TRANSIT COOPERATIVE RESEARCH PROGRAM

SPONSORED BY

The Federal Transit Administration

TCRP Report 3

Workbook for Estimating Demand for Rural Passenger Transportation

Transportation Research Board
National Research Council

Report 3

Workbook for Estimating Demand for Rural Passenger Transportation

SG ASSOCIATES, INC.
Annandale, VA
with
LEIGH, SCOTT & CLEARY, INC.
Tahoe City, CA
and
C.M. RESEARCH, INC.
Little Rock, AR

Subject Area

Public Transit

Research Sponsored by the Federal Transit Administration in Cooperation with the Transit Development Corporation

TRANSPORTATION RESEARCH BOARD

NATIONAL RESEARCH COUNCIL

NATIONAL ACADEMY PRESS
Washington, D.C. 1995

TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transit Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, the National Academy of Sciences, acting through the Transportation Research Board (TRB), and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended endusers of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

TCRP REPORT 3

Project B-3 FY '92
ISSN 1073-4872
ISBN 0-309-05700-0
Library of Congress Catalog Card No. 95-61341

Price $28.00

NOTICE

The project that is the subject of this report was a part of the Transit Cooperative Research Program conducted by the Transportation Research Board with the approval of the Governing Board of the National Research Council. Such approval reflects the Governing Board's judgment that the project concerned is appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the Transit Development Corporation, the National Research Council, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

Special Notice

The Transportation Research Board, the Transit Development Corporation, the National Research Council, and the Federal Transit Administration (sponsor of the Transit Cooperative Research Program) do not endorse products or manufacturers. Trade or manufacturers' names appear herein solely because they are considered essential to the clarity and completeness of the project reporting.

Published reports of the

TRANSIT COOPERATIVE RESEARCH PROGRAM

are available from:

Transportation Research Board
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America

FOREWORD

By Staff
Transportation Research Board

This report will be of interest to agencies engaged in planning, operating, or funding passenger transportation services in rural areas. The methodology for estimating demand for rural passenger transportation presented in this Workbook is based on a comprehensive review of previously developed methods; discussions with agencies that would use these procedures—including state transportation and human service agencies, local transportation and human service agencies, and local transportation providers; collection of data from a sample of 39 selected counties across the nation; and detailed analysis of relationships among county population characteristics, services provided, and actual rural passenger transportation demand served.

Under the TCRP Project B-3, research was undertaken by SG Associates, Inc. to provide methods for forecasting rural passenger transportation demand. The objectives were to evaluate current methods used to forecast rural passenger transportation demand and to develop improved methods. The research approach, which lead to the development of methods for demand forecasting for rural passenger transportation, involved several phases. These phases included identification and assessment of previously developed methods for forecasting rural passenger transportation demand; development of a framework for demand estimation methodologies; data collection, methodology development and testing; and preparation of a Workbook for application of the methodologies.

The methodologies developed and reported under this research effort demonstrate that there are relationships between the population characteristics and transportation services provided in rural areas and the demand for transportation services. The methodologies reported in the Workbook should enable agencies engaged in planning or operating rural passenger transportation services to prepare reasonable estimates of demand and to analyze the effects of different levels of resource allocation.

The findings of the agency interviews and the review of previous methods are documented in TCRP Project B-3, Interim Report No. 1. The 39-county dataset and the analysis leading to the methods for estimating rural passenger transportation demand are documented in TCRP Project B-3, Interim Report No. 2. The Final Report has an overall description of the analysis, the procedures, and the recommended methodology. All of these documents are available from TCRP.

In addition, the full 39-county dataset, with documentation, has been provided to the Mack-Blackwell National Rural Transportation Study Center at the University of Arkansas for use by others engaged in research on rural transportation needs. Inquiries should be addressed to:

Mack-Blackwell National Rural
Transportation Study Center
4190 Bell Engineering Center
Fayetteville, Arkansas 72701
(501) 575-7957

To assist users of this Workbook in applying the methodologies, a spreadsheet template for use on personal computer systems has been prepared. This spreadsheet, in QuattroPro and LOTUS 1-2-3 formats, is available from TCRP and will be available through the McTrans Center for Microcomputing in Transportation at the University of Florida, Gainesville, FL (1-800-226-1013); it is also available for downloading on the RTAP TAP-IN Bulletin Board maintained by the Community Transportation Association of America (202-628-2537).

