-12	20	30	50	44
Operating speed (miles per hour)	30	25	18	18	15	15
Vehicle Acquisition Cost - Standard	$5,500-7,000	$9,000	$17,000	$33,000	$65,000	$18,000
Vehicle Acquisition Cost - with lifts and wheel chair modificat.	Not applicable	$11,000	$20,000	$37,000	$70,000	$21,000
Types of fuel	gasoline	gasoline	gasoline	diesel	diesel	gasoline
Fuel Consumption rate (miles per gallon)	13-12	10-9	7	6	5	7
Price per gallon of fuel	$0.65	$0.65	$0.65	$0.49	$0.49	$0.65
Tires and tubes cost per mile	$0.006	$0.01	$0.02	$0.023	$0.05	$0.04
Vehicle repairs and maint. expense per mile	$0.045	$0.07	$0.09	$0.125	$0.15	$0.14
Relative insurance costs (relative to vans)	0.75	1.0	1.5	2.0	2.5	2.0
Annual cost of Driver, Exam, Training, Lic. and tags per vehicle	$75	$100	$200	$300	$500	$500
Vehicle service life in miles	130,000	110,000	200,000	300,000	500,000	500,000

The Parametric Cost Equations

As noted earlier, Table 1 displays the seventeen cost elements and the system variables which drive each output. It would be advantageous to describe total system costs in terms of one system output: vehicle miles. Therefore, it is necessary to combine all the variables and cost elements into one expression which explains all cost attributable to a given system output. Then by converting all the system output equations into equations representing costs per vehicle mile, the total cost per vehicle mile can be determined.

The first step in this process (producing cost equations for each system output) is represented by equations (1), (2), (3), (4), and (5). Each of these equations represents the total system costs attributable to a given system output or combination of outputs. The equations account for all the cost elements and variables related to the given system output.

$$(OCVM_i) = \Big\{ [(1+\sigma)(\alpha_{s,k})(\gamma_{s,T})(1/mpg_i)(PF_i)] + [(\lambda_k t_i) + (\delta_k)(p)(re_i)] + [(\delta_k)(1-p)(re_i)(1-VR)] \Big\} (VM_i) + (\delta_k)(i-p)(re_i)(VR)(VM_i) \tag{1}$$

$$(OCVH_i) = (1+f_R)(DW_R) \left[(1-VD) \left(\frac{DH}{VH}\right) + \left(\frac{DPW}{DW}\right)(1-VPD)\left(\frac{DPH}{VH}\right) \right] (VH_i) + (\theta)(1-f_R)(DVW_R) \left[(VD)\left(\frac{DH}{VH}\right) + \left(\frac{DPW}{DW}\right)(VDP)\left(\frac{DPH}{VH}\right) \right] (VH_i) \tag{2}$$

$$(OCV_i) = [(INS_i)(INS_R) + (MR)(DR_i)(DMC_T) + (LIC_i) + (DR_i)(FCC) + (SC)] (N_i) + (MR)(DR_i)(DSC_T)(STAT_T) \tag{3}$$

$$OVERHEAD = (OVRATE_F) \sum_i (OCVM_i) + (OCVH_i) + (OCV_i) \tag{4}$$

$$CCI = \Big[(DR_i)(CRF_{n,r})(tvd_i)(DSC_T)(STAT_T) \Big] + \Big[(CRF_{n,r,i})(1-CG)(VC_i)(tv_i) + (DR_i)(DMC_T) + (tvd_i)(CRF_{n,r}) \Big] (N_i) \tag{5}$$

where

- $OCVM_i$ = annual operating costs which are dependent on vehicle miles, for vehicle type i
- mpg_i = miles per gallon of fuel for vehicle type i
- PF_i = price per gallon of fuel for vehicle type i (with different prices for gasoline and diesel depending on the type of engine)
- σ = proportion that oil and lubrication costs per mile are of fuel costs
- t_i = expenses in tires and tubes per vehicle mile for vehicle type i
- p = proportion that expenses in parts are of the total costs of repairs and maintenance of the vehicles
- re_i = expenses in vehicle repairs and maintenance per vehicle mile for vehicle type i
- VR = proportion of volunteer labor out of the total labor hours spent on vehicle repairs and maintenance (for non-volunteers systems VR = 0)
- VM_i = annual vehicle mileage driven by vehicle type i
- δ_k = cost parameter representing increases in repair costs due to road surface conditions (k=1 paved, k=2 gravel, k=3 earth roads)
- $\alpha_{s,k}$ = cost parameters denoting increases in fuel costs due to speeds and paving conditions k.
- $\gamma_{s,k}$ = cost parameters denoting increases in full comsumption due to speeds and topography T.
- λ_k = cost parameter denoting increases in tires and tubes cost due to road surface condition k.
- $OCVH_i$ = annual operating costs which are dependent on vehicle hours, for vehicle type i
- f_R = fringe benefit rate (ratio of fringe benefits to wages) in region. R
- DW_R = driver hourly wage rate in region R
- DVW_R = inputed driver volunteer wage rate in region R
- VD = proportion of volunteer driver hours out of total driver hours
- VDP = proportion of volunteer dispatcher hours out of total dispatcher hours
- $\frac{DH}{VH}$ = ratio of driver hours to vehicle hours (in large systems this ratio is 1.1, while for most systems it is 1.0)
- $\frac{DPW}{DW}$ = ratio of dispatcher hourly wage to driver wages. While this ratio shows some variability, it is usually 1.0. An exception occurs in instances where some supervisory personnel are used in dispatching on a part-time basis, in which case the ratio becomes 1.10.
- $\frac{DPH}{VH}$ = ratio of dispatcher hours to vehicle hours. This ratio is very volatile, its mean is 0.25 ranging from a low of 0.10 to a high of 0.40
- VH_i = annual vehicle hours of operation of vehicle type i
- θ = 1 if volunteer labor costs are to be inputed in the calculation of social costs, 0 if volunteer labor costs are not inputed, that is, if only monetary costs are analyzed.

OCV_i = annual operating costs which are dependent on the number of vehicles for vehicle type i

INS_i = relative ratio of insurance costs for vehicle type i to the annual insurance cost of a 10-12 seat van (INS_i = 1.5 for 20-seat small transit bus; 2.0 for both 30-seat medium transit and for school buses, and is 2.5 for the large 50-seat transit bus)

INS_R = annual cost of insurance for a basic 10-12 seat van in region R

MR = proportion that dispatch equipment annual maintenance costs are of the acquisition cost of the dispatching equipment.

DR_i = 1 if the vehicle is part of a demand responsive system, 0 if not

LIC_i = annual cost of driver examination, training and tags, (varies from locality to locality)

FCC = annual cost of an FCC radio transmission license; applicable only to demand responsive systems

SC = annual vehicle storage costs per vehicle

N_i = number of vehicles of type in the fleet

DSC_T = cost of acquisition and installation per station of demand responsive systems including base, antenna and repeaters.

$STAT_T$ = number of stations per county according to topographic type T.

DMC_T = cost of acquisition and installation of mobile radio units

OVERHEAD = annual overhead expenses for the rural transportation system

OVRATE = overhead rate which varies according to firm type F. Among the types of firms are Welfare System, city owned and privately owned.

OCM_i = annual operating costs which are dependent on vehicle miles for vehicle type i

$OCVH_i$ = annual operating costs which are dependent on vehicle hours, for vehicle type i

OCV_i = annual operating costs which are dependent on the number of vehicles for vehicle type i

CCI = annual capital cost for vehicle type i

CG = UMTA capital grant subsidy rate

VC_i = vehicle acquisition cost for vehicle i

tv_i = proportion terminal value of vehicle i

tvd_i = proportion terminal value of dispatching equipment type i

$CRF_{n,r}$ = capital recovery factor for n years, and rate of interest r

The second step in producing the "standardized" cost model requires that the equations be stated in terms of a common system output. By multiplying equation (2) by the average operating speed of the vehicle, this equation can be coverted to represent costs per vehicle mile. By multiplying equation (3) by the annual vehicle miles travelled per vehicle, the same result can be realized. Finally, the equation representing capital costs, equation (5) can be multiplied by one over the expected life of the vehicle (in vehicle miles) to yield an equation representing capital costs per mile. By multiplying the indicated equations by the correct factor, the only system output remaining in the equations will be vehicle miles.

It should be noted that the final equation can be adjusted to fit any system. By specifying the correct topographical conditions and service specifications, the cost per mile for a particular system can be determined.

Regionally-Oriented Cost Factors

Adjustments for regional differences in cost factors must begin by defining the regions. We have distinguished four census regions: 1) South 2) Northeast/MidAtlantic (involving New England, and the Mid-Atlantic States), 3) Midwest/Mountain, and 4) Pacific Region (involving California, Oregon, Washington, Alaska, and Hawaii).

Cost factors which vary by region include wage rates, fringe benefits, and insurance costs. The typical cost factors used in this study are presented in Table 3. These cost factors were developed for FY1977 from the information presented in the Section 147 demonstrations. As a general rule there is a divergence in wage rates and insurance costs across regions. The insurance rates vary widely at the state level, while wages vary within states, depending on the unionization of the project staff. Faced with these wide divergences we note in Table 3 the wide ranges of experiences within each region. It is obvious from Table 3 that the highest cost per vehicle mile of transit operation are found in the Northeast and Pacific regions. This is mainly due to the significantly higher wage rates, fringe benefits, and insurance costs in these regions.

Cost Factors Unaffected by Vehicle Type and Regional Location

In addition to the cost factors which are variant according to regional location and vehicle type, several cost factors and cost relationships, were constant across all vehicle types and all locations. These cost factors and cost relationships are presented in Table 4. It should be noted that these costs were fairly constant although cost items such as vehicle storage costs will vary depending on the sophistication of the facilities. Several other costs, including the ratio of dispatchers hours to vehicle hours and the ratio of drivers hours to vehicle hours varied slightly depending on the size of the firm. The ratio of oil and lubrication costs to fuel costs, the proportion of parts in vehicle repairs and maintenance costs, and the ratio of dispatching equipment maintenance to dispatching acquisition costs all exhibit constant values.

An Example

Table 5 provides an example of the costing analysis presented in this paper. To illustrate the methodology a hypothetical transit system was assumed to be operating in the Northeast region with 5 vehicles, each of which covered 25,000 miles annually. The tables present the resulting component costs for each of six vehicle types. All costs in the tables are per vehicle mile. An overhead rate equal to 31% of all operating costs was used.

This costing system is convenient from several standpoints. It allows an immediate examination of how the total costs of a system are allocated. Simply dividing the fuel cost per mile by the total cost per mile yields the percentage of total costs allocated to fuel. The costs presented in this paper were compiled from several sources and accurately represent average conditions in the four geographic regions.

A Note on Economies of Scale

This cost model does not include any adjustments for economies of scale resulting from large rural transit operations. Dr. Gary Nelson has found that the elasticity of transit costs with respect to bus miles is in the range of .98 to 1.01. (1) This is approximately one, implying that transit costs increase proportionally with increases in bus miles. Dr. Nelson points out the fact that the fixed capital costs, which are very high for fixed rail systems, are low for bus transit systems. Since the bulk of bus transit costs are variable costs, it is almost impossible to realize any economies of scale.

