NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Report 8

Simplified Guidelines For Evaluating Transit Service In Small Urban Areas

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Report 8

Simplified Guidelines For Evaluating Transit Service In Small Urban Areas

DAVID R. MILLER, GEORGE T. LATHROP, and DARWIN G. STUART
Barton-Aschman Associates, Inc.
Evanston, Illinois
and
THEODORE O. POISTER
Pennsylvania State University
University Park, Pennsylvania

AREAS OF INTEREST

- Planning
- Forecasting
- Finance
- Socioeconomics
- User Needs
- Energy and Environment
- Operations and Traffic Control
- (Public Transit)

RESEARCH SPONSORED BY THE URBAN MASS TRANSPORTATION ADMINISTRATION OF THE U.S. DEPARTMENT OF TRANSPORTATION

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. OCTOBER 1984

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT PROGRAM

Administrators, engineers, and many others in the transit industry are faced with a multitude of complex problems that range between local, regional, and national in their prevalence. How they might be solved is open to a variety of approaches; however, it is an established fact that a highly effective approach to problems of widespread commonality is one is which operating agencies join cooperatively to support, both in financial and other participatory respects, systematic research that is well designed, practically oriented, and carried out by highly competent researchers. As problems grow rapidly in number and escalate in complexity, the value of an orderly, high-quality cooperative endeavor likewise escalates.

Recognizing this in light of the many needs of the transit industry at large, the Urban Mass Transportation Administration, U.S. Department of Transportation, got under way in 1980 the National Cooperative Transit Research & Development Program (NCTRP). This is an objective national program that provides a mechanism by which UMTA's principal client groups across the nation can join cooperatively in an attempt to solve near-term public transportation problems through applied research, development, test, and evaluation. The client groups thereby have a channel through which they can directly influence a portion of UMTA's annual activities in transit technology development and deployment. Although present funding of the NCTRP is entirely from UMTA's Section 6 funds, the planning leading to inception of the Program envisioned that UMTA's client groups would join ultimately in providing additional support, thereby enabling the Program to address a large number of problems each year.

The NCTRP operates by means of agreements between UMTA as the sponsor and (1) the National Research Council as the Primary Technical Contractor (PTC) responsible for administrative and technical services, (2) the American Public Transit Association, responsible for operation of a Technical Steering Group (TSG) comprised of representatives of transit operators, local government officials, State DOT officials, and officials from UMTA's Office of Technical Assistance, and (3) the Urban Consortium for Technology Initiatives/Public Technology, Inc., responsible for providing the local government officials for the Technical Steering Group.

Research Programs for the NCTRP are developed annually by the Technical Steering Group, which identifies key problems, ranks them in order of priority, and establishes programs of projects for UMTA approval. Once approved, they are referred to the National Research Council for acceptance and administration through the Transportation Research Board.

Research projects addressing the problems referred from UMTA are defined by panels of experts established by the Board to provide technical guidance and counsel in the problem areas. The projects are advertised widely for proposals, and qualified agencies are selected on the basis of research plans offering the greatest probabilities of success. The research is carried out by these agencies under contract to the National Reserch Council, and administration and surveillance of the contract work are the responsibilities of the National Research Council and Board.

The needs for transit research are many, and the National Cooperative Transit Research & Development Program is a mechanism for deriving timely solutions for transportation problems of mutual concern to many responsible groups. In doing so, the Program operates complementary to, rather than as a substitute for or duplicate of, other transit research programs.

NCTRP REPORT 8

Project 40-1 FY'81
ISSN 0732-4839
ISBN 0-309-03852-9
Library of Congress Catalog Card No. 84-72603

Price: $10.40

NOTICE

The project that is the subject of this report was a part of the National Cooperative Transit Research & Development 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 program concerned is of national importance and appropriate with respect to both the purposes and resources of the National Research Council.

The members of the technical committee 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 committee, they are not necessarily those of the Transportation Research Board, the National Research Council, or the Urban Mass Transportation Administration, U.S. Department of Transportation.

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

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the Federal Government. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine. The National Academy of Engineering and the Institute of Medicine were established in 1964 and 1970, respectively, under the charter of the National Academy of Sciences.

The Transportation Research Board evolved in 1974 from the Highway Research Board which was established in 1920. The TRB incorporates all former HRB activities and also performs additional functions under a broader scope involving all modes of transportation and the interactions of transportation with society.

Special Notice

The Transportation Research Board, the National Research Council, and the Urban Mass Transportation Administration (sponsor of the National Cooperative Transit Research & Development 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 project reporting.

Published reports of the

NATIONAL COOPERATIVE TRANSIT RESEARCH & DEVELOPMENT 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

City managers and transit agency staffs in small urban areas will find this report of particular interest. Procedural guidelines and techniques are presented to aid transit and municipal agencies in small urban areas (less than 200,000 population) to evaluate potential new transit systems or improvements to existing systems. Through a comprehensive review of previous research and studies, a seminar involving transit decision-makers, and case study applications, the research team identified the most important factors in the transit decision-making process. Specific techniques for estimating individual factors are identified along with more comprehensive techniques for evaluating transit proposals. Emphasis is placed on techniques that use readily available data and that do not require extensive technical training for the user. Numerous other reports are available describing various approaches and techniques related to analyzing transit proposals, mostly directed to larger urban areas. NCTRP Report 8 is designed to make the available information applicable to smaller areas, easier to use, more accessible, and to provide assistance in presenting the analysis results to decision-making groups.

Small transit systems, as well as larger systems, need to determine the potential impacts of investment decisions on transit users as well as on the community at large. These impacts are often difficult to determine. In addition to obvious impacts, such as changes in vehicle-miles of travel, fuel consumption, pollution, etc., there is also a group of not-so-obvious impacts that relate to the costs and benefits of a transit investment (e.g., vehicle accidents, peak-hour congestion, commercial parking space requirements, and changes in future capital costs for street construction). Nonquantifiable impacts must also be considered, such as changes in mobility for the economically disadvantaged and for those who cannot drive (i.e., handicapped, elderly, and young people).

NCTRP Project 40-1 was initiated to develop procedural guidelines for use by transit and municipal agencies in guiding their analysis of transit and paratransit proposals and in presenting their proposals to the decision-making bodies. Use of these guidelines will provide the basis for the comprehensive analysis of transit proposals and will result in more consistent and informed appraisals by city managers and councils, as well as the public's better understanding of proposed investments for a new transit system or improving an existing system.

The guidelines have been designed for application by nontechnical persons and are directed to the type of decisions faced in urban areas up to 200,000 population. Relevant resource materials are presented that have applicability to the evaluation of public transit proposals. Existing analysis techniques that are considered to be most applicable to small urban areas are described, as well as information requirements and availability.

In the conduct of this research and in this report, transit impacts and measures of those impacts have been classified into three categories—effectiveness, efficiency, and equity. The researchers note on page 15 that there is not a consensus in the transit community on the definitions of these categories and that the definitions used herein are for convenience in presenting the various impact measures. These definitions were derived in part from input from transit managers and local officials, representing small urban areas (less than 200,000 population), who participated in this research. The reader should note, however, that the Urban Mass Transportation Administration has developed and encourages the use of a single set of definitions for these terms to provide consistency in their interpretation and use. UMTA's definitions were developed for use in urban areas of all sizes and are based on some basic concepts that are different from those used herein for small areas. To avoid any potential confusion, a statement regarding these definitional differences is included on page 15 and referenced on other pages.

The researchers also developed recommendations for improved presentation techniques designed to explain the key results of technical analyses to lay persons. Specifically, a three-part educational package targeted for local elected officials and lay advisory board members was prepared. It includes a general introduction to small-city transit, an explanation of the variables used to evaluate proposals, and examples of good presentation formats. This package is described in Appendix B and is available for purchase, or on loan, upon request from the Program Director, Cooperative Research Programs, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.

CONTENTS

ACKNOWLEDGMENTS

This research was performed under NCTRP Project 40-1 by Barton-Aschman Associates, Inc., and its subcontractors Dr. Theodore Poister, The Executive Technique, Inc., and John Allee, Inc. Dr. David R. Miller, Principal Associate, Barton-Aschman Associates, Inc., was the Principal Investigator. The Assistant Principal Investigator was Dr. G. T. Lathrop, former Senior Associate of Barton-Aschman Associates, Inc., now Assistant Director, Department of Transportation, Charlotte, North Carolina. Other authors of the report include Dr. Darwin G. Stuart, Principal Associate, Barton-Aschman Associates, Inc. and Dr. Theodore O. Poister, Associate Professor, Pennsylvania State University.

Barry D. Lundberg, Vice President, Barton-Aschman Associates, Inc.; Len Brandrup, Jr., Senior Associate, Barton-Aschman Associates, Inc.; and Maria T. Lu and Robert W. Smith, Associates, Barton-Aschman Associates, Inc. assisted in the research, as did Robert C. Buenger, formerly of The Executive Technique, Inc., now Marketing Director, Ernst & Whinney, Chicago, and John Allee, President of John Allee, Inc.

Special acknowledgment is due to the participants in the research seminar: John Arnold, City Manager, Fort Collins, Colorado; Daryl Brennick, Mayor, Marysville, Washington; Donald Canney, Mayor, Cedar Rapids, Iowa; Terry Cooper, Transit Director, Kalamazoo, Michigan; Janet D'Ignazio, Assistant General Manager, Greater Roanoke (Virginia) Transit Company; Robert Dunlavey, Transit Manager, Santa Rosa, California; Corinne Goldgar, Transit Planner, Appleton, Wisconsin; Jerry Harmon, Board Chairman, North San Diego County (California) Transit District; Karl Hekler, Board Chairman, Berkshire County (Massachusetts) Regional Planning Commission; Richard Hillman, Mayor, Annapolis, Maryland; and Richard Millbrodt, City Manager, South Lake Tahoe, California.

SIMPLIFIED GUIDELINES FOR EVALUATING TRANSIT SERVICE IN SMALL URBAN AREAS

SUMMARY

Different amounts and types of information are needed by local decision-makers, transit managers, and transit staff. This report deals with the information that should be presented to officials who have ultimate responsibility for local transit decisions. Transit managers (and staff) need detailed information on which to base their recommendations to the decision-makers or local elected officials (LEOs), they are accustomed to dealing with large quantities of data and complex tables, and typically have rather clear views of their own information needs.

LEOs, by contrast, often are confronted with more information than they want or need to make decisions about transit options. A short, concise summary is preferred to a mass of data. But transit managers must have the backup data at hand in case questions are raised during the discussion of options.

In the absence of specific advance guidance from LEOs, staff and transit managers often attempt to anticipate questions they will receive from LEOs and to include information addressing all possible questions in the initial presentation package. This approach tends to lead to a clutter of details that obscures the issues at least as often at it helps in decision-making. LEOs, in somewhat similar vein, frequently ask the questions they anticipate receiving from their constituents.

"Experience" and "confidence" are important factors in determining the amount of detail LEOs request when a decision is to be made. When a transit manager and a group of LEOs have worked together long enough to develop mutual respect, confidence, and rapport, the LEOs are likely to demand less information. Where mutual experience is relatively short-lived, LEOs are more likely to request more detail about a recommended plan and/or to ask for details about alternatives considered but not recommended.

The time-experience-trust phenomenon makes it difficult to provide a set of guidelines that will be appropriate for all situations. Local requirements that data be presented in certain formats (for example, an annual budget to be approved in a format consistent with the rest of the city's budgeting procedures and formats) are a source of many variations in the level and amount of information that must be given to decision-makers. Thus, rather than attempting to be exhaustive in coverage, this report presents a normative set of recommendations that suggest what decision-makers should concern themselves with, at a minimum.

The recommendations presented in Appendix A cover the information designed for presentation to decision-makers in three situations: system justification, routine decision-making, and monitoring (periodic reporting when no decision is required). Emphasis is on generality and simplicity, based on research findings. The most significant findings of the study are the need to simplify presentations to decision-makers and the need to expand the use of graphics in making presentations. A small set of key variables that address the issues of primary concern to LEOs should comprise the initial presentation. Other information should be available as background, but on an on-request basis. Graphics need not be elaborate, but should be used extensively

to simplify the presentation of complicated situations. Once workable formats have been developed by a given transit system, they can be used and reused at relatively low cost (and time) for preparation.

A three-part educational package is developed and presented in Appendix B. Part One is a general introduction to small-city transit intended for orientation of new decision-makers. It consists of a slide show and accompanying script. Part Two is a discussion of variables to be examined in the course of evaluating alternatives, also in slide/script format. This part is intended to introduce a discussion of alternatives. Part Three presents templates for use in describing alternatives in system justification and routine decision-making circumstances and for drawing attention to significant factors in monitoring.

A discussion of local government decision-making models is contained in Appendix C. Appendix D is a bibliography.

CHAPTER ONE

INTRODUCTION AND RESEARCH APPROACH

RESEARCH PROBLEM STATEMENT

Both small and large transit systems are caught in a continuing struggle to determine the impacts of transit system investment decisions on users as well as on the community at large. The actual impacts of a transit system are difficult to determine. In addition to the obvious potential impacts, such as changes in vehicle-miles of travel, fuel consumption, pollution, etc., there is also a group of not-so-obvious impacts that relate to the costs and benefits of a transit investment (e.g., vehicle accidents, peak-hour congestion, traffic volume changes, commercial parking space requirements, and changes in future capital costs for street construction). Nonquantifiable impacts also must be considered, such as changes in mobility for the economically disadvantaged and for those who cannot drive (e.g., handicapped, elderly, and young people).

To ensure that transit board members, city managers, and councils have information on which to make intelligent and consistent appraisals pertaining to such investments, many types of factors must be fully considered. In addition to the basic transit planning criteria and factors, e.g. service and costs, other typical factors are (1) socioeconomic (e.g., percentage of elderly population, minority population, chronic unemployment problems, diversity of existing industries, existence of large institutions); (2) political (e.g., attitude of the affected parties, social/economic advocate groups); (3) current local concerns (e.g., ecology, air quality, traffic congestion); (4) business decisions; and (5) geographic (e.g., climate, topography, proximity to major urban areas).

Transit planning methods for cost-benefit analysis and for cost-effectiveness analysis have been well documented in studies sponsored by AASHTO, FHWA, UMTA, and the Office of the Secretary, U.S. Department of Transportation (U.S. DOT). Typically, however, these studies have been too complex and, in many cases, too data-intensive for understandable public presentation and use in small cities. Therefore, research is needed to prepare a technically based, yet simple, analytical tool for use in the public decision process relating to the potential impacts of transit alternatives.

EXISTING KNOWLEDGE

Beginning in the last 1970s, a number of studies examined the problem of measuring transit performance. Some of the criteria recommended for performance measurement can be adapted to the evaluation of transit alternatives by replacing the measurement of existing conditions with a technique for forecasting future conditions. Numerous forecasting techniques likewise are available, some of which are applicable to small city transit performance measures. Literature on public budgeting appears in general to be of little use, except in establishing a framework for understanding the decision-making process in small cities. Many techniques for cost-benefit and cost-effectiveness analysis have been proposed. The challenge is to select the appropriate technique for application in a specific small-city setting, rather than to invent a new technique. Virtually nothing has been published about the behavior of small-city decision-makers in the specific context of transit system alternatives evaluation. Likewise, little research appears to have been done on selection of optimal techniques for information presentation.

RESEARCH OBJECTIVE

As originally specified in the Project Statement, the objective of this research was to develop procedural guidelines for use by transit and municipal agencies in analyzing proposed transit and paratransit alternatives and in presenting their proposals to the decision-making bodies. Use of these guidelines should result in better public understanding of proposed investments for a new transit system or improving an existing system. Also, increased use of sound cost-benefit techniques to safeguard against inadequate analysis was expected to result from the availability and use of these guidelines. The guidelines were to be designed for application by nontechnical persons and directed to the types of decisions faced in urban areas of up to 200,000 population. Considerations such as total costs, avoided costs, transportation alternatives, ridership, urban development factors, conservation of energy and other resources, and typical evaluation criteria were to be included.

Three components were included in the scope of the overall objective:

1. Determine what information policymakers need in order to make informed choices among alternative transit plans.
2. Identify the analytical techniques that will most simply and effectively yield the required information.
3. Identify the best techniques to communicate the information about alternatives and their impacts to the decision-makers.

The research effort comprises four tasks plus report preparation. These tasks are:

1. Identify impact factors.
2. Review literature and related material.
3. Develop procedural guidelines.
4. Develop educational package.

The educational package was to be used for demonstrating the analysis procedures and the factors considered in evlauating transit improvements and alternatives. It was to be suitable for presentations to city councils and transportation planning boards and, although based on a prototype application, was to be adaptable to local situations.

RESEARCH APPROACH

Development of Impact Factors

Figure 1 presents the task sequence diagram used in the research. Impact factors were identified through a screening process. First, a portion of the literature search was devoted to developing a list of impact factors that had been applied or recommended to evaluate alternative small urban area transit plans. The literature search included examination of the following categories:

1. Studies of transit performance measures.
2. Studies of indirect impact of transit investments, including implicit trade-offs between investments in transit and investments in other transportation infrastructure.

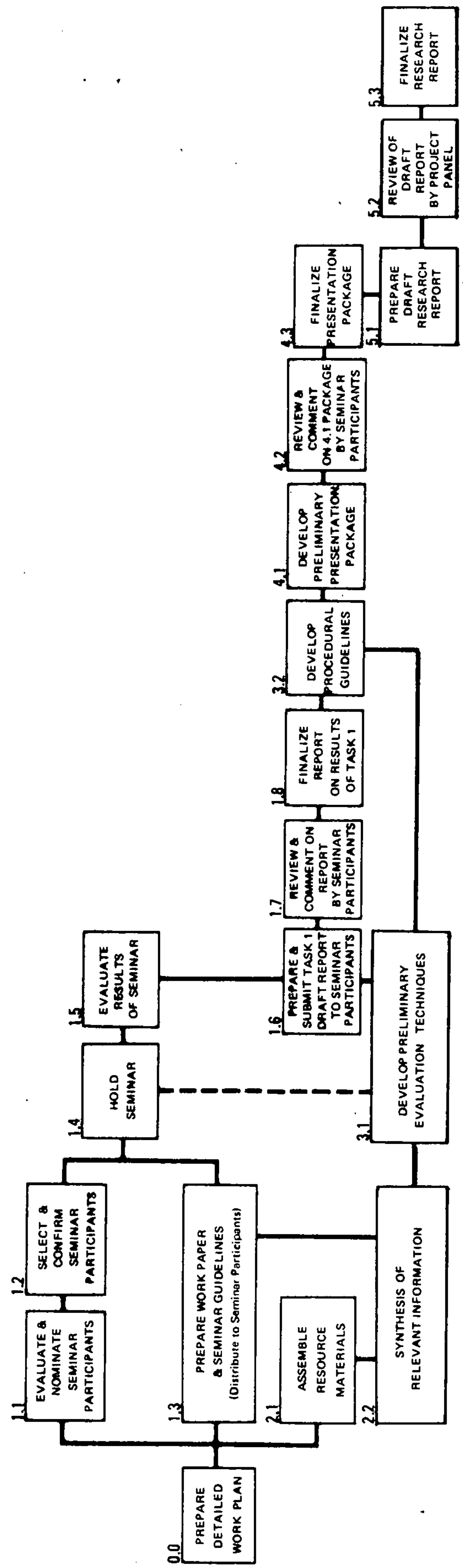


Figure 1. Task sequence diagram.

3. The transit budgetary and decision-making process, including cost-benefit and cost-effectiveness analysis techniques.
4. Literature on general municipal budgeting procedures.

The research team added to the list of impact factors developed from the literature search those factors which, in its experience, had been or deserved to be considered in evaluating small-city transit alternatives.

The list of impact factors thus developed was subjected to a preliminary screening which eliminated techniques requiring a great deal of expensive data collection or sophisticated analytical techniques. Those impact factors were then listed in a work paper prepared as part of the materials to be used in the next step of the option screening process.

A seminar panel, consisting of 11 individuals involved with decision-making in small cities, was convened to assist in testing the practicality of the impact factors developed in earlier steps. Seminar participants included small-city transit managers, transit board members, mayors, and city managers. Participants were asked to describe the transit planning process in their communities and to indicate the impact measures and other items of information that were used in choosing among transit alternatives. After the seminar, a work paper, entitled "Impact Factors for Transit Decision-Making in Small Urban Areas," was prepared and circulated to seminar participants for review and comment. The work paper described local government decision-making behavior, factors and impacts used in planning, and evaluation and decision-making processes from the perspective of the existing body of literature and the practical experience of the seminar participants. Recommendations for potential improvements in applying performance measures and evaluation methodology were presented.

Development of Procedural Guidelines

The work paper which resulted from the seminar foreshadowed the direction the procedural guidelines would take. After comments from the seminar participants were received and incorporated, work proceeded on development of the guidelines. The approach used in developing the guidelines report was based on the following logic.

Screening of impact measures and input from seminar participants resulted in identification of a useful set of impact measures which should be considered by decision-makers weighing transit alternatives in small urban areas. Once the appropriate set of measures was identified, further research was necessary, combining the available literature and the research team's experience to select the best procedures for impact measurement. Formal evaluation of alternatives, according to the information provided by seminar participants, appeared to be of minor importance. A much more serious issue was development of good techniques to communicate information about alternatives and their impacts to the decision-makers. Accordingly, the remaining research effort emphasized selection of good, simple, measurement techniques and deemphasized evaluation techniques. In particular, additional emphasis was placed on development of good graphics to portray the impacts of transit options.

A draft of the recommended procedural guidelines was developed next and circulated to the project panel for review and comments. Comments received were incorporated as appropriate in the final version of the guidelines report.

Development of Educational Package

By indicating some of the difficulties experienced by practitioners in attempting to present alternatives, the seminar guided the development of the educational package. This was consistent with the original research design, which anticipated that the educational package would be designed after earlier steps in the research had identified the need for improvements in presentation format. Although the original research design called for an on-site test of the educational package, this proved impractical. It was realized that a one-city test (as called for in the research) was of limited value and that the best indicator of the usefulness of the educational package would be its acceptance and use by the transit industry in small city settings. Accordingly, a portion of the research effort was devoted to developing a format which would lend itself to wide circulation and easy adoption by the transit industry.

SUMMARY

The primary usefulness of the research to the transit industry lies in the guidelines report (presented in Appendix A) and the educational package (presented in Appendix B).

CHAPTER TWO

FINDINGS

Research conducted in this project led to findings in four areas: the decision-making process, the relevant factors (alternatively called performance measures), the measurement and evaluation techniques, and the presentation techniques.

THE DECISION-MAKING PROCESS

A primary goal of the research was to improve real world decision-making. Accordingly, an early phase of the research concerned the way transit decision-making actually occurs. Examination of the literature of local government decision-making was combined with discussions with seminar participants and the research team's experience to develop a description of how transit decisions are made.

Decision-Making Models

Several local government decision-making models have been proposed on a continuum from the "comprehensive-rational" model to the "incremental" model. Appendix C discusses decision-making in greater detail. Table 1 summarizes some of the more important contrasts between the models.

Judging by recent studies, the current trend is to move toward the introduction of more rational elements in a process that is basically incremental. Models of this type of decision-making behavior are called "limited rationality" models. Performance measures, program budgeting, and other objective measures are used in increasing numbers of cities and circumstances. Nonetheless, the process is still largely incremental. As a result, elaborate evaluation schemes are viewed as unnecessary. Goals emerge as part of the analytical process rather than being clearly articulated before an analysis begins. In some cases, decision-makers do not want to state their objectives clearly, because they may have to make difficult trade-offs among conflicting objectives and prefer the greater flexibility that accompanies unstated positions.

Table 1. Chief characteristics of decision-making models.

Characteristic	Comprehensive-Rational	Incremental
Goals	Goals and objectives clearly defined. Constraints identified; priorities established.	Goals and objectives may evolve along with constraints. Priorities perhaps clarified.
Alternatives	All alternatives identified in comprehensive search.	Only a few marginally different alternatives considered.
Consequences	Full range of consequences predicted; both immediate and longer-term consequences considered.	More limited set of consequences considered, usually on a short-term basis.
Analysis	Comprehensive analysis in terms of objectives and constraints. Trade-offs identified. Formal techniques employed.	Limited analysis intertwined with goal determination. Expert judgment, "back of envelope" approach used more often.
Decision	Preferred alternative identified based on complete "objective" assessment.	Choice based on more "subjective" assessment of feasibility. Serial process with decisions reconsidered and adjusted.

Institutional Arrangements

Transit operations in small urban areas are administered in a variety of ways, including the following:

1. Single-purpose transit authority with autonomous local funding source.
2. Transit board (single-purpose agency) dependent on general funds.
3. A transit department within city government.
4. A transit division within another city department such as public works.

Factors affecting transit decision-making vary according to the institutional/administrative setting. The range of options that a single-purpose transit authority considers, and the variables used to evaluate those options, may be quite different from the options considered and the variables analyzed by a city council dealing with a consolidated city budget wherein transit, in effect, competes for funds with other local government functions. Hence, it is inappropriate to attempt to determine a single, unique set of factors and impacts for examining transit decision-making, regardless of setting.

Decision-Maker Involvement

Responsibility for making transit decisions in small urban areas ultimately rests with the local elected officials or, in some cases, an appointed transit board. These decision-makers are referred to as LEOs (local elected officials) henceforth. The difference between elected and appointed officials does not appear significant with regard to the decision-making process. The level of decision in which the LEOs involve themselves appears to differ significantly across cities and, in some cases, in the same city over time. At one extreme, LEOs get involved in great detail in system monitoring, looking closely at large numbers of performance indicators. In some cases, they follow up with transit management on reports of individual incidents which are really operational rather than policy in nature. When service-level decisions are to be made, they may ask the transit manager to present them with a full range of alternatives and the consequences of each, and make the decision themselves. At the other extreme, LEOs are relatively unconcerned with system details and want the transit manager to present them with a recommended alternative and its costs and consequences. Development and evaluation of alternatives prior to choice of a recommended alternative is left to transit management and staff. Where any particular city is on the continuum at any given time appears to depend on several factors. Key among these is the length of tenture of the transit manager and the consequent level of trust that has built up between management and LEOs.

Classification of Decisions

Because there are so many variations in institutional arrangements and degree of decision-maker involvement, it proved necessary to develop a simple classification scheme for situations rather than to attempt to develop recommendations for each cell in a matrix of situations cross-classified by decision-making model, decision-maker involvement, and institutional arrangements. Fortunately, further analysis determined that the same variables, factors, and impacts were of concern to decision-makers in a wide variety of institutional arrangements. The most useful classification scheme deals with the nature of the decision to be made rather than the nature of the decision-makers.

The types of decisions being made can be grouped into three broad categories:

1. Major decisions, such as a determination to initiate or discontinue operation.
2. Minor decisions, such as a midyear modification in service

or budget or the annual adjustments for the coming year's service and budget.

3. Nondecisions, the provision of information about month-to-month (or quarter-to-quarter) operations in a "monitoring" activity.

Accordingly, the recommended factors and impacts to be considered in evaluating alternatives are listed for three different situations called: (1) system justification, (2) routine, and (3) monitoring.

In each case, findings are reported with respect to presentation, content, and format for decision-makers who are elected or appointed officials, whether they have broad responsibilities or are concerned only with the transit system.

FACTORS AND IMPACTS

One of the most important findings of the research is that major decisions in the system justification category are based on decision-makers' study of a relatively small number of factors. Planners and system managers tend to tell LEOs more than they want to know in such cases. By contrast, LEOs appear willing to deal with greater numbers of factors, impacts, and performance indicators when routine or monitoring issues are under discussion. In all three instances, careful selection of the variables to be presented can help avoid unnecessary clutter of detail.

System Justification Variables

To assist LEOs in focusing on key issues, attention should be directed first to seven primary indicators:

1. Number of trips served.
2. Highway congestion.
3. Operating and maintenance cost.
4. Annualized capital cost.
5. Fare box revenue.
6. Net annual cost.
7. Funding sources.

A comparison of transit and private auto modes is presented for each of the primary indicators. Next, eight secondary indicators are presented. Six of these deal with indirect effects of the transit system:

1. Capital outlays to planning horizon.
2. Capital funds by source.
3. Probable accidents.
4. Emissions.
5. Energy consumption.
6. Unemployment effects.
7. Economic development effects.
8. Parking requirements.

For the last six of these indicators, a comparison of impacts with and without the transit system is presented.

A series of transit descriptive variables is presented next. These variables are informative and are intended to give LEOs an overview of the scope of transit operations (existing or contemplated). The information contained in these measures is not intended to affect the transit/no-transit decision. The same indicators are used in routine decision-making and, in a disaggregated form, in monitoring. The descriptive variables are:

1. Number of routes.
2. Hours of service, days of service.
3. Buses required.
4. Number of employees.
5. Annual vehicle-hours and vehicle-miles of service.
6. Fare structure.

Finally, a number of performance indicators should be presented. Like the transit descriptive variables, the performance indicators presented here also appear in information given for routine decision-making or monitoring. These indicators deal with the effectiveness of the system as measured by the proportion of the service area's households that have access to the system, passengers per unit of service provided, and the efficiency of the system as measured by cost per passenger. The performance indicators are:

1. Percent of households served.
2. Percent of minority households served.
3. Percent of low-income households served.
4. Percent of no-auto households served.
5. Percent of elderly, handicapped served.
6. Transit cost per passenger.
7. Transit revenue per passenger.
8. Transit passengers per vehicle-hour or vehicle-mile.