CONTENTS

LIST OF FORMS

ACKNOWLEDGMENTS

The research reported herein was performed under Transit Cooperative Research Program Project B-3 by SG Associates, Inc. with the support of Leigh, Scott & Cleary, Inc. and C. M. Research, Inc.

Mr. Frank Spielberg of SG Associates, Inc. was the principal investigator. Others contributing to the analysis and this report are Mr. Randall Farwell of SG Associates, Inc.; Mr. Gordon Shaw and Ms. Selena McKinney of Leigh, Scott & Cleary, Inc.; and Ms. Christie McGetrick of C. M. Research, Inc.

The work was done under the direction of Mr. Spielberg. Mr. Spielberg, Mr. Shaw, and Ms. McGetrick conducted interviews with federal, state, and local agencies involved in some aspect of rural passenger transportation. Mr. Farwell was responsible for the literature review to identify previously developed methods and for development and analysis of demographic data for the counties included in the data sample; Ms. McGetrick and Ms. McKinney undertook the data collection effort including direct contact with almost 200 agencies; Mr. Shaw developed the databases and conducted analyses both of the applicability of previously developed models and of program-related transportation demand and program participation rates; and Mr. Spielberg conducted the analysis of non-program-related transportation demand.

WORKBOOK FOR ESTIMATING DEMAND FOR RURAL PASSENGER TRANSPORTATION

SUMMARY

Agencies engaged in planning, operating, or funding passenger transportation services in rural areas require methods to assess their investment in services, to estimate the demand for transportation, and to evaluate the effect of changes in services on expected ridership. The research results of TCRP Project B-3 present the views of representative agencies on the needs for and the use of demand estimation methods; review previously developed methods for their adequacy in meeting expressed needs; and document a new methodology, based on detailed data collected from a targeted sample of 39 rural counties across the United States. The companion Workbook, which presents the methodology in simplified form by providing computation worksheets and step-by-step instructions, is contained in this report.

The methodology reported is applicable in rural counties, defined as those that are outside of a Metropolitan Statistical Area (MSA) and have a population density of less than 1,000 persons per square mile (about 400 persons per square kilometer). It is designed to estimate demand for passenger transportation services. Demand is defined as the ridership that is expected when a given quantity of service is provided. Demand is not the same as need.

Passenger transportation is defined to include all services where the driver is acting as an agent for some entity. Passenger transportation is broader than public transportation because it includes services that are restricted to use by individuals that are eligible by virtue of their meeting specific criteria such as age, disability, or enrollment in a social service program. Passenger transportation demand includes public transportation demand.

The demand estimation methodology treats separately two distinct types of passenger transportation demand. These types are *program-related* demand—trips that would not occur but for the existence of specific social service program activities—and *non-program-related* demand that includes all other trips. Program-related demand is estimated as a function of program enrollment. Methods are provided for estimating enrollment in individual program types based on population characteristics. Non-program-related demand, including "general public travel," is estimated as a function of a) the size of the three population groups most likely to use a rural passenger transportation service, i.e., the elderly, persons with disabilities, and persons in poverty; b) the size of the service area; and c) the amount of service (measured in annual vehicle-miles) available to each of the population groups. The "county" is the service area unit for which these relationships were developed. Tables S-1 and S-2 summarize the recommended methodologies.

Two approaches to applying the developed methodology are provided. An incremental method, designed for use where passenger transportation services already exist, estimates the expected change in demand when population composition or service supplied changes.

A synthetic method, designed for use where there are no current services for one or more groups, estimates the demand to be expected if a given amount of service is supplied.

The methodologies contained in the final report and in this Workbook should enable agencies to prepare consistent estimates of the demand for passenger transportation services in rural areas. The methods should prove useful not only to local agencies involved in the operation of services, but also to the state agencies engaged in the administration of funding programs and the preparation of state transportation plans.