Dr. Nelson's findings are supported by David R. Miller in his article on urban bus transit costs. (2) He notes that scale economies are realized only by systems with extremely small operations. Dr. Roger Koenker also concluded that there are no economies of scale in the trucking industry, in the long run. Dr. Koenker's research indicates some economies of scale in the short run, which he attributes mainly to accounting peculiarities. (3)

In this model, the only fixed costs per vehicle are insurance, vehicle storage costs, and driver exam and licensing costs. These costs represent only a small percentage of total operating costs. By driving the vehicles more miles per year, some economies of scale could be realized by reduced costs per mile in the insurance, vehicle storage, and licensing cost categories. But, increasing the number of yearly miles a vehicle is driven may cause increases in repair costs.

Therefore, this model assumes that there are no economies of scale for rural transit operations.

Table 3. Cost Factors Dependent on Regional Characteristics — FY1977

Parametric Cost Factor Description	Symbol	Range of Estimates	Regions			
			South	Northeast/ Mid-Atlantic	Midwest/ Mountain	Pacific
Driver Hourly Wage Rate	DW_R	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*	3.54	6.00	4.90	7.00**
Fringe Benefit Rate	f_R	mean	0.15	0.18	0.15	0.18
Annual Insurance Costs per 10-12 Seat Van	INS_R	low	$ 350	$ 450	$ 300	$ 410
		mean	695	1,000	450	730
		high	1,200	1,200	1,200	1,200

Notes: *the highest cost figures represent wage conditions typical of unionized labor force and wages paid in non-urbanized areas of metropolitan counties.

**driver wage rates of $10.00 per hour characterize the applications from Alaska.

Source: Ecosometrics Incorporated. Tabulations from the Section 147 Rural Public Highway Transportation Demonstrations

Table 4. Cost Factors Unaffected by Vehicle Type and location Characteristics — FY1977

Parametric Cost Factor Description	Parametric Cost Factor Value	Observations
Proportion of oil and lubrication cost of fuel costs	0.05	
Proportion of parts in vehicle repairs and maintenance costs	0.50	
Ratio of dispatching equipment maintenance costs to dispatching equipment acquisition costs.	0.10	
Ratio of dispatching hourly wages to driver hourly wages	1.0	This ratio generally increases to 1.10 whenever supervisory personnel are used for dispatching on a part-time basis
Ratio of dispatcher hours to vehicle hours	0.25	This ratio has a wide variance, ranging from a low of 0.10 to a high of 0.40. The ratio did appear to be related to firm size or region of the country.
Ratio of driver hours to vehicle hours	1.0	This ratio becomes 1.1 in some of the larger systems with more than 20 buses.
License cost for an FCC radio transmission license	$30.00	
Annual storage costs per vehicle	$500.00	
General and administrative overhead expense rate	0.31 0.46	This rate varies from 31 percent for private companies in Pennsylvania and the state of Washington to 46 percent for social welfare transportation systems

Table 5. Typical Demand Responsive Rural Transportation Costs Per Vehicle Mile Northeast and Mid-Atlantic Region — FY1977)

	COSTS PER VEHICLE MILE					
	Auto/ Station Wagon	Van	Small Transit Bus	Medium Transit Bus	Large Transit Bus	School Bus
Adult Seats	8	12	20	30	50	44
Operating speeds (miles per hour)	30	25	18	18	15	15
Cost Categories[a]						
Fuel	0.052	0.069	0.093	0.081	0.097	0.093
Oil	0.003	0.003	0.004	0.004	0.005	0.004
Tires and tubes	0.006	0.010	0.020	0.023	0.005	0.004
Vehicle repairs and maintenance	0.045	0.070	0.090	0.125	0.150	0.140
Driver wages and fringe benefits	0.138	0.165	0.229	0.229	0.275	0.275
Dispatcher wages and fringe benefits	0.035	0.041	0.057	0.057	0.069	0.069
Insurance	0.030	0.040	0.060	0.080	0.100	0.080
Maintenance of dispatching equipment	0.006	0.006	0.006	0.006	0.006	0.006
Driver exam, training, licenses and tags	0.004	0.005	0.009	0.013	0.021	0.021
Vehicle storage costs	0.020	0.020	0.020	0.020	0.020	0.020
General and administrative expenses	0.105	0.134	0.184	0.199	0.233	0.222
Vehicle capital costs	0.064	0.105	0.127	0.194	0.305	0.085
Dispatching equipment capital costs	0.011	0.011	0.011	0.011	0.011	0.011
Total costs per vehicle mile	0.519	0.679	0.910	1.042	1.297	1.030

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A POISSON MODEL OF RURAL TRANSIT RIDERSHIP

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A Poisson Model for ridership on rural public transportation routes is developed. Models are tested on data collected previously in the research, and some modifications made. Illustrated is a technique of using analysis of variance on ridership rates to determine those which are significantly different, so as to form categories for cross-classifications which are not arbitrary.

One of the technical problems facing Rural Public Transportation Planning is the lack of suitable techniques for estimating route ridership. The U.S. Department of Transportation, Office of University Research has sponsored a project at West Virginia University to develop techniques of demand estimation which are compatible with the resource constraints faced by planners in rural areas (1). The more important requirements were that the models should be simple to understand, easy to apply, and be low cost in nature; that is, capable of utilizing existing sources of data, such as the census. At the same time, the methods were to be accurate enough for reasonable estimates of needed vehicle sizes, and potential revenues. Another desirable characteristic was that the models should offer the possibility of transferability from the areas where the model was calibrated to other areas. Yet another concern was that the models be capable of identifying the needs generated by specific target populations along routes, such as the elderly, carless, or households with low income.

The most comprehensive previous work in this area has emphasized the use of regression anlaysis to forecast route ridership as a linear function of aggregate route characteristics such as total population along routes and route length and destination population (4). The same approach was attempted in the first phase of the reported research, but without good results. Generally, these models have met the requirements of being easy to apply, and low cost in nature. The models have often taken an econometric form with a moderately complex underlying structure in which parameters similar to coefficients of elasticity govern the estimates, for example,

$$\frac{R}{P_o \cdot P_d} = A \cdot F^{B1} \cdot D_R^{B2} \qquad (1)$$

where

R - Route passengers/day
P_o - Origin Population
P_d - Destination Population
F - Frequency - vehicle trips/day
D_R - Round Trip distance
A,B1,B2 - coefficients determined by regression.

The sensitivity of the predictions to errors in parameter estimates with this type of model can be high, which means that the application of the model may be limited to the range of values used in calibration and to the area represented by the values. The route ridership approach based on linear regression models has been found to produce large forecasting errors when applied to other areas of the nation (5). Due to the structure of the models, however, the reasons for the error cannot be easily identified and corrected, in as much as the models involve a set of simultaneously determined exponential coefficients. A second drawback of the linear regression models has been a lack of sensitivity to the causal socioeconomic variables which are usually hypothesized to create a need for transit. Though aggregate route variables such as number of households with incomes below $3,000 have been tested as independent variables in regression analyses, they have seldom shown consistent, significant correlations with ridership and have not appeared in the final models. The authors concluded that a different modelling approach was needed.

First it intuitively appeared that probabilistic models were more appropriate than linear causal models. It was observed that one of the major problems with the route regression approach was that the model linear mathematical structure was better suited to the kind of relationship in which transit ridership along a route could be represented as a total magnitude that every person along the route contributed to in an extremely small but consistent amount. In reality rural transit ridership represented a small number of discrete daily occurences from among a large sample space of people. Thus, a probability model structure which could predict the probable range of a small number of riders, was conceptually more appropriate than a linear model structure which failed to recognize the probabilistic aspects of demand. Given this, a second observation followed: it was realistic to depict ridership generation as a phenomenon that occured at the level of the household, where the decision to use transit was influenced by the socioeconomic characteristics of the household. Thus, some form of cross-classification approach was desirable, in which types of households were grouped on the basis of similar ridership rates. Combining the two observations resulted in the concept of a Poisson Model of Rural Transit Ridership which utilized a household level cross-classification of trip rates to establish a probable range of ridership along a route.

The Model

A poisson Model of Rural Transit Ridership may be developed in the following way: let us assume that we have a typical rural transit route that leaves a central city, goes out through the countryside in a loose loop and returns to the city, picking up people with no drop-offs. Let us suppose that we can dimension the loop in some sense, with N being a linear dimension describing the loop, e.g., distance, population, number of autoless, etc. Let the probability of having n people on the bus be $P_n(N)$. Let the probability of picking up one person in a short length of the route, ΔN, be $p\Delta N$. If ΔN is sufficiently short, then the probability of picking up two riders is negligible, so that the probability of picking up no riders is $1 - p\Delta N$. At the point $N + \Delta N$, the probability of having n people on the bus is the sum of two probabilities:

1. The probability of n-1 people on the bus at N times the probability of picking up someone in ΔN.
2. The probability of n people on the bus at N times the probability of picking up nobody in ΔN.

In other words,

$$P_n(N + \Delta N) = P_{n-1}(N)p\Delta N + P_n(N)(1 - p\Delta N) \quad (2)$$

This can be rearranged to read

$$\frac{P_n(N + \Delta N)-P_n(N)}{\Delta N} = p[P_{n-1}(N) - P_n(N)]. \quad (3)$$

letting $\Delta N \to o$ in the limit, we obtain

$$\frac{dP_n(N)}{dN} = p[P_{n-1}(N) - P_n(N)]. \quad (4)$$

To solve this equation, let us start by solving the situation in which the bus is empty and remains empty. In this case 4 simplifies to

$$\frac{dP_o(N)}{dN} = -pP_o(N) \quad (5)$$

Since $P_o(0) = 1$, the solution to 5 is

$$P_o(N) = e^{-pN} \quad (6)$$

For n = 1, 6 can be substituted into 4 to yield

$$\frac{dP_1(N)}{dN} = p[P_o(N) - P_1(N)]. \quad (7)$$

This can be solved to yield

$$p_1(N) = (pN)e^{-pN} \quad (8)$$

And, in general

$$P_n(N) = \frac{(pN)^n}{n!} e^{-pN} \quad (9)$$

which is the Poisson distribution with parameter pN.

To apply the Poisson distribution to the problem of estimating ridership, let us suppose that a route has been divided into sections, designated N_i. If, in each section, we find the probable ridership, we can then sum the probable ridership over all sections to find the total probable route ridership. The probable (or expected) ridership in each section will be the number of riders, X, multiplied by probability of obtaining that given number of riders, $P_x(N)$, and summed over all numbers of riders. In other words

$$S_i = \sum_{x=1}^{\infty} xP_x(N_i) \quad (10)$$

$$= \sum_{x=1}^{\infty} x \frac{(pN_i)^x}{x!} e^{-pN_i} \quad (11)$$

$$= pN_i \quad (12)$$

where S_i is the section ridership.
Probable Route ridership, Q, will be

$$Q = \Sigma S_i = p\sum_i N_i \quad (13)$$

This also shows that the parameter p is independent of section size and that the route can be considered as a whole, merely by summing properties of sections.

To provide more generality, let us suppose that we can divide riders into G groups with each group having its own probability, P_g, of belonging to the subgroup which uses public transportation and probability, r_g, of riding on a given day. The section measure for each group would be N_{ig}, the population in group g for section i. Total probable ridership on a route would be found by summing over all groups. If S_g is ridership by group, then

$$S_g = \Sigma S_{ig} = \Sigma\Sigma p_g r_g N_{ig} = \Sigma(p_g r_g \Sigma N_{ig}) \quad (14)$$

Again, this implies that each group can be treated as a whole for each route. The parameter $\sum_g S_g$ can be used in a Poisson distribution

$$P_n(\Sigma_g S_g) = e^{-\Sigma S_g} (\Sigma_g S_g)^n \quad (15)$$

to estimate the probability associated with different values of total ridership, n, over the route (6).