Routine Decision Variables

Five primary indicators are recommended for presentation to local decision-makers in the context of routine decision-making, which covers such areas as annual operating budget approval, minor route restructuring, or minor schedule changes. Since the continuation of transit service is (by definition) not at issue in a routine decision, the comparisons focus on the changes between the proposed, the existing, and the recent past. A dozen secondary indicators are used. They combine the secondary indicators and the system descriptor variables from the system justification situation and are presented in a manner that enables the decision-makers to quickly grasp the system differences in service levels between existing and proposed.

The primary indicators are:

1. Total operating cost.
2. Total passengers carried.
3. Total operating revenue.
4. Net cost of operation.
5. Sources of additional funding.

The first eight secondary indicators are the same variables cited as transit descriptive variables in the system justification section. They include the number of routes, the days and hours during which service is provided, the number of buses required, the number of employees, the annual vehicle-hours and vehicle-miles of service, and the fare structure. In routine decision situations, the descriptions should be given on a system level;

they are provided on a route-by-route basis in the monitoring information.

The remaining four measures are discussed as performance indicators in the system justification section. They are transit cost per passenger, revenue per passenger, passengers per vehicle-hour or vehicle-mile (vehicle-hour is preferred, but vehicle-mile may be used if customary on a given property), and percent of households served. The percent of households served is subdivided into the various target population categories: minority, low-income, no-auto, elderly, handicapped. Comparisons with current and previous year statistics should be presented, as for the descriptive variables.

Monitoring Variables

Although a number of the measures are identical with those used in system justification and routine decision-making settings, the level of detail presented in the monitoring context, and the comparisons provided here, are different from those that prevail in the other contexts. The organization of information is also somewhat different, reflecting the relative importance that should be given to the various indicators. Key monitoring variables are provided first, efficiency and effectiveness measures second, and system descriptors last. In all cases, the information presented should include comparisons of year-to-date and prior year-to-date, current period and same period last year, and budgeted-to-actual data. It was found that the usefulness of monitoring information can be increased by using a clear, concise graphic format; recommendations and findings about appropriate formats are discussed later. The following key monitoring variables are recommended:

1. Total system operating cost, with breakout by major function.
2. System revenues, both fare box and nonfare box.
3. Net public cost (subsidy) and sources of funding.
4. Route-by-route detail on total operating cost, total operating revenue, and net public cost.
5. Systemwide detail on total operating cost, total operating revenue, and net public cost by time of day (peak, off-peak, daytime, evening) and day of week (weekday, Saturday, Sunday, if applicable).

The following performance measures should be presented next. They combine aspects of efficiency and effectiveness. It was found that the distinction between the two types of measures is subject to debate and of little or no use to LEOs, so no attempt is made to categorize them.

1. Cost per vehicle-hour.
2. Vehicle-hours per employee.
3. Number of employees required.
4. Annual employee turnover rate.
5. Number of peak vehicles required.
6. Annual vehicle-miles per vehicle.
7. Number and dollar cost of accidents.
8. Number of complaints.
9. Percent of transfers.

Except for cost per vehicle-hour, all the measures above are presented on a systemwide basis, and compared with the past year. Cost per vehicle-hour, and the measures which follow, should be presented on both a systemwide basis and a route-specific basis (also by time of day and day of week, if appropriate to the LEOs' current interests).

1. Cost, revenue, subsidy per passenger.
2. Recovery ratio.
3. Passengers per vehicle-hour.
4. Passengers per vehicle-mile.

The following system descriptors should be provided, but only when changes occur. Typically, they will not change from one reporting period to the next.

1. Fare structure.
2. Service frequency, hours and days of service, by route, time of day, and day of week.

MEASUREMENT AND EVALUATION TECHNIQUES

Measurement Sources and Techniques

The data now collected by virtually all United States transit systems under the uniform transit reporting requirements (Section 15) established by UMTA in 1978 provide a substantial amount of performance and operating information for small-city transit systems, ensuring that system-level data are available on a more or less comparable basis for all transit systems receiving UMTA aid. Route-by-route and time-of-day data suggested for monitoring activities require a level of data collection exceeding Section 15 requirements, but nonetheless one that most transit systems need anyway for internal analysis of their operations.

Four different transit planning handbooks, developed under UMTA and TRB research funding, have been produced in the last few years. Among them, they cover techniques for system performance analysis, travel demand forecasting and related models, and analysis of ridership, costs, and socioeconomic/environmental impacts. One finding of this study was that scaled-down, quickly applied analysis methods are all that are necessary or desired for small-city transit planning. The available methods were reviewed and classified with regard to assessment of data requirements, time to obtain results, and degree of statistical sophistication. Results of this review and classification are presented in the guildelines manual in Appendix A.

Two types of impact analysis were not covered well in the existing handbooks. Both are important at the system justification level of decision-making. One involves analysis of current and projected automobile travel characteristics as these might be impacted by the presence or absence of transit service. The other addresses basic indirect economic impacts, including employment and economic development. Several previously suggested methods for dealing with these impact areas were adopted. The manual (App. A) presents some noncomputerized analysis methods for these indirect impacts.

Evaluation Techniques

Review of the literature indicates no lack of plan evaluation methodologies. Three basic approaches to evaluation of transportation improvement alternatives exist: economic efficiency analysis, cost-effectiveness analysis, and scoring methods. Efficiency analysis has limited capability, even when restricted to analysis only of direct costs and of incremental cost/benefit ratios. Attempts to deal with indirect benefits are subject to criticism on grounds of incompleteness, double-counting, and subjectivity. Scoring methods that use summary scores and relative goal weights too often suffer from superficiality and potential disagreement over weights and goal identification. Neither is recommended from a technical standpoint.

Cost-effectiveness analysis, on the other hand, has more widespread applicability and is gradually achieving wider acceptance. Explicitly or implicitly, it appears to be the method of choice of transit staff and managers when screening alternatives and even when selecting a single alternative to recommend to the LEOs. The ultimate decision-makers, however, generally rejected all formal evaluation techniques. They prefer to receive information about selected impacts of a recommended alternative (or several options) and to perform individual evaluations on an intuitive basis. There is virtually no support for elaborate evaluation schemes among decision-makers and a positive distrust of such tchniques in some quarters.

PRESENTATION TECHNIQUES

Study of a number of examples of the format in which information was presented to decision-makers was combined with discussion with seminar participants to ascertain the effectiveness of presentation techniques in use. It was found that two problems exist when information is given to LEOs. First, as mentioned earlier, the information provided by planners and managers may not be the information on which the LEOs wish to base their decisions. Second, the formats in which information is presented leave much to be desired in all too many cases. Communication and a focus on the important issues can be improved by better use of graphic material. In most cities, far too much reliance is placed on use of tabular materials and narrative text.

It was found that many cities lack in-house capacity to develop and produce good graphic formats. A need for standardized materials was identified and met through development of the educational package which forms an integral part of this research project. The materials are presented in Appendix B.

A need for further research in the area of presentation techniques was also identified. This subject is discussed further in Chapter Four.

CHAPTER THREE

INTERPRETATION, APPRAISAL, APPLICATION

THE DECISION-MAKING PROCESS

Practicing professionals and academics concerned with urban management long have been interested in the local government decision-making process in general, and a substantial literature on the subject has been built up over the years. Appendix C summarizes current theories in the field. Observations and insights obtained from the project seminar confirmed that local decision-making regarding transit services is largely consistent with the more general theory and conventional wisdom. This section examines the nature of decision-making with respect to transit in small- and medium-size local jurisdictions, roughly in a population range of 25,000 to 200,000 people, focusing on the kinds of transit-related decisions that are made in these jurisdictions, who makes them, the kinds of considerations that seem to influence them, and the implications of existing practice for efforts to improve transit decision-making. To summarize at the outset, local transit decision-making behavior is basically incremental in nature as far as the range of alternatives and criteria used to analyze them is concerned, but nevertheless highly rational in terms of the goals, objectives, and underlying values in the minds of local policymakers. The local transit decision-making process is clearly an information-sensitive one, but there is also a degree of tension between the tendency toward information overload on the one hand and the inclination to sometimes overlook or ignore "objective" data on the other hand, particularly when it does not fit the policymakers' predetermined approach to a given problem. Finally, there is obviously wide variation from jurisdiction to jurisdiction as to how transit-related decisions are arrived at, some of it systematically related to area characteristics and some of it more random.

Decisions and Decision-Makers

One theme that emerged in the project research was that policymakers—mayors, city council members, and transit authority board members—as well as professional managers and sometimes planners are involved in most transit-related decisions, but that their roles are likely to vary from community to community and depend on the types of decisions being made. With respect to the roles played by these participants and the kinds of considerations and information they will bring to bear on the issue, there is a need to distinguish between policy and managerial decisions: "policy decisions" set the basic scope of services to be provided (system objectives, general levels of effort, and perhaps macrostrategies), whereas "managerial decisions" focus on operations issues within this framework. In theory, policy decisions are primarily in the province of the policymakers and managerial decisions typically the responsibility of the professional managers. In practice, this distinction is not at all clear-cut. Indeed it must be recognized that managers almost always will influence policy decisions to some extent and that policymakers may, in some cases, intrude upon managerial decision-making.

It is clear, however, that decision-making on these two levels is approached differently, especially in the extent to which performance data are relied upon. For instance, the set of performance indicators discussed later in this report clearly is used by transit planners and managers in their work, particularly those indicators representing internal operating efficiency, effectiveness, and cost-effectiveness. Many of these indicators are tracked over time and used to develop forecasts of future performance. They may be compared to peer group performance on a systemwide basis and used for individual route analysis. However, for the most part, these same detailed indicators are simply not of great interest to the policymakers.

Types of Decisions

It should be understood that, as in other program areas, transit-related decision-making is a continuing process that goes on at various levels across the entire fiscal year. Major "budget" decisions, of course, are made at discrete points during the budget cycle of preparation, approval, and execution, but major "program" decisions, though they are usually reflected in budgets, are made on a less regular basis when the need arises. Lower order decisions, basically the managerial decisions, are made periodically along the way. The kinds of decisions that often involve policymakers include:

1. Initiation, substantial overhauling or upgrading, continuation, or termination of transit service in the local area.
2. Major changes in the service area to be covered or in the institutional arrangements for providing transit service.
3. Relative coverage among major portions of the service area and general orientation of the network (e.g., CBD-centered radial vs. grid system, etc.).
4. Provision of regular transit versus demand-responsive service for the elderly and handicapped.
5. Commitment to big capital projects.
6. Overall level of service to be provided and level of funding.
7. Fare increases or decreases.
8. Specific route additions or deletions and significant changes in service levels on existing routes.
9. Implementation or elimination of special services (e.g., Sunday or evening service, sheltered workshop runs, etc.).

Moving through this list it should be noted that generally those issues near to the top tend to call for "one-time decisions" or at least those that arise infrequently; once such decisions are made, they tend to remain in effect for some time. By contrast, those issues listed near the bottom tend to arise more frequently; every so often there may be proposals for fare increases, route additions or deletions, or changes regarding special services which require the policymakers' attention. Even more frequently, managerial decisions are taken, typically not requiring input from the policymakers, concerning minor revisions in routes and schedules, maintenance practices, vehicle assignments, dealing with breakdowns, and a host of problems which crop up on a day-to-day basis.

Decision-Making Responsibilities

Paraphrasing Ref. 1, prevailing theory holds that power in urban government is shared by private sector influentials, elected officials and the professional managers they appoint, and municipal bureaucracies, which, with civil service and union protection, are seen by some as the new machines that have replaced the older political party machines of an earlier period (*1*). Although decision-making concerning transit may be somewhat less politicized than in certain other policy areas, the private sector groups which most often show an interest in influencing transit decision-making would include downtown business interests, groups representing special target populations such as the elderly and handicapped, and sometimes neighborhood or taxpayers associations. The elected officials include city council members and mayors, and the officials they appoint who are most directly concerned with transit decisions include city managers or chief administrative officers, transit authority board members, and transit managers. In smaller and medium-size cites, the bureaucracies tend to be less powerful because they have fewer administrative layers and control is less decentralized, and the power of the transit managers, whether reporting to an authority board, mayor, or city manager, is likely to increase commensurately.

Formal authority and responsibility for making decisions clearly reside with the governing bodies—city councils or transit authorities and sometimes both—and with other elected officials such as mayors. These parties are continually making decisions which affect transit service, even in situations where avoiding a decision automatically means retaining existing policy. Yet, who actually makes these decisions varies widely. In some jurisdictions, the policymakers may delegate many decisions to transit managers, such as those concerning alterations of the basic service plan, which in other cities the policymakers would reserve for themselves. External and conflicting political pressures may be brought to bear on certain issues in some communities, while in others there is strong consensus or else little interest in the matter. This political context will often define how the elected officials approach transit decision-making.

Most important with respect to the roles of policymakers and managers concerning transit, there is continuing interaction between the two levels, which tends to routinize the decision-making process based on trust the longer that key individuals remain in the same positions. These interactions occur on different levels such as (1) part of major budget and program decision-making in a formal context; (2) the conveying of routine information by managers to policymakers on a regular basis, again in a formal context; (3) sporadic requests on the part of managers to policymakers on a formal basis; and (4) sometimes frequent informal communications as when policymakers check with managers regarding a constituent's complaint. While these lower levels of exchange are not usually decision situations—certainly not policy-making situations—they do provide an educational function and serve to build a firmer context of information about the transit system which may well influence policymakers' positions on future issues.

With respect to formal decisions on basic policy issues, professional transit managers usually play an important role even when they are not making the decisions themselves. Not only may they propose courses of action and react to other alternatives being considered by the policymakers, but in practice they may in effect serve a "gatekeeper" function. Based on their professional judgment and familiarity with the system, they often initiate issues for decisions in the first place and screen the alternatives that are possible solutions. In this mode, the transit manager and planners may look at a wide set of alternatives, subject them to closer scrutiny in terms of performance criteria, and convey a few preferred options with their pros and cons to the governing body for a decision.

Decision Criteria

In moving toward decisions on the types of issues enumerated earlier, policymakers and transit managers to some extent may have different criteria in mind. Whereas professional managers tend to gear their assessment of options primarily to effectiveness and efficiency considerations, the policymakers may be just as concerned with equity, responsiveness, and appropriateness. Transit managers are primarily concerned with providing an adequate level of service to their riders and attracting new riders if possible (effectiveness), and with costs in relation to level of service (efficiency) and costs in relation to ridership (cost effectiveness). The policymakers, elected officials in particular, will be much more sensitive to the distributional consequences of various alternatives (equity), their responsiveness to the desires of constituents, and how they square with public sentiment in general (appropriateness).

To better understand the range of criteria that can influence major policy decisions concerning transit, consider why city councils support transit in the first place or conversely the kinds of arguments that would be made in opposing a move to eliminate transit service in a small- or medium-size city. First on the list would be the "mobility" argument: public transportation is essential for providing mobility to transit-dependents—disadvantaged groups, including low-income families and the elderly and handicapped whose life-styles and productivity may be severely limited if forced to rely on private means of transportation, which are often unavailable to them. Second would come the "economic and commercial" arguments that transit can be beneficial to the local economy in a number of ways: (1) by attracting people to the central city and in particular helping to support CBD retail activity, (2) perhaps by contributing directly to downtown redevelopment as with the construction of a major transfer facility, (3) by helping to maintain property values in general in all areas served, and (4) by directly providing employment to drivers, mechanics, and other transit agency employees.

Next would come a set of "environmental" arguments that it is necessary to provide an alternative mode of transportation in order to attract commuters to become by-choice transit riders to reduce use of private automobiles in the city. Although these arguments are usually less salient in smaller and medium-size urban areas, transit is sometimes promoted on the grounds of (1) having a favorable impact on downtown traffic congestion and parking problems, (2) reducing energy consumption and air pollution, and (3) helping to contain urban sprawl and the need for extensive new infrastructure.

Finally, an "image" argument is sometimes made at least implicitly, one which in part encompasses all those arguments listed previously, that a public transit system is simply a necessary component of a truly viable city. As a form of boosterism, civic leaders and elected officials may see a transit system as one indicator that the urban area is progressive—one which presents itself to existing and prospective major employers as well as conventioneers, etc., as a real "going concern."

Obviously, not all of these arguments are considered for each major transit issue. In some cities, the environmental and image concerns, and perhaps even the economic and commercial concerns, may not be of interest. However, in other local areas, some of these considerations, which go well beyond the immediate effectiveness and efficiency criteria, do surface as real issues. Furthermore, some of these concerns can translate into conflicting criteria in evaluating a given issue. For example, in deciding whether to initiate a new route which would connect the central city in a transit system's service area with a regional shopping mall on the periphery of that service area, local officials may find themselves caught between the competing values of providing access to a full range of activities and the desire of downtown business interests to retain a high percentage of transit-dependents as "captive customers."

Some impacts are less suceptible to objective measurement than are others. Service levels, ridership, and cost factors associated primarily with the concern for mobility are among the most directly observable and, thus, the most easily measured. Impacts such as the extent to which transit can relieve traffic congestion or shore up downtown retail activity are much more difficult to measure. Moreover, some of these considerations—primarily the efficiency, effectiveness, and cost effectiveness of providing service to transit-dependents—lend themselves quite readily to periodic monitoring on a regular basis. Quantifying other kinds of impacts is apt to require substantial and unusual research efforts.

What this means is that those aspects of transit service provision which tend to be of the greatest concern to transit managers in terms of allocating funds and actually managing the system's operation are also among those which are most feasible to examine on a regular basis.

In general, the transit industry, including local operators, UMTA, state DOT personnel, consultants, and researchers, has become "enamored" of data, particularly since the advent of the uniform transit reporting system. Data bases are built to provide the kinds of information which are seen as useful in making decisions at the managerial level. The same kinds of information are also perceived as being helpful at the local policymaking level and at higher funding levels. The effort to build data bases is consistent with a management science, information-based approach to decision-making.

It is clear both from the project seminar and the experience of the research team that detailed performance indicators are used by transit managers and planners. Such measures are also used to some extent at the central executive/general management level in cities where transit service is provided by a department of the city government rather than by an authority, as evidenced by the results of a survey conducted by the Institute of Public Administration at the Pennsylvania State University (*2*). The survey included a question about which public services were provided by the jurisdiction and whether certain types of performance measures were used to monitor programs. The types of performance indicators, for which definitions and examples were given, included work load or output measures, unit cost or efficiency measures, effectiveness measures, and indicators of client or citizen satisfaction.

Of the 460 cities responding to this survey, most of which had 250,000 or fewer in population, 36 percent reported that they directly provide transit service in their community. Of these, 62 percent reported the use of work load or output measures (up from 51 percent in 1976), 59 percent reported the use of unit cost or efficiency measures (up from 43 percent in 1976), 45 percent indicated that they use effectiveness measures (up from 39 percent in 1976), and 60 percent reported the use of client or citizen satisfaction measures (no 1976 data available). It should be stressed that the survey was addressed to top-level professional managers in these cities, including city managers, chief administrative officers, or finance directors, and not to program managers, council members, or mayors. Thus, it elicited information about the use of various management tools by top executives with responsibility for the whole range of municipal functions.

Top-level managers are likely to be less interested than transit managers in highly detailed analysis of such performance indicators, but more concerned with monitoring overall transit system performance over time than members of the city council might be. The general trend toward increased use of such indicators from 1976 to 1982 is not at all surprising, given the promotion of performance measurement during that period, both within the transit community and the professional associations concerned with urban management in general. The finding that effectiveness measures are reported to be used with less frequency than the other types of measures probably reflects the feeling that effectiveness measures are often more difficult to define and collect than are work load and unit cost data. This seems particularly true when effectiveness is viewed as the actual impact of the service provided, such as the number of work trips that are made by transit-dependents which could not have been made without the availability of transit. The main point here, however, is that performance indicators are used in transit decision-making to some extent by substantial numbers of central executives who are above the level of transit managers but below the level of the elected officials who make policy in these cities. The elected officials presumably will be interested in some of this same information, particularly citizen satisfaction, but in more of a summary form.

Variation Among Jurisdictions

As indicated earlier, there is considerable variation in the transit decision-making process among local jurisdictions in terms of both who makes certain kinds of decisions and the factors that are taken into account in making them. Decisions that are delegated to professional managers in some cities may be dealt with directly by the city council in others; some councils may want to have certain kinds of information available in considering certain issues, which in other cities will be ignored.

During the project seminar, it became clear that certain contextual factors have a lot to do with how transit-related decisions are actually made at the local level. First, size is an obvious factor, although the direction of its effect is not always clear. Within the size class of urban areas that is the focus of this report, 25,000 to 200,000 population, a transit system may consist of anything from a handful of vans to an operation utilizing 50 buses. Everything else equal, the larger systems are likely to have more experienced, professional managers who use more sophisticated management techniques and are more inclined to try to exert influence over major issues confronting the system. In the smallest areas, the individual with responsibility for overseeing the transit operation may also be managing other city functions; these managers may not have the time, ability, or inclination to develop carefully considered arguments for major transit decisions.

Larger municipalities typically provide a broader range of functions and have much larger budgets. Many more decisions have to be made and are often more complicated; thus, governing bodies may delegate more decisions to professional transit managers. They may also solicit more information relating to the transit decisions they make themselves. Smaller cities, whose council members are usually part-time public servants with other full-time interests outside of city hall, may tend more to defer to the judgment and recommendations of the transit manager if he/she is seen as a professional who is consistently sensitive to community concerns. In general, it is probably fair to say that whatever arrangements have evolved for sharing authority in making decisions, the maintenance and use of objective information is a more important element in the decision-making process in the larger areas than in the smaller areas.

Institutional Arrangements

Other factors that influence the local transit decisionmaking process include institutional arrangements, the source and share of local revenue going into the transit system, and whether programming is generally in a growth or cutback situation. In some small- and medium-size cities, the transit system is operated by a line department of the general purpose municipal government with the transit manager reporting to the mayor or city manager and ultimately to the city council. In many other cities, however, the transit system is managed by a transit authority which is largely a separate governing body but which may depend on municipalities for funding. Generally speaking, "transit authorities"—which tend to be independent of city hall on most policy matters and whose service areas often encompass several municipal jurisdictions—are more likely to take a pro-transit stance on major issues. In their role as authority board members, these decision-makers are concerned solely with transit and not with other public services. Hence, they tend to regard transit as an essential public service that should be supported to whatever extent possible as long as it can be demonstrated that it is needed and beneficial to the communities served.

This generally pro-transit outlook, however, is by no means unbridled. Many transit authority boards also take a somewhat businesslike view of how a transit system should be managed as a revenue-generating enterprise, and therefore they are more inclined than city council members to want to track performance at least on a system level, particularly in terms of costs, service levels, and especially ridership trends. Given this "no-nonsense" businesslike orientation, transit authorities often place a premium on hiring a professional to manage the system, one who, in addition to understanding the substance of transit service, is also skilled in managing people and activities and in maintaining high productivity levels. In this atmosphere, efficiency often becomes an important criterion in decision-making at the policymakers' level.

While transit authority members usually delegate authority for managerial decisions to the professional manager and also give substantial weight to his/her recommendations in their own policy deliberations, occasionally their interest in transit can lead to overinvolvement. Authority members, especially those with long tenure, sometimes develop such a familiarity with the details of transit service delivery that they adopt the attitude or posture of transit management specialists. This can result in their simply wanting to see a lot of detailed information in considering certain kinds of issues, but in some cases, it can lead to their becoming backseat managers who actually intrude into the province of managerial decision-making.

In contrast, "city councils" view the transit systems operated by departments of city government (or by dependent authorities for that matter) as just one of numerous services provided by their municipality. While authority board members are likely to be familiar with the general operating characteristics of their transit systems and perhaps to be interested in some of the more operational decisions, city councils are more likely to "blackbox" the transit system and look upon it simply as one of several services competing for funds. Within this context, transit is usually not a high priority on a continuing basis, and city councils are almost necessarily more concerned with problems in the area of police, fire, public works, etc., than with transit.

Transit's relatively low profile in the overall scheme of things on city councils' agendas basically means less interest in the specifics of many issues which would be of concern to transit authority boards. This often translates into less interest in reviewing data on the transit system's performance on the part of the council and the delegation of more of the routine decisions to professional transit managers. Again, generally speaking, once a city's transit system is in place and operating on an ongoing basis—when the system's parameters are set and not being called into question—it is probably fair to say that the city council is more likely to be interested in costs than in anything else. While these circumstances result in a greater share of transit-related decisions being left to the discretion of the transit manager and the manager in turn being less subjected to interference from policymakers on managerial decisions, this somewhat apathetic attitude of council members toward transit can make it more difficult for the transit manager to build support for new initiatives he or she wishes to promote.

When major issues do arise, however, such as significant expansions or contractions of the service area covered or the levels of service provided, city councils are apt to view them in a broader context than are transit authorities. Whereas authorities are primarily concerned with effectiveness in terms of providing mobility to current and potential users along with the cost consequences of various alternatives, city councils are likely to be equally concerned with the economic, environmental, and image kinds of impacts outlined above. Furthermore, city councils are typically much more sensitive to political pressures brought to bear on major transit issues, while transit authorities are by design somewhat insulated from external political pressures. Indeed, one reason for creating separate authorities is to "take the politics out of government"; city council members are, by their nature, concerned with the political consequences of their decisions. The implication of these differences, then, is that decisions made by transit authorities will tend to be more objective in terms of explicit effectiveness and efficiency criteria in the traditional transportation planning framework, while city councils' decisions may appear to be less objective but yet equally rational in terms of balancing a much broader set of considerations and competing demands.

One additional aspect of institutional arrangements as they affect local transit decision-making behavior concerns intergovernmental relations. While all local transit operators must satisfy the same set of federal requirements in order to receive capital grants and operating assistance, there is a wide variation in related policies among the states. State funding policies and eligibility requirements can and do influence local decision-making. For example, Pennsylvania reimburses local operators for the number of trips made by senior citizens during "free fare" periods; thus, the impact on senior citizen ridership of various alternatives under consideration is now accorded greater importance by local decision-makers than before this policy was in effect. In addition, in calculating dollar amounts to be awarded to localities as part of purchase-of-service agreement, Pennsylvania uses numerous factors such as ridership increases or decreases and cost-recovery factors; obviously, such factors are taken into account to some degree by local decision-makers.

Local Revenue Source and Share

The source and amount of local revenue used to subsidize the transit system have an effect on the relative importance of impact factors. When locally generated revenues are earmarked for transit, for instance, or when state funds are apportioned to localities to serve as the local match to federal grants as with the case of the TDA funds in California, the completion against other service areas for funding is not a consideration. In such circumstances, when budgeting concerns only the allocation of the "transit" dollar, city councils are more likely to delegate decisions to the managerial level. When local funds going into transit, however, represent dollars which might otherwise be allocated to other service areas, council members are more concerned about cost-sensitive issues that arise and tend to reserve these transit decisions for themselves.

Furthermore, council members' concern with transit issues is likely to vary directly with the amount of local subsidy going into the system. Everything else equal, when the costs of operating a local transit system are totally or almost totally covered by earned revenues plus federal and perhaps state financial assistance, the council will be more inclined to delegate decisions to the transit manager than will be the case when substantial local funding is required to operate the system. If the system can run on its own (from the local perspective), it can be managed on very objective criteria; if local subsidy is involved, the issues become more political. While these associations between the local funding situation and the policymakers' direct concern with the issues may prevail to some extent for transit authorities also, they would not be as pronounced as with city councils.

Fiscal Status—Growth Versus Cutbacks

A second theme arising during the seminar was fiscal status as it affects local decision-making. Traditionally, decision-making processes at all levels of government in this country have been geared to conditions of growth; what new programs are needed and how is increasing funding to be allocated among existing programs? Transportation planning typically has been geared to the idea of planning transportation facilities and services to serve the needs created by urban/regional growth and to promote further growth. While such decisions are often controversial and rarely go uncontested, decision-making in the growth mode is nevertheless somewhat easier because there need be no losers in the process. Indeed, one of the simpler theories of how budgets are actually allocated, the share-of-the-pie model, is based on the assumption that the path of least resistance in reaching agreement is to provide at least minimal increments in all areas—something for everyone.

In growth conditions, additional funding is often available as long as the need for it can be demonstrated and sometimes even when this is not the case. Many participants in the project seminar indicated that (1) policymakers are not really interested in any more than the general outline of transit system performance, (2) that they do not have the time to become involved in the system in any depth, and (3) that their approach is to delegate as much of the decision-making as possible to the professional managers they hire for just that purpose. This generally seems to hold true for governing bodies of transit systems that are operating under growth conditions: adequate funding is available and the policymakers simply want to be assured that the professional managers are operating the system efficiently and effectively, providing the best service to the community with those resources. To the extent they are confident that this is the case, they also can be reasonably confident that a hands-off posture on their part will not embarrass them.

