Development of Ideal Model for Identification of Rural Public Transit Needs

WILLIAM R. BLACK

As part of a statewide multimodal planning effort, Indiana recently undertook the development of a procedure for estimating rural transit needs in each county of the state. A ridership model based on small urban areas in the state was used along with average fares and costs to generate total revenues, operating costs, and subsidies. A computerized analysis system developed during the research allows the evaluation of different service scenarios.

The state of Indiana is in the process of preparing a multimodal transportation system plan. One part of that plan will address the rural public transit needs of Indiana. This paper summarizes the research undertaken to identify these needs. A more detailed report is available elsewhere (*1*).

The paper has three major parts. The first section identifies the model used to estimate rural transit demand. The second section notes the procedure developed for estimating the supply of rural transit service to be offered and the operating costs and subsidies for this service. The third part discusses estimates derived under two sets of assumptions. The primary goal is not to provide an operating system for a single county, but to provide state-level analysts with a picture of potential rural transit operations across all counties in the state.

ESTIMATING RURAL TRANSIT RIDERSHIP

An insufficient number of rural transit operators in Indiana necessitated the use of an exogenous model for estimating rural transit ridership. A recent analysis of transit demand for small urban areas in Indiana identified ridership as being a function of the size of the transit network, the population over age 55, and local economic conditions (*2*), as measured by "monthly contract rents." This variable is collected by the U.S. Census Bureau and is available for political units ranging from small towns to counties and states.

The small urban area model developed was based on an analysis of the 13 smallest transit operations in the state of Indiana. The explained variation from this model was 98.6 percent and the model had the form

$$\text{Ridership} = 22.23\ \text{POP55} + 849.6\ \text{SYSKM} - 330\ \text{CONRENT}$$

Department of Geography and Transportation Research Center, Indiana University, Bloomington, Ind. 47405.

where

POP55 = population 55 and older,
CONRENT = local (county) monthly contract rents, and
SYSKM = size of transit network (km).

Two of the variables necessary for estimating ridership, POP55 and CONRENT, are identical to those used in the urban transit research noted earlier (*2*). SYSKM is not as easily identified as it is in the urban context. Given such an estimate of ridership from the preceding model, annual revenues were estimated as the product of ridership and an average (default) fare value of $1.00.

ESTIMATING OPERATING COSTS AND SUBSIDIES

A computer program entitled RURAL was written to assess operating costs. The user of the program has the flexibility of changing default values for most of the variables including headways, hours of service, speed, operating costs per kilometer, and proportion of network to be served each day. RURAL uses the default or revised values for these variables to estimate daily kilometers of transit service and annual revenue kilometers. The variable daily kilometers of service is the product of the proportion of the system served each day, the maximum size of the transit network (in kilometers), the reciprocal of average headways, and the daily hours of service. The value for annual kilometers of service is the product of daily kilometers and operating days per year (here taken to be 260). Annual operating costs are the product of the average operating costs per kilometer and the annual kilometers of service. There are more precise ways of estimating rural transit costs, but most of these require data that were not available in Indiana (*3*). Operating subsidies (profits) are equal to annual revenues less the annual operating costs. The procedure also estimates vehicles needed as the daily kilometers of operation divided by the daily kilometers per vehicle (the product of hours of operation and speed), and adds to this a 10 percent backup fleet.

Since any county or state road within a county can have people living along it, there is reason to believe that all of these should be served by rural transit. Although it is reasonable to exclude Interstate highways and toll roads, there is certainly no reason to assume that some of the other roads should be excluded a priori, except for counties with urban transit, where the urban kilometers of roads and highways would be excluded.