This approach has a number of advantages which make it theoretically superior to linear regression route models.

1. It is a disaggregate model in the sense that transit users are disaggregated into socioeconomic groups and usage relationships are developed for each group. In this sense, the model

forms the theoretical basis for placing a confidence interval around values obtained with a cross-classification approach (it is relevant to note that cross-classification approaches are rapidly replacing zonal linear regression approaches in urban transportation studies). It is sensitive to the causal factors of transit usage.

2. The model produces the probabilities of attaining given numbers of riders and thus can be used to determine the likelihood that demand would exceed capacity of various sizes of buses. Regression models can give similar information by use of confidence intervals, but the confidence interval has severe drawbacks for forecasting rural transit usage. First, it is possible (and very likely) to give negative values of ridership. Second, there are two confidence intervals that must be considered: one about the regression line itself, the other about a fixed point on a line. The latter is much wider than the former and is more likely to provide negative values. The width of the confidence intervals depends upon the error remaining after the regression line has been fitted; in previous regression models for rural ridership the error has been large, producing very large confidence intervals. In contrast, the probabilities generated by the Poisson model are easier to comprehend, may span a smaller range of values, and there cannot be negative ridership.

3. The model can be applied very simply. Once a calculation of the term $p_g r_g \sum_i N_{ig}$ has been made the planner can go to a table of Poisson probabilities and immediately determine the probabilities associated with different numbers of riders. The planner does not need to understand logarithms. The probabilities p_g and r_g can be explained in a very simple heuristic manner.

Parameter Estimation

Thus far, the means for obtaining the values of p_g have not been discussed. To provide a way to estimate the value of p_g, a maximum likelihood estimator will be derived. Such an estimator would be used on a present route to provide estimates for p_g for use in planning other routes. On a present route, let us suppose that in each section i and for each group g we have n_{ig} people boarding the bus.

For a Poisson distribution, the maximum likelihood is described as the product of all the probabilities for all the observations. One will be done for each class.

$$L_g = \prod_{i=1}^{m} \frac{(p_g N_{ig})^{n_{ig}} e^{-p_g N_{ig}}}{n_{ig}!} \qquad (16)$$

To find the maximum likelihood estimator, we will take the natural log of both sides

$$\ln L_g = \sum_{i=1}^{m} [n_{ig} \ln p_g N_{ig} + \ln e^{-p_g N_{ig}} - \ln n_{ig}!] \qquad (17)$$

Taking the derivative of both sides with respect to p_g and setting it equal to zero yields, for p_g

$$p_g = \frac{\sum_{i=1}^{m} n_{ig}}{\sum_{i=1}^{m} N_{ig}} \qquad (18)$$

This is the maximum likelihood estimator for p_g and is the same estimator one would use in cross-classification trip generation.

Study Area

A portion of northern West Virginia on the boarder of Pennsylvania was chosen for study due to an abundance of existing transit services and nearness to the research institution. The counties studied included Harrison, Monongalia, and Marion. The data base consisted of on-off counts, a survey of rider characteristics, and census data. Maps prepared by the State Department of Highways were used to determine locations of buildings along roads in the study area to estimate the portions of the census population living within 1.21 km of each route. Each of the counties had a county seat of between 26,000 and 35,000 population which served as the focal point for the rural routes. Average density for the rural portions (exclusive of the county seat) of the three county area in which the routes operate is 12 dwelling units per square km (31 per square mile).

Expansion of Survey

The probabilities p_g and r_g were estimated from the rider survey and on-off counts which were conducted as part of the research (1,2). First, the rider survey had to be factored to equal total ridership on the day on-off counts were taken to compensate for people who did not respond to the survey. Among the daily routes, a total of 117 questionnaires were obtained, and there were 277.1 trip ends recorded from the rural areas. Assuming two trip ends were associated with each unique individual in the survey, the factor by which the survey had to be expanded was (277.1)÷(2 x 117)= 1.18. Thus, all responses to the survey questionnaire had to be expanded by this factor. Among weekly routes, a total of 116 questionnaires was returned, and the on-off counts revealed a total of 229.5 trip ends. The expansion factor for this group of riders was estimated as (229.5)÷(2 x 116)= .99, which was close enough to 1 to eliminate the need for any expansion. Next, factors had to be developed to compensate for a sampling bias which caused under-representation of infrequent riders. It was obvious that people who used transit daily or every week on weekly service had a high probability of being included in the survey sample. But the distinct individuals who rode less frequently tended to be under-reported since the odds of surveying them on any given day decreased as their frequency of use decreased.

Mathematically, the problem was expressed as follows: let the expected number of riders who ride x days per month that would appear on a given day of service be S_x. Let the total number of unique individuals who ride x days per month be N_x. If a person rode x days per month and service was offered D days, it was assumed that the odds of surveying him on any random day of the month would be x/D. Thus, the expected number of riders who ride x days per month who would be surveyed on a random day is $S_x = N_x \cdot x/D$. If it is assumed that a sample of riders is taken on one day and the number who indicate they ride x days is S_x, then the total number of unique riders who ride x days can be estimated by

$$N_x = \frac{S_x \cdot D}{x} \qquad (19)$$

The number of weekdays of service offered per month, D, was estimated to be 21.7 days based on an average calculated over a 12-month period (this was approximately 4.34 weeks per month). For daily routes, the number of survey respondents responding to the question, "How often do you ride the bus?" was multiplied by the expansion factor (1.14) for each category of response, to provide S_x. If a person said he or she rode daily, it was assumed to mean 21.7 days per month, the value of x. For responses of "2-4 times a week," "once a week," "2-4 times a month," "once a month," and "less frequently" the number of days per month the individual rode, x, was assumed to be 13.0, 4.3, 2.5, 1.0 and 0.5, respectively. It may be questioned whether people could actually respond to this question in a correct manner. It is possible that they did not provide accurate information but no independent data existed to verify their answers. The answers were assumed correct due to lack of knowledge otherwise. The total number of riders, N_x, who ride x days per month was then estimated by the previous relationship, $N_x = S_x \cdot D/x$. The probability of riding on any given day of service, r_g, was estimated as $\sum_x S_x/\Sigma N$. This approach produced a large number of unique riders and a low probability of riding on a given day. This approach assumed that users were randomly distributed among the days service was offered, and had equal probability of riding on any given day.

Daily Routes

Among the routes operated on a daily basis, total population served (within 1.21 km of route) was estimated as 18,693. The probability that an individual belonging to socioeconomic group g utilized public transportation, P_g, was calculated as the ratio of ΣN_x to the total population living along the route as follows from the development of the maximum liklihood estimator. Previous research done in conjunction with the project showed that there were no significant differences in ridership rates for daily routes among different sub-populations. Age, income, and auto ownership did not appear to influence the rate of ridership. Thus, P_g and r_g were the same for all age, income, and auto ownership groups.

The predictions of the model for each of the daily routes are shown in Table 1. The table lists the minimum number of individuals J which have a cumulative probability greater than .05 of riding on a given day, and the maximum number J which have a cumulative probability less than .95 of riding on a given day. Thus, the J values associated with .05 and .95 cumulative probabilities define a 90 percent confidence interval for the number of riders. Also shown are the expected number of riders $N_g \cdot P_g \cdot r_g$, and the actual number of riders. The cumulative probabilities associated with the actual number of riders are presented, making it possible to determine the likelihood of that many riders actually materializing under the assumptions of the Poisson model. As can be seen in the table, the Poisson model did not fit the data well. Two routes had actual ridership values less than the values associated with the .05 level, and one had actual ridership greater than the .95 level, with the result that only two routes, Crown and Wolf Summit, had values falling within the .90 probability interval of the Poisson model. These results indicated that the model tended to over-predict and under-predict. To further investigate the reasons for this, the relationship between actual ridership rates and accessibility measures were analyzed to determine if accessibility might have had an influence on ridership. The ratio of actual riders to service area population was calculated for each route. This ratio represented the value that the

TABLE 1
POISSON MODEL RESULTS
DAILY ROUTES
Rider estimates based on service area population,
$p \times r = .02600 \times .291 = .00757^a$

Route	90% prob. interval	Expected Riders	Actual Number	Cum Prob. Actual no.
Enterprise	27-45	31.4	18.7	.0120
Crown	8-19	13.8	18.7	.9301
Cheat	24-42	33.2	49.6	.9976
Wolf Summit	31-52	41.7	44.4	.6772
Worthington	14-28	20.9	7.7	.0004

[a]Rider estimates = total trip ends ÷ 2.0

TABLE 2
POISSON MODEL RESULTS
DAILY ROUTES

Rider estimates based on service area population with p x r estimated as a function of route length[a]
$pxr = .000304 \times \text{length (km)}$

Route	90% prob. interval	Expected J	Actual Number	Cum Prob, Actual no.
Enterprise	15-30	22.6	18.7	.2650
Crown	11-24	18.1	18.7	.6463
Cheat	39-61	50.4	49.6	.5126
Wolf Summit	28-47	37.8	44.4	.8628
Worthington	5-16	10.9	7.7	.2416
Doddridge Co.	0-4	2.2	6.6	.9981

[a]Rider estimates - total trip ends ÷ 2.0

Poisson parameter $S_g = P_g \cdot r_g \cdot N_g$ would have to take to provide a good Poisson model estimate of ridership for each route. A plot of the ratio S_g versus route length for each route produced an extremely good straight line relationship with a correlation of .971. A least squares model of S_g versus length with suppression of the g intercept was obtained. The model had an R-square value of .94 and the intercept was not significantly different from zero, making it possible to refit the model with suppression of the intercept. The resulting relationship obtained was

$$\hat{S}_g = .000304 \times \text{route length (km)} \qquad (20)$$

This relationship was used to estimate $\hat{S}_g$ for each route. Results of utilizing $\hat{S}_g$ in place of $S_g = N_g \cdot P_g \cdot r_g$ are shown in Table 2. All actual ridership figures fell within the .90 probability interval except for Doddridge County, which was a new daily route initiated after the model had been developed.

Ridership Estimates for Weekly Routes

Because of previous research carried out (2,3) in conjunction with the project, wherein it was shown that there are significant differences in ridership rates among people of various groups for weekly routes, whereas there were none for daily routes, it was felt that it would be necessary to divide the population into groups and form a cross-classification model for weekly routes.

The independent socioeconomic variables tried in the analysis were age, sex, income and auto ownership. Unfortunately, census data at the enumeration district (ED) level was cross-classified only by age and sex. No cross-classification existed for any other sets of variables. Therefore, only one-variable classifications were available for any variables except age and sex.

The selection of categories in cross-classification is usually somewhat arbitrary. To reduce the arbitrariness and to strengthen the estimates, an analysis of variance was applied. This was done by using the category variables as classification variables for analysis of variance. Even though it was believed that the statistical distribution underlying the cross-classification analysis was Poisson, nevertheless, the cross-classification rates derived were estimates of the means of the Poisson distribution and were therefore normally distributed, and thus could be analyzed using analysis of variance. Furthermore, multiple range tests, such as Duncan's test or Tukey's test, could be applied to the means(rates) of the categories to determine those which were not significantly different from one another. Those which were not significantly different were combined to form new categories which, having a greater number of observations, reduced the variance in the new categories and thereby produced better estimates.