TABLE S1 Recommended methodology for estimating annual program-related rural passenger transportation demand

Program Type	D = Annual One-Way Person-Trips
Developmental Services: Adult	
Participants <25;	D = 358 x Number of Participants
Participants >= 25;	D = 430 x Number of Participants - 1,686
Developmental Services: Case Management	D = 39.2 x Number of Participants
Developmental Services: Pre-School	D = 224 x Number of Participants
Group Home	
Participants < 10;	D = 2.05 x Number of Participants x Days of Operation or, if the number of days of operation is not known, D = 615 x Number of Participants
Participants >= 10;	D = (1.42 x Number of Participants + 5.94) x Days of Operation or, if the number of days of operation is not known, D = 291 x Number of Participants + 3,760
Headstart	D = 263 x Number of Participants
Headstart: Home Base	D = 0.16 x Number of Participants x Days of Operation or, if the number of days of operation is not known, D = 30.5 x Number of Participants

TABLE S1 Recommended methodology for estimating annual program-related rural passenger transportation demand (continued)

Program Type	D = Annual One-Way Person-Trips
Headstart: Other	D = 1.86 x Number of Participants
Job Training	D = 137 x Number of Participants
Mental Health Services	D = 347 x Number of Participants
Mental Health Services: Case Management	D = 6.35 x Number of Participants
Nursing Home	
Participants < 50;	D = 9.10 x Number of Participants
Participants >= 50;	D = 12.5 x Number of Participants - 173
Senior Nutrition	D = 248 x Number of Participants
Shelter Workshop	D = 1.58 x Number of Participants x Days of Operation or, if the number of days of operation is not known, D = 384 x Number of Participants

TABLE S2 Recommended methodology for estimating annual non-program-related rural passenger transportation demand

$$D = R_e E\left(\frac{1}{1 + k_e e^{-U_e}}\right) + R_m M\left(\frac{1}{1 + k_m e^{-U_m}}\right) + R_p P\left(\frac{1}{1 + k_p e^{-U_p}}\right)$$

where:

D = annual demand for Non-Program Related passenger transportation. (One-Way Trips per Year)

$R_e = 1{,}200$

$R_m = 1{,}200$

$R_p = 1{,}200$

E = number of persons age sixty or over.

M = number of mobility limited persons age sixteen to sixty-four.

P = number of persons, age sixty-four or less, in families with incomes below the poverty level. The definition of the poverty level is that used for the 1990 U.S. Census.

$k_e = e^{6.38}$

$k_m = e^{6.41}$

$k_p = e^{6.63}$

$$U_e = 0.000510 \times \frac{\text{Annual Vehicle-Miles Available to Elderly Market}}{\text{Area of the County}}$$

$$U_m = 0.000400 \times \frac{\text{Annual Vehicle-Miles Available to Mobility Limited Market}}{\text{Area of the County}}$$

$$U_p = 0.000490 \times \frac{\text{Annual Vehicle-Miles Available to Low-Income Market}}{\text{Area of the County}}$$

CHAPTER **1**

INTRODUCTION

This Workbook is for use in forecasting the demand for passenger transportation services in rural areas. The intended users of the Workbook include transportation service providers who wish to assess the performance of their services relative to expected values or to assess the likely effects of service changes; local, county or multicounty planning agencies that need to assess ridership under alternative service plans, including the effects of coordination; state transportation agencies that need to quantify passenger transportation served in rural areas as part of their statewide planning efforts; and funding agencies at all levels of government that need to understand the ridership impacts of different levels of investment in rural passenger transportation.

The methodologies for estimating demand for rural passenger transportation services presented in this Workbook were developed as part of Transit Cooperative Research Program (TCRP) Project B-3. The derivation of the methodologies, together with a description of the dataset used for methodology development, are described in detail in the final report of that project, which is available separately from the TCRP.[1]

The materials presented in the Workbook describe the types of information required to develop estimates of passenger transportation demand and step-by-step instructions, with examples and computation forms, for developing the demand estimates. For the most part, the data—related to social service program enrollment, demographic characteristics of the service area, and the quantity of service available—should be relatively easy to obtain. U.S. Census reports, county agencies, and transportation providers will be the best sources. For data that may not be readily available, alternative estimation methods are provided.

DEFINITIONS

To properly use this Workbook, it is necessary to understand the meaning of certain key terms. These definitions reflect the approach used to develop the methods and relate to the conditions for which the methods described are appropriate.