Decision-making in areas where transit is operating in a cutback management mode is quite different, however. In this context, when many of the decisions have to do with reducing the number of daily runs on a route, possibly eliminating entire routes, increasing fares, etc., the policymakers face difficult choices. Many of the options being considered are likely to be unpopular, and yet the policymakers are under pressure to make cuts in order to retain the balance between overall revenues and expenses. In these circumstances, the equity issue of who gets hurt often becomes paramount, and the policymakers, particularly elected officials, are much less inclined to delegate these decisions. In general, decision-making in the cutback mode is much tougher, and the decision-makers are very aware of the greater likelihood that negative political consequences will be generated by what they decide. In such circumstances, the policymakers are much more inclined to reserve decisions for themselves rather than delegate to managers. Moreover, they are much more likely to go into these issues in detail and to want to have more information available as the basis, or at least the justification, for their decisions. Whereas in the growth mode policymakers tend to be most interested in information regarding the level and distribution of service provided, they tend to be more concerned with ridership information—how many trips and whose trips are affected by various alternatives—when facing cutback issues.

Local Transit Decision-Making

With the sustained encouragement and support of UMTA and, in many cases, state agencies, the management of local transit systems throughout the country has become considerably more professional over the past 15 years or so. This may have been somewhat easier to accomplish than in some other program or service areas provided by local government for a number of reasons. In relative terms, transit has a clearly defined product and more easily understood service delivery components which lend themselves to the establishment of performance standards and are susceptible to technical solutions or improvements. While in good part, however, the management of a transit system is a science that can be approached with standard management tools, the art of transit management lies in the ability to develop a good fit between service provision and the needs and preferences of the community. Transit management has become more professionalized not only in terms of the day-to-day operation of the system, but also in terms of major decision-making regarding the general shape and size that a locality's transit system should have.

Role of the Transit Manager

Professional transit managers know that for the most part they will be rewarded in their careers if they can provide quality service to existing passengers and, if possible, attract additional ridership without expending resources unnecessarily. Given the specifics of these parameters in a local community, good transit mangers can be expected to make decisions on an objective basis to pursue these ends within the range of discretionary decision-making allotted to them. Furthermore, they are also likely to have well-informed positions on major issues decided by the policymakers, and they can be expected to advance reasonable, well-supported arguments along these lines to convince the policymakers that certain alternatives are, indeed, the best decisions.

The role of the transit manager with respect to major policy issues varies considerably and is determined by both the attitude of the policymakers to whom he/she reports and the management style of the individual. In some cases, governing bodies such as transit authorities and city councils guard their prerogative to make decisions, while in others the attitude is to leave as many issues as feasible to the discretion of the transit manager. Within this context, the manager can exert more or less influence over major issues being considered by the policymakers by developing their trust in his/her judgment over time, demonstrating an understanding of the factors that are important to them, and advocating certain positions and backing them up with sound arguments. Some managers of small- and medium-size transit systems are individuals who have come up through the ranks of drivers or mechanics. They have a good grasp of the details of the operation but often lack appreciable interest in major policy issues. Increasingly, however, transit managers are professionals with training in business, public administration, planning, economics, or other related fields. These professional managers are much more likely to have a concern for major policy issues, an understanding of the policy-making process in their jurisdictions, and an ability to analyze policy issues and develop policy proposals.

It is probably fair to say that most transit managers are concerned with influencing the major policy decisions taken by elected officials, and one way they do this is with the use of information. Indeed, local transit operators are required to report substantial amounts of operational and performance-oriented data to UMTA and, in many cases, to state DOTs. Transit managers necessarily develop and maintain detailed data bases to meet these reporting requirements as well as for their own internal managerial purposes, and they naturally tend to want to inject this kind of data into the policy-making process. While policymakers are often not particularly receptive to being inundated with masses of detailed data, passing some of this kind of information up to the policymaker is a legitimate educational function of the manager. The professional sees data as useful in helping to establish a context of service standards and performance criteria within which transit issues should be considered. However, many managers need to learn better methods of presenting real information in summary formats, and modes of presentation which will be more responsive and acceptable to the policymakers' needs. Present practice all too often merely presents data in overwhelming detail.

Beyond their service and performance orientation, professional managers know that in order to be effective in a policy leadership role they must also concern themselves with the broader issues to which the policymakers are most sensitive. To be able consistently to influence the major transit issues in their community, professional managers need to be able to anticipate the kinds of equity issues, economic and commercial factors, environmental concerns, and even image concerns that are likely to impact on the resolution of a major transit policy issue. To do this, most professional transit managers make it their business to be concerned with community relations and to be familiar with the political environment within which the transit system operates.

Policymakers' Perspective

By contrast, the local policymakers' attitudes toward transit-related decision-making can be summarized as definitely wanting to retain control over the major decisions that concern transit service, but not wanting to be unduly burdened with detailed information about operations and lower level issues that should be resolved at the managerial level. The policymakers do get involved in different levels of decisions, ranging from aggregate service levels and funding to such issues as fare increases and route changes. There is a wide variation among localities as to how much they rely on professional managers to make decisions and how much information they (the policymakers) require or will even give attention to. During the seminar a number of points emerged concerning the policymakers' approach in the decision-making process:

1. Governing bodies want to see options when they are faced with major decisions, rather than being presented with single preferred alternatives by the transit managers and planners. Particularly in the cutback mode of decision-making, the policymakers may well suggest options other than those proposed by the professionals—they do not want to be constrained unduly by the technical perspective when the decisions are likely to have some negative impact. However, the desire to see options is reduced when council members have developed trust and confidence in the manager over time.

2. City councils and transit authority boards want to be assured of basic operating efficiency and cost containment before considering service reductions.

3. Policymakers tend naturally to look at incremental changes—how much less service, how many more riders, expected change in revenues, etc.—because these represent the realistic alternatives. They are not interested in broad sensitivity analysis beyond the range of what is feasible; thus, they usually are not interested in the zero-base option or wish-list alternatives unless these are real possibilities.

4. The desire for information depends in large part on anticipated questions from the next level of authority. Just as the transit managers will provide the kind of data that the city manager is likely to want to see, and they both in turn will be responsive to the council's demands for information, the policymakers themselves, particularly elected officials, will be cognizant of what the public will want to know about the alternatives considered and the decisions made and will ask for information accordingly.

5. Policymakers obviously tend to find absolute figures—total cost, number of buses, total ridership, etc.—more meaningful than the kinds of effectiveness indicators or efficiency ratios often used by transit planners and managers. For example, city council members may ask about the percent of total cost recovered through fare box revenues, but more than that they really care about the absolute dollar amount of the deficit, no matter what percentage of costs that represents.

6. With respect to particular items of information, the policymakers tend to be most concerned with such basic performance measures as (1) overall coverage of the system, level of service, who is served or who is hurt; (2) fares; (3) ridership levels and general trends in ridership; and (4) total cost of operating the system, and particularly the local share of the total deficit.

7. Given inflation and continuing uncertainty about federal funding for transit, policymakers are increasingly concerned with the near-to-mid-term future. For example, they are likely to be particularly concerned about the implications of a decision made now with respect to the size of the local deficit 5 years from now.

One clear impression derived from the seminar is that the local policymakers, city council members, and transit board members alike are serious about the transit-related decisions they are faced with and do not take them lightly. To some extent, the apparent lack of interest in the performance indicators available seems to be a function of the policymakers' desire for flexibility to use their discretion in setting policy. Given the intangibles as well as the more quantifiable criteria that they must take into consideration, the decision-makers do not want to be held hostage to the numbers (*3*). In some communities, there may well be some kind of absolute commitment to retaining a transit system even though it might not pay in terms of the objective indicators. Clearly, these decisions are not made carelessly even when the criteria on which they are based are not made explicit; rather, there is almost always a rationality beneath the surface even when the decisions seem to be in conflict with the conventional performance criteria.

MEASURES OF TRANSPORTATION PERFORMANCE

The results of a review of the literature in the transportation field related to measures of transportation and transit performance are discussed in this section. It also describes several frameworks within which measures of performance may be derived, and describes the use of various measures in actual situations as reported in the project seminar.

Performance and Productivity Measures

In the past few years, a large body of literature has emerged dealing with measures of transit performance and productivity. A series of UMTA-sponsored conferences and research projects on productivity, combined with the availability of uniform financial and nonfinancial statistics for transit systems, naturally led to considerable scholarly interest in this field. Some general observations about the nature of this body of literature are in order:

1. The measures advanced are limited, by and large, to those that lend themselves to quantification.
2. The availability of the so-called "uniform transit statistics" (henceforth referred to as the Section 15 data) produced a great flurry of ratios, differences, and other measures of transit performance. This activity, in turn, was followed by a number of research projects designed to reduce the set of measures to a manageable size. Ideally, the remaining measures were supposed to be independent of one another, which clearly was not the case with the original ratios.
3. There appears to be general agreement that transit impacts fall into three categories: "efficiency," "effectiveness," and "equity." However, the industry has yet to reach consensus on which category certain measures belong in. Our categorization is for convenience; the generic term "performance measures" may be more helpful in dealing with LEOs.

NOTE: For consistency purposes UMTA is encouraging the use of a single set of definitions for the terms effectiveness, efficiency, and equity, and has developed recommended definitions based on experience in transit studies in urban areas of all sizes, as well as on various research projects. Because the definitions used herein are different from those currently being recommended by UMTA, to avoid any misunderstanding the reader should note that the differences do exist. UMTA's definition of equity is essentially the same as used in this report. Effectiveness is defined more broadly by UMTA and denotes the need for local decision-makers to establish specific goals and objectives to guide the evaluation of transit proposals. Effectiveness measures how well the proposals achieve the stated goals and objectives and also how well the proposals perform. Efficiency measures, on the other hand, describe how well the costs of services and facilities match-up with their benefits or products. Proposals are most efficient when the incremental benefits are greater than the incremental costs.

4. Perhaps because it is so obvious, one impact is rarely mentioned in any of the literature: the simple cost of each alternative for the subsequent year or years. Yet, decision-makers usually want to know the cost of the options as early as possible. Alternatively, the planners are working against an established budget constraint.
5. Annual operating budgets appear to receive more attention than capital budgets. This may be because the relative magnitude of transit capital items in small cities is small compared with the annual operating budget. Annual operating costs of $50,000 to $75,000 per bus in the peak hour are relatively common. At that rate, a 30-bus operation might have an annual operating budget of $1,500,000 to $2,000,000. Annualized capital costs of the fleet and storage-maintenance facilities are relatively small by comparison, and the local share of the deficit for capital purposes has been, in most jurisdictions, trivial compared to the size of the annual operating deficits borne from local funds.
6. Cost and cost savings that are relatively difficult to measure, such as savings in the urbanized area's overall fuel consumption budget or reductions in the level of air pollution, usually receive only slight attention.

The following sections discuss in more detail some of the specific impact measures that have been proposed for each of the three areas of efficiency, effectiveness, and equity.

Efficiency Measures

In classic economic terms, efficiency refers to the ratio between inputs and outputs in a production process. An efficient allocation of resources is one which maximizes output per unit of input. Many measures of efficiency have been proposed in the transit literature. However, a great number of these measures appear to be inappropriate for choosing among transit options. For example, those measures which primarily test the efficiency of a transit firm's maintenance operations are irrelevant in the decision to deploy transit service in one way or another. Other typical measures which appear to be inappropriate for choosing among alternatives include:

1. Ratio of peak to base vehicle requirements.
2. Annual miles per revenue vehicle.
3. Vehicle-miles per gallon of fuel.
4. Vehicle-miles per quart of oil.
5. Buses per maintenance department employee.
6. Road call statistics.
7. Accident statistics.
8. Employee/vehicle ratio.
9. Operating employee/total employee ratio.

These measures basically attempt to assess how well a system is managed. They cannot be used, as a rule, to differentiate among routes within the same type of service. A peer-group comparison is often used to determine how well a transit system under study is performing relative to others of its class with regard to measures in this category.

Application of efficiency measures to alternative service options involving different types of service may lead to perverse decisions. For instance, consider a choice between conventional fixed-route, fixed-schedule transit service, on the one hand, and demand-actuated ("dial-a-ride") service on the other. Productivity of demand-actuated service is virtually certain to be inferior to fixed-route, fixed-schedule service. The customized nature of the demand-actuated service makes 7 to 10 person-trips per vehicle-hour a fairly high utilization target; 25 person-trips per hour would be a typical goal for conventional transit service. On efficiency grounds, therefore, one would tend to reject the demand-actuated service.

A further complication is introduced by an ambiguity in the literature relating to the definition of system output. Is transit service to be measured in terms of the amount of service available (vehicle-miles, seat-miles, or vehicle-hours, for example) or in terms of the amount of service used (passenger-miles, passenger-trips)? If one measures efficiency by referring to system capacity, a transit option involving high-capacity vehicles (such as articulated buses) would appear superior, other things being equal, to one involving relatively low-capacity vehicles. Yet, if the demand does not warrant the larger vehicles, the apparent efficiency gain by using them is illusory.

Introducing measures of system use diverts the discussion into the area of system effectiveness. The concept of effectiveness has evolved to address the question, "How well does the system serve its intended users?" By contrast, the efficiency question may be phrased, "How well does the system combine inputs to produce service?"

Strange as it may seem, one conclusion of the research is that pure efficiency measures are of little help in choosing among transit options. Granted, no local official can afford to be in the position of advocating an inefficient system. Yet the measures that appear to be most commonly used as tests of system efficiency really combine efficiency with effectiveness elements. In this category, those measures which seem to offer some promise as being easily understood and estimated tend to fall into a generic category of cost per passenger served. The notion that the best system is the one with the least cost per passenger carried has inherent appeal to a lay audience as well as some sound basis in economic theory. A measure of this sort probably should be labeled a measure of cost-effectiveness rather than one of pure efficiency. That distinction aside, measures of a cost per passenger or cost per passenger-mile variety merit consideration as efficiency measures.

Effectiveness Measures (See **Note** on page 15)

Measures of effectiveness suffer from some of the same ambiguity which besets efficiency measures: should one examine the service provided or the service used? The answer is by no means clear-cut. It has been argued, with some merit, that (other things equal) the system which provides access to the greatest number of destinations is the preferred one. As a result, such measures as the percent of households within one-quarter mile of a bus stop, the number of attractors (shopping centers, stores, schools, employment centers) which are accessible by transit, and the percent of households having access to transit have been used as measures of effectiveness.

The other side of the argument is that it does not matter who or what is theoretically accessible by transit; what matters is actual use of the system. Measures like the percent of employees using transit for the work trip, the total ridership of the system, and the annual number of rides per capita have been used to evaluate actual use.

Both types of measure (and, by inference, both sides of the argument) appear to have merit. As a pragmatic matter, it is difficult to predict the characteristics of system ridership before the fact. Thus, in evaluating possible new transit options, planners feel more comfortable comparing the availability of service than attempting to compare predicted use. Also, there is a need to test for the equity of the proposed systems in the civil rights sense: the benefits of publicly funded programs should be equally available to all. At a minimum, for example, the level of service available to minority residential areas should be at least as great as that available in nonminority areas. These considerations encourage use of measures such as:

1. Percent of low-income households within one-quarter mile of transit service (also other target groups such as senior citizens).
2. Number of major traffic generators served.
3. Percent of service area within one-quarter mile of one or more routes.

An additional rationale for using service availability rather than service use measures is the difficulty of collecting information on user characteristics. While it is relatively easy to determine the number of system riders (in most cases), it is far more difficult to find out how many of these riders are elderly, how many are downtown workers, etc. Direct interview surveys, a relatively labor-intensive technique, must be used to determine rider characteristics.

Measures depending only on aggregate ridership, however, are appealing because they provide a market test of the value of the system as perceived by the public. In this context, cost-effectiveness measures deserve consideration. The following have been used in various studies and transit development programs:

1. Operating cost per rider.
2. Capital cost per rider per year.
3. Subsidy per rider.
4. Revenue per rider.

Cost subsidy and revenue per passenger-mile also have been advocated, but are rarely used in smaller cities because of the lack of adequate trip-length data. (The figures reported under Section 15 may not be strictly comparable from city to city because of the use of different estimating techniques.)

In addition to the cost-effectiveness measures, some other simple measures of effectiveness appear appropriate and have been advocated in various published sources. Indeed, the handbook, *Analyzing Transit Options for Small Urban Communities* (Peat, Marwick, Mitchell and Co.), states that maximization of ridership is the most important objective for a transit service. Hence, such measures as total ridership, ridership by time of day, and ridership by target market group are appropriate to consider.

Equity Measures

Service Accessibility. One measure of equity—service accessibility to minority groups—was mentioned above. Measures used to establish service equity in this context, as required by the Urban Mass Transportation Administration, include comparisons of the accessibility of minority and nonminority households to employment opportunities, the central business district, schools, medical service, shopping centers, and various social services. Accessibility is measured in terms of number of households which can reach a given type of attractor within a certain amount of time (which is specified, and varies with city size) using transit. For employment, the statistic is the percent of all employment in the urban area available within a certain amount of travel time by transit.

While statistics and measures of this type give a good picture of the level of service provided by the system, they are far too detailed for top-level choices among alternative transit systems. A simple test to ensure that the service is equitably distributed (in the civil rights sense) may be an appropriate screening measure, but is not likely to cause rejection of an alternative in the planning stages.

Fares and Fare Structure. Equity of a different sort—the "who benefits, who pays" issue—is often measured in evaluating alternative transit options. Many of the measures causing debate during the decision-making process come from this category. Some are not even recognized as evaluation criteria, because they may be the same for all options under cosideration. For example, consider the fare structure. Placement of fare zone boundaries and amount of zone fares is likely to engender debate among elected officials whose constituencies are affected by zone fares. Yet, if the fare structure is identical for all options considered, this equity issue will not assist in the selection of an alternative.

Fares and fare-related issues fall into the equity area. Measures which appear frequently in the literature include:

1. Total system revenue.
2. Average adult fare.
3. Recovery ratio (operating revenue divided by operating costs).
4. Revenue per rider.
5. Revenue per passenger-mile.

Note that the latter two also were listed as effectiveness measures. There is a built-in ambiguity in these measures, since they measure the effectiveness of the service as evidenced by riders' willingness to pay for it, but also the equity of the service as measured by the fare charged, which, in turn, may be related to trip length or rider characteristics.

Public Subsidy. The equity of the public subsidy required is highlighted by use of measures which show subsidy per household or per capita, and indirectly reflect the type of tax source which subsidizes transit. A distinction sometimes is made between local subsidies, which come directly from local taxpayers' pockets, and subsidies from state and federal sources, which may reflect income redistribution. This distinction may be absolutely crucial to the local elected official, and therefore merits a place in the evaluation. It must be mentioned, however, that from the economist's perspective, only the total subsidy matters. It reflects an inability of the free market to allocate resources in ways deemed socially desirable. Using local share of subsidy as a determinant of the preferred option may lead to further distortions, because it runs the risk of imposing even higher costs on society as a whole.

Summary

This brief discussion outlines some of the issues in choosing criteria for evaluating transit options. Although a great deal of work has been done on efficiency measures, it appears that they are less useful in selection of an option than in evaluation of performance of an ongoing system. Effectiveness may be measured by system availability or by system use. The former is easier, the latter somewhat more valid. Both have been applied and are relevant in varying degrees, depending on local goals and priorities. Equity is perhaps the subject most debated and with the least information on differential impacts of a system. Average cost impacts, however, are relatively easy to calculate and certainly relevant.

Specific Measures from the Literature

How Measures Should Be Established

In general, there are two approaches to evaluation of alternative systems of performance monitoring. One might be termed "top-down," and is a classic model of evaluation. Goals or objectives are established or stated, performance measures are devised which operationalize the objectives, data are collected to establish values for performance measures, and analysis of the system's performance is undertaken, using the operationalized measures to determine performance relative to the objectives.

Alternatively, one might work from the "bottom up" by reviewing data available, analyzing and synthesizing that data, and relating the measures available from it to the perceived objectives for the system.

Ideally, the first method is preferred because of its potential efficiency. Practically, the second is frequently followed. Realistically, design of any performance monitoring or evaluation technique or system combines both approaches in an iterative process. One starts with the ideal, balances it with the realities of data availability, collection difficulty, and cost, and, compromising at both extremes, reaches a practical solution.

Examples from the literature which basically follow each of these strategies are presented below.

How Performance Measures Are Used

The objectives of this research refer to the "information . . . used to make choices among alternative transit plans or programs." Previous parts of this chapter imply that this information is contained within performance measures and that it is used to make choices, to compare alternatives, to evaluate alternatives, and, also, to monitor an existing system.

The measures have been categorized according to the kinds of things they measure: efficiency, effectiveness, and equity. Another way of looking at the measures is through different kinds of evaluation. Two general types may be characterized: (1) diagnostic and (2) comparative (or system-level).

"Comparative evaluation" permits evaluation analysis and comparison of a transit system as a whole: how well does the transit system do in terms of absolute performance desired by managers and policy makers during this year as compared to its operation last year or the year before? How well does the system perform compared to transit systems in other cities operating in similar circumstances?

"Diagnostic evaluation," on the other hand, attempts to identify portions of the system which might be altered to improve the overall level of performance. What is the average number of passengers per hour of operation on a route-by-route basis? What is the ratio of passengers per vehicle-mile on different segments of a route? What are the differences in productivity per vehicle-hour during the peak as opposed to the off peak?

For comparative or system-level evaluation, aggregate information generally is adequate. For example, the type of information to be collected under the requirements of Section 15 provides a strong basis for comparative or system-level evaluation of the system.

Diagnostic evaluation, on the other hand, requires much more precise information oriented to specific routes or route segments

Table 2. Basic indicators by comprehensive summary levels.

Indicators	Total Area	Sub-Area	Mode	Line	Annual	Peak Hour	Off-Peak Hours	Purpose
Physical and Socioeconomic								
Land Area	X	X						
Population (Trans. Dep.; E&H, etc.)	X	X						
Employment	X	X				X	X	
Income (Average, Median)	X	X						
Buildings	X	X						
Dwelling Units	X	X						
Auto Availability	X	X						
Origins (Productions)	X	X	X	X		X	X	X
Destinations (Attractions)	X	X	X	X		X	X	X
System Description (Input)								
Headway	X	X		X		X	X	
Route Miles	X	X	X	X	X	X	X	
Seat Miles	X	X	X	X	X	X	X	
Vehicle Miles of Capacity	X	X			X	X	X	
Person Miles of Capacity	X	X	X	X	X	X	X	
Capital Cost	X	X	X	X	X			
Fare				X	X	X	X	
Accessibility		X	X			X	X	X
Mobility		X	X			X	X	X
Outcomes								
Person-Trip Length (Average)	X	X	X	X	X	X	X	X
Person-Trip Time (Average)	X	X	X	X	X	X	X	X
Vehicle-Trip Length (Average)	X	X	X	X	X	X	X	X
Vehicle-Trip Time (Average)	X	X	X	X	X	X	X	X
VMT		X	X	X	X	X	X	X
PMT	X	X	X	X	X	X	X	X
VHT	X	X	X	X	X	X	X	X
PHT	X	X	X	X	X	X	X	X
Passengers	X	X	X	X	X	X	X	X
Average Person Travel Speed	X	X	X	X	X	X	X	
Average Vehicle Travel Speed	X	X	X	X	X	X	X	
Person Delay	X	X	X	X	X	X	X	
Vehicle Delay	X	X	X	X	X	X	X	
Zone-to-Zone Travel Time	X	X	X			X	X	
Transfers	X	X	X	X	X	X	X	
Accidents	X	X	X	X	X	X	X	
Operating Cost	X	X	X	X	X	X	X	
Out-of-Pocket Cost	X	X	X	X		X	X	X
Revenue	X	X	X	X	X	X	X	
Deficit	X	X	X	X	X	X	X	
Noise Above Standard	X	X		X				
Fuel Consumption	X	X	X	X	X	X	X	
Pollution	X	X	X	X	X	X	X	
Crime Incidents	X	X	X	X	X	X	X	
Operations (Efficiency)								
Operators	X	X	X	X	X	X	X	
Operator Hours	X	X	X	X	X	X	X	
Vehicles	X	X	X	X	X	X	X	
Maintenance Man-Hours					X			
Maintenance Cost	X	X	X	X	X			
Road Calls for Maintenance	X	X						
Deadhead Miles	X	X	X	X	X	X	X	
Schedule Adherence	X	X	X	X	X	X	X	
Employees	X	X	X	X	X	X	X	

at various time periods throughout the day and fairly detailed information regarding passenger characteristics. This report concentrates almost exclusively on comparative evaluation. Diagnostic evaluation is typically used by staff and transit managers. As noted earlier, policymakers tend to work with aggregate measures.

A General Set of Measures

An earlier analysis *(4)* of various measures used in comparing and evaluating transit alternatives was directed to identifying the basic information contained in a variety of measures, identified in a number of sources. Table 2 presents the information items and groups them according to whether they relate to the physical and demographic context in which the "alternative" operates, the alternative system itself, the outcomes or results of implementing the system, or the internal efficiency of the operation. Table 2 also indicates summary levels by which the indicator might be presented: area, subarea, mode, line, time of day, and so forth.

Not obvious from Table 2, however, but perhaps more important than the individual items, is the potential for using the items *together* to establish performance measures. For example, the efficiency of system operation might be described by the vehicle-miles/unit of fuel consumed or buses per maintenance department employee. Effectiveness might be characterized by passengers per dollar of operating cost of passenger-miles per vehicle-mile. In each case, these are made up of individual items selected from one of the four categories described above.

Performance Measures from Objectives

In a recent study *(5)* for the U.S. Department of Transportation, a list of some 300 performance measures was prepared, drawing on objectives for multimodal urban transportation. A set of criteria for selecting a manageable and useful subset of the 300 was prepared (see Table 3) and was used to reduce the number to about 70. In general practice, the list of performance measures may be shortened to the following set:

- Point-to-point travel time.
- Traffic volumes.
- Vehicle delay.
- Number of vehicles by occupancy.
- Vehicle-miles of travel (VMT).
- Vehicle-hours of travel (VHT).
- Person-miles of travel (PMT).
- Person-hours of travel (PHT).
- Transit passengers.
- Transit passenger-miles of travel.
- Energy consumption.
- Air pollution emissions.

Several of these relate to all modes of travel, as opposed to transit alone, while others relate only to transit or to automobile travel. In part, selection of a specific set of measures is related to whether the transit alternative is being evaluated in a context of objectives for the transit system or of objectives for the community at large in which transit service is a tool for implementation.

Performance Measures from Data

Two other recent studies *(6, 7)* report the results of formal analysis of various performance measures, using criteria of independence and relevance for selection. These measures are oriented specifically to the performance of transit and are compared in Table 4. (For comparison purposes, they are grouped according to the efficiency of effectiveness objectives discussed earlier.) Identical or essentially similar measures are listed opposite each other in the table.

In general, the efficiency measures relate consumption of resources to delivery of services. The other is measured either by vehicle-miles or vehicle-hours, and the numerator and denominator are reversed in several instances, but the measures clearly express the same information. Objectives regarding fuel consumption and accidents are reflected in one set, while vehicle use and driver wages appear to be of concern in the other. (Vehicle use usually is compared to a standard which reflects adequate reserves rather than a goal of scheduling every vehicle in the fleet during the peak. Given wage rates, driver and operating costs measure, in part, efficiency of driver scheduling.)

Effectiveness measures relate use, measured by number of passenger or revenue, to the supply of service, measured by cost or vehicle-miles. Percent transfers is an indicator of the "fit" between route design and use, while vehicle-hours per urban population addresses the service-provided criterion, as opposed to service used, which is measured by passengers or revenue. (see **Note** on page 15).

Table 3. Criteria for developing measures of effectiveness (MOE).

Relevancy to objectives: Each MOE should have a clear and specific relationship to TSM objectives in order to insure the ability to explain changes in the condition of the transportation system.

Simple and understandable: Within the constraints of required precision and accuracy, each MOE should be simple in application and interpretation.

Quantitative: MOEs should be specified in numerical terms whenever possible.

Measurable: Each MOE should be suitable for application in pre-implementation simulation and evaluation (i.e., have well-defined mathematical properties and be easily modeled) and in post-implementation monitoring (i.e., require simple direct field measurement attainable within reasonable time, cost, and staffing budgets).

Broadly applicable: MOEs which are applicable to many different types of strategies should be used wherever possible.

Responsive: Each MOE should be specified to reflect impacts on the various actor groups, taking into account, as appropriate, geographic area and time period of application and influence.

Sensitive: Each MOE should have the capacity to discriminate between relatively small changes in the nature or implementation of a control strategy.

Not redundant: Each MOE should avoid measuring an impact that is sufficiently measured by other MOEs.

Appropriately detailed: MOEs should be formulated at the proper level of detail for the analysis (e.g., if conceptual-level sketch planning is involved, the appropriate MOE is probably less detailed than one useful for more detailed implementation planning and design.

Table 4. Performance measures from data.