The first step in deriving the model was to estimate the age-sex distribution of the ridership. Individual units of observation were considered to be routes. The questionnaire data (as described previously, (2,3)) was used to estimate the age-sex distribution of riders by route. The number of people in each age-sex category within the service area of the route for each ED was then estimated. The numbers in each category were summed along the route. The ratios of ridership to total population in each category were estimated. The breakdown by age followed those used in the Census. The categories were as follows:

5-14	35-44	65-up
15-24	45-54	
25-34	55-65	

An analysis of variance of the rates was then undertaken for both weekly and daily routes, the results of which are illustrated in Table 3. As illustrated by the table, in the daily routes there was a significant difference between sexes, but not a significant difference by age and no interaction. This tends to follow all previous results and to indicate that a total population-based model may be applicable to daily routes. For weekly routes it was found that there was a significant difference among age groups and by sex and there was significant interaction. To find where the significant difference occurred, Duncan's multiple range test was employed. The results are shown in Table 4. Each letter in the grouping indicates groups in which the means were not significantly different. Three groups were evident, of which two were overlapping. One group stands out by itself, women over 65. Another group is women between the ages of 45 and 64 and men over 65. The third group is all men and women below the age of 45. There is an overlap, since the categories "men over 65" and "women between 45 and 54" belong to two groups. For the purpose of forming cross-classification categories, it appeared that these two old categories should be grouped with the women 55-64. Therefore, the final cross-classification categories derived were:

TABLE 3
ANALYSIS OF VARIANCE OF RIDERSHIP RATES

Source of Variation	Degrees of Freedom	Square	F-Ratio	Prob of F> Calculated
		DAILY		
Sex	1	0.00636	13.56	0.0005
Age	6	0.00358	1.27	0.2847
Interaction	6	0.00307	1.09	0.3791
Residual	56	0.00047		
		WEEKLY		
Sex	1	0.02214	19.65	0.0001
Age	6	0.11144	16.48	0.0001
Interaction	6	0.05458	8.07	
Residual	182	0.00113		

TABLE 4
Grouping of Means for Cross-Classification

CLASSIFICATION Sex	Age	Mean	Grouping
F	65 & over	.1210	A
F	55-64	.0398	B
M	65 & over	.0232	BC
F	45-54	.0203	BC
M	45-54	.0081	C
M	35-44	.0065	C
F	35-44	.0053	C
M	55-64	.0049	C
F	15-24	.0038	C
F	5-14	.0013	C
F	25-34	.0000	C
M	15-24	.0000	C
M	25-34	.0000	C
M	5-14	.0000	C

1. Women over 65
2. Men over 65 and women 45-64
3. All others

With these new categories formed, new rates were calculated. These were:

Group	Rate·trips/person/ day of service
I. Women over 65	.121
II. Men over 65 and women 45-64	.0398
III. All others	.0027

These rates were applied to existing routes and the results are shown in Table 5. Also shown in the table are the Poisson probabilities associated with each route. There were significant over- and underestimates. Only seven out of fourteen estimates were within the 90% interval. With respect to underestimates, these occurred on routes which went through hamlets (population 500-1500) as well as the countryside. To correct this problem, the ridership and population were divided into two groups, those in the countryside and those in hamlets. Ridership rates were then calculated for these two groups separately, and a new estimate was made as shown in Table 6. Rates utilized were as follows:

COUNTRYSIDE RATES

Group		Rate-Trips/Person/Day
I.	Women over 65	.1338
II.	Men over 65 and Women 45-64	.0336
III.	All others	.0029

HAMLET RATES

Group		Rate-Trips/Person/Day
I.	Women over 65	.0424
II.	All others	.0018

A comparison of the two estimates is shown in Table 7. Nine out of fourteen estimates were within the 90% interval. A improvement in ridership estimates was immediately evident. In all cases but two the percentage error decreased. In particular for the three gross over-estimates, much better estimates were obtained.

The same analysis was also performed for auto ownership, household size, and income, using a one-way classification. The error of prediction was greater for each of these than for the age-sex cross-classification. Also, the error was reduced when a division between countryside segments and hamlet segments was used. Nevertheless, the error was still greater than with the age-sex cross-classification as segmented.

Conclusions

Presented in this paper has been a Poisson model for estimating rural transit ridership which utilizes cross-classification data. This model has been derived theoretically, and theoretical estimators for parameters have been derived. These derivations provide a theoretical basis for placing confidence intervals around the cross-classification approach which, heretofore, has been a purely empirical approach to trip generation and modal split. Having a theoretical basis for the approach now permits refinements in the approach, such as the setting of confidence intervals around route estimates and development of statistical tests. A further benefit of the approach is its simplicity which permits its use in all sorts of unsophisticated planning operations.

The application to daily routes shows that there is a significant contribution of route length, which strengthens the model greatly. What the relationship suggests for daily routes is not immediately clear. It could reflect the influence of level of service, or the care taken to locate a route within a service area. Although the relationship to route length is strong, further research is necessary to discover if it is universal. For weekly routes, differing rates by population group were found. The rates can be tested by using analysis of variance and multiple range tests, to provide the best grouping, i.e., the one union which has the minimum variance, yet retains statistically significant differences. A further discovery made was that ridership rates vary according to whether riders are in the countryside or in hamlets, and thus much better estimates were obtained by treating these two areas separately.

Use of cross-classification trip rates for specific groups of people with similar socioeconomic characteristics increased the sensitivity of the prediction of the socioeconomic factors hypothesized to create the need for public transportation. Though the models were not tested outside the portion of West Virginia where they were calibrated, the trip rate approach would make it easier to compare results from one area of the

TABLE 5
POISSON MODEL RESULTS
WEEKLY ROUTES
Rider estimates based on age-sex classification[a]

Route	90% prob. interval	Expected no. J	Actual Number	Cum Prob, Actual no
Grafton	13-28	21.2	12.3	.0227
Mt. Heights	27-48	38.2	20.7	.0018
Blacksville	5-14	9.6	13.2	.8938
Carolina	0-7	4.5	9.8	.9929
Fairview	24-44	34.7	12.0	.0
Kingmont	7-20	14.3	11.8	.3324
Mannington	84-116	100.3	19.3	.0
Colfax	1-7	4.6	10.5	.9972
McWhorter	18-33	25.7	28.0	.7183
Kincheloe	18-33	26.3	22.0	.2349
Johnstown	10-23	16.7	14.0	.3029
Sardis	9-21	15.7	18.0	.7668
Wyatt	55-81	68.6	24.0	.0
Wallace	21-38	29.5	28.0	.4402

[a]Rider estimates = total trip ends.

TABLE 6
POISSON MODEL RESULTS
WEEKLY ROUTES - HAMLET SEPARATED
Rider estimates based on age-sex classification[a]

Route	90% Prob, Interval	Expected J	Actual Number	Cum.Prob, Actual No.
Grafton	16-32	24.3	12.3	.0046
Mt.Heights	13-26	19.5	20.7	.5151
Blacksville	6-16	13.3	10.9	.7905
Carolina	2-8	5.2	9.8	.9823
Fairview	11-24	18.0	12.0	.0917
Kingmont	10-22	16.3	11.8	.5362
Colfox	2-8	5.2	10.5	.9823
Monnington	16-32	24.2	19.3	.1701
Mt.Wharter	11-25	19.0	28.0	.9805
Kincheloe	14-28	21.5	22.0	.5987
Johnstown	9-21	14.9	14.0	.4759
Sardis	11-24	18.0	18.0	.5622
Wyatt	27-46	36.4	24.0	.0193
Wallace	19-34	26.7	28.0	.5739

[a]Rider estimates = total trip ends

TABLE 7
COMPARISON OF RIDERSHIP ESTIMATES

Route	Actual Ridership	Entire Route % Error	Hamlet Separated % Error
Grafton	12.3	72.1	97.7
Mt.Heights	20.7	84.2	-6.0
Blacksville	13.3	-27.8	-18.0
Carolina	9.8	-54.1	-46.7
Fairview	12.0	189.2	50.0
Kingmont	11.8	21.2	38.1
Colfax	10.5	-55.2	-50.5
Mannington	19.3	419.7	25.4
McWhorter	28.0	-8.2	-32.1
Kincheloe	22.0	36.4	-2.3
Johnstown	14.0	19.3	6.4
Sardis	18.0	-12.8	0.0
Wyatt	24.0	185.8	51.7
Wallace	28.0	5.4	-4.6

country to another. Rather than comparing the simultaneously determined coefficients of multiple linear regression models, with their often obscurely intercorrelated values, a comparison could be made of simple age and sex specific rates. Level of service variables such as route length could be used to modify the rates.

In most cases, the models have reasonably accurate results. Over seventy percent of the routes were estimated within a 90 percent confidence interval. Though some predictions were not as accurate as the planner would like to obtain, they were realistic and could easily be used to determine a probable range of demand for planning purposes. For example, by examining the minimum and maximum values of the confidence intervals, the planner possibly could begin to make a preliminary assessment of the need for vehicles of different capacities and the probable range of revenues which could be anticipated.

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RURAL HIGHWAY PUBLIC TRANSPORTATION DEMONSTRATION PROGRAM EVALUATION--PROGRESS REPORT

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Section 147 of the 1973 Federal-Aid Highway Act established the Rural Highway Public Transportation Demonstration Program which authorized funds to encourage the development, improvement, and use of public transportation for residents of non-urban areas, so as to improve access to employment, health care, retail centers, education, and public services. Total funding of $24.65 million for FY 1975 and 1976 permitted the selection of 102 projects from more than 500 applications. Ninety-eight of the projects have been authorized to proceed with about three-fourths in actual operation. A variety of organizational arrangements, service types, and sizes are being demonstrated. There is a significant evaluation component to the program which will provide needed information for future decisions regarding possible national programs for rural transportation. The results of the first two quarters' evaluation, although preliminary, show performance measures comparable to or better than previous rural public transportation projects. It is significant to note that over half of the initial projects studied were performing according to pre-project estimates of ridership and service.

Section 147 of the 1973 Federal-Aid Highway Act established the Rural Highway Public Transportation Demonstration Program which authorized funds to encourage the development, improvement, and use of public transportation for residents of non-urban areas, so as to improve access to employment, health care, retail centers, education, and public services.

The original legislation authorized the expenditure of $30 million for fiscal years 1975 and 1976, and the responsibility for the adiminstration of the program was delegated jointly to the Federal Highway Administration (FHWA) and the Urban Mass Transportation Administration (UMTA).

To implement the provisions of the law, four basic program objectives were established:

1. Increase the mobility of those persons in rural areas who do not have reasonable access to alternate forms of transportation and are often deprived of mobility where public transportation is inadequate or nonexistent.
2. Encourage the various programs or agencies which provide transportation or social services to develop a coordinated approach to the organization and financing of public transportation.
3. Develop the results of the demonstration into a useful guide for rural areas needing public transportation.
4. Develop the technical, organizational, and economic information needed for future decisions regarding national programs for ruraltransportation.

The following sections discuss the program results as compared to these objectives, describing the progress that has been made to date, evaluation results, and problems that have been encountered.

Service Characteristics

Initially, Congress authorized $30 million for FY 1975 and 1976. The authorization was later increased to a total of $75 million by the 1974 amendments to the Federal-Aid Highway Act. However, actual appropriations for the 2 years that this program was funded amounted to only $24.65 million. This level of funding permitted the selection of only 102 projects from more than 500 applications that were submitted over a 2-year period. Ninety-eight of these preliminarily selected projects have completed the public hearing requirements and have been authorized to proceed with project implementation. To date, three-fourths of these projects have begun actual operations, with the others expected to begin very shortly.