Rural

The passenger transportation demand estimation procedures described in the Workbook apply only to *rural areas.* Rural areas, following the U.S. Census definition, are those places outside of an urbanized area. In general, places meeting this definition

- are outside a Metropolitan Statistical Area (MSA) (i.e., not suburbs of a major city) and
- have a population density of less than 1,000 persons per square mile (386 persons per square kilometer).

The methods described apply to transportation services in low-density areas. They do not apply to, and should not be used for, estimation of demand in small cities, even those with populations less than 50,000, where public transportation service is provided by small fixed-route, fixed-schedule transit systems.

Passenger Transportation

Passenger transportation, as used in this Workbook, includes all travel by individuals where the driver either is an entrepreneur or is affiliated with a public agency or private entity that provides transportation service. Passenger transportation, as used here, does not include travel arranged by the rider where the driver is a relative, friend, or acquaintance of the passenger and there is no agency involvement.

Passenger transportation is not the same as public transportation. Public transportation is defined as a service open to any individual who requests service and is willing to pay the fare, if any, that is charged. Passenger transportation includes both public transportation and services that limit ridership to members of a specific group (e.g., persons enrolled in a program for the developmentally disabled) or that limit ridership to persons meeting a set criteria (e.g., persons 60 years of age or older).

Demand

Demand is defined as the number of passenger trips that will be taken when a given level of passenger transportation service is available. Passenger trips are *one-way* trips, that is, trips on a vehicle from one point to another. Round-trips (e.g., from home to shopping and return to home) are counted as two one-way trips.

Demand is not the same as "need." The need to travel, however defined, exists whether or not passenger transportation service is available. The procedures in this Workbook do not address need. The procedures relate only to the number of trips expected given the programs available, the demographic composition of the service area, and the amount of passenger transportation service available.

[1] SG Associates, Inc., "Estimating the Demand for Rural Passenger Transportation," Final Report (unpublished), Transportation Research Board, National Research Council, Washington, DC (Feb. 1995).

OVERVIEW OF METHODOLOGY

Trip Types

The methodology for forecasting passenger transportation demand has two components reflecting the different types of passenger transportation typically found in rural areas. Each component of the methodology addresses a different trip type. The two trip types are

1. Program related and
2. Non-program related.

Program Related

Program-related trips are those that would not occur but for the existence and operation of a specific social service program. These trips are associated with travel to or from a specific social service program and program activities. Travel is generally restricted to program participants traveling for program purposes. Program travel tends to be many-to-one rather than many-to-many. Program types considered include

- Developmental services: adult;
- Developmental services: case management;
- Developmental services: children;
- Developmental services: pre-school;
- Group homes;
- Headstart;
- Headstart: home base;
- Headstart: other;
- Homeless persons transportation;
- Job training;
- Mental health services;
- Mental health services: case management;
- Nursing homes;
- Senior nutrition;
- Shelter workshops; and
- Substance abuse.

More complete descriptions of these program types are presented in Table 1 (see Chapter 2).

Note that Medicaid trips are considered to be non-program-related because the time of travel and destination are at the rider's discretion.

The methods for forecasting demand for program-related trips involve 1) determining the number of participants in each program and 2) applying a trip rate per participant.

Most of the trip rates yield annual trip estimates, but for some program types (e.g., sheltered workshop) a daily trip rate is suggested with the resulting daily estimate multiplied by the number of days per year the program is operated. Daily rates are provided only for those program types for which the database assembled for model development supported such analysis.

The trip rates used in the computation forms provided are based on the analysis of passenger transportation services in 39 counties across the United States. These rates, and the range of observed values, are presented in Appendix A.

In most cases, the number of program participants can be determined directly from the agency operating the program. For situations when these data are not available, alternative methods for estimating program participation are provided (see Form D-1).

Non-Program Related

The methods for estimating the demand for non-program-related passenger transportation consider three population segments:

1. Persons aged 60 and over;
2. Persons, aged 16 to 64, with mobility limitations; and
3. Persons, aged 64 or less, residing in households having incomes below the poverty level.

Separate demand estimates are developed for each population group. These three groups make up the majority of riders on rural passenger transportation services. To the extent the individuals not belonging to one of these population segments made trips on services analyzed in developing these methodologies, the trip rates used for these market segments are slightly higher than they would be otherwise. As a result, the non-program estimates include "general public" demand.