Reference 6		Reference 7
	Efficiency	
Revenue Vehicle Hours/Operating Cost	—	Cost/Vehicle Mile
	—	Driver Cost/Vehicle Hour
Vehicle Miles/Peak Vehicle	—	Vehicle Hours/Vehicle
Vehicle Miles/Gallon of Fuel	—	
Vehicle Miles/Maintenance Employee	—	
Revenue Vehicle Hours/Accident	—	
	—	Cost/Vehicle
	—	Vehicle Miles/Employee
	—	Percent Peak Vehicle Use
	—	Driver Cost/Operating Cost
	Effectiveness	
Passengers/Revenue Vehicle Miles(1)	—	Revenue Passengers/Vehicle Mile(1)
Vehicle Hours/Urban Population	—	
Passenger Revenue/Operating Expense(1)	—	Operating Ratio(1)
	—	Cost (Operation; Maintenance; Administration)/Revenue Passenger
	—	Percent Transfers
	—	Revenue/Vehicle
	—	Revenue/Revenue Passenger
	—	Deficit/Revenue Passenger

(1) Measures included in an earlier list of "Measures from Objectives." Underlined items, forming part of measure, also were included in this earlier list.

Practical Experience of Seminar Participants

The Circumstances of Decision-Making

The most significant finding of the seminar and the interaction of the participants with each other and the research team is that there is no single set of performance measures which is used or needed by decision-makers in smaller urban areas. Not only is there the normal variation which might be anticipated from the differences among cities and circumstances, but there also appear to be systematic and signficiant differences which, to a large extent, are common to all the situations represented by the participants and vary on common dimensions. These were discussed in a previous section on decision-making and are summarized here prior to discussion of the specific performance measures:

- *Who is making the decision?* The first distinction here is between policy- or decision-makers, on the one hand, and management or technical personnel on the other. However, a further distinction emerges between (1) elected officials, who might at first glance be considered policy- or decision-makers; (2) members of appointed boards or authorities with the responsibility and authority to make financial decisions; (3) members of appointed boards with only advisory responsibilities; and (4) management, planning, and technical personnel. Interest in and use of detailed performance measures increased among these groups generally in the order of the list.
- *When is the decision being made?* Although there are significant differences among various systems, a real difference in the detail and number of performance measures of interest to decision-makers appears to be based on the point in the annual cycle of local decision-making. At budget time, succinct general measures are used and expected. During the year, periodic reports, with considerably more detail reflecting trends and status, are of interest, while ad hoc requests for information (during the year) often require very specific information. The latter situation frequently is tied to complaints, citizen (voter) questions or requests, or media activities.
- *What decision is being made?* In many, if not most cases, local decision-makers are faced with alternatives involving marginal change. Year-to-year changes at budget time (such as those mentioned in the paragraph above) are typical examples. Occasionally, however, local decision-makers face the question of starting service or stopping service, or making a change in service of undocumented magnitude. As opposed to making marginal changes, in effect the system is being justified: Should we or should we not have transit service? In this situation where the existence of the service is not taken for granted, an additional set of objectives and performance measures, relating to broader community objectives, may be required.
- *What is the status of the system?* Differences are apparent among systems which are faced with reducing service and those which are in an expansion mode. One member of the seminar group commented, "When we're expanding, they're interested in the service being provided. But when we are cutting back, they want to know about the use of service."
- *What is the source of funds?* Most of the systems represented by the seminar participants finance their operations (as opposed to their capital needs) through a combination of federal, state, and local funds. However, in some instances, local funds come from annual appropriations and in others from a "dedicated" source fixed by formula, such as a given percent of sales tax. Although this dimension is not entirely independent of the expansion-cutback and elected official-appointed authority dimensions, it appears that systems with independent, continuing, and predictable sources of local income rely to a greater extent on management advice than other systems. They tend to avoid specific, detailed performance measures, leaving these to management, and rely on more general measures.
- *What kind of analysis?* To some extent, this dimension is circular—the kind of analysis dictates the performance measures, but there are only certain measurs that are appropriate to the kinds of analysis or evaluation. Earlier two kinds were suggested: comparative and diagnostic. Both require measures of efficiency and of effectiveness, but comparative evaluation frequently involves aggregate measures (system-to-system or alternative-to-alternative comparison), while diagnostic evaluation requires "within-system" information and greater detail.
- *What is the local situation?* Finally, local circumstances frquently influence the kind of measures of interest and their detail. The length of tenure of management (and council or authority members) is reflected in the confidence and trust developed between decision-makers and management. As confidence increases, the interest on the part of the decision-makers in detailed performance measures decreases.

Predictably, the form of government influences the kind of measures used or requested. Where a council is elected in a ward system or members have an allegiance to a group of voters (geographic or otherwise), more detailed measures comparing use by and service to the group or locality are of interest. Similar interests are apparent among representatives of local political units when systems serve a number of jurisdictions.

The nature of council, board, or authority members makes a difference in the kind of information and measures. Groups or persons with traditional political labels (such as liberal or conservative) tend to shift emphasis in objectives and, in turn, in the measures used. Personalities, occupational and educational backgrounds, and regional differences also influence—directly or indirectly—the kinds of measures of interest.

Specific Performance Measures Utilized

The major conclusion regarding performance measures resulting from the seminar is that decision-makers want and use very few measures, and that they want those in a brief, summarized form. Almost as important, many want the measures, for, at most, the "do nothing" alternative and the staff's recommendation. However, decision-makers in some cities want to see a range of alternatives.

There are a number of exceptions to these generalities. Perhaps the major exception is that when decision-makers do want more information or greater detail, they expect staff to provide it—quickly, clearly, and succinctly.

The following first reviews the items that appear to be of general interest, and then discusses the exceptions:

1. *Information for decision-makers at budget time*—There was general consensus among the seminar participants that three categories of information are almost uniformly of interest:

   a. Operating cost. In many cases, there is concern about local cost, as opposed to total cost, including nonlocal shares. Specifically, this is the effect on the next year's budget (and tax rate) and includes concern about revenue.

   b. Ridership. By and large, the seminar participants indicated that interest rarely went beyond the basic number: how many people will ride? (Obviously, there are several interpretations of this question: How many people? How many boardings? How many linked trips? etc.).

c. Incremental change. What is changed in the new (alternative) compared to current circumstances? What is the marginal cost? What are the anticipated effects? Who will lose service? Gain Service? Where will service be cut or added? When will service be cut or added? What will be the new fare?

d. In addition to these three general categories, they want to know the trends. Is cost increasing? Is local share increasing? What has happened in the relationship between cost, revenue, fare, and ridership? What will happen?

Other measures are of interest in special circumstances. For example, California requires that each system reach a specified recovery ratio. Therefore, decision-makers in California properties are interested in the actual and projected recovery ratios. As another example, a number of systems operate under fixed taxing levels for operating costs or have ceilings on the tax rate they may impose. In these situations, decision-makers invariably want to know where a proposed system or alternative will put them relative to the maximum tax level.

2. *Exception for decision-makers*—Perhaps the two most common types of exceptions to the generalities described above occur (a) at times other than budget time—i.e., throughout the year—and (b) when an elected official must respond to a citizen inquiry or complaint.

The former circumstance was characterized by the seminar participants in various ways: monthly or quarterly reports, work sessions with councils or committees, or, simply, informal meetings with elected officials who are particularly interested in public transportation.

It was not clear, in the context of the seminar, whether these meetings are oriented to a review or monitoring of the ongoing operation or to consideration of alternative possible future operations. Presumably, they might be either or both, and, because the important point in this context is the kind of information they want, it seems reasonable to assume that the significant difference would be "now" or "future" rather than in the specific performance measures.

Table 5 presents efficiency and effectiveness measures which summarize the comments of the seminar participants. Several observations about the content are appropriate. First, as was observed earlier, decision-makers who are looking at possible alternative new systems are not very interested in efficiency measures (nor do they provide a basis for discriminating among alternatives, as also noted earlier). Occasionally, they are concerned about fuel consumption rates or accidents or equipment selection and utilization, but this interest usually stems either from citizen inquiry or follows from concern about rising unit costs. The latter also stimulates interest in the subsidy on a per household or per citizen basis, as opposed to the effectiveness measure of the subsidy on a per trip or per passenger basis.

Second, as an extension of the general interest in marginal change, there appears to be an interest in many of the effectiveness measures on a transit line-by-line basis (or area-by-area) as well as for different alternatives. But, just as they are impatient with large amounts of paper and data at budget time, decision-makers are likely to be impatient with wading through data at other times. They are likely to ask questions, seek guidance to answers contained in written material, or expect an oral answer.

Third, no single decision-maker (or group) is likely to be interested in all of the measures listed in Table 5 at any given time. Some are more concerned with costs, others with service to special groups or areas, and still others with total ridership.

Table 5. Performance measures used by decision-makers in informal discussions.

Efficiency
Cost (operating cost or subsidy)/vehicle-hour (or vehicle-mile)
Cost (operating cost or subsidy)/household (or capita)
Personnel (employees)/activity (operations, maintenance, administration)
Lay-offs/activity (operations, maintenance, administration)
Effectiveness
Ridership
Ridership/capita
Ridership by trip purpose
Passengers/vehicle-mile (or vehicle-hour)
Service hours
Coverage (one-quarter mile standard; within taxing unit)
Vehicle hours
Headways
System-miles (route-miles)
Cost (total, local, subsidy)
Cost (total, local, subsidy)/passenger
Recovery ratio (i.e., revenue as a proportion of cost)

3. *Exceptions for staff*—Given that decision-makers appear to have the interests described above, it is clear that staff must be prepared to respond. This conclusion simply suggests that staff must have available the efficiency and effectiveness measures suggested in Table 4, and those recommended below, by line and area where appropriate and for the total system. Just as important, they must summarize and present those measures in meaningful ways at budget or decision-making time as well as in informal (or less formal) contexts. Presentation is the subject of a later section in this report.

4. *The system justification circumstance*—Although discussed briefly by the seminar participants, the basic system justification situation did not receive much attention or comment, perhaps because all of the participants were associated with an ongoing system and did not (or had not) faced the question "Why have a system?"

The performance measures which relate to this basic question generally are related to community objectives for transportation, as opposed to transit alone or to even more general objectives such as total energy use, air pollution, accidents or social equity (i.e., public welfare), and to comparison of absolute investment in transit in comparison to other public programs.

Actual analysis of the performance of transit or transportation in comparison to other local programs rarely takes place. However, the list of recommended performance measures, below, does reflect the larger set of objectives which is relevant to the "justification" circumstance.

Listing of Recommended Performance Measures, Factors, and Impacts

Research into the decision-making process and measures currently used led to several conclusions. First, the appropriate set of measures is best determined in the context of the basic decision-making situation: system justification, routine decision-making, or monitoring. An attempt to exhaustively cross-classify situations according to the circumstances of decision-making (who, when, what, etc.) would lead to a proliferation of lists of measures that would be largely duplicative as well as difficult to follow. Second, no general set of performance measures, such as those presented below, will satisfy completely the needs of any particular system's decision-makers at all times. Third, staff and professional managers tend to have their own lists of measures and impacts which they use in developing and screening alternatives. Since the focus of this work is on improving decision-making and on needs of decision-makers, a conscious effort has been made to concentrate the research effort on decision-makers' needs. The results are intended to reduce the level of effort transit staff and managers need to prepare information for decision-makers, rather than to advise the transit professionals what to examine and what to ignore.

For Decision-Makers in a System-Justification Situation

1. *Primary indicators*—These should be presented for the complete transportation system (i.e., both transit and automobile/highway) for each alternative (or with and without transit):

- Trips served by each mode.
- Highway congestion (measures by travel time or vehicular delay).
- Operating and maintenance cost.
- Annualized capital cost.
- Fare box revenue, transit system.
- Net annual cost, transit system.
- Sources of funding.

2. Secondary indicators—These should be presented similarly to the primary indicators, i.e., both major modes, each alternative.

- Total capital outlays to planning horizon.
- Capital funds, by source, again to planning horizon.
- Probable accidents.
- Emission of pollutants.
- Energy consumption.
- Unemployment effects.
- Economic development effects.
- Parking requirements.

3. *Transit descriptive indicators*—These are intended to give decision-makers a general picture of the transit system. If the automobile/highway system varies from alternative to alternative, it should be described also, with analogous indicators.

- Number of routes.
- Hours of service; days of service.
- Buses required.
- Number of employees.
- Annual vehicle-miles and vehicle-hours of service.
- Fare structure.

4. *Performance indicators*—These indicators, in juxtaposition to the number of trips served among the primary idicators, furnish a picture of the service provided by the transit system:

- Percent of population/households served.
- Percent of low-income, minority, no-auto, and elderly/handicapped households served.
- Transit cost/passenger.
- Transit revenue/passenger.
- Transit passenger/vehicle-hour or vehicle-mile.

For Decision-Makers in a Routine, Budget-Time Situation

1. *Primary indicators*—In this circumstance, the primary indicators are intended to be used to compare the coming year to the current year and, perhaps, to the year just past. Generally, it is not necessary to present information about the automobile/highway system:

- Total operating cost.
- Total passengers carried.
- Total operating revenue.
- Net cost of operation.
- Sources of additional (to operating revenue) funding.

2. *Secondary Indicators*—The first eight of these are the same as the transit descriptive variables in the system-justification situation:

- Number of routes.
- Days/hours of service.
- Buses required.
- Number of employees.
- Annual vehicle-miles/vehicle-hours of service.
- Fare structure.

Four additional indicators are the same as four of the performance indicators in the justification situation:

- Transit cost/passenger.
- Revenue/passenger.
- Passengers/vehicle-hour (or vehicle-mile).
- Percent of households served (by subgroup, if desired).

For Decision-Makers at Other Times, in a Monitoring Situation

As may be seen, many of these indicators are identical to those listed earlier. By and large, this reflects the need for staff to maintain basic information in order to prepare summaries required in other circumstances. However, it also reflects an inherent need to maintain detailed information on the system in anticipation of questions and to evaluate the system and its components.

As a result of these considerations, the level of detail and suggested comparisons are different from those implied above. As appropriate, detail might include routes or subareas and comparisons should include year-to-date and prior year-to-date, current period, and the same period of the prior year and budgeted-to-actual.

1. *Financial indicators:*

- Costs: total operations, maintenance, and administration.

- Operating revenue: fare box, other.
- Net cost.
- Funding, by source.

If possible, costs by route should be available (as well as for the entire system).

2. *Efficiency measures:*

- Cost per vehicle-hour.
- Vehicle-hours per employee.
- Number of employees.
- Employee turnover rate.
- Vehicle requirements.
- Accidents
- Complaints.

These measures also should be available by route, if possible.

3. *Effectiveness Measures:*

- Cost per passenger.
- Revenue per passenger.
- Subsidy per passenger.
- Recovery ratio.
- Passengers per vehicle-hour.
- Passengers per vehicle-mile.
- Percent of transfers.
- System descriptors (when changes occur).
- Fare structure.
- Headways.
- Hours of service.

Again, these measures should be available by route to permit evaluation of route performance. (See **Note** on page 15)

MEASUREMENT AND EVALUATION TECHNIQUES

As noted in Chapter Two, there is no lack of measurement techniques for most of the variables recommended. Similarly, many evaluation techniques have been proposed for comparing alternatives. Because so many variables are involved, the detailed discussion of application of existing techniques to measurement of relevant variables is presented in Appendix A—the recommended guidelines.

Appendix A was designed to stand alone as a handbook for use in preparing information for transit decision-makers. It discusses each variable, sources of data, and rationale for use in detail. Some general observations about limitations of available data and techniques are appropriately stated here, nonetheless.

Use of Section 15 Data

To minimize the added cost of data collection, much of the discussion in the guidelines centers on information already collected for the Section 15 report. In that context, several things should be noted. First, any transit system will have more up-to date statistics than are available in the latest published Section 15 report. The forms used to collect the Section 15 data on the system should be the primary source, not the printed summaries.

Second, Section 15 data are collected for a system as a whole. When information is needed about performance of individual routes, the transit system will have to look to its internal data collection process. Since the level of information desired by decision-makers will vary from system to system, no attempt has been made in this report to prescribe the minimal level of information to be collected, beyond indicating that route-by-route comparisons, by time of day and day of week, are useful in the monitoring function. It is assumed that the transit planner either has these data available as part of the continuing planning process or knows how to acquire the information.

Third, although Section 15 data may be used for peer-group comparisons, great caution should be taken in this context. Despite the attempt to standardize on definitions, it has been found that different transit systems still count the same item in different ways. Efficiency comparisons are particularly prone to confusion because of the many different arrangements existing in various cities for performance of the same function. For example, in some cities, the revenue-handling function is performed by the city treasurer or other finance department staff member. In others, a transit system employee does most of the revenue accounting, including counting coins and currency. In still others, money is collected, counted, and deposited by a commercial service. In the first case, the cost of revenue handling and the number of employees required may not appear as a charge against the transit system at all. In the second, the cost and staffing level shown in Section 15 will reflect the true state of affairs, and in the third, the system may appear to have a very efficient ratio of nonoperating to operating employees, but a higher than normal cost for purchased services. Similar examples abound in the maintenance area.

Limitations of Secondary Impacts Analysis

Techniques have been suggested for measurement of such secondary impacts as accidents, pollution, energy consumption, unemployment, economic development, parking, and travel time costs. It is by no means a foregone conclusion that a transit system will improve conditions. Indeed, lightly patronized transit is less energy-efficient than private autos (particularly when carpooling can be substituted), may create more air pollution under some circumstances, and rarely, if ever, contributes to reducing traffic congestion in cities of under 200,000. It is also highly probable that the difference in values of secondary impact variables, calculated by the best technique available, may not be statistically significant. In other words, the benefits of transit to small cities may have been exaggerated in some cases.

PRESENTATION TECHNIQUES

The two key findings with regard to presentation techniques were a need for better identification of the information decision-makers really want on which to base decisions, and a need for improved presentation formats. The guidelines presented in Appendix A and summarized above suggest what material is appropriate to present. The discussion which follows, along with Appendix B, suggests improved presentation formats.

One improvement in presentation format results from establishing a common basis of knowledge about the transit industry. Experience has indicated that some common misunderstandings about what public transportation can and cannot do keep reappearing as new decision-makers take office. (One common example is the idea that small buses could be operated at a substantial saving over the cost of large bus operations.) To explain some of the basic facts of the industry, an audiovisual presentation has been prepared consisting of a series of slides with accompanying script. This presentation addresses three basic issues:

1. Whom does transit serve?
2. How do we know when transit is doing its job?
3. What kinds of transit service can we use effectively in our community?

Statistics used in the presentation are taken primarily from Section 15 data, supplemented with some ridership information from a sample of transit development programs. It is recommended that this presentation be used at approximately yearly intervals for orientation of new board members and/or citizen advisory committee members. Ideally, the presentation should be given at a time when no decision needs to be made. It is intended for general orientation and not as an aid in resolving a specific issue.

A second improvement in presentation format can result from better understanding of the meaning of the impact variables used to analyze transit alternatives in a particular setting. An audiovisual presentation has been developed for this purpose as well. It consists of a "library" of slides and accompanying text to illustrate and explain each of the variables actually used by a given transit agency. This "library" is available for purchase through NCTRP, as is the first presentation described. A transit system wishing to use the "library" to explain variables used in analyzing alternatives would select the appropriate slides and text and make the presentation to the decision-making body. This should occur either immediately prior to presentation of information requiring a decision or at the meeting previous. For example, the definitions might be presented at the meeting preceding the annual budget meeting. LEOs would have an opportunity to review the variables they would be seeing as part of the budget presentation in order to come to the decision-making session with a clear understanding of what is involved in each variable.

Finally, when comparisons among alternatives are to be made, or a recommended alternative is to be ratified, a set of templates is presented for use with an overhead projector. The intent is to present a simple, clear-cut format using standard layouts, within which the transit manager or planner can hand-write (using a grease pencil) the values of the variables under consideration. The templates are reproduced in Appendix B at full size, enabling a transit manager to make acetate copies directly from the text, and then insert the appropriate numbers. This part of the presentation package is to assist small-city transit managers who do not have ready access to graphics capability to make neat presentations in a simple graphic style with a minimum of effort.

A full description of the presentation package is given in Appendix B.

CHAPTER FOUR

CONCLUSIONS AND SUGGESTED RESEARCH

CONCLUSIONS

The major conclusions of the research are embodied in Appendixes A and B, which present the guidelines for evaluating transit options and the educational package for orienting decision-makers to transit. Beyond those conclusions, the research pointed up some general principles.

First, cities differ. As a consequence, there is no universally applicable set of guidelines. Anyone attempting to use the guidelines must take local conditions into account. The recommendations are normative, in the sense that they suggest what decision-makers should be concerned with, at a minimum. However, because each urbanized area is unique in the level of detail it needs before making a decision, the guidelines must be applied judiciously.

Second, decision-makers tend to ask the questions they expect their constituents, in turn, to ask them. Constituencies vary widely in their level of interest and sophistication; it is not practical to attempt to construct a logical table covering all contingencies.

Third, the usefulness of a research report such as this depends on the presence of an individual with enough technical background to use the findings. The report cannot substitute for basic knowledge of the principles of transit planning. The research has concentrated on identifying techniques and measures that can be applied without a high degree of technical knowledge, but baseline knowledge is still necessary.

SUGGESTED RESEARCH

Two lines of further research are suggested. The first is to follow up on the usefulness of the guidelines through tracting of agencies which order the audiovisual parts of the educational package. A questionnaire asking for information on the use to which the package was put and its effectiveness should be designed and incorporated in the package. Feedback on the templates' usefulness could be sought through incorporating a similar questionnaire in the guidelines report, if it is produced separately for circulation. Alternatively, those receiving the final project report could be sent a mail questionnaire after several months, if careful records of shipment of the questionnaire were kept by all agencies sharing responsibility for report distribution.

Further research on graphic presentation techniques appears warranted, although it is not advocated as a very high priority item. There appears to be very little published on the subject of selecting the most appropriate presentation mode for statistical information. For instance, when should one use a pie chart? When a series of bar graphs? How many sets of variables and comparisons can be presented on one screen or sheet without confusing the viewer? Little guidance was available to the research team, beyond the professional experience and judgment of the graphics consultant. The recommendations carry the weight of practice and experience, but not of basic research in visual perception. Although the recommendations represent a solid advance over some presentation techniques in common use today, they are not represented to be the best possible. Further research in this area is warranted.

REFERENCES

1. LINEBERRY, R. L. and SHARKANSKY, I, *Urban Politics and Public Policy.* (Third Edition, Harper & Row, N.Y. (1978) pp. 172-203.
2. POISTER, T. H., and MCGOWAN, R. P., "The Use of Management Tools in Municipal Government: A National Survey." *Public Administration,* Vol. 44, No. 3 (May-June 1984) pp. 215–223.
3. WHITE, L. G., "Improving the Goal-Setting Process in Local Government." *Public Administratin Review* (January/February 1982) pp. 77–83.
4. LATHROP, G. T., and MARTIN, R. L., "Energy Conservation Through Transportation Systems Management Actions." John Hamburg and Associates and Kimley-Horn and Associates (1981).
5. ABRAMS, C. M., and DIRENZO, J. F., "Measures of Effectiveness for Multimodals Urban Traffic Management and Evaluation of TSM Strategies." JHK and Associates and Peat, Marwick, Mitchell & Company (1979).
6. ANDERSON, S. C., and FIELDING, G. J., "Comparative Analysis of Transit Performance." Insitute of Transportation Studies and School of Social Sciences, University of California, Irvine (1982).
7. SINHA, K. C., and JUKINS, D. P., "A Comprehensive Analysis of Urban Bus Transit Efficiency and Productivity: Part I. Definition and Measurement of Urban Transit Performance." Purdue University (1978).

APPENDIX A

GUIDELINES FOR IMPROVED DECISION-MAKING

Contents — ***Page***

1. INTRODUCTION—USING THE GUIDELINES

This manual presents the procedural guidelines recommended for use by transit and municipal agencies in analyzing proposed transit and paratransit alternatives and presenting their proposals to the decision-making bodies. It covers the list of variables that should be presented to decision-makers in each of three situations: major system change, minor system change, and monitoring.

Section 2 discusses the situations covered in this manual. Section 3 lists the variables that should be presented in each situation, giving a brief rationale for each. Section 4 discusses the fundamentals of good graphic presentations and presents examples that can be adapted for use by readers. Section 5 cites measurement techniques and evaluation techniques and includes suggestions to assist in selection of appropriate methods.

Users should refer to Section 2 to determine which of the three basic situations they are addressing. Next, turn to the appropriate heading in Section 3 to learn which variables to include and then to Section 4 for suggestions on presentation techniques. Information on techniques for measuring variables can be looked up as needed in Section 5.

2. CONTEXTS FOR APPLICATION

The guidelines for selection, presentation, and analysis of information required to support decision-making are divided into three contexts called:

1. System justification.
2. Routine.
3. Monitoring.

In each case, recommendations with respect to presentation, content, and format are made for decision-makers who are elected or appointed officials and have broad responsibilities or are concerned only with the transit system.

The staff responsible for preparing information to present to elected/appointed officials will require more information than they actually present. The additional information is typically needed in the course of developing and evaluating alternatives on a technical basis, using traditional transit planning techniques. Therefore, staff information needs are not cited separately.

In general, the information appropriate for system justification is less detailed (more aggregated) than that for routine decision-making. Monitoring activities appear to require even greater detail. However, there is a difference in the type of information required as well, particularly for the justification of the system. Regardless, if the staff maintains the information needed to perform the monitoring function, the major portion of the information for aggregation to meet the needs of higher levels or different circumstances will be available.

Occasionally, information is needed for a management level between transit staff and the elected/appointed decision-makers. This situation arises, for example, where transit is grouped with other municipal functions under a city management official who may wish to review alternatives and recommend one to the official decision-makers. The amount of information required by such intermediate-level managers appears to vary according to the experience and interests of the individual. No attempt is made to recommend uniquely appropriate levels and kinds of information for these instances.

Examples of Contexts or Situations

System Justification

- Should our city establish a transit system?
- Should we abolish the transit system?
- Should we change the mode of operation of the entire system from fixed-route/fixed-schedule to dial-a-ride?
- Should we increase annual miles (or hours) of operation by 50 percent? (or 100 percent, etc.)
- Will the system still be viable if we reduce annual miles/hours operated by 50 percent? (35 percent, etc.)
- Should we expand service to include an adjacent community?

Routine

- How can we adjust service for next year to hold our budget constant in the face of 8 percent inflation in operating costs?
- What changes should we make in response to an unexpected increase (or decrease) in ridership and income on three of our eight routes?
- What changes should we make in response to an unexpected increase (or decrease) in state operating assistance?
- Should we proceed with a grant application for a new garage? Replacement of one-third of the feet?
- Should we take advantage of the possibility of replacing full-time drivers with part-time?
- Should we accept a new contract with the operators' union calling for a 15 percent wage/fringe increase and a guaranteed level of employment?

Monitoring

- Monthly or quarterly report on operation.
- Regular meeting of transit authority.
- Response to elected official or manager regarding citizen question or complaint.
- Briefing for newly elected council member (or newly appointed authority member).

Universe of Applicability

No set of guidelines for content of presentations, such as these, can satisfy every situation. Even if the situation is captured fairly accurately, local interests and local circumstances will suggest additional information and, in many cases, demand it. Local transit staffs and managers will find through trial and error what works well in their situation. However, these guidelines represent a starting point. They are the distillation of research, professional judgment, and expertise, and, perhaps most important, they are internally consistent and reflect sound practice in decision-making, within a context that balances the resources and circumstances of smaller transit systems with some theoretical ideal.

3. LIST OF VARIABLES AND COMPARISONS FOR EACH SITUATION

This section suggests the minimum set of variables that should be presented to decision-makers in each of the three basic situations: system justification, routine decision, and monitoring. The appropriate comparisons are indicated for each variable. These are usually time-based, e.g., the same accounting period as the previous year. Techniques for measuring the values of the recommended variables and for evaluating different alternatives are discussed in Section 5. Suggestions for presentation are included in Section 4 arranged in the same basic order as the list in this section. (However, where several variables are presented in the same graphic, the sequence may be different.) A summary listing of indicators precedes the discussion in this section.

For Decision-Makers in a System-Justification Situation

1. *Primary indicators*—These should be presented for the complete transportation system (i.e., both transit and automobile/highway) for each alternative (or with and without transit):

- Trips served by each mode.
- Highway congestion (measures by travel time or vehicular delay).
- Operating and maintenance cost.
- Annualized capital cost.
- Fare box revenue, transit system.
- Net annual cost, transit system.
- Sources of funding.

2. *Secondary indicators*—These should be presented similarly to the primary indicators, i.e., both major modes, each alternative.

- Total capital outlays to planning horizon.
- Capital funds, by source, again to planning horizon.
- Probable accidents.
- Emission of pollutants.
- Energy consumption.
- Unemployment effects.
- Economic development effects.
- Parking requirements.

3. *Transit descriptive indicators*—These are intended to give decision-makers a general picture of the transit system. If the automobile/highway system varies from alternative to alternative, it should be described also, with analogous indicators.

- Number of routes.
- Hours of service; days of service.
- Buses required.
- Number of employees.
- Annual vehicle-miles and vehicle-hours of service.
- Fare structure.

4. *Performance indicators*—These indicators, in juxtaposition to the number of trips served among the primary indicators, furnish a picture of the service provided by the transit system:

- Percent of population/households served.
- Percent of low-income, minority, no-auto, and elderly/handicapped households served.
- Transit cost/passenger.
- Transit revenue/passenger.
- Transit passenger/vehicle-hour or vehicle-mile.