The projects represent a variety of types, sizes and organizational schemes. They can range from the smallest one-bus, fixed-route system sponsored by a local town or social service organization, to relatively large, multicounty or regional transportation authorities providing fixed-route, demand-responsive, and contract-type service. The actual services are operated either by the project sponsors themselves, or by existing private operators under contract.

One of the more interesting approaches being observed is a six-county project operated by a regional transportation authority. A survey of the six counties found that there were several small, private bus companies, mostly working on charter and school contracts. After determining the type and level of public transportation service that was needed, rather than establish a new operation, the authority decided to request bids from private operators (on a cost-per-vehicle-mile basis). In areas with insufficient vehicles, the authority purchased the necessary additional buses and made them available at cost to the private operators. The authority also acts as a broker and arranges contract service with the local social service agencies. Since the agencies pay a fixed price based on the route miles of service, they have a strong incentive to fill up the vehicles and thus reduce the per-passenger cost. Due to the success of this operation, the area's largest agency on aging has recently decided to abandon its own service and will contract exclusively with the authority.

In order to ensure the provision of transportation service on an ongoing and cost-effective basis, many of the projects have been quite resourceful in obtaining different sources of support. In addition to the previously mentioned contracts with social service agencies, projects have obtained subsidies from local towns or counties through grants or agreements for sharing expenditures based on vehicle miles of service provided to the different jurisdictions; universities have agreed to purchase full fare passes to be made available to the student body at discount; projects have obtained capital and operating assistance from State programs available for such purposes; projects are acting as local ticket agents for larger intercity carriers that serve the project area; and finally, many projects obtain additional income through package and meal pickup and delivery services.

Coordination

The second objective, coordination, has been strongly emphasized throughout the program. It was recognized in the developmental stages that, this being a demonstration program with only "one shot" funding, every effort would have to be made to obtain ongoing local support together with any other Federal or State funding support available, not only for the demonstration period, but for continuation beyond the demonstration phase as well. With this in mind, a decision was made early in the program to administer the demonstration projects through the State transportation agencies. With 102 projects covering 48 of the 50 States, this decision to work through the States has proven to be a fortunate one.

In our view, the State role as coordinator is extremely important. Effective coordination means much more than the physical linking of transportation services over a defined territory into a multicounty regional network. It also means coordinating the activities of various State and Federal agencies that can be used to promote effective public transportation, such as regulatory agencies like the public utilities commission and the insurance commission, as well as State agencies whose functions often require them to provide transportation, most notably departments of education and departments of human resources or welfare.

Some examples of State activities that have provided assistance to the Section 147 applicants are:

1. Technical assistance to applicants in developing a service plan. This included the preparation of a detailed operating plan, a budget, and the development and printing of a report document which served as an application. States also provided sample resolutions and assisted in the development of an operating organization.

2. Advertising and conduct of the public hearing on the project, including arrangements for a verbatim transcript.

3. Preparation of a contract between the State transportation agency and the applicant agency, and assistance in development of local agreements necessary for multijurisdictional areas forming transportation authorities.

4. Assistance in developing vehicle specifications and purchase of vehicles through State purchase orders.

5. Assistance in hiring and training drivers, selecting and acquiring garage, maintenance, and dispatch facilities.

6. Assistance in conducting ridership surveys.

7. Financial assistance during and after the demonstration project.

8. Coordination with other State agencies to encourage their use of the transportation services provided by the project.

9. Investigation of regulatory and statutory restraints that create barriers to the provision of public transportation services, and development of legislative action to overcome these restraints.

To encourage coordination at the local level, each applicant had to identify all existing transportation providers (public and private) in the proposed service area and had to describe how these existing services would be integrated into the proposed operation. In addition, applicants were requested to provide statements of commitment from agencies or organizations providing or needing transportation to use the areawide service funded under the demonstration. This commitment to coordination was one of the most important criteria in determining which applications would be selected for funding. Not surprisingly, (and with varying degrees of enthusiasm) coordination and consolidation of transportation services at the project level is taking place.

Finally, at both the Federal-regional, and the national level, representatives of the various Federal agencies which either need or provide transportation for the delivery of their services were brought together with representatives of the Department of Transportation to see what could be done in terms of coordinating transportation services across the many programs which they administer and for which they provide funding support. In the case of the Department of Health, Education, and Welfare (HEW), this has resulted in the review of their existing statutory requirements and administrative procedures for the delivery of social service programs, so as to identify any actual or perceived barriers to the coordination and consolidation of their service delivery systems. The HEW field offices have been instructed to make every effort to streamline administrative procedures to facilitate such coordination and to report to the national office any problems or obstacles in achieving this objective.

Performance Evaluation

The last two program objectives relate to the evaluation of the demonstration results. On a quarterly basis, each project reports to us summaries of the following information: vehicle trip statistics, passenger-trip statistics, trip purposes, revenues and costs, and a narrative discussion. From this information we calculate performance measures for each project and for the national program, and compare these measures to those of the previous quarter. As most of the projects have become operational since the first of 1977, our operating data so far is based on a relatively small number of projects.

Each quarter, a set of three computer tabulations are produced for each project that is operating vehicles and has submitted the completed data forms. The format allows for comparison of the particular project with its peer group and with the national average of all projects evaluated for that quarter. Peer groups were not developed for the first two quarters because of the small number of projects (8 and 18 respectively). Results of the second quarter evaluation follow.

Ridership

Passenger-trips per quarter for the April - June 1977 quarter ranged from a low of 65 trips (for a project operating one vehicle) to 17,347 trips (for a project operating 21 vehicles). For the 18 projects, an average of 27.4 percent of the trips were by elderly riders (with a range of 2.1 percent to 58.3 percent). Handicapped riders comprised 12.4 percent of the trips, with a range from 0 to 53.9 percent. While all projects are required to be able to meet the service needs of elderly and handicapped riders, some projects have obviously been more successful than others.

Excluding to-home trips, the predominant trip purposes were work, school/education, and shopping, the three making up over one-half of all trips; the remaining included nutrition sites, social/recreation, medical, and other miscellaneous trip purposes. The 1972 study of transportation of the rural disadvantaged by Burkhardt (1) showed the predominant trip purposes in the five States studied were also work, shopping, and school.

Costs and Revenues

Drivers' wages account for just over half the operating costs. Fuel, repairs, and insurance are the other significant items, and contribute about a third of the operating costs. Administrative costs, which are calculated separately, are made up predominately by supervisory labor, with office expenses being the other significant cost item in this category.

Operating revenues come from a variety of sources, but the predominant sources are: contracts, 49.6 percent; and fares, passes, and contributions, 40.4 percent. Revenues for the 18 projects averaged $0.62 per passenger trip and covered about 20 percent of the operating and administrative costs.

Grants for the rural projects came 74.3 percent from Federal sources, with States contributing 18.7 percent, and local and private agencies contributing 7.0 percent.

Performance Measures

Performance or productivity measurements provide meaningful comparisons between projects and useful national rural transportation indicators. Several different performance measures--e.g., per vehicle-mile, vehicle-hour, passenger-trip, or passenger-mile--have been used to evaluate transit systems. All were used in our evaluation so the measures could be compared to various other studies.

The average trip length (passenger-miles/passenger-trip) of 9.7 miles (range 3.9 to 91.5 miles) reflects the longer trips for rural systems as compared to average urban public transportation trip lengths--e.g., 8.3 miles for work travel. (2)

Seat-miles per vehicle-mile averaged 14.7 whereas passenger-miles per vehicle-mile were only 1.8 on the average. The resulting load factors (passenger-miles per seat-mile) averaged 12.1 percent, with a range from 4.8 to 36.5 percent. The Governor's Task Force on Rural Transportation in Pennsylvania (3) assumes load factors of 18 and 33 percent to calculate costs for proposed rural operations. Since many of the Section 147 projects are in initial operations, the load factors are expected to improve over time.

Operating cost measures vary considerably. Operating and administrative costs (i.e., all non-capital costs) per passenger-trip average $3.25 for the 18 projects, the range being $1.54 to $10.47. Revis (4) reports that operating costs for van-type service for the transportation disadvantaged in rural areas appear to have ranged from $3.50 to $7.50 per passenger-trip. For specialized services in urban areas, Revis estimated costs of $1.20 to $1.50 per passenger-trip. Operating costs per bus passenger for conventional urban transit averaged $0.54 in 1976. (5)

Operating costs (including administrative costs) per vehicle-mile averaged only $0.59 for the 18 projects. Costs reported by Revis (4) for rural projects were $0.50 to $0.70 per vehicle-mile. Bruton, et al., in 1972 (6) reported similar costs for rural projects, i.e., $0.33 to $0.60 per vehicle-mile. McKelvey (7) reports similar cost results. Operating costs per vehicle-mile for urban systems were $1.90 in 1976. (5) This reflects factors such as higher labor costs, lower speeds, and larger vehicles for urban operations.

Operating costs per passenger mile averaged $0.33 for the 18 rural projects. This is an important measure of performance but, unfortunately, few other programs or systems have collected passenger-mile information.

Fuel efficiency for the 18 projects averaged 16.0 passenger-miles per gallon. Dividing by 1.8 passenger-miles per vehicle-mile gives 9.0 miles per gallon. This is about as expected for a minibus or van (8) operating at an average speed of about 20 miles per hour. Typical urban transit bus fuel efficiency is about 4.3 miles per gallon. (9)

For 17 of the 18 projects which had submitted pre-operational estimates of passenger-trips and vehicle-miles, a comparison was made to actual performance. It was encouraging to find that, for 10 of the 17, performance was close to or above expectations; one project is carrying four-and-one-half times more passengers than expected with half the vehicle-miles. The remaining 7 projects anticipated substantially higher passenger-trips than they are actually getting.

It should be emphasized again that these results cover only a small number of the total projects in the 147 program. Also, as stated earlier, data for most of the projects are for the early stages of their demonstration period. Crain (10) indicates significant improvement in unit operating costs over time in an UMTA-sponsored demonstration project for the elderly. For both of these reasons, the performance measures are likely to change in subsequent quarters.

Start-up Problems

The start-up period has taken considerably longer than had been expected--from 6 months to a year from the date a project is selected for funding

In addition to the requirement for having public hearings, which are mandated by Congress, there are delays in developing vehicle specifications, obtaining vehicle insurance, delivery of vehicles from manufacturers, etc. Some projects waited over 6 months to get deliveries.

Another factor contributing to project start-up delay is that the proposals that were selected for funding had been written quite some time ago and changes in the local political situation had occurred since that time. The former governor or county commissioner or mayor that was very supportive of a project, for example, might no longer be in office. The new county commissioners might not be nearly as supportive of the public transportation project, especially when they realize that it might take quite a bit of local financial support to keep the operation going once the demonstration period ended.

Other things that tend to delay start-up are regulatory problems in certain areas and objections to the proposed service from existing providers. Some projects also have problems with inter-local agreements as the projects might be serving several different jurisdictions, all of which are, of course, expected to join together to support the system and share the costs. Problems develop as jurisdictions usually strive for a higher level of service and a lower share of the costs.

The experiences of many of the projects with the above problems have lead to successful efforts in seeking and obtaining solutions. Several State transportation agencies have developed standard vehicle specifications and have agreed to purchase, through State procurement channels, the vans and buses needed for the projects. State agencies, working closely with the projects, have also succeeded in developing new model regulations governing the licensing and operation of smaller local public transportation systems. This, in turn, has led to efforts to obtain more reasonable insurance rates for these previously difficult-to-classify projects. Increasingly, programs are also being developed at the State level to share the costs of establishing and operating rural public transportation systems.