It should be apparent that some very large transit operations would be in place if the road lengths suggested were used. Systems with networks of 1100 to 1300 km (700 to 800 mi) would not be uncommon. With normal headways of an hour, annual revenue kilometers would run from 3 million to 4 million (2 million to 2.5 million mi). This is not unreasonable for urban public transit [Indianapolis has revenue kilometers in the range of 9.7 million (6 million mi)], but the density of population in rural areas is such that the ridership would not be sufficient to merit such a high level of service. There are two solutions to such a predicament: significantly reduce the size of the system to be served or significantly increase demand.

As noted earlier, there is no way of easily reducing system length before laying out the actual routes to be used. In addition, it may not be possible to increase transit demand. However, it may be possible to focus the demand. An earlier study found that transit service attributes had little impact on ridership (*2*). It is believed that this is due in part to the dominance of older riders on public transit systems. This is particularly so in small cities and rural areas, where the 55-and-older age groups are the dominant users of public transit. These riders will adjust their schedules to use the service when it is provided. In effect, these individuals "consume" transit when it is offered. Given that this is so, it is reasonable to assume that most rural transit demands could be satisfied if service were offered 1 day a week. On that day a high level of service would be offered with 1-hr headways through 12 hr of the day.

This scheme would also have the effect of reducing the variable portion of operating costs by 80 percent. It would have no impact on fixed (e.g., administrative) costs. All roads in the county (except those served by urban public transit) would be served once a week instead of five times a week. This would bring the operating costs to a level that would be more manageable for most counties. The county would be divided into five small systems, each covering about 20 percent of what could be called the residential roads there. Many configurations for such service are possible. Examples of two such service patterns for 5 days of operation appear in Figure 1. Of these two, the second appears to offer a higher level of access across the region. Actual configurations would be influenced by the county's network of roads to be served.

Such a system does not provide a full rural transit service. It would not serve the needs of commuters or students, who require daily service, nor would it provide service between all parts of a county. The assumption is that transit service is being provided to a central area, perhaps a county seat, so that elderly individuals would have access to medical care, social organizations and services, banking and legal services, shopping, and so forth. The methods are capable of examining other spatial and temporal service patterns.

This is the basic model proposed for providing transit service to the rural areas of Indiana. Each application is based on a county, although it may make sense to consolidate counties in some cases. Several other assumptions have been made with regard to the service proposed. As noted, it is assumed that the average fare for rural transit service is $1.00. Each subsystem would be served during 12 hr with headways of 1 hr on the day that it receives service. It is assumed that the average speed of buses will be 35 mph. Given that these are state and county roads, with occasional stops for passengers, this is not unreasonable. Finally, it is assumed that the average operating costs per kilometer are $1.93 ($3.12/mi). This value is the average operating cost per unit of distance for all transit (urban, rural, and demand-responsive) service in the state in 1990; it is reduced in a second scenario examined later.

The analysis also estimated capital equipment needs based on kilometers to be served and vehicular speeds. Only vehicles were considered. The analysis has incorporated an average size bus for this service with an estimated cost of $45,000/unit. The needs of areas may differ, and to alter the vehicular capital costs, the number of units should be multiplied by the alternative unit costs to estimate the cost of vehicles. There are no cost estimates here for shelters or maintenance facilities. There may be very little need for shelters, but maintenance facilities would have to be factored into the analysis. Given the number of vehicles involved, it seems that regional maintenance facilities would be the most desirable.

RESULTS OF ANALYSIS

Estimated operating costs across the 92 counties are not highly variable. This finding is consistent with the relatively uniform area of Indiana's counties and the road networks that traverse them. In addition, the type of service proposed is the same across all counties; transit service would cover 20 percent of the network on each of five days a week.

Subsidies for these county operations generally range from $1 million to $2 million. A dozen counties have estimated subsidies under the $1 million level; nine counties would require a subsidy in excess of $2 million. The subsidies per trip range from $2.00 to $7.00. This subsidy level is consistent with existing rural and demand-responsive services in Indiana. The latter have an average subsidy of $4.50/trip.