For Decision-Makers in a Routine, Budget-Time Situation

1. *Primary indicators*—In this circumstance, the primary indicators are intended to be used to compare the coming year to the current year and, perhaps, to the year just past. Generally, it is not necessary to present information about the automobile/highway system:

- Total operating cost.
- Total passengers carried.
- Total operating revenue.
- Net cost of operation.
- Sources of additional (to operating revenue) funding.

2. *Secondary indicators*—The first eight of these are the same as the transit descriptive variables in the system-justification situation:

- Number of routes.
- Days/hours of service.
- Buses required.
- Number of employees.
- Annual vehicle-miles/vehicle-hours of service.
- Fare structure.

Four additional indicators are the same as four of the performance indicators in the justification situation:

- Transit cost/passenger.
- Revenue/passenger.
- Passengers/vehicle-hour (or vehicle-mile).
- Percent of households served (by subgroup, if desired).

For Decision-Makers at Other Times; in a Monitoring Situation

As may be seen, many of these indicators are identical to those listed earlier. However, the level of detail and suggested comparisons are different from those implied above. As appropriate, detail might include routes or subareas and comparisons should include year-to-date and prior year-to-date, current period, and the same period of the prior year and budgeted-to-actual.

1. *Financial indicators:*

- Costs: total operations, maintenance, and administration.
- Operating revenue: fare box, other.
- Net cost.
- Funding, by source.

If possible, costs by route should be available (as well as for the entire system).

2. *Efficiency measures:*

- Cost per vehicle-hour.
- Vehicle-hours per employee.
- Number of employees.
- Employee turnover rate.
- Vehicle requirements.
- Accidents.
- Complaints.

These measures also should be available by route, if possible.

3. *Effectiveness measures:*

- Cost per passenger.
- Revenue per passenger.
- Subsidy per passenger.
- Recovery ratio.
- Passengers per vehicle-hour.
- Passengers per vehicle-mile.
- Percent of transfers.
- System descriptors (when changes occur).

- Fare structure.
- Headways.
- Hours of service.

Again, these measures should be available by route to permit evaluation of route performance.

System Justification

This section discusses the indicators recommended for presentation to local elected officials in the context of a system justification decision. Seven primary indicators are recommended. Each of them involves a comparison between transit and private automobile modes. Eight secondary indicators are recommended, six of which deal with indirect effects of the transit system or a lack thereof. Eight measures that describe the transit system are presented, along with nine performance indicators. The discussion in this section is confined to a simple description of the indicators and an explanation of the reason for including each. The reason for inclusion is deliberately expressed in simple terms. It is intended for inclusion in a presentation packet for a nontechnical audience, to accompany a system justification discussion.

Primary Indicators

Number of Trips Served. The number of trips served by transit and by private automobile is a very basic indicator of the importance of each mode in the city's overall transportation system. Typically, transit trips will be a relatively small proportion of the total. In the absence of a transit system, the number of automobile trips will, of course, be higher than when a transit system exists. However, the difference between total trips with and without a transit system indicates the number of trips that will not be made if the transit system does not function. Although it is not possible to generalize, it is likely that shopping and work trips would be among the most common unmade trips.

Highway Congestion. The difference in highway traffic volumes with and without a transit system indicates one of the most direct benefits of transit. Typically, in smaller cities, the volume of trips carried by transit in any given corridor is too small to make a difference in the number of traffic lanes needed. However, under exceptional circumstances. it may be large enough to make a significant difference in the level of service in the corridor during peak times. Where such differences exist, they are best illustrated on an individual basis rather than by looking at the entire city.

Measures of travel time by transit and by automobile are not recommended. A typical transit trip in a small city will take substantially longer than the same trip by private automobile, if only because the transit vehicle must stop to serve other passengers.

Operating and Maintenance Cost. This indicator shows the aggregate cost of operating the transit system for a year and the costs incurred by private individuals to own and operate an automobile. It is included to inform decision-makers of the relative sizes of budgets necessary to keep the public and private transportation systems operating. These costs may be compared with the relative number of trips served by each mode.

Annualized Capital Cost. The annualized capital cost for the transit system is included as a measure of the investment in the transit system. It includes the cost of rolling stock, garage and maintenance base, and other fixed facilities.

No comparable cost is provided for facilities used for the automobile. It is assumed that user taxes paid by automobile operators (which are omitted from the calculation of the operating costs) cover the capital cost required to build, maintain, and operate the highway system. It is recognized that this assumption is open to debate. However, an attempt to estimate the annualized capital cost of the highway system by any other means would be an exercise of questionable value. The outcome would be quite sensitive to such variables as the expected lifetime of facilities, interest rates, discount factors, and historical land values. While the exercise of computing the value of the city's capital investment in highway facilities might be intrinsically interesting, the level of effort involved is not justified in terms of the potential range of variation in the estimate.

Fare Box Revenue. The amount of revenue the transit system generates through user charges (fares) and other miscellaneous sources of income, such as sale of advertising rights, is informative in several ways. First, as an aggregate measure of user charges, it indicates the amount of support for the transit system raised from users and, by subtraction, the amount that must be generated from various sources of subsidy. It also forms the numerator of the recovery ratio, a common indicator of system performance. (The denominator for this ratio is operating and maintenance costs for transit.)

Net Annual Cost. The net annual cost of the transit system is comprised of the operating and maintenance costs, plus annualized capital costs, less fare box revenue. This represents the annualized public outlay required to support the transit system.

No net annual cost is shown for the highway system because of the assumption that taxes just cover system costs.

Funding. The sources of subsidy for the net annual cost of the transit system are presented and compared with the amount of spending on the highway system at each level of government. This comparison is possible because state and local budgets typically indicate the dollar volume of outlay for roads, street maintenance, traffic control, and traffic and street operations.

Secondary Indicators

Capital Outlays to Planning Horizon. This variable indicates the total amount of capital expenditure required for the transit system and the highway system to the planning horizon. It is presented to indicate the relative magnitudes of economic resources that would be devoted to each mode by the public sector within the planning horizon. It should be pointed out that because of the nature of grant programs, resources are typically not transferable from transit to highways. Some transfers to permit more spending on transit and less on highways have been allowed in the past, but mainly in larger cities.

Capital Funds by Source. This comparison indicates the relative amounts of the total capital budget that would be provided by local, state, and federal sources under current grant program conditions. It indicates the magnitude of relative local shares of funding required to ensure that the needed capital facilities will be available.

Probable Accidents. This indicator is the first of the series measuring indirect effects of the transit indicator system that are often cited as reasons for preserving the system. On close scrutiny, these measures typically are found to be relatively unimportant.

In most jurisdictions, available records will at best permit a breakdown of total accident figures only between personal injury and property-damage-only accidents. The comparison between accidents with and without the transit system is made by assuming that the frequency currently experienced for automobile accidents would continue if there were no transit system, and that the increase in vehicle-miles of travel by automobile would be reflected in a proportionate increase in accidents. From this total figure the number of transit accidents is subtracted.

Emissions. Pollutants emitted by transit and automobiles are calculated as a function of vehicle-miles traveled by each mode. In those cases where a significant difference in congestion in specific corridors can be measured, which affects vehicle speeds, depending on whether a transit system is operating or not, the change in emissions will be based on the difference in speeds (typically, more pollution at lower speeds) as well as on total vehicle-miles of travel. Comparison is made between total emissions with and without the transit system.

Energy Consumption. Fuel consumed is calculated on the basis of averge fuel mileage for the respective fleets in operation. Whether a transit system is more energy efficient than private automobiles depends almost entirely on the rate at which the transit system is utilized. With low utilization, transit may actually be less energy efficient than a system based totally on private automobiles.

Unemployment Effects. This indicator measures the unemployment that may result if workers who presently depend on transit to get to and from their jobs become unemployed because the transit system ceases operation and they have no alternative mode of transport. Transit system employees are not included in this count; however, the number of system employees is given below in the section on transit descriptive variables.

Economic Development Effects. This indicator measures the impact the absence of a transit system would have on economic development in the city through the reduced level of business development that may occur if developers perceive the retail market or the labor market as diminished in the absence of the transit system. It must be noted, however, that most of the variables affecting the economic development of an urbanized area have to do with the area's overall economic condition rather than the availability of transit. Transit is more likely to influence specific site location decisions within an urbanized area than to influence a firm's decision to locate or not to locate in the area at all. The site location decision may be of concern if the urbanized area includes more than one political subdivision, however. It is conceivable, for example, that a firm might choose to locate within the city if good public transportation were available and the firm could thereby reduce or eliminate the cost of providing parking for customers and/or employees. In the absence of a transit system, the firm might well decide to locate in suburban or unincorporated territory.

Parking Requirements. Parking must be provided for those trips that would switch from public transit to automobile if the public transit system were not in operation. This indicator measures the additional number of parking spaces that would be required in the absence of the transit system, given the overall travel demands.

Transit Descriptive Variables

The variables in this section are informative and are designed to give local decision-makers an overview of the scope of transit operations. The information contained in these measures is not intended to affect the transit/no-transit decision. The same indicators are used in the routine decision-making context and, in a disaggregated form, in monitoring.

Number of Routes. This variable measures the number of distinct routes that the system operates. It is a basic measure of the system's extent and carries no connotation of norms or standards.

Hours of Service, Days of Service. These variables merely indicate the times and days during which transit service is available. For most small cities, a convenient way to describe the system is in terms of the hour at which the first trips arrive in the downtown area and the hour at which the last trips leave the downtown.

Buses Required. This variable indicates the maximum number of buses needed to maintain the scheduled service, without inclusion of any spare vehicles.

Number of Employees. The total number of transit system employees is given. Where part-time employees are used, the number of full-time equivalents is also given.

Annual Vehicle-Hours and Vehicle-Miles of Service. These variables are basic measures of output that are recognized in the transit industry as indicative and descriptive of the system's scope.

Fare Structure. This section includes information on each distinct price charged for using the transit system, including discount fares for various classes of riders and for multiple-ride users. It may be compared with the performance indicator of transit revenue per passenger (see performance indicators below) to indicate the average discount or the relationship between the basic adult cash fare and the actual revenue realized per ride taken. In some cities, an apparently high basic fare is offset by the wide availability of discounted fares.

Performance Indicators

Like the transit descriptive variables, the performance indicators presented here also appear in information given for routine decision-making or monitoring. These indicators deal with the effectiveness of the system as measured by the proportion of the service area's households that have access to the system, passengers per unit of service provided, and the efficiency of the system as measured by cost per passenger.

Percent of Population/Households Served. A transit system typically serves most but not all the households in the political jurisdiction or service area within which it operates. Population density in outlying areas, terrain, and existing street and highway facilities are among the factors that determine where the transit routes will end and, thus, which households will have access to the service. The percent of households served is a basic indication of the coverage of the service area provided by the transit system. A map showing transit routes and the area within convenient walking distance of the routes is often provided to illustrate more precisely which portion of the community is included in the area served.

Percent of Minority Households Served. This indicator compares the number of minority households that have convenient access to the transit system with the total number of minority households in the service area. Federal law requires that access provided by the transit system to minority households be at least as good as that provided to nonminority households.

Percent of Low-Income Households Served. Transit is frequently characterized as a service that is particularly important to low-income households. This variable measures the effectiveness of the transit system in providing access to low-income households within the service area.

Percent of No-Auto Households Served. Like the preceding variable, this indicator measures the effectiveness of the system in providing service to transit-dependent households, i.e., those without automobiles.

Percent of Elderly, Handicapped Served. These two measures indicate the effectiveness of the system in reaching two other transit target groups: the elderly and handicapped. Where a demand-actuated system is in operation, catering to the elderly and handicapped, by definition it provides service to all members of the target groups residing within the service area. It must be stressed that these measures indicate availability, not use.

Transit Cost Per Passenger. Operating cost per rider is a useful indicator of the performance of the transit system. It may be compared over time for a given system to observe trends as well as with other systems in a peer group to examine the relative performance of the system under study. Because wage rates are a major component of transit operating costs, care must be taken in making comparisons between different systems.

Transit Revenue per Passenger. This indicator, calculated by dividing total fare box revenue by total passengers carried, indicates the fare yield per passenger. Taken in conjunction with the fare structure (mentioned above under transit descriptive variables), it gives an indication of the system's fare discount structure. Subtracting revenue per passenger from cost per passenger gives the subsidy per transit passenger.

Transit Passengers per Vehicle-Hour or Vehicle-Mile. This indicator is used within the transit industry to provide another basic measure of system performance. In very broad terms, the more passengers carried per vehicle-hour or vehicle-mile, the better the system. Trends within a given system may be observed over time by applying this measure consistently; peer group comparisons with other systems are also possible.

Routine Decision

Five primary indicators are recommended for presentation to local decision-makers in the context of routine decision-making, which covers such areas as annual operating budget approval, minor route restructuring, or minor schedule changes. Because the continuation of transit service is (by definition) not at issue in a routine decision, the comparisons focus on the changes between the proposed, the existing, and the recent past. A dozen secondary indicators are used. They combine the secondary indicators and the system descriptor variables from the system justification situation and are presented in a manner that enables the decision-makers to quickly grasp the system differences in service levels between existing and proposed.

Primary Indicators

Total Operating Cost. Total operating cost reflects a year's financial commitment to the proposed level of transit service. Decision-makers have an opportunity to investigate the components of operating cost in the context of monitoring information; it is felt that a component breakout is not needed for the routine decision-making function and may, in fact, detract from the issues.

Total Passengers Carried. To give decision-makers a sense of the overall scope of the transit service in terms of people served, passenger volume is presented next.

Total Operating Revenue. Fare box revenue plus other operating sources, such as advertising, are combined in this statistic. Although a distinction is made in subsidy calculation between nonfare box operating revenues (which may be counted for maintenance-of-effort calculations) and fare box revenues (excluded from maintenance-of-effort calculations), that issue is not relevant to decision-making.

Net Cost of Operation. The amount of public operating assistance, or subsidy, required to maintain the proposed level of transit service is given in this indicator. It represents the gap between the cost of providing the service at the proposed level and the amount estimated to be received from user charges for the service.

Sources of Additional Funding. Decision-makers are typically concerned about the local share of funding but also want to know the amounts and sources of other portions of the subsidy. Presenting this indicator with a breakout of other sources enables the decision-makers to quickly sense the impact of policy changes at other levels of government in terms of potential changes in either the amount of local funding required or the amount of service that can be provided.

Comparisons. In all cases, primary indicators are presented in a format that shows the proposed, the current, and the previous year's situation, with absolute amounts and percent differences. Table A-1 is an example of a suitable format for the presentation.

Table A-1. Primary indicators for routine decision.

Indicator	Proposed	Current Year (FY ____)		Last Year (FY ____)	
	Amount	Amount	Percent Change from Current	Amount	Percent Change from Current
Total Operating Cost	$	$	%	$	%
Total Passengers	#	#	%	#	%
Total Operating Revenue	$	$	%	$	%
Net Cost of Operations	$	$	%	$	%
Sources of Additional Funding:					
Local	$	$	%	$	%
State	$	$	%	$	%
Federal	$	$	%	$	%
Other	$	$	%	$	%
Shortfall (Surplus)	$	$	%	$	%

Secondary Indicators

The first eight secondary indicators are the same variables cited as transit descriptive variables in the system justification section. They include the number of routes, the days and hours during which service is provided, the number of buses required, the number of employees, the annual vehicle-hours and vehicle-miles of service, and the fare structure. In routine decision situations, the descriptions should be given on a system level; they are provided on a route-by-route basis in the monitoring information.

The format used should be the same as for the primary indicators, comparing the proposed with the current and previous year's statistics. Where no change has occurred or is proposed, the words "no change" may be used in place of the actual numbers for a given variable. If the fare structure involves a large number of discount fares or prepaid fare instruments, the information on fares should be presented on a separate page to avoid giving the tabular format a cluttered appearance.

The remaining four measures are discussed as performance indicators in the system justification section. They are transit cost per passenger, revenue per passenger, passengers per vehicle-hour or vehicle-mile (vehicle-hour is preferred, but vehicle-mile may be used if customary on a given property), and percent of households served. The percent of households served is subdivided into the various target population categories: minority, low-income, no-auto, elderly, handicapped.

Comparisons with current and previous year statistics should be presented, as for the descriptive variables.

Monitoring

This section discusses the indicators recommended for presentation to local elected officials (LEOs) in the context of monitoring or periodic briefing. By definition, the variables presented in this context are not associated with the need to make an immediate decision. They provide information to LEOs on the overall performance of the transit system, time trends, comparison with prior years' performance, and a general overview to aid LEOs in discussions with their constituents. The information set recommended for regular presentation includes financial statistics, system descriptors, and some basic measures of system effectiveness and efficiency.

Although a number of the measures are identical with those used in system justification and routine decision-making settings, an explanation of each variable is presented afresh in this section. The level of detail presented in the monitoring context, and the comparisons provided here, are different from those that prevail in the other contexts. The organization of information is also somewhat different, reflecting the relative importance that should be given to the various indicators. Key monitoring variables are provided first, efficiency and effectiveness measures second, and system descriptors last. In all cases, the information presented is to include comparisons of year-to-date and prior year-to-date, current period and same period of the previous year, and budgeted-to-actual comparisons.

Unlike the discussion of variables in the system justification section, the discussion here is primarily for transit staff preparing briefing materials. The appropriate definitions or explanations may be extracted from a glossary or a briefing book for a new LEO.

Financial Indicators

Cost Indicators. Total system operating cost is presented, with a breakout to show cost of providing the transportation, maintenance, and administration. (Depending on the level of detail desired by an individual transit board, a further breakout may be provided in supplementary tabular form.) The purpose of the three-way breakdown suggested is to provide an initial indication of the source of changes in the cost picture from period to period.

Operating Revenue. System fare box revenues, including cash fares, tickets, transfers, passes, and other methods of fare payment, are presented along with "other" revenue, which typically includes such items as advertising, miscellaneous leases and rents, etc.

Net Cost. The difference between operating cost and operating revenue is presented as the net cost, or net public subsidy, required to balance the operating account.

Funding. The sources of funding to cover the net public cost are given and broken out by local, state, and federal agencies. If a shortfall or surplus exists, it should be indicated as a separate line item.

Route Detail—Financial Statistics. Total operating cost, total operating revenue, and net cost for each individual route are presented. Comprisons between the current period and the same period of the previous year as well as year-to-date and last year-to-date also should be given.

Systemwide data also are provided to compare the costs and revenues from weekday service with costs and revenues from Saturday and Sunday service, and the costs and revenues from peak-hour weekday service with costs and revenues from off-peak service. Again, comparisons to the previous year should be made. No attempt is made to cross-tabulate by individual route in the monitoring statistics.

Typically, there are significant cost and revenue differences between weekday, Saturday, and Sunday service and between peak-hour and off-peak service. It is informative to LEOs to advise them of the relative portion of the total operating deficit attributable to service at different time periods. Since the peak-hour weekday service is primarily used by passengers making work trips, and services at other times are used by passengers with different trip purposes, providing the financial statistics in this way also makes it possible for LEOs to use their own intuitive judgments about the relative importance of continuing, expanding, or decreasing service at different time periods.

Efficiency Measures

Efficiency measures indicate the performance of the system in producing service at minimum cost. For consistency, the efficiency measures recommended are related to quantities of output produced. By contrast, effectiveness measures (in the next section) relate to the quantity of output consumed. That is, effectiveness measures typically deal with the number of passengers carried, in contrast to efficiency measures that are more likely to deal with vehicle-hours or vehicle-miles of service provided. (See Note on page 15.)

Cost per Vehicle-Hour. Cost per vehicle-hour is a basic measure of the efficiency of the service provided. It reflects both the cost of inputs such as labor and fuel and the quantity of inputs used to produce the service. Performance indicators typically generated for use by transit managers and staff include a more detailed breakout of cost per vehicle-hour, which enables them to identify the source of cost increases and opportunities for cost reductions. Managers should have this material at hand when discussing monitoring information with LEOs, but the greater level of detail is not usually of interest to LEOs.

Cost per vehicle-mile rather than cost per vehicle-hour is sometimes used as the primary measure of efficiency. Cost per vehicle-hour is recommended because it more clearly emphasizes the highly wage-sensitive nature of operating costs in the transit industry. Furthermore, if peer group comparisons are desired, using hourly costs eliminates the need to adjust for differences among systems in average operating speed obtained.

Vehicle-Hours per Employee. The transit system's efficiency in use of labor is indicated by this measure. Both peer group comparisons and time trend analysis are useful in tracking a system's performance on this measure. However, care must be taken to ensure that the variable is not distorted by such items as, for example, use of part-time help. Specifying full-time equivalent employees (FTE) in the denominator should enable the appropriate adjustment to be made in peer group comparisons. On a given property, if no change in the composition of the labor force occurs over time, no adjustment is needed to make accurate comparisons.

Employee Requirements. Two measures of employee requirements are recommended. The first is the number of employees, which serves to indicate to decision-makers the size of the transit system in human terms. The second is the annual turnover rate, expressed as the ratio of terminations (voluntary or otherwise) to the total labor force.

The turnover rate can be an early indicator of areas needing attention and improvement. A high turnover may be caused by unreasonable working conditions, poor labor management relations, or wages significantly below the prevailing local rates. Since a high turnover rate tends to be disruptive and inefficient because of normal learning curves, reducing the turnover rate should promote efficiency. Policymakers need to be aware of this situation because some of the variables causing high turnover, notably the wage rate situation, are typically not within the control of transit management alone.

Vehicle Requirements. Two measures of vehicle requirements are suggested. The first, number of peak vehicles required, gives a dimension of the transit system in terms of the rolling stock required. Whether or not it appears particularly relevant to policymakers, it is a question frequently asked by people in the transit industry wishing to gain some insight into the size of a system.

The second measure, vehicle-miles per vehicle, indicates the efficiency of fleet utilization. A decline in the number of vehicle-miles per vehicle may indicate an excessive spare ratio or difficulty in the maintenance department. An unusually high utilization rate may occur because vehicles are sidelined for a long time awaiting repairs or because the spare ratio is too small to permit adequate down time for maintenance. Since this measure has implications for capital decisions, it is worth bringing to the attention of policymakers.

Accidents. The number and dollar cost of accidents are recommended as efficiency measures. Accidents represent an unproductive use of resources. They also may signal problems elsewhere in the system, such as high driver turnover rates or (rarely) inadequate maintenance. Because accidents can also result in lawsuits against the transit system or its parent body, LEOs should be advised of the current status and trends in the system's accident rate.

Complaints. Complaint statistics provide a more complete picture of the public's perception of the transit system's performance than the fragmentary evidence provided by individual complaints directed to individual LEOs. In the absence of major system changes, a simple comparison of the number of complaints in the current year and the previous year is sufficient. Where major changes have occurred, complaints per 10,000 passengers (or some other ratio) may be a more representative measure.

Effectiveness Measures

Effectiveness measures indicate how well the transit system is doing its job of serving the public. A system may be producing transportation capacity in the most efficient manner conceivable, but if no one is using it the system is not effective. The aggregate effectiveness measures provide an overview of how well the system is doing. Disaggregate measures detailing the performance of the system at various time periods or by individual routes provide greater insight into the effectiveness of the service in meeting the transit needs of specific submarkets.

Cost per Passenger. This measure indicates the average total operating cost for providing service to a passenger. Other things being equal, the lower this cost, the more effective the service.

Cost per passenger is sometimes regarded as an efficiency measure. However, since the marginal cost of service is virtually independent of the number of passengers carried on a bus, cost per passenger is determined more by the ridership than by the expenses. Therefore, it is categorized as an effectiveness measure in this report. The distinction between effectiveness and efficiency may not be worth preserving; both types of measures may be described as performance measures for simplicity.

Revenue per Passenger. Like cost per passenger, this indicator is calculated by dividing system revenue by total passengers carried, or revenue for a specific route or time of day by the corresponding passenger load. This indicator also reflects the effective discount structure when compared with the adult cash fare, thus giving an indication of the ridership composition. The lower the average revenue per passenger, the greater the proportion of the ridership traveling at a discount fare (senior citizen, school, discount ticket, or pass).

Subsidy per Passenger. This indicator is the difference between the cost per passenger and the revenue per passenger. It indicates for the system as a whole, and by route and time of day or day of week, the relative proportion of public funds (local, state, and federal) devoted to specific portions of the service. As such, it provides an indication of the equity of the service provided.

Recovery Ratio. The recovery ratio is the proportion of operating cost recovered from fare box revenue. The recovery ratio is established as a policy variable in some jurisdictions. In such cases, the fare level is adjusted to enable the system to meet the recovery ratio targets. Although it has generally been acknowledged for a long time that the cost of providing transit service cannot and should not be met entirely from fare box revenues, some public agencies feel that it is appropriate to establish a minimum proportion of the operating cost that should be met directly by user charges.

Passengers per Vehicle-Hour. For the system as a whole, the trend in passengers per vehicle-hour is an indicator of continuing, increased, or diminished effectiveness of the system. Overall ridership may, of course, be affected by factors outside the system's control, notably economic conditions.

Passengers per vehicle-hour statistics by route, time of day, and day of week indicate which components of the overall service are most heavily patronized and which are least used. This information is important to policymakers in the context of equity, primarily as it relates to the geographic incidents of benefits and costs of service.

Passengers per Vehicle-Mile. The same comments that apply to passengers per vehicle-hour apply here for those systems that are accustomed to providing statistics by vehicle-mile rather than by vehicle-hour. Both measures may be used in peer group comparisons as well as for internal monitoring of the system.

Percent of Transfers. From the passenger's point of view, the most effective system is one that requires no transfers. From the system's perspective, it is not possible to tailor the service so that everyone gets a one-vehicle ride from origin to destination. Other things being equal, a lower transfer ratio (the percent of all passengers who must transfer to complete their journeys) is an indicator of a more effective system. A higher transfer ratio leads logically to the question: Are the current route alignments optimal?

System Descriptors. The system descriptors provide a basic profile of the service offered. Typically, they do not change from one reporting period to the next. Therefore, rather than presenting the same statistics in every reporting period, it should be sufficient to present them only when changes occur, indicating the effective date of the change and providing the former values of the descriptors.

Fare Structure. The total structure of fares for the entire system is presented. Where discount fares are offered, the prices and the conditions for eligibility are presented as well. If there are differences in the fare by route, day of week, or time of day, these are also shown.

Headway. The headway is the interval between successive buses. It is presented on a route-by-route basis, with separate columns for weekday peak, weekday off-peak, and Saturday and Sunday service.

Hours of Service. The clock-hours during which service is provided are shown on a route-by-route basis, classified in a manner similar to headways.

4. COMMUNICATION TECHNIQUES

Appendix B is an educational package which includes specific examples of graphics to be used in various circumstances and scripts for introducing the general topic of small-city transit service and the specific measures to be used in analyzing alternatives. This section summarizes the recommendations for use of the educational package and gives some suggestions for other presentation techniques.

Using the Educational Package

The package consists of three parts. Part One is a general introduction to small-city transit services, comprised of a script and a set of slides. It is intended to be shown in a context of general orientation of decision-makers who are new to the decision-making body, perhaps on an annual basis. It is not intended to be used in specific decision-making situations.

Part Two consists of a "library" of slides and descriptive paragraphs which should be used to explain the specific variables selected by a given city for use in analyzing transit alternatives. Because different cities may wish to use different variables, the transit manager may select from the library only those slides and paragraphs that apply and use them for a presentation just prior to the evaluation of alternatives. The purpose of Part Two is to establish a common basis of understanding and definitions prior to undertaking an evaluation.

Part Three is a set of templates for use with an overhead projector. They organize commonly used transit statistics in a simple format for ease of comprehension. They are intended for use in routine decision-making and system justification. Monitoring data are more likely to be presented in a format which the transit system has developed over time and with which everyone is familiar.

Refer to Appendix B for further information on available audiovisual material.

General Recommendations on Communicating

1. *Keep it simple*—Avoid the temptation to crowd as much data on a page as possible. Recognize that accounting statements, while they may be required by law, are not always the most informative format for lay audiences. Some time spent developing a local format to highlight variables of local concern, and to present them at regular intervals in a standard format, will pay off in terms of greater understanding by LEOs.

2. *Use graphics to make a point*—To show the relative importance of wages, fuel costs, parts, etc., per hour of bus operation, a pie chart is much more effective than a table of dollars and percentages. To flag out the impact of declining federal operating assistance, a series of bar charts (one per year) has been used very effectively by some transit properties. (An example is shown as Figure A-1.)

The large number of variables and comparisons recommended for presentation in the routine monitoring context can easily lead to a series of complicated and confusing tabular presentations; thus, it is particularly important to develop a clear, concise graphic format that will convey the desired information simply. The tabular material should be available at the back of the briefing packet for those who desire it, but the graphic materials should be presented first. This will draw attention to trends and deviations from plan.

3. *Have the detail available*—Detailed information must always be available to decision-makers who want it. However, the key points can be brought out with a carefully prepared summary out in front, leaving the backup data at the back of the package.