In conclusion, we are pleased with the overall progress that has been made through the initial operational stages of the demonstration program. With all of the projects either operating or on the verge of becoming operational, efforts over the next year will be concentrated on program monitoring, evaluation, and information dissemination.

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ATTITUDES TOWARD TRANSIT SERVICE IN SMALL URBAN AREAS

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An analysis of the attitudes of residents of several small urban areas toward transit improvement was conducted in an attempt to identify groups with similar preferences. The groups were described by several demographic characteristics: age, sex, auto owned. Two methods were used: a comparison of the preference rankings of each group across the cities; and discriminant analysis to identify groups with similar attitudes. The results indicate that there is some similarity within certain demographic groups, across the cities. However, respondents as a whole exhibited great similarity of preferred choices, irrespective of demographics or city. The two most preferred improvements were special vehicles for the handicapped and reduced fares for the elderly and handicapped. It is concluded that there exists some similarity in the attitudes towards transit improvement among the cities, but the development of any distinct groups proved impossible with the limited set of demographics available for use in this study.

This study compares the attitudes of the residents of seven small urban areas in upstate New York towards transit service improvements. The objective is to test the hypothesis that a similarity of attitudes towards transit improvements exists within certain demographic groups across these communities, independent of the residence location. If the hypothesis is found to be correct, the necessity to survey each small urban area to determine the response to various system improvements will be reduced, saving a considerable amount of time and effort in the planning for those improvements. The availability of this large data base, consisting of data from small urban areas, provided an excellent opportunity to test this hypothesis.

Background

During 1974 and 1975, home-interview surveys were conducted in small upstate New York cities. The New York State Department of Transportation (NYSDOT) surveyed three cities (Hudson, Johnstown-Gloversville, and Oneonta) and Applied Research Integration, Ltd. (ARI) surveyed four cities (Glens Falls, Plattsburg, Watertown, and Elmira). The purpose of these studies was to determine the potential market of fixed-route and dial-a-bus operations. In each community, respondents were chosen at random, and questions were used to determine the frequency with which the respondent would use those bus services under varying levels of fares and gasoline prices (non-commitment ridership), the level of subsidy the respondents were willing to pay to support the system, and attitudinal questions asking for the individual's most preferred system improvement. Map 1 and Table 1 summarize the location and characteristics of the communities. It should be pointed out that these places are not suburbs of large metropolitan areas, but rather, each is the central point for a fairly large rural region.

An analysis of the non-commitment ridership rates (1) showed that the expected number of trips per week per resident was approximately the same for similar residents across each community. Two possible reasons were advanced to explain that similarity. First, the method used to forecast the ridership rates could force the same results for each city, or alternatively, the people in those communities could have the same attitudes towards transit. The purpose of this study is to examine the attitudinal information in the data set in an effort to determine if any similarity of attitudes towards transit exists between these small upstate New York cities, or among the various groups within them.

Limited evidence now exists to support this hypothesis from two studies dealing with the comparison of attitudes in small urban areas. The first was performed in New York State, comparing the attitudes of different urban areas toward transit service (2). A statewide public opinion poll of 1,000 households was conducted on public transportation roles, services, and financing. Included in the survey was a question dealing with reduced fares and special services for disadvantaged groups, specifically the elderly and handicapped, low-income, and school-age children. It was reported that, generally, there was strong support to provide some special services and/or

Map 1. Location of the small urban areas in New York State.

Table 1. Characteristics of the small urban areas.

City	1970 Population	% 65+	% 0-Car HH	1970 Median Family Income	% Blue Collar
Glens Falls	17222	14.3%	24.3%	9861	53.9%
Plattsburg	18715	9.9%	20.7%	10165	43.5%
Watertown	30787	14.9%	24.5%	10113	52.7%
Elmira	39945	13.7%	27.8%	9145	55.8%
Hudson	8940	17.4%	36.4%	9093	58.0%
Johnstown-Gloversville	29722	15.6%	22.5%	9576	63.4%
Oneonta	16030	11.2%	21.8%	11062	41.5%

lower fares for the elderly and handicapped, followed by school-age children, and low-income. This sentiment was expressed by all groups across the state.

The second study (3) reviewed the effects of transportation availability on the vitality of small communities, and the transportation-related problems and needs of those areas. Eight small communities in Maine, Vermont, South Carolina, and Colorado were studied. Over 300 interviews with community leaders, employers, and other residents were conducted to determine their perceptions of the existing transportation facilities and needs. In addition, about 100 questionnaires were distributed to those people interviewed to survey their opinions on alternative transportation strategies for meeting those needs. The results of the interviews and surveys showed there is great concern for the mobility of the transportation-disadvantaged, specifically the elderly, the handicapped, and the low-income. Strategies for dealing with this need were ranked high by those individuals who completed the questionnaire. No discernible pattern by which the states varied from one another was observed in these results.

Questionnaire Structure

In each survey the respondents were asked to indicate which one of a set of potential improvements to a transit system they would prefer most (Table 2). The list of possible improvements used in each questionnaire was virtually identical; however, the surveys differ in the system for which the preferred improvement is requested. The NYSDOT surveys directed the respondent to indicate the most preferred improvement for each system, fixed-route and dial-a-bus, separately, where the potential improvement list differed slightly. The ARI survey requested that the individuals select their most preferred improvement for any of the three systems (fixed-route, dial-a-bus, and shared-ride taxi) with the list of possible improvements similar to the NYSDOT lists. Almost half of the options have to do with reduced fare policies for special groups. Only one had any relation to the work trip (subscription service); the rest were primarily for non-work travel. Since these questions were asked in slightly different contexts, care must be exercised when comparing the responses among cities.

Analysis

An examination of the responses to the NYSDOT surveys revealed that each city surveyed expressed similar preferences for improvements to fixed-route systems and improvements to dial-a-bus systems. Thus, the responses to the NYSDOT questions can be assumed to be independent of the bus system under consideration, and hence, are directly comparable to the ARI responses.

The analysis of the responses was performed in two phases. First, a ranking of the improvement options based on the frequency each was selected by the respondents was developed for each community, controlling for several demographic characteristics. The second phase used discriminant analysis to uncover similar groups of respondents based on their most preferred system improvement. Due to data access limitations, discriminant analysis was only performed in two cities: Hudson and Johnstown-Gloversville. Each city was examined using two types of groupings of respondents: one with two different categories of improvements, and the other with three.

The results from the frequency rankings are illustrated in Figure 1. The improvements shown here are those which placed at the top of the frequency rankings. The information for each city, across the demographics, is read horizontally; the information for a demographic group, across the cities, is read vertically. The dominance of the preferences for Reduced Fares for the Elderly and Handicapped is obvious. Other improvements are also rated first in the frequency rankings, but Reduced Fares for the Elderly and Handicapped is clearly the next most preferred improvement. The similarities between the cities within the demographic groups are also evident. However, there is also similarity between the demographic groups, within the cities, as evidenced by Oneonta, Hudson, Watertown, and Plattsburg.

Based on these results, several conclusions can be reached. In most communities and most demographic groups, the most preferred system improvements are Reduced Fares for the Elderly and Handicapped followed by Special Services for the Handicapped. In most cities and groups, these two transit improvement options rank as the top two respectively. This indicates some concern by all the residents of these areas for special planning for those special groups. Secondly, it is clear that the demographic characteristics of AGE, SEX, and AUTO OWNERSHIP seem to have little effect on the individual's preferences for transit service improvements.

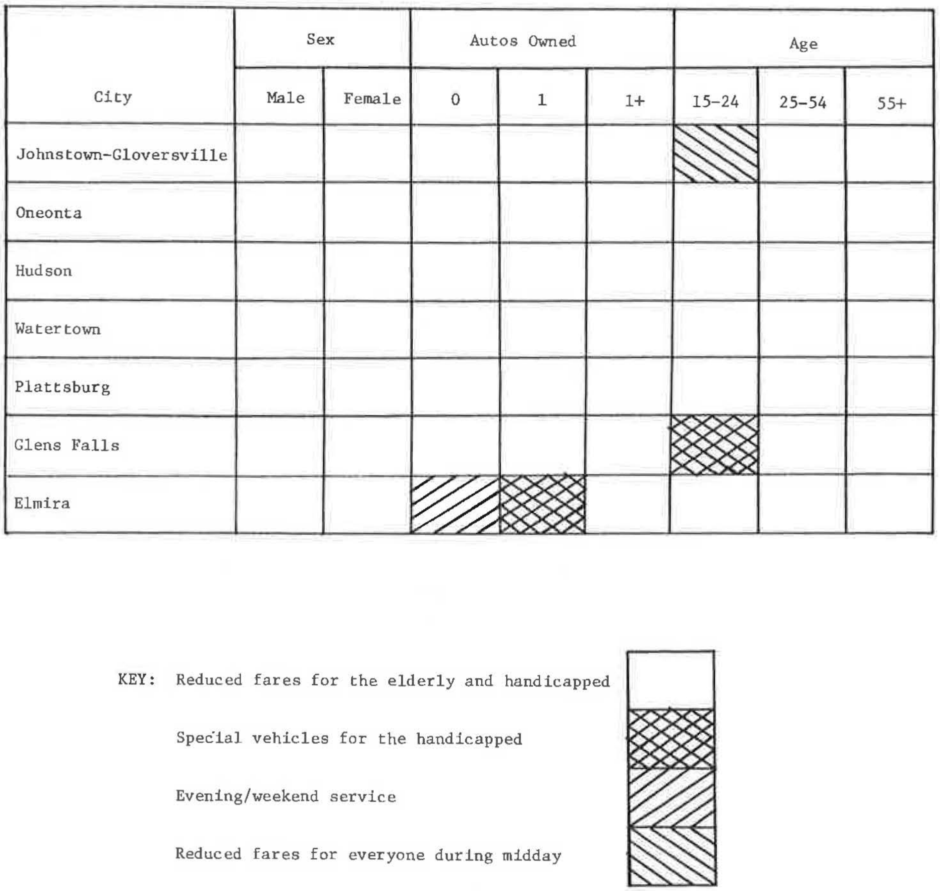
For the discriminant analysis, the three demographic variables used earlier are included, as well as two others: PROPOSED TRIP PURPOSE ON LOCAL

Table 2. List of improvement options.

Improvement	NYSDOT Fixed-Route	NYSDOT Dial-A-Bus	ARI All
Special vehicles for handicapped	x		x
Buses to special events	x		x
Reduced fares for elderly and handicapped	x	x	x
Reduced fares for poor	x	x	x
Reduced fares for school children	x	x	x
Reduced fares for everyone during midday	x		x
Free shopping trips to particular stores	x	x	x
Evening service[a]	x	x	x
Weekend service[a]	x	x	x
Subscription service		x	x
Family and group reduced rates		x	
Other	x	x	x

[a]Combined into one improvement in NYSDOT survey (evening and weekend service)

Figure 1. Most preferred improvement options.



BUS, and PROPOSED TRIP PURPOSE ON DIAL-A-BUS. These variables were used to see how well they would discriminate between groups of respondents. In each of these two cities, two discriminant analysis runs were performed, dividing the respondents into two or three categories, based on the most preferred improvement selected by each individual. These categories are listed in Figure 2. It is felt that these categories represent some rational groupings of the improvement options.

The results for this portion of the analysis are presented in Tables 3-6. In no case were the discriminant models significant. All had insignificant F-statistics, and the model could only correctly classify 60% of the respondents. Therefore, it can be concluded that the variable used in these models (AGE, SEX, AUTO OWNERSHIP, and the two TRIP PURPOSES) are not good predictors of the preferences for transit service improvements. This discriminant analysis result gives added support to the conclusion reached in the first portion of the analysis: i.e., the demographics have little effect on the respondent's choice of service improvement.