It is of interest to examine what would happen to total costs, revenues, and subsidies if transit fares increased or costs decreased. It should be obvious that a $0.50 increase in fares will increase revenues by 50 percent (since the assumed fare is $1.00), assuming no ridership is lost due to the fare increase. Since revenues are small in comparison to operating costs, this type of change has little impact on subsidies. On the other hand, decreases in operating costs can significantly decrease the level of subsidy. As an illustration, bear in mind that

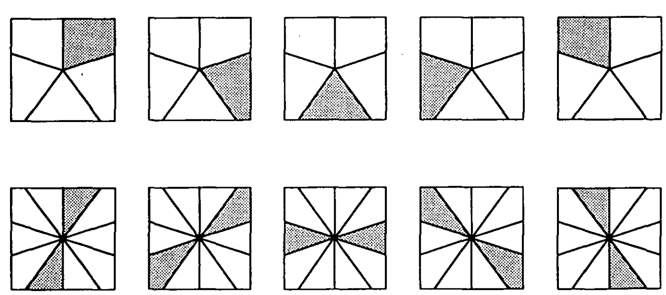

FIGURE 1 Two seats of idealized service patterns for 20 percent coverage 5 days a week.

subsidies can never exceed operating costs. Therefore, reducing operating costs by a third or a half will drop subsidy levels by at least that much in the absence of any revenue. If revenues are present, the decrease is even more significant. For example, assume an operation has a $1 million operating cost and a revenue base of $200,000. This results in a subsidy of $800,000. A 50 percent decrease in operating costs results in a 62.5 percent drop in the subsidy.

It is easy to assess the impact of single-variable changes on the rural transit financial picture for each county; simultaneous changes in fares, hours of service, and operating costs are more difficult to estimate. It is problems of this type that RURAL was set up to examine. For example, assume that fares will increase by 50 percent (from $1.00 to $1.50), the hours of service will be cut back by 16.6 percent (from 12 to 10 hr each weekday of service), and operating costs per kilometer will be reduced by 33.3 percent (from $1.93 to $1.29). Although it has not been used here, one could assume that the Simpson-Curtin rule (*4*) is operative with change in fares. That rule suggests a 15 percent drop in patronage with a 50 percent increase in fares. If we had a better idea of a proper average fare, then we would know if such adjustments were merited.

For this second case, there is an increase in revenues of 50 percent. Operating costs have dropped in the range of 30 to 45 percent. The subsidy has dropped to an overall average of $570,166. Considering current subsidies in the state, this subsidy level would suggest that at least several of the operations may merit further review by the counties involved since they may be paying subsidies at this level for a less attractive service.

CONCLUSION

This research effort has identified a procedure for examining the potential costs, revenues, and subsidies of rural transit operations across all counties in a state. In the process several questions for future research in the area became apparent. How does one identify a rural transit network? How elastic are fares in the rural context? Does fixed-route service of the type envisioned here have a role in rural areas? Progress in this field requires better data as well as further research.

ACKNOWLEDGMENT

This research was supported by the Division of Public Transportation of the Indiana Department of Transportation.

REFERENCES

1. W. R. Black. *The Identification of Public Transit Needs in Indiana: Part 2, Rural Public Transit*. Transportation Research Center, Indiana University, Bloomington, 1992.
2. W. R. Black. *The Identification of Public Transit Needs in Indiana: Part 1, Urban Public Transit*. Transportation Research Center, Indiana University, Bloomington, 1992.
3. K. P. Ceglowshi, A. M. Lago, and J. E. Burkhardt. Rural Transportation Costs. In *Transportation Research Record 661*, TRB, National Research Council, Washington, D.C., 1985, pp. 15–20.
4. A. M. Lago, P. D. Mayworm, and J. M. McEnroe. Transit Ridership Responsiveness to Fare Changes. *Traffic Quarterly*, Vol. 35, 1981, pp. 117–142.

Publication of this paper sponsored by Committee on Rural Public and Intercity Bus Transportation.