4. *Focus the audience's attention*—When making a presentation, particularly with visual aids (slides, story boards, view graphs), let the listeners concentrate on you. Save printed material for handout afterwards so that listeners do not divide their attention.

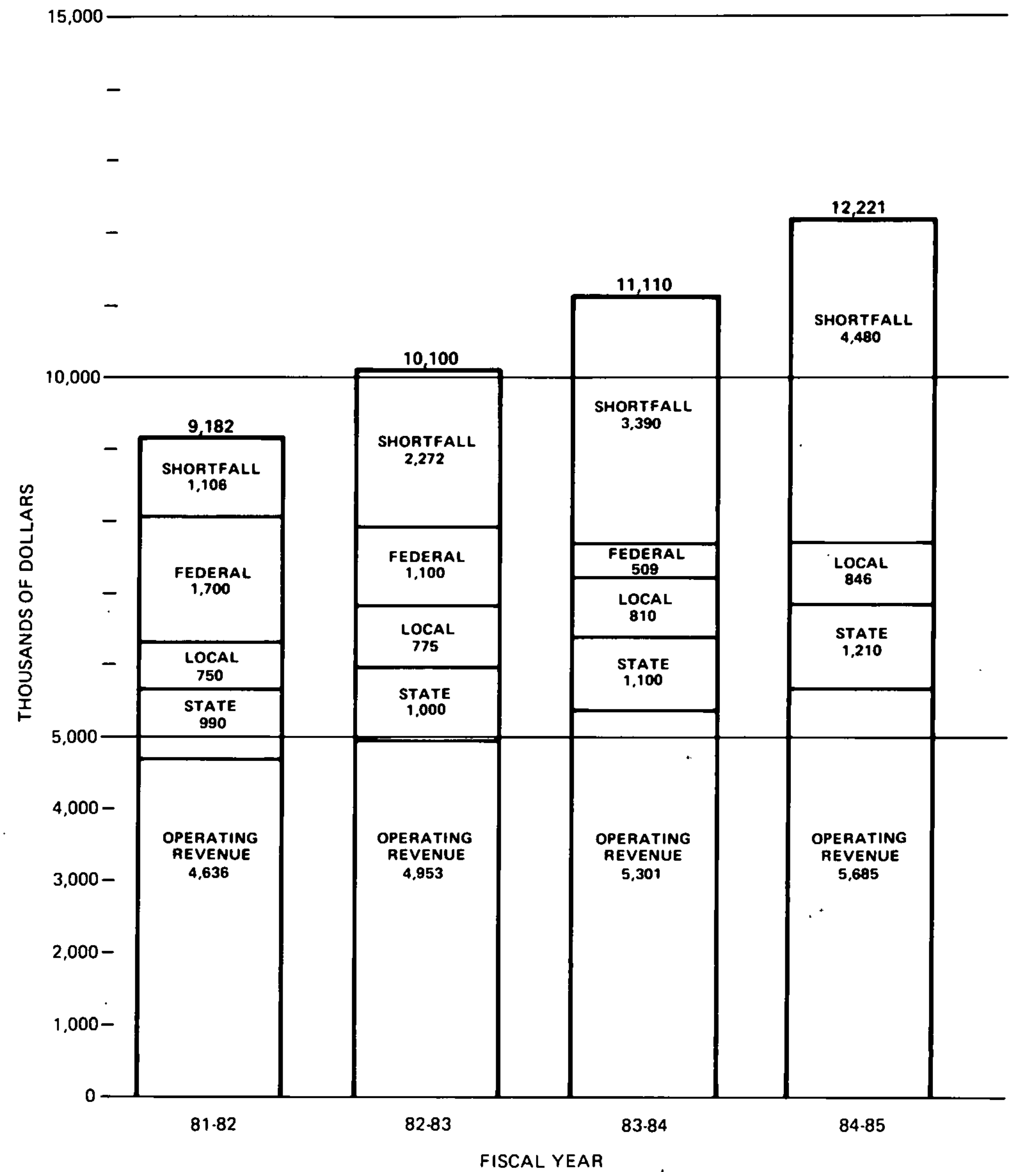


Figure A-1. GARY PTC—*Projected operating results, present fares, and level of service.*

Preparing Graphics

Frequently, small-city transit properties do not have in-house capability to prepare good, sharp, simple graphics. The templates provided in Appendix B are one solution to that problem. Others include the following potential sources of low-cost graphic assistance: local high school, college or art school classes; other city departments; and other local agencies. It is relatively common to find an employee with artistic abilities working in a totally unrelated job. Such individuals also represent a potential source of improved graphics.

Some general principles of good graphics practice for presentations include:

- Where possible, use a horizontal format to take advantage of our custom of reading left to right. (This will not work with most overhead projectors, unfortunately.)
- Resist the temptation to crowd as much information as possible onto one screen or panel. Viewgraphs of typewritten tables, for example, are not readable as a rule.
- Try to limit the text on a screen to four or five lines. Use key words and talk from them rather than trying to put everything on the screen.
- Highlight with color or underscoring those details you want the audience to retain.

Recent developments in computer graphics have made it possible to generate reproducible graphics of route statistics such as percent boardings by hour, average daily ridership, and boardings and alightings by route segment. Route statistics are part of the monitoring process, and graphic depiction can assist in understanding the process.

Communications as a Potential Improvement in Evaluation Methodology

While the current need for and use of evaluation aids in small-city transit planning-management is simple and straightforward, some potential improvements relate largely to communicating effectively the differences among alternatives. This communication effort generally will be directed by managerial staff to both policymakers and the general citizenry (particularly citizen advisory committees). It is useful to distinguish between transit improvement options that are capital-intensive and those that are not.

Noncapital-Intensive Improvement Options

These kinds of alternatives generally involve incremental change, on an annual basis, in the existing transit service system. They may involve relatively modest route expansions or cutbacks, changes in hours or frequency of service, changes in route alignment or the pattern of transit stops, changes in driver scheduling, or other management-oriented actions designed to achieve cost efficiencies. Because these options are incremental, the primary interest of both policymakers and managers has been found to be in criteria relating to direct impacts on users and system operations—measures relating to efficiency and effectiveness that match Section 15-type measures against ridership levels and associated revenues.

These kinds of measures are not numerous (five or ten). If only one or two alternatives are considered seriously, the management of evaluative data in the form of simple cost-effectiveness tables (although they do not need that label to have full usefulness) is an easy task. Three factors do, however, suggest a need for more careful presentations of differences among alternatives, particularly with expanded use of visual aids (graphs, charts, etc.). These include time trend analyses, need for multiple alternatives, and concern for distributional impacts.

1. *Time trend analysis*—In general, concern for the direction of transit finance has led to concern for both local ridership patterns and local subsidy requirements, particularly for cities that are currently in a service cutback mode of management. Graphing of recent ridership trends (and projection of them in relation to alternatives), as well as revenues and costs by source and component, can be of considerable value in decision-making. Projections for at least 2 or 3 years into the future, possibly on varying assumptions regarding the availability of federal and state revenues, could be included. Projection of fare box revenues, based on alternative fare levels (and associated shifts in ridership), could also be helpful.

2. *Need for multiple alternatives*—Policymakers have shown a clear concern for achieving maximum service impact from the service provided. Under a service cutback theme, they wish to minimize detriment to riders. Particularly because policymakers have, in this situation, become involved in the details of routing and scheduling, there is a strong likelihood that they will also either ask for or become involved in the design of additional alternatives. (Such involvement could also occur, though it seems much less likely, in the design of new routes and route extensions in areas where expansion of service is occurring.) When more alternatives are generated, the need to consistently compare them within overall cost-effectiveness matrices and supporting visual aids grows.

3. *Geographic distributional impacts*—Again, in a context of service cutback planning, decision-makers have shown particular concern for who will get hurt. Concern for lower income transit-dependents emerges here, so that both the geographic location of these riders and the extent of their dependency on transit become important factors. Again, policymakers can become directly involved in the details of service delivery and the design of alternatives, but here from an equity standpoint. (Again, the potential exists for similar concerns to be associated with route extensions or new routes, but decision-makers typically rely on managers to identify the best location—in terms of ridership potential or in response to local community pressures for new routes.) Where distributional impact issues are raised, again the amount of information generated in the evaluation process increases. Effective tabular display of impacts and use of graphic aids can be valuable.

Capital-Intensive Transit Options

In smaller cities, the range of capital-intensive transit improvement options is limited. These generally relate to vehicle replacement and purchase, including options with regard to vehicle size (small bus versus big bus), vehicle type (demand-responsive versus fixed-route/fixed-schedule), or total fleet (expansion or reduction). Infrequent capital decisions, such as replacing or expanding the transit maintenance garage or the construction of a ground transportation center in the CBD, do present special one-time decision-making challenges.

Because capital investment options carry with them associated service and routing plans, each of the three potential areas of improvement described above for noncapital-intensive options still applies. In addition, however, two other areas of possible improvement in evaluation method can be identified—more careful consideration of economic efficiency and more careful consideration of indirect impacts.

1. *Economic efficiency measures*—Calculation of total transportation costs, with time streams of costs brought back to present value, provides a basic measure of economic efficiency for any set of capital-improvement options. This applies in small cities as well as large cities. Where transit improvement alternatives involve trade-offs between, for example, big buses versus small buses, or demand-responsive vehicles versus conventional vehicles, calculation of total transportation costs can be instructive. (Note that equity impacts for these demand-responsive versus conventional vehicle trade-offs are also significant, particularly when economic efficiency differences can be large, both in terms of life cycle costs and direct measures like cost per passenger or passenger-miles per route.) Because different vehicles have different useful lives, maintenance costs, fuel requirements, and driver or operating costs, comparison of such cost differences over a 5- or 10-year time frame provides the most meaningful and consistent basis for comparison. This kind of life cycle cost analysis has drawn increasing attention in larger urban areas, and still has carry-over to smaller areas.

2. *Indirect impacts*—In general, bus systems in small urban areas have negligible economic or environmental impacts, except in very localized circumstances (air pollution or noise directly adjacent to a bus route). Social impacts, however, in terms of equity of service to transit-dependents, and the degree of mo-

bility offered to all socioeconomic groups and/or subareas, can be important, as noted above. In special cases, such as the development of a ground transportation center, opportunities for significant economic impact may arise. Alternate locations for such a center may require assessment in these terms. In general, if significant indirect impacts are associated with small-city transit options, they will be associated with capital-intensive options. To this extent, the number of impacts to be evaluated is expanded, and the amount of evaluative information to be considered by managers and decision-makers increases. Again, simple cost-effectiveness matrices and supporting visual aids may be useful.

5. Measurement Sources and Techniques

This section describes techniques for determining values of the measures recommended in earlier sections for presenting transit alternatives to local elected officials. Three general circumstances have been described: (1) the system justification situation in which establishment or abandonment of a transit system is contemplated or a significant change in service is being reviewed; (2) a more routine, end-of-the-year situation in which marginal change in the service and operation of the system is expected; and (3) a monitoring circumstance where staff is responding to questions from elected officials or is providing information on the status of the system on a regular basis.

In the system justification context, it is important to be able to estimate what will happen, given a major change. One or more alternatives is being compared to an existing or do-nothing situation. In most cases, values of the measures describing the system must be estimates of a circumstance which does not exist or, at best, is a major extrapolation from existing conditions.

In the routine end-of-the year consideration of marginal change in an existing system, the importance of knowledge about current operations and performance is much greater. In this case, although estimates must be made (for the next year), they relate much more closely to existing information about the system as it currently operates.

Similarly, the monitoring situation is based entirely on existing information which should be available for the management and staff.

The next subsection briefly covers sources of data describing the existing situation, which also are useful as the basis of a large majority of estimation techniques for other measures.

Following the discussion of data sources, the next two subsections describe techniques for estimating both present and future values of the various measures. They are followed by a short subsection on evaluation techniques which bring the measures together for use in decision-making. (Section 4 described suggested related presentation techniques.)

A number of excellent documents have been prepared in the past few years which present techniques for estimating the various measures that describe transit systems. In parallel to computerized demand and related projection models, which require considerable resources, the techniques described in these reports permit estimation of reasonable values for various measures, but without the use of large computers. They provide good usable estimates, particularly for smaller cities.

Because these resources are available, the material that describes techniques for estimating measures is divided in two parts.

Following an introductory review of the measures with specific suggestions and "pointers" to succeeding subsections, a first part reviews handbook techniques for estimating demand, costs, and certain socioeconomic measures, in both narrative and tabular form. The second part describes estimation techniques for measures that are not included in the referenced handbooks.

The handbooks used as the basis of the estimation subsection are as follows (information for ordering the books is included):

1. Sosslau, A.B., et al., "Travel Estimation Procedures for Quick Response to Urban Policy Issues," *NCHRP Report No. 186*, Transportation Research Board, Washington, D.C., 1978.
   Available from:
   Transportation Research Board Publications Office
   2101 Constitution Avenue, NW
   Washington, D.C. 20418
   202/334-3216
   Price: $5.60
2. Sosslau, A.B. et al., "Quick Response Urban Travel Estimation Techniques and Transferable Parameters," *NCHRP Report No. 187*, Transportation Research Board, Washington, D.C., 1978.
   Available from:
   Transportation Research Board Publications Office
   2101 Constitution Avenue, NW
   Washington, D.C. 20418
   202/334-3216
   Price: $10.20
3. Gilbert, K., *Transportation System Management: Handbook of Manual Analysis Techniques for Transit Strategies* (NCTCOG), U.S. DOT, UMTA, Washington, D.C., reprinted 1981.
   Available from:
   National Technical Information Service
   U.S. Department of Commerce
   5285 Port Royal Road
   Springfield, Virginia 22161
   Cite Report No. PB 81-210361
   Price: $17.50
4. Peat, Marwick, Mitchell and Co., *Simplified Aids for Transportation Analysis: Transit Route Evaluation*, U.S. DOT, UMTA, Washington, D.C., 1979.
   Available from:
   National Technical Information Service
   U.S. Department of Commerce
   5285 Port Royal Road
   Springfield, Virginia 22161
   Cite Report No. PB 299983
   Price: $8.50
5. Peat, Marwick, Mitchell and Co., *Analyzing Transit Options for Small Urban Communities: Analysis Methods (Volume 2)*, U.S. DOT, UMTA, Washington, D.C., 1978.
   Available from:
   UMTA
   202/426-9157
   Price: Single copies free.
6. *National Urban Mass Transportation Statistics: (Second) Annual Report, Section 15 Reporting System*, U.S. DOT, UMTA, Washington, D.C., annual.
   Available from:

UMTA
202/426-9157
Price: Single copies free.
"Second Annual" Report is for fiscal years ending between July 1, 1979, and June 30, 1980. Later versions will be available.

Perhaps the most difficult task the planner/analyst will face is the selection of estimation techniques and balancing between his/her own skills, and resources of time and data, and the demands of a particular technique. Thorough review of the techniques and their descriptions is necessary before any particular one is selected.

Data Requirements and Sources

Requirements

Data required by the estimation techniques vary widely, depending on the technique. Generally, the techniques that require less specific data are quicker and easier to use, but represent a trade-off in accuracy and in the confidence which may be placed in the results.

The justification circumstance is the most demanding of data because it includes all of the measures needed for the routine and monitoring situations (although not in as great a detail as is required for the transit system in the monitoring context).

The types of data required by one or more of the techniques include:

1. *Data describing people*—Socioeconomic data from the census, by tract, or from a transportation study by zone:

- Population.
- Dwelling units or households.
- Household auto availability.
- Employment.
- Major land-use.

2. *Data describing travel*—Trip-making, from zone to zone, usually available only from a transportation study:

- By major purpose (i.e., work, shop, etc.).
- Average trip length.

3. *Data describing the characteristics of service provided by the transporation system*—Zone-to-zone (or tract-to-tract) travel time, by highway and transit, or airline distance:

- Cost (auto operating, fare), transit operating costs.
- Travel speed (highway speeds).
- Schedule, headways.

4. *Data describing use of the transportation*—These are:

- Patronage of transit system by purpose, route, and time of day.
- Volumes on the street system.
- Vehicle occupancy.

5. *Data describing funding and expenditures*—Present and projected funding for operations, maintenance, and capital costs.

Obviously, this is an intimidating list. However, no estimation technique requires all of these data or detail and, in many cases, reasonable assumptions for values may be substituted or satisfactory approximations may be used. Many of these techniques offer suggested typical values or approximations.

Sources

Section 15 Data. Information describing an existing system normally will be available from local records. Perhaps the best single source is the worksheets used to collect and prepare the Section 15 data reported annually to UMTA. Although the Section 15 data are aggregated on a systemwide basis, the source data used to prepare the Section 15 report frequently include route-by-route data, particularly for the nonfinancial statistics. The system itself can be expected to have more recent data than is available in published Section 15 reports because of publication lags.

Section 15 data include information related to:

1. *Number of trips served*—Daily, monthly, and annual ridership data are covered. Section 15 reporting calls for "annual unlinked passenger trips," a statistic derived from boarding counts for individual lines in the transit system. Any trips involving transfers (linked trips) are counted twice, since the prior mode of each passenger is not known.

2. *Operating and maintenance costs*—Section 15 reporting procedures require the stratification of operating/maintenance costs in two ways. First, annual (fiscal year) operating costs are reported by function: vehicle operations, vehicle maintenance, general administration, and total. Second, the same annual operating expenses are classified by "object class": labor, salaries and wages (operations, other), fringe benefits, service, materials and supplies (fuels and lubes, tires and tubes, other) casualty and liability, other, and total. A cross-tabulation of operating expenses by object class and by function also is required, yielding a further breakdown of annual operating expenses. Operating expenses normally are tabulated by the transit operator on a monthly basis as well as for the fiscal year overall.

Tables A-2, A-3, and A-4 give excerpts from the July 1982 UMTA Section 15 Annual Report, for a sampling of smaller transit systems covering operating expenses by function, by object class, and cross-classified by both. These data are generally useful at the monitoring level (annual or monthly), with total expenses important at both major and routine decision levels. Note that the specific reporting forms on which local transit properties submit these data to UMTA are identified in the table caption.

3. *Fare box revenue*—Fare box revenues typically are tabulated on a daily, weekly, monthy, quarterly, and annual basis by all transit operators. Fare box revenues are understandably one of the most critical and carefully watched dimensions of local transit operations, since implications for changes in federal, state, and/or local subsidy are a direct result. Revenues are sometimes, but not always, available by route as well as by system. Revenues by route can be estimated by applying the average systemwide fare to route-by-route ridership. Alternatively, because some properties segregate fares by route, ridership may be estimated from average fare.

Table A-2. Transit operating expenses by mode and function: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Forms 303, 304, 305, and/or 306 are used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	MODE	FLEET SIZE	TOTAL OPERATING EXPENSES $	PERCENT OF OPERATING EXPENSES BY FUNCTION				
					VEHICLE OPERATIONS	VEHICLE MAINTENANCE	NON-VEHICLE MAINTENANCE	GENERAL ADMINISTRATION	TOTAL
5045	GARY PTC	MB	99	5384507	59.8	24.1	5.1	11.0	100.0
1050	GRTR BRIDGEPORT TRAN DIST	MB	99	2569867	48.1	16.2	0.8	35.0	100.0
2060	MERCER COUNTY METRO	MB	99	6390595	61.1	22.0	6.6	10.3	100.0
5033	GRAND RAPIDS AREA TRANSIT	MB	79	4013863	58.3	16.0	2.3	23.4	100.0
		DR	17	774725	58.8	16.3	2.2	22.8	100.0
		TOTAL	96	4788588	58.4	16.1	2.3	23.3	100.0
4039	ST. PETERSBURG MTS	MB	79	3478440	59.1	20.2	3.7	17.0	100.0
		DR	13	247288	72.4	14.1	1.5	12.1	100.0
		TOTAL	92	3725728	59.9	19.8	3.6	16.7	100.0
5011	CANTON RTA	MB	91	3447699	55.0	18.4	8.5	18.2	100.0
2044	RIVERDALE TRANSIT CORP	MB	89	5735909	60.6	23.5	0.4	15.5	100.0
0002	CITY OF SPOKANE TS	MB	80	4755829	63.4	17.1	2.6	16.9	100.0
		DR	8	117382	44.6	8.6	0.0	46.8	100.0
		TOTAL	88	4873211	63.0	16.8	2.6	17.6	100.0
1006	NEW BEDFORD SERTA	MB	84	3822568	67.3	22.5	1.0	9.2	100.0
		DR	4	107873	70.9	24.0	0.5	4.7	100.0
		TOTAL	88	3930441	67.4	22.5	1.0	9.0	100.0
4041	TAMPA DEPT OF PARK & TRAN	MB	83	3114811	73.2	17.9	0.4	8.6	100.0
6019	SUN-TRAN OF ALBUQUERQUE	MB	82	4683669	64.1	15.2	0.7	20.0	100.0
2034	WESTCHESTER STREET TRANSP. CO.	MB	81	6087980	59.7	24.3	0.5	15.6	100.0
5024	WESTERN RESERVE TRANSIT	MB	76	3571797	64.6	12.7	3.0	19.7	100.0
		DR	5	169065	57.8	16.8	0.0	25.4	100.0
		TOTAL	81	3740862	64.3	12.9	2.9	20.0	100.0

Table A-3. Transit operating expenses by mode and object class: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Forms 312, 313, and 315 are used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	MODE	FLEET SIZE	TOTAL OPERATING EXPENSES $	PERCENT OF OPERATING EXPENSES BY OBJECT CLASS: LABOR SALARIES AND WAGES		FRINGE BENEFITS	SERVICE	MATERIALS AND SUPPLIES			CASUALTY & LIABILITY	OTHER	TOTAL
					OPER.	OTHER			FUEL AND LUBE	TIRES AND TUBES	OTHER			
4041	TAMPA DEPT OF PARK & TRAN	MB	83	3114811	36.2	17.5	25.6	1.7	10.2	1.0	3.4	1.7	2.6	100
6019	SUN-TRAN OF ALBUQUERQUE	MB	82	4683669	39.9	16.8	10.9	0.0	10.3	1.1	13.1	0.0	7.9	100
2034	WESTCHESTER STREET TRANSP. CO.	MB	81	6087980	33.0	15.9	15.9	5.9	9.5	1.0	8.5	5.3	5.0	100
5024	WESTERN RESERVE TRANSIT	MB	76	3306603	40.1	15.9	26.8	0.2	7.5	0.8	2.3	4.7	1.7	100
		DR	5	158944	35.6	9.1	21.2	0.0	6.2	0.0	12.2	14.9	0.7	100
		JE	81	276532	0.0	30.3	0.0	29.1	0.0	0.0	9.3	10.7	20.5	100
		TOTAL	81	3742079	37.0	16.7	24.6	2.3	6.9	0.7	3.3	5.5	3.0	100
1014	WORCESTER RTA	MB	71	3718063	47.9	10.0	23.6	1.4	10.8	0.0	5.3	-0.4	1.4	100
		DR	10	364847	12.0	5.7	7.2	0.5	2.1	0.0	0.9	0.0	71.5	100
		JE	81	1340793	0.0	31.8	11.8	16.4	0.8	3.4	10.8	12.7	12.3	100
		TOTAL	81	5423703	33.7	15.1	19.6	5.0	7.8	0.8	6.3	2.8	8.8	100
6002	AUSTIN TRANSIT SYSTEM	MB	71	3548638	38.9	20.6	11.8	0.0	12.3	1.1	7.3	6.8	1.3	100
		DR	10	490998	21.3	18.1	7.8	0.0	3.9	0.4	2.2	4.1	42.1	100
		JE	81	208403	0.0	0.0	0.0	46.6	0.0	0.0	10.1	0.0	43.3	100
		TOTAL	81	4248039	34.9	19.3	10.8	2.3	10.7	1.0	6.9	6.1	8.1	100
3014	HARRISBURG-CAP. AREA TA	MB	81	3826890	35.4	17.2	18.0	1.7	9.4	0.9	4.6	3.5	9.3	100
4001	CHATTANOOGA AREA RTA	MB	78	4141829	29.0	20.0	14.4	7.6	10.2	1.1	9.1	6.2	2.5	100
		DR	2	574385	23.4	12.6	7.8	17.9	0.1	0.0	21.5	11.3	5.4	100
		TOTAL	80	4716214	28.3	19.1	13.6	8.8	9.0	1.0	10.6	6.8	2.9	100

Table A-4. Operating expenses by function and object class: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Forms 312, 313, and 315 are used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	TOTAL NUMBER REVENUE MOTOR BUSES	FUNCTION	TOTAL OPERATING EXPENSES BY FUNCTION $	PERCENT OF OPERATING EXPENSES BY OBJECT CLASS									
					LABOR SALARIES AND WAGES		FRINGE BENEFITS	SERVICE	MATERIALS AND SUPPLIES			CASUALTY & LIABILITY	OTHER	TOTAL
					OPER.	OTHER			FUEL AND LUBE	TIRES AND TUBES	OTHER			
			041	762773	0.0	39.4	12.7	0.0	0.0	0.0	47.6	0.4	0.0	100
			042	51020	0.0	0.9	0.2	0.0	0.0	0.0	84.5	14.5	0.0	100
			160	517451	0.0	20.6	4.9	21.9	0.0	0.0	4.5	26.5	21.6	100
			TOTAL	3685966	34.4	14.3	16.7	4.7	9.6	1.2	12.0	4.0	3.0	100
9006	SANTA CRUZ MTD	76	010	3124030	52.4	7.5	17.6	0.1	21.7	0.0	0.6	0.0	0.2	100
			041	1197853	0.0	0.0	0.0	82.3	0.0	0.0	0.0	17.7	0.0	100
			042	194451	0.0	73.9	20.5	4.6	0.0	0.0	1.0	0.0	0.0	100
			160	600036	0.0	39.8	10.4	18.0	0.0	0.0	17.6	3.9	10.3	100
			TOTAL	5116370	32.0	12.0	12.8	21.6	13.2	0.0	2.5	4.6	1.3	100
2066	SOMERSET BUS CO	74	010	3259643	52.0	6.3	22.7	0.0	16.2	2.4	0.0	0.0	0.5	100
			041	1563428	7.3	0.4	3.1	65.0	0.1	0.0	20.8	3.2	0.1	100
			042	44423	0.0	0.0	0.0	55.3	0.0	0.0	44.6	0.1	0.0	100
			160	876655	0.0	17.8	9.6	3.9	0.0	0.0	0.6	43.5	24.6	100
			TOTAL	5744149	31.5	6.4	15.2	18.7	9.2	1.4	6.1	7.5	4.0	100
2025	CLUB TRANSPORTATION CO	73	010	2727358	57.6	5.8	18.2	0.1	15.4	2.3	0.5	0.0	0.1	100
			041	1217496	0.0	33.4	9.6	15.4	0.9	0.0	32.2	6.6	1.9	100
			042	28199	0.0	35.6	17.3	29.6	0.0	0.0	17.5	0.0	0.0	100
			160	851671	0.0	15.9	3.7	5.9	0.0	0.0	1.3	39.6	33.6	100
			TOTAL	4824724	32.6	14.7	13.4	5.1	8.9	1.3	8.8	8.7	6.5	100

4. *Funding (local, state, and federal*—Section 15 reporting procedures provide a convenient summary of overall transit revenue sources, particularly for nonfare box revenues. Table A-5 gives an illustrative monthly monitoring report on operating revenues, operating expenses, and associated deficit funding of the difference. Note that comparisons with the current month and the same month one year ago, as well as the year-to-date and prior year-to-date, are both made as a quick means for checking emerging problems. The percent change also provides for this double check against past patterns. Consequently, these types of data are used for both major and routine decision-making, as well as for regular monitoring.

Tables A-6 and A-7, excerpted for small transit properties from the 1982 Section 15 Annual Report, give additional examples of typical reporting categories. Local nonfare box revenues include charter operations, advertising revenues, and (potentially) local taxes. Governmental transfers from other local or state agencies to cover discounted fares for the elderly and handicaped or others may also exist. Other capital and operating grants from federal, state, and local governments are also included and further detailed in Table A-7. These types of data are reported annually by nearly all local transit operators, in conformance with Section 15 requirements.

5. *Capital funds (by source)*—The Section 15 reporting format covers several categories of federal, state, and local public funding potentially available for meeting capital assistance needs. Table A-8 gives an excerpt from the latest Section 15 Annual Report for these capital assistance funding categories, for smaller transit systems across the country. Only some of the potential sources are drawn upon by any one operator. These transit funding data should be available from Section 15 reporting forms.

6. *Accidents*—The Section 15 reporting on number of accidents, number of fatalities, and number of injuries is further classified according to vehicle collisions, non-collision accidents, and station or stop accidents. Original data on accidents also should be available by route. Comparison of accidents of each type against total vehicle-miles or vehicle-hours will permit the derivations of accident rates by accident type. Typically, monthly, quarterly, and/or annual accident data also can be applied in routine decision-making and system monitoring.

7. *Energy consumption*—Energy consumption by fuel type is a part of Section 15 reporting and should be available from the appropriate forms submitted by each local transit system operator to UMTA. Gallons of diesel fuel should be distinguished from gallons of gasoline. Annual or monthly fuel efficiencies per vehicle-mile are calculable from annual vehicle-mile estimates. Fuel efficiencies by route may be difficult to calculate, however, unless fuel consumption records are kept for individual vehicles, together with records indicating the day-to-day route assignments of individual vehicles. Routes with significant differences in average speeds are likely to display different fuel economies.