Figure 2. Categories used in discriminant analysis.

2-Category		3-Category
Services for the mobility - restricted	Special vehicles for the handicapped	Services for the disadvantaged
	Reduced fares for elderly and handicapped	
	Reduced fares for the poor	
	Reduced fares for school children	Reduced fares
Extra services	Reduced fares for everyone during midday	
	Evening/weekend service	Extra services
	Buses to special events	
	Free shopping trips to particular stores	

Table 3. Discriminant model statistics.

City	Groups	Approx. F	U-Statistic
Johnstown-Gloversville	2	1.717 (5,196)	
Johnstown-Gloversville	3	1.203 (10,390)	0.981 (5, 2, 199)
Hudson	3	2.348 (10,394)	0.891 (5, 2, 201)

Table 4. Johnstown-Gloversville, 2 group classification.

Group	Number of cases classified into group A	B
A	78	50
B	34	40

Table 5. Johnstown-Gloversville, 3 group classification.

Group	Number of cases classified into group A	B	C
A	54	16	29
B	22	14	19
C	15	13	20

Table 6. Hudson, 3 group classification.

Group	Number of cases classified into group A	B	C
A	67	40	27
B	9	25	14
C	6	8	8

Conclusion and Implications

In summary, it was found that the most preferred improvements to transit service were Reduced Fares for the Elderly and Handicapped, and Special Services for the Handicapped. Similarity of attitudes was found among the cities within each demographic group. However, there was also similarity between the groups themselves, leading to the conclusion that the groups are not distinct. It may be stated that the residents of these seven small urban areas exhibit similar attitudes towards transit service improvements, and the strength of that similarity is strong. There is extremely strong support for planning for the elderly and handicapped by almost every group in every city. The mobility problems of these travelers are a large concern of the residents of these communities. The implication of this type of study is important since survey efforts to plan transit services in other communities may be reduced, reoriented, or eliminated if a similarity of attitudes is uncovered. The responses to the implementation of, or improvement to, a transit system could be better predicted. If it functions well in one area, planners could expect a similar reaction from the residents of another area. The development of effective and efficient transit improvement strategies could be enhanced by consideration of the residents' attitudes toward various options. A word of caution, however: care must be exercised to account for any special or extraordinary groups or attitudes which may be present in the area being studied, as these groups or attitudes may seriously affect the results.

Overall, it is felt that this research shows some promise, and future efforts should be initiated to further the conclusion reached in this study.

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Abridgment

PUBLIC TRANSPORTATION PLANNING FOR THE SUBURBS

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Due to the demogaphic characteristics of suburban areas and the unusual transportation problems they present, effective public transportation planning demands flexible and innovative approaches. This paper describes a unique procedure used in a recent planning assignment for Camden and Burlington Counties, the New Jersey suburbs of Philadelphia. They typify the diversified geographic, socio-economic and population attributes and limited planning resources of such areas across the country. The essence of the planning methodology was a "prototype" approach which entailed:

- *Formulating a list of the bi-county transportation problems which was then condensed to a shorter list of "model problems."*
- *Selecting a "prototype" for each particular problem within the general categories of: transit user groups, geographic areas and major trip attractors/generators.*
- *Developing a unique solution for each problem.*
- *Analyzing each prototype solution for adaptability to other similar problems within the same group.*

Using this mechanism as the primary tool for public transportation planning for suburban areas maximixes the impact of available resources by concentrating upon solving specific problems while concurrently establishing the basis for wide application of results and recommendations.

Public transportation planning for suburban areas presents a variety of problems which, in their number and diversity, stand in stark contrast to the relatively common and homogeneous issues comprising the planning agenda in urban areas. Other than in the few heavily-traveled corridors linking residential suburbs with the central city, travel patterns are unfocused. Major employment centers are isolated and often consist of a single employer rather than the very heavy concentrations found in commercial or industrial sections of the city. Schools, hospitals and governmental activities are scattered. Pockets of transit dependents, particularly the elderly, are dispersed. Development patterns range from concentrated small cities to commercial strips or isolated regional shopping centers to rural. And the transportation infrastructure, in terms of both institutions and facilities, is fragmented.

Compounding these difficulties, the resources available to support the planning effort and, perhaps more significant, the implementation of changes and improvements, are severely limited.

Innovative approaches are necessary to deal successfully with these problems. Comprehensive regional plans emphasizing traditional area-wide public transportation systemic approaches must give way to individualized elements geared to addressing unique sub-regional problems. In a recent planning effort for Camden and Burlington Counties, the New Jersey suburbs of Philadelphia, an unusual planning methodology was developed, tested and applied.

The key element in this procedure was termed a "prototypical" approach. It consisted of:

- grouping all the particular public transportation deficiencies in the two counties by aggregating those of a similar nature, thus producing a relatively short list of problems, each of which might be amenable to a common solution;
- selecting one particular situation or geographic area from each group as a prototype for that type of problem;
- developing a unique solution for each of the prototypes chosen; and
- examining the applicability of that solution to other problems in the same group.

Certainly this concept of "prototypical solutions," if not the name, is neither new nor startling. Borrowing an idea which works in one city, and adapting it to fit a similar situation in another, is a legitimate, appropriate and frequently used tool in the planning process. What is different in this instance is the systematic application of this procedure as the principal planning mechanism in a public transportation study.

The balance of this paper describes how the prototypical approach was applied in Camden and Burlington Counties. But first it is necessary to describe briefly the public transportation environment in which the study was performed.

The Transportation Setting

The bi-county area is typical of suburban areas across the country in many respects. Population has increased rapidly -- by more than 80% since 1950 -- from about 437,000 to the current level of about 805,000 residents. There is great diversity in socio-economic, developmental and land-use patterns. The character of development varies from core city urban

Table 1. Prototype Candidates.

Category	Criteria	Examples of Candidates: Camden County	Examples of Candidates: Burlington County
User Groups			
Senior Citizens	Areas with high concentrations and 4,000 elderly people or more	Pennsauken Merchantville	Riverfront Communities
Handicapped	Entire Bi-County Area		
Low-Income	Entire Bi-County Area		
Geographic Areas			
Multi-Units	Communities with high concentrations of residential land use	Lindenwold Pennsauken	Burlington City Mt. Holly
Isolated Single-Family Homes	Greater than 200 dwelling units	Winslow Crossing Glen Oakes	Medford Lakes Ramblewood
Rural	50% or more of its area devoted to non-residentail use and density less than 600 people/square mile	Chesilhurst Waterford	Bass River Lumberton
Trip Attractors/Generators			
Town Center	Central Business District and greater than 200 employers	Haddonfield Gloucester City	Mt. Holly Burlington City
Regional Commercial Center	Regional influence and greater than 500,000 sq. ft. of gross leasable space	Echelon Mall Cherry Hill Mall	Moorestown Mall Willingboro Plaza
Single Employers	Over 2,000 employees at one location	RCA Campbell Soup	Public Service E&G RCA
Industrial Park	None	Fishers Dike	East Gate/Mt. Laurel
Hospitals	Greater than 100 beds	Cooper Our Lady of Lourdes	Garden State Comm Deborah
Colleges	More than 2,000 students	Rutgers (Camden) Camden Community	Burlington Community
Government	Regional Influence	Camden City Hall Lakeland	Burlington County Complex

to suburban to rural, even to wilderness in eastern Burlington County. Communities vary from older well-established towns with mature institutions to newer areas still establishing their structures. Income levels vary from very high to so low as to approach poverty levels -- median family incomes range from a high of $15,786 to a low of $7,279. Residential population density varies from 56,590 to 360 persons per square mile of residential area.

The major trip market is focused on Philadelphia, but the Trenton area also exerts considerable influence. Intra-county travel is increasing dramatically as industry continues its migration to the suburbs and regional shopping and service centers develop. Interspaced throughout the counties are specialized types of travel generators, creating their own unique needs.

Of particular interest in considering possible public transportation improvements are the 'transit dependents' who either have no automobile available to meet their mobility needs or who have only limited access to an auto. These people comprise a relatively significant proportion of the bi-county population and include the young (about 30% of the bi-county population); the elderly (9% of Camden County's population and 6% in Burlington County); low-income families (5% of the families in Burlington County and 7% in Camden County); and zero-auto households (10% of Burlington County households and 16% in Camden County).

The transportation infrasturcture serving the bi-county travel market is severely limited. Conrail service connecting the area with Atlantic shore communities is the single surviving railroad passenger link. The highway network includes only perhaps half a dozen major arterials, all operating at or near capacity. Substantial volumes of local traffic move on the three limited-access facilities which pass through one or both counties.

The institutional framework is fragmentary at best. The Delaware Valley Regional Planning Commission coordinates planning activities, but transportation operations are subject to no single controlling authority. The Interstate Commerce Commission, the Delaware River Port Authority, New Jersey DOT, New Jersey PUC, and county and municipal authorities are all variously involved in regulating and operating highway and transit facilities.

It is not surprising that the public transportation system which has developed in this setting is diverse and poorly coordinated. It has grown rapidly and includes as its major components:

- Transport of New Jersey (TNJ) buses on radial, intercity and feeder routes, many subsidized by New Jersey DOT.
- Delaware River Port Authority High Speed Line (PATCO) rapid transit service.
- Community or social service agency-supported special transit services, primarily oriented to serving the elderly and handicapped.
- About 25 taxicab operations ranging from small, one-cab, owner-operated services to larger fleet-type operations involving as many as 75 vehicles.

Prototype Approach

The diversity of travel needs and desires, the shortfalls of existing transit services and the variety of public transportation operations in the two counties made it highly unlikely that there would be a single solution to the area's public

Table 2. Summary of Prototypical Service Improvement Proposals

CATEGORY	FACILITY/AREA	SERVICE IMPROVEMENT PROPOSALS
Government Center	Burlington County Complex	• Employee Carpooling • Rover Bus Service
College	Burlington County Community College	• Improved TNJ Service • One Club Bus Route • Employee Vanpooling
Elderly	Burlington County Riverfront Communities	• Expanded Rover Bus Service
Elderly	Pennsauken/Merchantville	• Free-fare Community Loop Route
Town Center	Mount Holly	• Improved TNJ Service • Three Jitney Routes
Employer	Campbell Soup	• Expanded Shuttle Service • Fare Reduction Program • Employee Vanpooling
Regional/Commercial Center	Echelon	• Improved TNJ Service • Shared Taxi Service

transportation problems. Rather, it appeared that a series of different proposals and concepts would be required to accommodate current and short-range needs.

In order to guarantee wide applicability of results, the study was designed to develop prototypical service improvement proposals. The prototype approach involved selecting "model problems" aimed at specific user groups, geographic areas or major trip generators and detailing specific solutions for particular problems. Thus, a transit service plan developed for a regional commercial center could be readily adapted to other regional centers. A service plan aimed at travel needs of a town center could be adapted to any other town center in either county with similar land-use and socio-economic characteristics. With a series of such service modules, improvements could be implemented incrementally as funds and equipment become available.

Three general kinds of prototypes were identified early in the study -- transit user groups, geographic areas and major trip attractors/generators. Each of these was then examined in more detail to identify more specific categories. The next step was to specify for each category a set of criteria which would specifically define the category and permit the selection of candidate areas or sites for analysis as prototypes. Results of this categorization process are summarized in Table 1.