The procedure involves the following:

1. Determining the number of persons in the planning area in each of the three groups.
2. Determining the size, in square miles or square kilometers, of the service area. Appendix B lists the area in square-miles of all counties in the United States.
3. Determining the annual vehicle-miles or vehicle-kilometers of service available, or planned to be available, to persons in each population group.
4. Computing a "service factor" for each group based on the annual vehicle-miles or vehicle-kilometers of service per square mile available to each group.
5. Multiplying the population in each group by a trip factor and the service factor to yield the demand estimate for each group.

The service factor computation presented in the worksheets is an approximation of the exact form that involves a slightly complex mathematical relationship. The exact function for the service factor is described in Appendix C for those readers who wish further information.

Alternatively, an annual trip rate per person in each population group may be read from graphs included in this Workbook and applied to yield a demand estimate.

Data Required

The following data will be required for application of the passenger transportation demand forecasting methods.

Program-Related Passenger Transportation Demand

Users will need the following data to estimate program-related passenger transportation demand.

1. The existence or planned implementation of social programs serving residents of the area under study, such as

- Developmental services: adult;
- Developmental services: case management;
- Developmental services: children;
- Developmental services: pre-school;
- Group homes;
- Headstart;
- Headstart: home base;
- Headstart: other;
- Homeless transportation;
- Job training;
- Mental health services;
- Mental health services: case management;
- Nursing homes;
- Senior nutrition;
- Shelter workshops; and
- Substance abuse.

2. The number of persons participating in each of the programs listed above. If the number of program participants cannot be directly determined, the following information is required. All of these data are included in the U.S. Census and should be available from county or regional planning agencies or the state data center. Appendix D provides information on obtaining U.S. Census data.

- Total population (may be used to estimate participation in all programs if the data items listed below cannot be obtained);
- Population aged 3 and 4;
- Population aged 16 and over;
- Population aged 16 to 59;
- Population aged 16 to 64;
- Population aged 75 and over;
- Total mobility-limited population;
- Mobility-limited population aged 16 to 64;
- Number of families with income below the poverty level; and
- Number of persons with income below the poverty level.

Non-Program-Related Passenger Transportation Demand

The following data are required for application of the non-program-related passenger transportation demand.

1. Size of the service area—typically a county—expressed in square miles (English units) or square kilometers (metric units). Appendix B lists the area in square miles for all counties in the United States.

2. Size of following population groups:

- Number of persons aged 60 or over,
- Number of persons aged 16 to 64 who are mobility limited, and
- Number of persons under age 65 residing in households with incomes below the poverty level.

These data are included in the U.S. Census and should be available from local or regional planning agencies or the state data center.

3. Vehicle-miles of service

- Annual vehicle-miles or vehicle-kilometers of service available to (i.e., that can be used by) or planned to be available to persons aged 60 or over.
- Annual vehicle-miles or vehicle-kilometers of service available to or planned to be available to persons who are mobility limited.
- Annual vehicle-miles or vehicle-kilometers of service available to or planned to be available to persons who reside in households with incomes below the poverty level.

The "availability" of service to a population group does not necessarily imply that the service is restricted to members of that group. In some cases, the service may be restricted to a specific group. For example, services provided by Area Agencies on Aging are often restricted to use by persons aged 60 and above. Such services would be "available" only to that group. Public transportation services (e.g., those receiving funds under Section 18 of the Federal Transit Act), taxi services, and certain other services are available to all population groups.

Vehicle-miles or vehicle-kilometers of service that are available to more than one of the population groups are *counted for each group*. For example, if a public transportation system provides 100,000 vehicle-mi of service, this is considered as:

- 100,000 mi available to persons aged 60 or over,
- 100,000 mi available to persons with a mobility limitation, and
- 100,000 mi available to persons residing in households with incomes below the poverty level.

Determining the vehicle-miles or vehicle-kilometers of service provided and available to each group will typically require contacting each transportation provider serving the county of interest. Most providers will have this information. Some for-profit operators, especially taxi services, may not have or may be unwilling to provide this information. A method for estimating vehicle-miles or vehicle-kilometers based on the number of vehicles operated is provided in Chapter 2.