8. *Buses required*—Total number of revenue vehicles is a primary distinguishing feature among transit systems included in Section 15 reporting. Fleet size represents a convenient index of system complexity and the associated market area served. Number of revenue vehicles includes vehicles actually required for peak-hour operation on any given day, not counting spares that may be held in reserve or are currently under repair.

9. *Number of employees*—The number of transit system employees in each of 10 different categories is another of the required data reports under Section 15. The different categories are grouped under three headings: transportation, maintenance, and general administration, with revenue vehicle operators representing the single largest category, followed by maintenance personnel. Table A-9 gives the typical breakdowns for these employee categories, for several representative small-city systems, drawn from the most recent Section 15 Annual Report. Generally, only the total number of employees is needed for major and minor decision-making efforts.

10. *Annual vehicle-hours and vehicle-miles*—Monthly and annual vehicle operating statistics also are included in Section 15 reports. In general, total vehicle-miles and vehicle-hours are distinguished from revenue vehicle-miles and vehicle-hours, with the difference being those vehicle-miles of deadhead or nonrevenue service required to travel from garages to the beginning and end of each route and/or for other vehicle servicing and maintenance purposes. Table A-10 is a sampling of the UMTA Section 15 report covering these system operating characteristics.

11. *Transit cost per passenger*—This is one of a number of possible effectiveness measures that can relate total operating costs to other measures of system supply and demand. It is generally regarded as the single most useful effectiveness measure, although other such measures, as illustrated in Table A-11 excerpted from the Section 15 Annual Report, also may shed light on system efficiencies. Cost per passenger-mile is a related derivative index that is tied to productivity and average load factors. All of these effectiveness measures are derived from other cost, supply, and demand measures.

12. *Transit revenue per passenger*—Average fare box revenue per passenger is simply the average fare. Other nonfare box revenues per passenger, such as federal, state, or local subsidies, represent another index of system performance. Most can be derived from Section 15 data.

13. *Transit passengers per vehicle-hour or vehicle-mile*—This and related indices of transit system productivity also are included in Section 15 reporting requirements. Local data rather than Section 15 aggregates are frequently used to analyze productivity on a route-by-route basis. Table A-12 gives an example of the use of passengers per bus-hour as a tool for the routine level of decision-making. Here, the context was to develop a ranking of all radial service routes, stratified by A.M., midday, and P.M. peak, to identify those route segments as candidates for deletion under a budget cutback. In general, the routes with the lowest productivity (passengers per bus-hour) represent the prime candidates for deletion. Note that this could lead to the elimination of midday service, but the retention of peak-hour service, or vice versa.

As depicted in Table A-13, both passengers and passenger-miles can be related to various measures of system supply as other indicators of overall performance. In general, passengers per vehicle-mile and per vehicle revenue-hour are most meaningful, particularly on a route-by-route basis.

Other Sources of Data

The U.S. Census or a local transportation study represent the best source of data describing characteristics of people.

The most common problem with both of these sources is that

Table A-5. Illustrative monthly statement of income and expense. (Source: Kalamazoo Metro Transit System, Michigan)

	APRIL 1983	APRIL 1982	YEAR TO DATE 1983	YEAR TO DATE 1982	% OF CHANGE +=UP -=DOWN
I. Operating Revenue					
A. Regular Route Cash	48.106	52.947	195.473	230.741	
B. Western Michigan Univ.					
1. Cash	1,762	2,420	9,285	18,122	
2. Subsidy	4,637	6,369	21,460	26,876	
C. Portage Cash & Passes	1,670	2,025	6,705	8,227	
D. Special Transit Fares	5,342	6,625	20.319	28.346	
E. Charters	3,838	2,158	11,994	6,866	
F. Pass Sales	8,585	9.452	40.177	48,008	
G. Aux. Transit Revenues	-0-	1,848	4,232	3,990	
H. Non-Transit Revenues	48	57	555	8,383	
TOTAL REVENUE	73.988	83,901	310,200	379,559	-18.3%
Fire Dept. Revenues	4,075	3,857	22.692	18.851	
II. Operating Expenses					
550-Fire Dept. Main.	4,075	3,857	22.692	18.851	
551-Maintenance	50.635	75.611	258,277	289,687	
552-Operations	147.893	181.388	578.756	691.429	
553-Administration	19.622	12.014	89.526	90,813	
554-General Overhead	9,275	8,861	44.016	50.095	
555-Portage Buses	12.884	15.660	54.422	57,677	
556-Zonal Service	14.939	31,489	64,921	117.043	
557-Evening Service	-0-	12.477	-0-	62.183	
558-Passenger Counter	4	-0-	74,556	205,432	
559-Ticket Vending	534	1,125	1,125	9,633	
TOTAL EXPENSES	259,861	342,482	1,188,291	1,592,843	-25.4%
Gross Operating Deficit	< 181.798 >	< 254.724 >	< 855.399 >	<1,194,433>	-28.4%
III. Deficit Funding					
Working Capital	< 17,738 >	22.124	< 37,082 >	99.592	
City of Kalamazoo	12.737	10.975	50.949	43,901	
City of Portage	8.750	10.727	34,858	23,227	
City of Parchment	223	342	929	1,217	
Township of Comstock	1,403	1,691	5,384	4,941	
Township of Kalamazoo	5,215	2,883	17,964	12.883	
Township of Oshtemo	500	227	2,099	1,477	
KVCC	376	118	1,682	1,243	
Village of Richland	-0-	1,556	-0-	1,556	
State of Michigan					
Ridesharing	75	-0-	75	-0-	
Operating	78,799	101,284	335,193	409,223	
Marketing/Training	-0-	-0-	-0-	-0-	
Zonal Service	11,720	29.924	50.867	109,360	
Evening Service	-0-	5,423	-0-	5,423	
Passenger Counter	4	-0-	74,556	205,432	
Ticket Vending	534	1,125	1,125	9,633	
UMTA	79,200	66,325	316,800	265.325	
TOTAL FUNDING	181.798	254.724	855.399	1,194,433	-28.4%

Table A-6. Sources of transit revenue: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Form 202 is used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	TOTAL NUMBER OF REVENUE VEHICLES	TOTAL REVENUE $(000)	PERCENT OF TOTAL REVENUE BY OBJECT CLASS: TRANSPORTN REVENUE		NON TRANS REV.	TAXES LEVD BY TRANS SYSTM	SPECIAL FARE ASSISTANCE		CASH—GRANTS AND REIMBURSEMENTS			OTHER	TOTAL
				PASSN FARES	OTHER			STATE	LOCAL	FED	STATE	LOCAL		
	50-99 REVENUE VEHICLES													
6018	METRO TULSA TRANSIT	99	4542.5	21.9	4.3	0.2	0.0	0.0	0.0	36.5	0.0	37.2	0.0	100.0
5045	GARY PTC	99	5847.6	32.0	27.9	1.5	0.0	0.0	0.0	20.0	8.3	10.3	0.0	100.0
1050	GRTR BRIDGEPORT TRAN DIST	99	2674.0	35.5	0.5	0.0	0.0	0.0	0.0	14.5	42.6	6.8	0.0	100.0
2060	MERCER COUNTY METRO	99	6369.9	35.4	4.4	0.1	0.0	2.4	0.0	30.5	19.9	7.3	0.0	100.0
5033	GRAND RAPIDS AREA TRANSIT	96	4841.7	19.3	1.6	2.4	0.0	0.0	2.9	36.7	37.0	0.0	0.0	100.0
4039	ST. PETERSBURG MTS	92	3817.8	41.7	3.3	0.0	0.0	0.0	0.0	27.1	0.8	27.1	0.0	100.0
5011	CANTON RTA	91	3790.9	10.8	1.4	0.8	19.1	12.8	0.0	40.1	14.1	0.9	0.0	100.0
2044	RIVERDALE TRANSIT CORP	89	6503.9	83.6	3.4	1.2	0.0	0.0	2.7	6.4	1.3	1.3	0.0	100.0
0002	CITY OF SPOKANE TS	88	4613.9	33.7	3.8	0.5	0.0	0.0	0.0	30.2	0.0	31.8	0.0	100.0
1006	NEW BEDFORD SERTA	88	4209.0	15.1	4.5	1.1	0.0	0.0	2.1	38.1	19.8	19.4	0.0	100.0
4041	TAMPA DEPT OF PARK & TRAN	83	2879.8	48.2	6.4	2.2	0.0	0.0	0.0	19.1	0.3	23.9	0.0	100.0
6019	SUN-TRAN OF ALBUQUERQUE	82	4752.9	25.7	0.5	1.2	0.0	0.0	35.6	37.0	0.0	0.0	0.0	100.0
2034	WESTCHESTER STREET TRANSP. CO.	81	6450.9	64.0	0.2	0.1	0.0	0.0	0.0	7.6	8.3	19.8	0.0	100.0
5024	WESTERN RESERVE TRANSIT	81	3780.7	10.2	1.7	0.3	13.9	2.8	0.0	39.9	29.9	1.3	0.0	100.0
1014	WORCESTER RTA	81	5690.0	34.5	0.3	2.8	0.0	0.0	1.7	31.1	15.1	14.6	0.0	100.0
6002	AUSTIN TRANSIT SYSTEM	81	4281.5	21.6	3.9	0.0	0.0	0.0	0.0	29.2	0.0	45.4	0.0	100.0
3014	HARRISBURG-CAP. AREA TA	81	3835.3	38.1	1.2	7.2	0.0	4.9	0.0	27.1	14.4	6.0	1.0	100.0
4001	CHATTANOOGA AREA RTA	80	4716.2	39.5	4.9	1.0	0.0	0.0	0.0	29.4	2.1	23.1	0.0	100.0

Table A-7 Sources of public assistance for transit: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Form 203 is used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	TOTAL NUMBER OF REVENUE VEHICLES	TOTAL PUBLIC ASSIST $(000)	PERCENT OF TOTAL PUBLIC ASSISTANCE: FEDERAL		STATE				LOCAL				TOTAL
							DEDICATED				DEDICATED			
				UMTA SEC 5	OTHER	GEN REV	TAX	TOLL	OTHER	GEN REV	TAX	TOLL	OTHER	
2034	WESTCHESTER STREET TRANSP. CO.	81	2302.2	21.3	0.0	23.3	0.0	0.0	0.0	55.4	0.0	0.0	0.0	100.0
5024	WESTERN RESERVE TRANSIT	81	2792.0	53.5	0.5	18.6	0.6	0.0	25.0	0.3	0.0	0.0	1.5	100.0
1014	WORCESTER RTA	81	3550.6	49.9	0.0	24.1	0.0	0.0	0.0	26.0	0.0	0.0	0.0	100.0
6002	AUSTIN TRANSIT SYSTEM	81	3191.3	38.8	0.4	0.0	0.0	0.0	0.0	60.9	0.0	0.0	0.0	100.0
3014	HARRISBURG-CAP. AREA TA	81	2010.4	51.2	0.5	27.5	0.0	0.0	9.4	11.5	0.0	0.0	0.0	100.0
4001	CHATTANOOGA AREA RTA	80	2575.5	53.5	0.4	2.6	0.0	0.0	1.2	42.3	0.0	0.0	0.0	100.0
4002	KNOXVILLE TRANSIT	80	1886.3	57.7	0.0	3.1	0.0	0.0	0.0	39.2	0.0	0.0	0.0	100.0
6017	MASSTRANS-OKLAHOMA CITY	79	2326.8	56.7	1.9	0.6	0.0	0.0	0.0	39.9	0.0	0.0	1.0	100.0
9031	RIVERSIDE TRANSIT AGENCY	78	2396.9	0.0	2.0	0.0	3.3	0.0	0.0	0.0	94.7	0.0	0.0	100.0
3013	ERIE MTA	77	2387.3	50.0	0.0	14.4	0.0	0.0	6.5	13.0	0.0	0.0	16.1	100.0
9006	SANTA CRUZ MTD	76	5073.0	8.8	0.0	0.2	0.0	0.0	0.0	0.0	91.0	0.0	0.0	100.0
3024	BERKS AREA READING TA	75	2592.9	50.8	0.0	14.1	0.0	0.0	10.4	9.3	0.0	0.0	15.4	100.0
2066	SOMERSET BUS CO	74	2135.4	24.5	0.0	70.6	0.0	0.0	4.9	0.0	0.0	0.0	0.0	100.0
2025	CLUB TRANSPORTATION CO	73	1473.8	21.3	0.0	23.3	0.0	0.0	0.0	55.4	0.0	0.0	0.0	100.0
3001	KANAWHA VALLEY RTA	71	2411.0	48.6	2.3	0.0	0.0	0.0	0.0	0.0	49.1	0.0	0.0	100.0
5044	FT WAYNE PTC	70	1626.3	82.7	0.8	16.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
2012	MOUNTAIN VIEW COACH	69	558.7	5.5	0.0	94.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
2058	LINCOLN TRANSIT CO	68	1385.6	51.4	0.0	38.3	0.0	0.0	10.3	0.0	0.0	0.0	0.0	100.0

Table A-8. Sources of public capital assistance for transit: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Form 103 is used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	TOTAL NUMBER OF REVENUE VEHICLES	TOTAL PUBLIC ASSISTANCE $(MIL)	PERCENT OF TOTAL PUBLIC FUNDING														
				FEDERAL					STATE				LOCAL					TOTAL
				UMTA			OTHER DOT	OTHER FED	GENL REV	DEDICATED			GENL REV	DEDICATED				
				SEC 3	SEC 5	OTHER				TAX	TOLL	OTHER		TAX	TOLL	OTHER		
5005	MADISON METRO	205	6.4	94.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.8	0.0	0.0	0.0	100.0	
4040	JACKSONVILLE TA	200	11.3	67.8	0.0	0.0	0.0	0.0	12.6	0.0	0.0	0.0	19.6	0.0	0.0	0.0	100 0	
9023	LONG BEACH PTC	178	6.5	59.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	40.1	0.0	0.0	100 0	
2018	CENTRAL NEW YORK RTA	167	0.5	80 0	0.0	0.0	0.0	0.0	8.5	0.0	0.0	0.0	11.5	0.0	0.0	0 0	100.0	
4004	NASHVILLE-MTA	160	0 1	85.3	0.0	0.0	0.0	0.0	14.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100 0	
9033	SUNTRAN OF TUCSON	140	0.6	18.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	81.5	0.0	0.0	0.0	100.0	
5082	SUBURBAN SAFEWAY	140	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	
0003	TACOMA TRANSIT SYSTEM	127	0.6	50 7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.3	37.0	0.0	0.0	100.0	
5017	MIAMI VALLEY RTA	125	2.0	75.8	4.2	0.0	0.0	0.0	0.0	0.0	0.0	9.1	0.0	10.9	0.0	0 0	100.0	
9008	SANTA MONICA MBL	124	3.4	74.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.7	0.0	0.0	100 0	
5010	AKRON METRO RTA	120	0.8	0.0	65.9	0.0	0.0	0.0	0.0	0.0	0.0	8.1	0.0	26.0	0.0	0.0	100.0	
9030	OCEANSIDE-COUNTY TS	118	0.6	21.0	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	61.3	0.0	0 0	100.0	
4008	CHARLOTTE TS	110	0.2	80.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0	100.0	
5025	DULUTH TRANSIT AUTH	106	4.9	85.2	10.2	0.0	0.0	0.4	0.0	0.0	0.0	0.5	0.0	0.0	0 0	3.6	100.0	
6007	CITRAN-FORT WORTH	106	0.4	0 0	79.7	0.0	0.0	0.0	12.9	0.0	0.0	0.0	0.6	0.0	0.0	6.9	100.0	
3004	PENTRAN-HAMPTON	106	0.1	11.7	69.3	0.0	0.0	0.0	16.5	0.0	0.0	0.0	3.5	0.0	0.0	0.0	100.0	
9027	FRESNO TRANSIT SYSTEM	102	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	0.0	0.0	0.0	0.0	100.0	
3031	DART-WILMINGTON	100	0.2	74.6	0.0	0.0	0.0	0.0	25.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0	

Table A-9. Transit system employee count: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Form 404 is used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	MODE	TOTAL NUMBER OF REVENUE VEHICLES	NUMBER OF OPERATING LABOR EQUIVALENTS										TOTAL
				TRANSPORTATION			MAINTENANCE					GENERAL ADMINISTRATION		
				EXEC PROF SUPERV	SUPPORT	REV VEH OPER	EXEC PROF SUPERV	SUPPORT	REV VEH MAINT MECH	OTHER MAINT MECH	VEH SERV PERSON	EXEC PROF SUPERV	SUPPORT	
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
		DR	6											
	OPERATING			1.0	2.0	6.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	9
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
0009	CITY OF SALEM MTD	MB	54											
	OPERATING			4.0	2.0	53.0	0.3	0.0	5.5	0.0	4.1	2.0	1.0	72
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
1017	GREATER HARTFORD TRANSIT DISTR	DR	53											
	OPERATING			4.7	0.6	35.4	0.0	0.0	0.0	0.0	0.0	6.0	3.6	50
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
4017	LEX/FAYETTE UCG	MB	52											
	OPERATING			5.0	0.0	72.0	3.0	1.0	8.0	0.0	8.0	2.0	3.0	102
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
6024	SHREVEPORT TRANSIT	MB	50											
	OPERATING			4.0	0.0	76.0	2.0	1.0	13.0	1.0	7.0	2.0	3.0	109
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0
5058	ROCKFORD MTD	MB	50											
	OPERATING			5.0	0.5	60.2	1.1	0.8	10.9	0.6	4.0	3.9	3 5	91
	CAPITAL			0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0 0	0

Table A-10. Transit operating statistics, service supplied and service consumed: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980. Note that Section 15 Report Form 406 is used by local transit properties to provide these data.

ID CODE	TRANSIT SYSTEM	MODE	TRANSIT SYSTEM SERVICE SUPPLIED								
			NUMBER OF VEHICLES/ PASSENGER CARS IN OPERATION WEEKDAY	NUMBER OF TRAINS IN OPERATION WEEKDAY	ANNUAL VEHICLE/ PASSENGER CAR MILES	ANNUAL TRAIN MILES	ANNUAL VEHICLE/ PASSENGER CAR HOURS	ANNUAL TRAIN HOURS	ANNUAL VEHICLE/ PASSENGER CAR REVENUE MILES	ANNUAL TRAIN REVENUE MILES	ANNUAL VEHICLE/ PASSENGER CAR REVENUE HOURS
5044	FT WAYNE PTC	MB	59	0	2143020	0	186080	0	2094950	0	186080
2012	MOUNTAIN VIEW COACH	MB	52	0	1771000	0	70840	0	1771000	0	70840
2058	LINCOLN TRANSIT CO	MB	46	0	4056210	0	195411	0	3863930	0	188580
4037	FLORIDA TRANSIT MGMT INC	MB	49	0	2876300	0	226600	0	2876300	0	226600
0007	LANE COUNTY MTD	MB	52	0	3349206	0	246899	0	3263707	0	237212
		DR	5	0	206777	0	13416	0	206777	0	13416
1004	BROCKTON AREA TRANSIT	MB	36	0	1476702	0	121982	0	1402026	0	121364
		DR	17	0	308018	0	24818	0	246544	0	21729
3015	LUZERNE COUNTY TA	MB	50	0	1800202	0	151688	0	1782302	0	146845
		DR	2	0	44022	0	0	0	0	0	0
5060	CHAMPAIGN-URBANA MTD	MB	34	0	1613541	0	125428	0	1562987	0	119025
7001	LINCOLN TS	MB	38	0	1527501	0	144064	0	1527501	0	144064
		DR	9	0	226066	0	17023	0	226066	0	17023
3010	LEHIGH/NORTHAMPTON TA	MB	52	0	2056000	0	154230	0	1883000	0	142520
4012	WINSTON-SALEM MTS	MB	44	0	1836689	0	128054	0	1739966	0	118869
1016	GREATER PORTLAND TRANSIT	MB	47	0	1351700	0	111726	0	1351700	0	111726

Table A-11. Transit performance indicators: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980.

ID CODE	TRANSIT SYSTEM	MODE	TOTAL REV VEH	TOTAL OPERATING EXPENSES								
				PER VEHICLE PM PEAK	PER VEHICLE MILE	PER CAPACITY MILE	PER VEHICLE HOUR	PER VEHICLE REVENUE HOUR	PER PASSENGER	PER PASSENGER MILE	PER EMPLOYEE	PER OPERATOR HOUR
9018	MONTEREY PENINSULA TRANSIT	MB	28	82188.3	1.39	0.02	25.1	26.6	0.60	0.14	26512.4	18.0
5030	BATTLE CREEK TRANSIT	MB	26	76561.2	1.66	0.05	24.2	26.7	0.69	0.33	26796.4	24.7
		DR	2	35730.0	0.00	0.00	0.0	0.0	5.40	0.86	11910.0	12.3
2029	LIBERTY COACHES INC.	MB	27	73806.6	2.46	0.06	23.2	23.2	0.46	0.12	28312.1	20.1
3008	GREATER LYNCHBURG TRANSIT	MB	27	77762.9	1.34	0.03	18.5	18.5	0.61	0.15	21413.0	16.1
5061	DECATUR PTS	MB	26	85692.0	2.06	0.04	26.4	26.4	0.85	0.29	27170.6	21.0
		DR	1	0.0	0.00	0.00	0.0	0.0	9.51	2.13	39183.0	25.1
7011	CITY OF DUBUQUE-KEYLINE	MB	26	51446.3	1.83	0.03	21.8	23.1	0.66	0.23	23486.3	15.7
5047	BLOOMINGTON-NORMAL PTC	MB	24	0.0	0.95	0.01	13.1	13.4	1.04	0.35	16077.8	11.3
		DR	2	0.0	1.30	0.05	15.3	20.0	1.57	0.27	14754.4	19.5
4009	FAYETTEVILLE AREA TS	MB	26	54195.8	1.20	0.02	16.3	16.3	0.83	0.25	17420.1	16.8
6009	LAREDO MTS	MB	26	63366.5	1.45	0.80	11.5	13.9	0.00	0.00	19802.0	14.9
2041	PELHAM PKY BUS SERVICE	MB	26	54702.6	2.39	0.03	30.1	30.1	1.23	0.08	0.0	0.0
2067	TRACKLESS TRANSIT	MB	25	83714.4	2.50	0.04	27.6	30.0	0.87	0.23	33485.8	24.1
5028	ST. CLOUD MTC	MB	21	53079.9	1.22	0.02	17.1	17.7	0.71	0.24	28435.7	16.6
		DR	4	0.0	1.26	0.26	17.5	21.2	5.58	1.30	12263.4	9.8
5039	SAGINAW TRANSIT SERVICE	MB	20	27893.0	1.07	0.02	13.9	13.9	0.64	0.22	18078.8	13.4
		DR	5	0.0	1.00	0.12	13.4	19.8	5.75	0.96	16102.4	16.3

Table A-12. Illustrative analysis of average passengers per bus hour.

Unit	Ranking	Passengers/Bus Hour	
Route #1-MID	1	58.16	
Route #3-MID	2	47.77	
Route #1-P.M.	3	47.56	
Route #7 P.M.	4	41.79	
Route #3-P.M.	5	41.37	
Route #4-MID	6	41.14	
Route #7-MID	7	40.97	
Route #1-A.M.	8	39.28	
Route #5-MID	9	37.27	
Route #13-MID	10	36.40	Mean - 35.91
Route #3-A.M.	11	35.11	
Route #2-MID	12	33.75	
Route #13-P.M.	13	31.55	Median - 30.55
Route #5-P.M.	14	29.60	
Route #10-MID	15	24.96	
Route #13-A.M.	16	24.78	
Route #7-A.M.	17	24.53	
Route #2-P.M.	18	20.68	
Route #6-MID	19	20.68	
Route #10-P.M.	20	20.64	
Route #6-A.M.	21	20.08	
Route #6-P.M.	22	19.63	
Route #10-A.M.	23	19.12	
Route #2-A.M.	24	18.79	
Route #5-A.M.	25	18.11	
Route #4-P.M.	26	17.61	
Route #4-A.M.	27	13.66	

Table A-13. Transit performance indicators: Section 15 Annual Report, fiscal year ending between July 1, 1979 and June 30, 1980.

ID CODE	TRANSIT SYSTEM	MODE	TOTAL REVENUE VEH	TOTAL ANNUAL PASSENGER MILES: PER LINE MILE (000)	PER VEHICLE PM PEAK (000)	PER CAPACITY MILE (000)	PER VEHICLE REVENUE HOUR	TOTAL PASSENGERS: PER LINE MILE (000)	PER VEHICLE MILE	PER EMPLOYEE (000)	PER VEHICLE REVENUE HOUR	TOTAL EMPLOYEES: PER VEHICLE (TOTAL)	PER VEHICLE PM PEAK
	25-49 REVENUE VEHICLES												
7008	CEDAR RAPIDS BUS	MB	45.0	42.5	243.8	0.11	98.1	11.8	2.1	30.3	27.2	1.5	2.2
		DR	4.0	0.0	0.0	0.09	37.9	0.0	0.5	7.8	6.2	1.4	0.0
3032	DAST-SPEC. TRANS	DR	48.0	0.0	0.0	0.20	59.0	0.0	0.2	1.0	4.3	1.2	0.0
4027	CENTRAL PINELLAS TA	MB	39.0	26.9	380.2	0.27	203.0	5.9	2.3	30.6	44.3	2.4	2.7
		DR	9.0	0.0	0.0	0.00	0.0	0.0	0.0	5.7	0.0	0.8	0.0
4030	ALACHUA COUNTY RTA	MB	38.0	38.7	0.0	0.08	73.0	13.5	1.6	26.6	25.4	1.9	0.0
		DR	10.0	0.0	0.0	0.19	35.7	0.0	0.2	4.1	3.1	1.8	0.0
2021	UTICA TRANSIT AUTHORITY	MB	46.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	1.3	0.0
5056	GREATER PEORIA MTD	MB	45.0	0.0	0.0	0.00	0.0	22.7	1.6	22.7	22.9	2.5	2.9
6005	DALLAS/FT WORTH SURTRAN	MB	45.0	0.0	0.0	0.00	0.0	0.0	0.0	0.0	0.0	3.8	6.8
5035	KALAMAZOO MTS	MB	44.0	33.8	225.0	0.08	62.1	10.5	1.7	30.0	19.4	1.9	2.3
		DR	1.0	0.0	0.0	0.19	20.5	0.0	0.1	0.8	3.5	5.1	0.0
4035	ORANGE-SEMINOLE-OSCEOLA	MB	44.0	34.3	413.5	0.13	116.6	8.4	1.8	40.1	28.4	2.2	2.5
9035	SOUTH COAST AREA TRANS	MB	43.0	91.5	612.9	0.20	181.1	20.8	2.6	41.4	41.2	1.7	3.4
5059	SPRINGFIELD MTD	MB	42.0	55.4	207.3	0.12	93.9	26.9	3.6	43.9	45.6	1.9	2.3
4015	CITY OF JACKSON TRANSIT	MB	36.0	82.5	304.9	0.17	157.7	18.7	2.3	36.8	35.8	1.5	1.9
		DR	5.0	0.0	0.0	0.09	23.3	0.0	1.2	26.7	17.4	1.3	0.0
0012	MUNICIPALITY OF ANCHORAGE	MB	40.0	45.2	392.6	0.15	118.1	9.6	1.4	28.2	25.1	2.1	3.0
4036	TALTRAN	MB	40.0	31.4	236.7	0.09	68.3	12.4	2.1	28.0	27.1	1.6	3.3
4043	MOBILE TRANSIT AUTHORITY	MB	40.0	27.1	222.9	0.07	73.2	7.9	1.6	23.8	21.5	2.2	2.8
6010	CITY OF LUBBOCK TRANSIT	MB	40.0	145.8	806.3	0.45	273.2	4.9	0.6	11.3	9.2	1.5	2.4
3012	CAMBRIA COUNTY TRANSIT	MB	38.0	47.9	757.4	0.33	238.3	16.3	5.7	81.9	81.3	2.2	3.2

they quickly become dated. A simple, usually available, method of updating can be based on local dwelling unit counts to update population figures, combined with an assumption that characteristics of the population have remained constant since the survey. Of course, there are exceptions to and flaws in this kind of assumption, and local information may make it unnecessary.

In many places, census tracts are too large to permit use of some of the analysis techniques below. If the problems are intractable, an alternative technique must be selected. Alternatively, local data or approximations may be used to disaggregate tract data to smaller areas.

"Total travel" (by purpose or mode, by time of day, etc.) normally only is available from a transportation study survey. If it is available, it is frequently dated. The latter problem can be overcome if the selected methodology warrants, through estimates of growth and factoring techniques. However, no quick, simple method of estimating detailed total travel patterns is available, and the only solution may be to turn to a different methodology.

More detailed ridership data also can be provided by origin-destination surveys or on-board passenger counting equipment. Original data collection is typically undertaken by line, so that statistics for individual routes also should be available. Daily, monthly, or annual revenues are not, alone, adequate measures of ridership because of the use of monthly passes/discounts for the elderly and handicapped, and other reduced and/or premium fare policies. The number of trips in each of these different fare categories is not directly related to total revenues (which are otherwise unstratified by fare type).