Transportation Solutions

From the list of candidates, a single prototype was selected in each category. Each was analyzed from the standpoint of solving the specific transportation problems associated with it. In effect, each prototype analysis was by itself a self-contained transit study.

Prototype solutions for each of the chosen candidates were developed through:

1. Identification of its particular geographic and socio-economic characteristics;
2. Definition of the travel needs and desires associated with it;
3. Evaluation of the adequacy of existing public transportation services;
4. Review of alternative public transportation solutions designed to meet the particular travel needs;
5. Development of recommended public transportation solutions including estimates of costs and revenues;
6. Definition of a program of implementation; and,
7. Review of the application of the solution to other candidates in the same group.

Table 2 summarizes the results of this analysis for six different categories of prototypes (service for the elderly was examined for one community in each county). The recommended prototype solutions covered a wide range; including modification of existing fixed-route service, car- and van-pooling, jitneys, club and shuttle buses and shared-ride taxi services.

Conclusion

The prototype approach developed in this study offers a systematic method for conducting public transportation planning in suburban or small urban areas where problems are diverse and planning resources limited. It maximizes the impact of these resources by concentrating upon specific solutions to specific problems while laying the groundwork for wide application of results and recommendations.

Abridgment

GEORGIA'S CRITICAL RURAL PUBLIC TRANSPORTATION NEEDS (1)

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This analysis is designed to identify public transportation needs of Georgia's rural transportation disadvantaged including elderly Georgians 60 years of age and older, and the handicapped under Section 16(b)(2) and Section 147. Approximately 12 percent or a half million of Georgia's population are over 60 years of age. One fourth of this group is handicapped numbering around 130 thousand. It is estimated that 1.5 percent of Georgia's under 60 population, or 60 thousand, are handicapped. Georgia's rural population approximates two million people. The rural target population, this study's focus, slightly exceeds 400 thousand of which 34 percent are transportation deficient. Subsequently, rural Georgians require 611.3 thousand trips to satisfy 135.4 thousand rural transportation deficient citizens. This analysis provides a cursory view by use of a broad-brush sketch plan. Many data gaps exist; the estimates are crude! Therefore, reliance on a professional "best-judgment" to identify Georgia's transport needy predominates.

This analysis intends to identify the critical needs of Georgia's transportation disadvantaged primarily in the rural areas of the State. Georgia's population was grouped into four age intervals where the elderly were defined as inhabitants 60 years of age and older. This definition comports with the lower limit used by Georgia's Office of Aging. (2) For the non-elderly category, only the handicapped portion was addressed. Since a significant portion of the elderly is also handicapped, careful analysis was necessary to delineate those who were over 60 and non-handicapped from those who were handicapped, in order to avoid double counting.

Target Population

The short time allowed for this analysis directed the focus to a target population which has lent itself to exploring the State's program for the "handicapped" and the "elderly" as the major components of Georgia's transportation disadvantaged. These components comport to the definition as proposed in studies conducted by Kimley-Horn and Associates. (3) In the interest of brevity, coefficients that were developed in their methodology were borrowed and applied to the Georgia condition. Extrapolations were made for transportation needs pertinent to trip number, time, length, and required vehicles to operate over the State of Georgia. Cost estimates relating to manpower, operations, and capital costs were also reviewed.

Values were derived for the partially mobile under 60 population from a percentage reported in a U.S. Department of Transportation report (4) using a ratio of 1.5 percent applied to find Georgia's under 60 handicapped population. The derived estimate approximates 60.7 thousand. Applying the same ratio to rural non-elderly, results in 19.2 thousand handicapped. Georgia's rural elderly number 227 thousand. (5)

Thus, the derived transit dependent target population is:

Table 1. Number of handicapped and elderly for all ages in rural Georgia:1970.

Physical Condition	Inhabitants	Share
Rural Elderly	226.9	92.2%
Rural Non-Elderly Handicapped	19.2	7.8%
Total Target Population	246.1	100.0%

While some of the rural population do suffer from total immobility, others do not. Using Kimley-Horn's model, travel demand was derived by using computations based upon the responses of the transportation sufficient. The trips were the product of the total number of trips required and desired in selected categories by various respondents. The deficient trips per week were identified then as those of met travel demand for the sufficient minus unmet demand by the transportation deficient. Based upon the Kimley-Horn Analysis, an average percentage for various essential life support trips was computed. These trips were derived from this ratio which is shown in Table 2. It is based upon the bare essential trip needs for grocery shopping, health care, and work education, which totalled 42.0 percent. (6)

Table 2. Percent of trips generating travel demand.

Trip Generator	Percent	Round-Trip Average Distance
Grocery shopping	31.4	19.2 Km (12.0 mi.)
Other shopping	16.2	19.2 Km (12.0 mi.)
Health care	5.0	34.6 Km (21.6 mi.)
Personal business	15.7	26.9 Km (16.8 mi.)
Social recreation and religious	24.5	19.2 Km (12.0 mi.)
Work-education	5.6	30.7 Km (19.2 mi.)
Other	1.7	26.9 Km (16.8 mi.)
Total:	100.0	21.9 Km (13.7 mi.)

Aggregated travel demand for the 246 thousand rural transportation deficient Georgians generated into approximately 293.0 million desired trips, while the 135 thousand rural transportation deficient population requiring bare essential life-support trips per week is as follows: (7)

Table 3. Trip demand for transportation deficient.

	Transportation Deficient (000)	Desired Trips (000,000)
Desired	246.1	293.000
Essential	135.4	0.611

Required Vehicles

Once the total distance (mileage) was computed, it became relatively simple to compute the number of vehicles required to service a 100 percent demand-satisfaction level. The rural desired level, approximating 384 million kilometers (240 million miles) annually requires around 8,100 vehicles. A similar technique was used for deriving the rural essential life-support travel demand. The demand for 168 million kilometers (105 million annual miles) generates a requirement of around 3,500 bus-vans to satisfy 100 percent of the essential trip needs for Georgia's rural transportation disadvantaged.

Cost Estimates

The operating cost for this service amounts to \$64.48 million to provide essential life-support demand for one passenger per vehicle at 100 percent level of satisfaction. The initial capital cost outlay amounts to \$52.44 million for financing 3,500 vehicles. Total maximum cost sums to \$116.92 million for providing service for 100 percent of essential demand-satisfaction assuming various load factor levels (see Table 4). (8)

Recognizing that the massive amount of funds necessary to finance such an undertaking is not feasible in the immediate or near future, several levels of effort were computed to indicate the various amounts of money required including the level of effort given the present budget program. In all cases, to derive the values for the various load factors, vehicle costs, operating costs, and total costs, the criteria were set based upon the assumptions listed below.

Table 4. Annual cost estimates with selected vehicle load factors for desired and life-support trips by the State's transportation disadvantaged at 100 percent demand satisfaction in rural Georgia.

Vehicle Load Factor	Resources Required 12=100%	9=75%	6=50%	3=25%	1=8%
Vehicles Required					
Rural Essential	292	389	583	1,167	3,496
Rural Desired	674	899	1,349	2,698	8,093
Vehicle Cost: Initial Capital (\$000,000)					
Rural Essential	4.3	5.8	8.7	17.5	52.4
Rural Desired	10.1	13.5	20.2	40.5	121.4
System Operating Cost (\$000,000)					
Rural Essential	5.4	7.2	10.8	21.6	64.5
Rural Desired	12.5	16.7	25.1	50.2	150.5
System Total Cost (\$000,000)					
Rural Essential	9.7	13.0	19.5	39.1	116.9
Rural Desired	22.6	30.2	45.3	90.7	271.9

Assumptions:
1. All vehicles = 12 passenger capacity vans.
2. Vehicle price = \$15,000 per unit.
3. Rural vehicles average 48,000 kilometers (30,000 miles) per year.
4. System Operations average 99.2¢ per kilometer (62¢ per mile).

It is unrealistic to assume that the load factor would total 100 percent at all times for every trip, even with the reported demand in rural regions, for 12-passenger vehicles. Therefore, it was assumed that a 75 percent load factor obtains a more realistic approximation. Using this load factor for 100 percent demand-satisfaction, the service for rural essential only would require \$13 million.

Since the State is budgeted currently for on-going capital programs at approximately \$750,000, the level of service possible approximates 17 percent for the 100 percent load factor. The same funding for the 75 percent load factor permits less than 13 percent of the rural demand-satisfaction. In any case, to operate effectively at these levels of effort, less than \$1 million is required from the State to meet only one-half to two-thirds of the 25 percent bare minimum rural transportation demand (see Table 5). (9) Figure 1 graphically illustrates the cost function of the various resource factors. (10)

The low level of service indicated above illustrates the dire need for a total in-depth analysis of what Georgia's actual transit requirements will be in the future for Georgia's rural transportation disadvantaged. This analysis omitted the economically deprived. In both load factor cases, it is apparent that only a minute proportion of Georgia's transportation disadvantaged is addressed. In no way does the above analysis provide for programs necessary to cover any specific region or target population. It also does not assess the existing systems and their lack of interfaces between the modal splits required to transport passengers over separate systems.

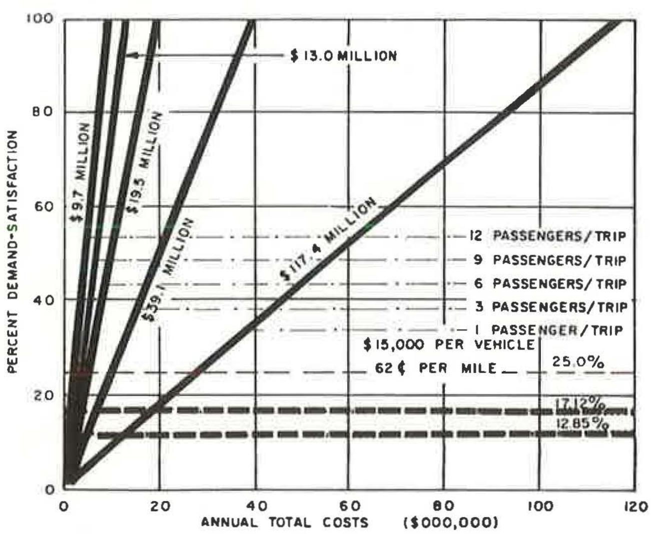
Table 5. Estimated annual total costs, 12-passenger vehicles required, and effective trip demand served of selected essential service levels on rural life support travel.

Passenger Load Factor	Effort Level	Vehicles Required	Per Vehicle Cost	Capital Cost ($000)	Operating Cost ($000)*	Total Cost ($000)*
	Current GDOT Capital Funds Program					
12 = 100%	17.12%	50	$15,000	$750.0	$924.5	$1,674.5
9 = 75%	12.85%	50	$15,000	$750.0	$925.2	$1,675.2

Passenger Load Factor	$644,800 Per 1% Per Vehicle Demand Satisfaction For One Passenger		Person-Trips Served	Vehicle-Trips Required	Cost Per Trip: Person	Cost Per Trip: Vehicle
12 = 100%	17.12%	$54.2 ($000)	1,273.0	106,085	$1.32	$15.78
9 = 75%	12.85%	$72.2 ($000)	955.5	106,167	$1.75	$15.78
12 = 100%	25.00%	N/A	1,859.0	154,913	$1.29	$15.48
9 = 75%	25.00%	N/A	1,859.0	206,551	$1.77	$15.48

Note: Detail may not sum to total due to rounding.

Figure 1. Annual total cost estimates for rural life support trips made by Georgia's transportation disadvantaged in 12-passenger vehicles at selected load factors.



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