"Service characteristics" for the transit system are available from schedules and route information. However, transportation network analysis probably is the only source for detailed, reasonably accurate measures of highway service (travel time and costs). A reasonably quick approximation may be made using airline distances between subareas, a factor to account for circuity in the street system and average speeds.

"Use of the transit system" also should be available from local records, probably by route. What may not be available is detail on the origin, destination, and trip purposes of passengers. Estimates may be made, however, from boarding/alighting data. Volumes of traffic on the street system (or particular segments) and typical vehicle occupancy should be available from local sources, such as the local transportation study or the city traffic engineer.

"Funding and expenditure" information for both the transit system and highway and parking facilities should be available locally. The former is contained within transit system records (or may be approximated using the experience of similar systems). Highway and parking expenditures and funding vary widely from locale to locale; however, local sources should have information.

Estimation Techniques

The handbooks referenced earlier in Section 5 provide estimation techniques for many (but not all) of the indicators recommended in Chapter Three. The next subsection reviews techniques that are included in the handbooks for each indicator.

Supplementary techniques, again organized by the indicator to which they are applicable, follow in a second subsection.

Handbook Techniques

Approximately 50 different impact analysis methods are reviewed here. All are designed for manual implementation, and most are simple in nature. They have been grouped into three basic areas: demand and system performance, costs, and socio-economic/environmental impacts. Some techniques have been structured to deal with more than one of these subject areas and are repeated in more than one category.

Most of these analysis methods have been developed since 1975, and the majority of them are reported in the handbooks referenced above.

Considerably more detail on the application of these analysis methods is given in each of these handbooks, and the reader is referred to them for further information.

The purpose of this review is to organize and classify these techniques on a consistent basis, so that the small-city transit planner/analyst can have a better understanding of the analysis options that are available. This is accomplished by reviewing each technique in tabular form according to basic methodology approach and via an assessment of such factors as data requirements and time to obtain results. A very brief description of each method also is given, intended only to provide the reader with some idea of its key features.

Tables A-14, A-15, and A-16 summarize the review of each impact analysis tool according to each of three basic impact areas: demand, costs, and indirect impacts. In general, techniques are listed according to two criteria. First, techniques are ordered by the amount of time needed to obtain results, with the more rapid methods listed first. Second, techniques requiring about the same amount of time to implement are then ordered by year of development, with the most recent techniques listed first. While the general implication is that recently developed techniques that take relatively little time to apply are "preferable," this is by no means assured.

The small-city transit planner/analyst must consult the source handbooks for further details on techniques that appear promising. Further information will be necessary to determine local acceptability and credibility and to apply any particular technique.

Table A-14 summarizes 34 impact analysis methods for demand and system performance. Most of the effort of the last decade in developing "short-cut" analysis procedures has been devoted to demand analysis. Three different types of demand analysis methodology are indicated: system-level (or route) ridership estimates, analysis of specific transit service improvements, and specialized aspects of demand analysis.

In general, more recently developed tools tend to be less time-consuming, requiring one-quarter to 2 or 3 days to apply. These include the use of simple algebraic formulas or two-variable graphs that relate various levels of demand to corresponding levels of service availability. The older techniques tend to represent scaled-back versions of the traditional four-step computerized demand modeling process and can require 2 to 8 weeks or more for actual application. Some of the older techniques also involve small-sample surveys to determine transit markets. These more time-consuming techniques do, of course, provide considerably more route and subarea detail than the simpler techniques.

Table A-15 summarizes 14 different cost-analysis techniques, generally covering either or both operating/maintenance and

Table A-14. Summary of manually applied impact analysis method—demand and system performance.

Name of Method	Impact Area Addressed	Year	Handbook Source	Methodology Approach: Perform Linear Algebraic Calculations	Apply Elasticities of Mode Choice Models	Apply Mode Choice Sensitivity Curves	Apply Empirically-Derived Nomographs	Apply Empirically-Derived Two-Variable Curves	Apply Two-Variable Tabular Data Relationships	Transfer Observed Data Relat. from Another Area	Manually Fit Response Curves to Survey Data	Fit Math. Equations to Survey Data	Small-Sample Surveys ("Market" Surveys)	Assessment: Time to Obtain Results (Days)	Cost to Apply[1]	Staff Requirements	Data Requirements	Output Measures
A. System-Level (or Route) Ridership Estimates																		
D-1. System Ridership Estimation	D	1978	UMTA—Small Cities	X[2]				X						0.125- 0.25	Negligible	PL	Aggregate Bus Miles and Population	Annual System Passengers
D-2. Estimating Ridership on Small Systems	D	1976	Passenger Transport January 2, 1976	X				X						0.25 - 1	Negligible	PL	Dwelling Units within One-Quarter Mile of Routes	Annual Route or System Passengers
D-3. Simplified Aids: Estimating Ridership	D	1979	UMTA Simplified Aids	X										0.25 - 1	Negligible	PL	U.S. Census, Modal Service	Annual System Passengers
D-4. Prediction of Bus Mode Split	D	1981	NCTCOG (Methods 6, 7, and 8)	X	X	X								0.125- 2	Very Low	PL	Trip Table Modal Service	Daily System or Corridor Mode Split Percentage
D-5. Demand Estimating Model for Small Urban Areas	D	1979	Transportation Research Record 730	X				X						0.50 - 2	Very Low	PL[4]	Measures of Transit Supply, Number of Households by Auto	Daily Route or System Passengers
D-6. Route Ridership Estimation	D	1978	UMTA—Small Cities	X[2]				X						0.50 - 2	Very Low	PL	Land-Use by Zone, Modal Service	Annual Route or System Passengers
D-7. Mode Choice Market Shares	D	1978	NCHRP 187	X			X							0.50 - 4	Very Low	PL	Modal Service, Trip Table Airline Distances	Zone-to-Zone Transit Trip Table, by Purpose
D-8. Simplified Procedure	D	1969	NCHRP 186	X[2]			X			X				10 -20	Low	PL	Census, Land-Use by Zone	Subarea-to-Subarea Transit Trip Table, by Purpose
B. Analysis of Specific Transit Service Improvements																		
D-9. Analysis of Fare Changes	D	1981	NCTCOG (Procedure B)	X[3]				X						0.25 - 1	Negligible	PL	Ridership, Costs	Daily System Mode Split
D-10. Analysis of Route Interlining	D	1981	NCTCOG (Procedure G)	X[3]										0.25 - 2	Very Low	PL	Ridership	Daily Corridor Mode Split
D-11. Analysis of Bus Speed Improvements	P, D, E, C	1981	NCTCOG (Procedure A; Methods 1, 2, 3, 4, and 5)	X[3]			X	X	X					0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Daily System or Corridor Mode Split
D-12. Analysis of Frequency Changes	D, E, C	1981	NCTCOG (Procedure C)	X[3]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Daily System or Corridor Mode Split

[1] Very low = under \$1,000; Low = \$1,000-\$2,000; Medium = \$2,000-\$5,000; High = more than \$5,000.

[2] Also uses map overlays.

[3] Includes application of mode split, environmental, and/or cost prediction methods.

[4] Demand-responsive transit.

P = System Performance
D = Demand, Revenues
E = Environmental Impacts
C = Costs
S = Socioeconomic Impacts

PL = Planner
SV = Survey Staff
DP = Data Processing Staff

Table A-14. Continued

Name of Method	Impact Area Addressed	Year	Handbook Source	Methodology Approach: Perform Linear Algebraic Calculations	Apply Elasticities of Mode Choice Models	Apply Mode Choice Sensitivity Curves	Apply Empirically-Derived Nomographs	Apply Empirically-Derived Two-Variable Curves	Apply Two-Variable Tabular Data Relationships	Transfer Observed Data Relat. from Another Area	Manually Fit Response Curves to Survey Data	Fit Math. Equations to Survey Data	Small-Sample Surveys ("Market" Surveys)	Assessment: Time to Obtain Results (Days)	Cost to Apply[1]	Staff Requirements	Data Requirements	Output Measures
D-13. Analysis of Service Hour Changes	D, E, C	1981	NCTCOG (Procedure E)	X[3]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Daily System Mode Split
D-14. Analysis of Demand-Responsive Service	P, D, E, C	1981	NCTCOG (Procedure H)	X[3]										0.50 - 2	Very Low	PL	Modal Service, Costs	Daily System Passengers
D-15. Analysis of Elderly and Handicapped Service	D, E, C	1981	NCTCOG (Procedure M)	X[3]										0.50 - 2	Very Low	PL	Modal Service, Costs	Daily System Passengers
D-16. System Ridership Estimation, DRT[4] (A)	D	1978	UMTA—Small Cities	X				X						0.50 - 2	Very Low	PL	Population, Population Density, Modal Service, Ridership	Hourly and Daily System Passengers
D-17. System Ridership Estimation, DRT[4] (B)	D	1978	UMTA—Small Cities	X				X						0.50 - 2	Very Low	PL	Census, Fares, Captive Ridership	Daily System Passengers
D-18. Analysis of Route Modifications	P, D, E, C	1981	NCTCOG (Procedure D)	X[3]										0.50 - 3	Very Low	PL	Modal Service, Ridership, Costs	Annual Route Passengers or Daily Route Mode Split
D-19. Analysis of Park-Ride Lots	D, E, C	1981	NCTCOG (Procedure F)	X[3]										0.50 - 3	Very Low	PL	Trip Table, Modal Service, Costs	Daily System or Corridor Mode Split
D-20. Fringe Parking Demand	D	1974	NCHRP 186	X			X			X				10	Low	PL	Trip Table, Modal Service	Zone-to-Zone Transit Trip Table
D-21. Demand for Improved-Quality Transit Service	D	1973	NCHRP 186	X							X		X	10 -25	Low	PL, SV	—	Daily Route Passengers
D-22. Dial-a-Bus Demand	D	1975	NCHRP 186	X						X			X	10 -25	Low	PL, SV	—	Daily System or Route Passengers
D-23. HOV Lane Demand	D, P	1975	NCHRP 186	X	X							X		20 -40	High	PL	Census, Modal Service	Zone-to-Zone Transit Trip Table
C. Specialized Aspects of Demand Analysis																		
D-24. Transit Use by Time of Day	D	1978	NCHRP 187	X										0.125- 0.50	Negligible	PL	Weekday Transit Ridership	Daily System or Route Passengers
D-25. Effects of Urban Travel Policies	D	1976	NCHRP 186	X	X					X				0.25 - 1	Negligible	PL	—	Percentage Change in Daily System Passengers

[1] Very low = under $1,000; Low = $1,000-$2,000; Medium = $2,000-$5,000; High = more than $5,000.

[2] Also uses map overlays.

[3] Includes application of mode split, environmental, and/or cost prediction methods.

[4] Demand-responsive transit.

P = System Performance
D = Demand, Revenues
E = Environmental Impacts
C = Costs
S = Socioeconomic Impacts

PL = Planner
SV = Survey Staff
DP = Data Processing Staff

Table A-14. Continued

Name of Method	Impact Area Addressed	Year	Handbook Source	Methodology Approach: Perform Linear Algebraic Calculations	Apply Elasticities of Mode Choice Models	Apply Mode Choice Sensitivity Curves	Apply Empirically-Derived Nomographs	Apply Empirically-Derived Two-Variable Curves	Apply Two-Variable Tabular Data Relationships	Transfer Observed Data Relat. from Another Area	Manually Fit Response Curves to Survey Data	Fit Math. Equations to Survey Data	Small-Sample Surveys ("Market" Surveys)	Assessment: Time to Obtain Results (Days)	Cost to Apply[1]	Staff Requirements	Data Requirements	Output Measures
D-26. Work Trip Modal Split Curves	D	1978	UMTA—Small Cities				X							0.50 - 2	Very Low	PL	Work Trip Table, Census, Land-Use by Zone, Modal Modal Service Map	Daily System Percent Work Trips by Transit
D-27. Trip Generation: Specific Generators	D	1978	NCHRP 187	X						X				0.50 - 2	Very Low	PL	Land-Use Development Density	Daily Transit Trip-Ends per Zone, by Purpose
D-28. Trip Generation: Urbanized Areas	D	1978	NCHRP 187	X				X		X				0.50 - 2	Very Low	PL	Households, Auto Trips, Employment, Dwelling Units	Daily Person-Trips per Zone, by Purpose
D-29. Trip Generation: Households	D	1978	NCHRP 187	X				X		X				0.50 - 2	Very Low	PL	Number of Households by Income or Autos Owned	Daily Person-Trips per Zone, by Purpose and Household Type
D-30. Trip Distribution	D	1978	NCHRP 187	X[2]			X		X					1 - 7	Low	PL	Trip-Ends by Purpose, Travel Time/Distance Matrix	Zone-to-Zone Person-Trip Table, by Purpose
D-31. Market Research	D	1978	UMTA—Small Cities	X[2]						X			X	3 -20	Low	PL, SV	Census, Employment by Zone	Daily System or Subarea Passengers, by Purpose
D-32. Latent Travel Demand	D	1974	NCHRP 186	X							X			10 -20	Low	PL, DP	Existing O-D Survey	Daily Trip Rates for Disadvantaged Groups
D-33. Successive Overlays	D	1974	NCHRP 186	X[2]									X	20 -40	Medium	PL, SV, DP	Census, Land-Use by Zone	Number of Zones with High Transit Potential
D-34. Transit Travel Analysis	D	1973	NCHRP 186	X						X			X	40 -60	High	PL, SV, DP	Census, Socioeconomic by Zone	Zone-to-Zone Transit Trip Table

[1] Very low = under $1,000; Low = $1,000-$2,000; Medium = $2,000-$5,000; High = more than $5,000

[2] Also uses map overlays.

[3] Includes application of mode split, environmental, and/or cost prediction methods.

[4] Demand-responsive transit.

P = System Performance
D = Demand, Revenues
E = Environmental Impacts
C = Costs
S = Socioeconomic Impacts

PL = Planner
SV = Survey Staff
DP = Data Processing Staff

Table A-15. Summary of manually applied impact analysis methods—costs.

	Name of Method	Impact Area Addressed	Year	Handbook Source	Methodology Approach: Perform Linear Algebraic Calculations	Apply Elasticities of Mode Choice Models	Apply Mode Choice Sensitivity Curves	Apply Empirically-Derived Nomographs	Apply Empirically-Derived Two-Variable Curves	Apply Two-Variable Tabular Data Relationships	Transfer Observed Data Relat. from Another Area	Manually Fit Response Curves to Survey Data	Fit Math. Equations to Survey Data	Small-Sample Surveys ("Market" Surveys)	Assessment: Time to Obtain Results (Days)	Cost to Apply[1]	Staff Requirements	Data Requirements	Output Measures
C-1.	Simplified Aids: Estimating Cost	C	1979	UMTA—Simplified Aids	X										0.25 - 1	Negligible	PL	Measures of Modal Service	Annual System Operating Costs
C-2.	Prediction of Bus Operating Costs	C	1981	NCTCOG (Methods 10 and 11)	X				X						0.50 - 2	Very Low	PL	Costs, Performance Data	Annual System or Route Operating Costs
C-3.	Analysis of Demand-Responsive Service	P, D, E, C	1981	NCTCOG (Procedure H)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Costs	Annual System Operating Costs
C-4.	Analysis of Elderly and Handicapped Service	D, E, C	1981	NCTCOG (Procedure M)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Costs	Annual System Operating Costs
C-5.	Analysis of Bus Speed Improvements	P, D, E, C	1981	NCTCOG (Procedure A: Methods 1, 2, 3, 4, and 5)	X[2]			X	X	X					0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual System or Route Operating Costs
C-6.	Analysis of Frequency Changes	D, E, C	1981	NCTCOG (Procedure C)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual System or Route Operating Costs
C-7.	Analysis of Service Hour Changes	D, E C	1981	NCTCOG (Procedure E)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual System Operating Costs
C-8.	Analysis of Route Modifications	P, D, E, C	1981	NCTCOG (Procedure D)	X[2]										0.50 - 3	Very Low	PL	Modal Service, Ridership, Costs	Annual Route Operating Costs
C-9.	Analysis of Park-Ride Lots	D, E, C	1981	NCTCOG (Procedure F)	X[2]										0.50 - 3	Very Low	PL	Trip Table, Modal Service, Costs	Annual System or Route Operating Costs
C-10.	Operating Expense Analysis: Direct Factor Methods	C	1978	UMTA—Small Cities	X					X					1 - 5	Low	PL	Measures of Transit Supply, Unit Costs	Annual System Operating Costs
C-11.	Operating Expense Analysis: Statistical Regression	C	1978	UMTA—Small Cities	X			X	X						1 - 5	Low	PL	Measures of Transit Supply, Ridership, Unit Costs	Annual or Daily System Operating Costs
C-12.	Single Acquisition of Capital Assets	C	1978	UMTA—Small Cities	X										1 -10	Low	PL	Unit Costs, System Quantities	Total Capital Cost
C-13.	Planned Capital Investment in Transit	C	1978	UMTA—Small Cities	X					X					2 -15	Low	PL	Unit Costs, System Quantities, Capital Recovery Factor	Total and Annualized System or Facility Capital Cost
C-14.	Operating Expense Analysis: Causative Factor Method	C	1978	UMTA—Small Cities	X										3 -20	Low	PL	Measures of Transit Supply, Unit Costs, by Route or Subarea	Annual, Daily, or Hourly Costs, by Route or Sub-Mode

[1] Very low = under $1,000; Low = $1,000-$2,000; Medium = $2,000-$5,000; High = more than $5,000.
[2] Also uses map overlays.

P = System Performance
D = Demand, Revenues
E = Environmental Impacts
C = Costs
S = Socioeconomic Impacts

PL = Planner
SV = Survey Staff
DP = Data Processing Staff

Table A-16. Summary of manually applied impact analysis methods—socioeconomic and environmental impacts.

	Name of Method	Impact Area Addressed	Year	Handbook Source	Methodology Approach: Perform Linear Algebraic Calculations	Apply Elasticities of Mode Choice Models	Apply Mode Choice Sensitivity Curves	Apply Empirically-Derived Nomographs	Apply Empirically-Derived Two-Variable Curves	Apply Two-Variable Tabular Data Relationships	Transfer Observed Data Relat. from Another Area	Manually Fit Response Curves to Survey Data	Fit Math. Equations to Survey Data	Small-Sample Surveys ("Market" Surveys)	Assessment: Time to Obtain Results (Days)	Cost to Apply[1]	Staff Requirements	Data Requirements	Output Measures
S-1.	Prediction of Fuel Consumption	E	1981	NCTCOG (Method 12)	X				X						0.125- 0.50	Negligible	PL	Average Bus Speed	Annual Gallons of Fuel Consumed
S-2.	Prediction of Air Pollutant Emissions	E	1981	NCTCOG (Method 13)	X				X						0.125- 0.50	Negligible	PL	Average Bus Speed	Annual Kilograms of Pollutants Emitted, by Type
S-3.	Prediction of Noise Generation	E	1981	NCTCOG (Method 14)	X				X						0.25 - 1	Negligible	PL	Hourly Bus Volume	Daily Sound Levels
S-4.	Analysis of Bus Speed Improvements	P, D, E, C	1981	NCTCOG (Procedure A; Methods 1, 2, 3, 4, and 5)	X[2]			X	X	X					0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-5.	Analysis of Frequency Changes	D, E, C	1981	NCTCOG (Procedure C)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-6.	Analysis of Service Hour Changes	D, E, C	1981	NCTCOG (Procedure E)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Ridership, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-7.	Analysis of Demand-Responsive Service	P, D, E, C	1981	NCTCOG (Procedure H)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-8.	Analysis of Elderly and Handicapped Service	D, E, C	1981	NCTCOG (Procedure M)	X[2]										0.50 - 2	Very Low	PL	Modal Service, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-9.	Analysis of Route Modifications	P, D, E, C	1981	NCTCOG (Procedure D)	X[2]										0.50 - 3	Very Low	PL	Modal Service, Ridership, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-10.	Analysis of Park-Ride Lots	D, E, C	1981	NCTCOG (Procedure F)	X[2]										0.50 - 3	Very Low	PL	Trip Table, Modal Service, Costs	Annual Fuel Consumption and Pollutant Emissions; Daily Sound Levels
S-11.	Analysis of Transit Dependency	S	1981	NCTCOG (Method-27)	X[2]										1 - 2	Very Low	PL	Census, Land-Use, by Zone	Number of Zones with High Transit Orientation

[1] Very low = under $1,000; Low = $1,000-$2,000; Medium = $2,000-$5,000; High = more than $5,000.

[2] Also uses map overlays.

P = System Performance
D = Demand, Revenues
E = Environmental Impacts
C = Costs
S = Socioeconomic Impacts

PL = Planner
SV = Survey Staff
DP = Data Processing Staff

capital costs. The more recently developed techniques contained in the NCTCOG, the manual by Gilbert, *Transportation System Management: Handbook of Manual Analysis Techniques for Transit Strategies,* was developed for the North Central Texas Council of Governments and is referred to here as "NCTCOG," generally tie cost analysis to specific types of service change and therefore are less time-consuming. The cost analysis techniques contained in the 1978 UMTA "small cities" manual involve the overall cost analysis of full system-level plans. They are somewhat more time-consuming. All of the techniques involve the use of unit costs whose local acceptability, relevance, and reliability are assumed to be established. The latter may, in fact, require additional effort not otherwise reflected.

Table A-16 summarizes the review of 11 impact analysis methods that address socioeconomic and environmental effects. All of these techniques are contained in the NCTCOG manual. It is likely that other methods for estimation of such impacts have been developed in the preparation of small-city transit development programs across the country, but a convenient cataloging of such additonal methods is not available. All of the NCTCOG analysis techniques require 3 days or less, typically one-half day, to apply. Many of the environmental impact analysis techniques are included as part of an overall analysis procedure dealing with a specific type of transit service improvement. For example, analysis of service hour changes follows a procedure that addresses demand, costs, and environmental impacts.

Methodology Approaches

Ten different methodology types are reflected in the summary reviews of Tables A-14, A-15, and A-16. Most involve graphical or tabular relationships among key service and impact variables that have been established via work in other cities. Transferability to any particular small city presently under investigation is assumed. While each of the methodology approaches is used at least once, the overwhelming choice involves performance of linear algebraic calculations. This is followed in popularity by the application of empirically derived two-variable curves. In general, the input data requirements and output measures listed in each table indicate the variables on which these algebraic calculations and curve inspections would be applied.

The methodology approaches are:

- *Perform linear algebraic calculations*—This involves such steps as multiplying out unit costs, occupancy ratios, round-trip route travel times, etc.
- *Apply elasticities of mode choice models*—Here the idea is to multiply out previously derived elasticities (from work in other cities) to numerically derive mode split shifts.
- *Apply mode choice sensitivity curves*—Here the emphasis is instead on looking up mode shifts on a curve plot, matched against service level or "utility" changes. Again, these curves are based on analyses performed elsewhere.
- *Apply empirically derived nomographs*—In general, nomographs involve more than a simple two-variable plot. Through the development of a series of related curves, one applies graphical procedures to establish "look up" relationships between several variables. The analyst traces through several curves to derive an answer.
- *Apply empirically derived two-variable curves*—Typically, such curves relate some measure of transit impact (such as ridership or energy consumed) to measures of transit service or supply (such as vehicle-hours of an index of travel time).
- *Apply two-variable tabular relationships*—This corresponds to a "table look-up" technique for irregular data relationships (for which curves have not been fitted).
- *Transfer observed data relationships from another urban area*—Much of the NCHRP Report 187 uses this methodology. Such travel variables as trip generation rates by land-use type are assumed transferable from one urban area to another.
- *Manually fit response curves to survey data*—This involves either the analysis of existing O-D survey data or newly collected market survey data.
- *Fit mathematical equations to survey data*—This is more precise than the preceding step and considerably more difficult.
- *Small sample surveys ("market" surveys)*—Expenses begin to mount when this approach is used, since both the conduct and the analysis of surveys are involved.

Criteria for Assessing Methods

Five criteria were used to assess each of the analysis methods, at a very preliminary level. These are the same kinds of criteria that the small-city transit planner/analyst might also use in narrowing down candidate methods to those for which further details can be obtained from the source handbooks:

1. *Time to obtain results (in days)*—Techniques range from a time requirement of as little as an hour to up to 3 months or more. Perhaps as an indication of the changing times, all techniques in the NCHRP Report 186 (which were developed in 1975 or earlier) take 10 days or more, while most techniques in the NCTCOG manual take from one-half to 2 days. All of the former deal with manual approaches to demand analysis, while most of the latter deal with short-cut procedures for analysis of impacts of service level changes.
2. *Cost to apply*—Five cost categories are distinguished here, ranging from negligible (those techniques that take less than a day to apply) to very low (under $1,000) up to high, those which involve costs of more than $5,000 and, typically, include survey administration.
3. *Staff requirements*—Because all techniques are manually applied and are not mathematically "elegant," the "typical" transportation planner with some exposure to statistical analysis can handle any of them. In addition, however, input from survey data staff and/or data processing staff also may be required. These are the only three staff distinctions carried forward. "Statistician" was initially considered, but none of the techniques is really sufficiently rigorous to require this specialized capability.
4. *Data requirements*—These are generalized in nature, distinguishing such data input as 1980 census, land-use by zone, modal service levels, study area trip table, ridership, costs, etc. Where only one or two very specific data items are involved, these are so listed.
5. *Output measures*—Output measures reflect the impact area assessed and/or the type of transit service improvement being analyzed. Techniques covering several impact areas generate a wider range in output measures.

The reader should be aware that more detailed narrative descriptions and summary material on most methods are given in the source handbooks. These narrative descriptions cover qualitative or judgmental aspects of many techniques, such as "effectiveness of results" and "merits" or "advantages/disadvantages." Understandability and reasonableness of results are necessarily qualitative in nature, and it is difficult to summarize these handbook assessments here. The manuals should be consulted to cover such judgmental comparisons.

Primary Indicators

Number of Trips Served. Several methods for estimating system-level (or route) ridership for small city transit systems are available in the handbooks. Methods D-1, D-2, D-4, and D-5 estimate annual or daily passengers as a function of measures of transit supply and simplified socioeconomic characteristics. (Note: Conversion between daily and annual ridership levels requires calculation of the number of equivalent weekday service days per year—usually about 300—a current function of ridership characteristics.) Methods D-6 and D-7 permit the derivation of a daily subarea-to-subarea transit trip table, by purpose. (Note: Calculation of the proportion of daily ridership that occurs during the peak hour—requiring hourly boarding data to have been collected—for current conditions permits the estimation of future-year peak-hour transit travel, useful in establishing the size of total peak-hour fleet requirements. A simplifying rule of thumb is to assume that total work trips by transit are equivalent to morning and evening, two-hour (each) peak-period transit ridership.)

Much more attention has been devoted to transit demand analyses in the handbooks than to any other aspect of system performance or impact. Consequently, there are a dozen and one-half analysis-techniques that deal with projecting demands for a wide range of specific transit service improvements. These are designed to estimate the potential ridership increase associated with such improvements as fare changes, park-n-ride lots, route organization, or HOV lanes. In addition, a dozen techniques are associated with specialized aspects of demand analysis, such as transit trip generation, latent travel demand, or market research approaches. Together, these simplified analysis tools provide an effective kit for analyzing the demand implications of both major and minor changes in transit service levels and availability.

Highway Congestion. The number of trips carried by transit, by route, and within major travel corridors can be used as an index of the impact of transit ridership on highway and street congestion. In general, peak-hour transit ridership volumes should be compared against peak-hour street and highway volumes on the route over which the transit line travels. Assuming the transit line were removed, all peak-hour transit passengers should be added to observed peak-hour vehicles flows (after adjusting for auto occupancy) to indicate *total* traffic flow that might be expected. This increased congestion level is the cost that would be borne without that transit line.

Volume/capacity ratios then can be calculated that indicate any change in associated level of service (consulting the *Highway Capacity Manual*). Associated changes in travel time for a typical two- to six-mile trip (that is, additional minutes of travel time required) can be calculated using associated speed changes. Any additional travel time delay should be multiplied by the total number of peak-hour travelers along that corridor (both morning and evening) to derive an estimate of *daily* congestion costs associated with the absence of transit. An annual expansion factor can be applied if desired.

The same analysis procedure for assessing the congestion-reducing impacts of existing transit service can be followed for any future year travel forecast. In general, the future-year peak-hour highway volumes associated with streets and highways over which the transit route travels should be derived from network assignments performed for the regional transportation plan. The additional vehicle volumes associated with the elimination of transit service can be derived from the peak-hour transit ridership along that line. Following the procedure above, total additional daily minutes of travel delay associated with the absence of transit, for future-year conditions, can be calculated.

Operating and Maintenance Costs. The handbook offers several alternate methods for projecting future-year transit operating costs. These generally rely heavily on existing cost characteristics, and the individual handbooks should be consulted further for additional details. In general, Methods C-1, C-9, C-10, and C-13 cover overall annual costs analyses (by system or route), while a number of other, more specialized methods address the cost variations of specific types of service improvements (such as frequency changes, service hour change, or route modifications). "Direct Factor" (C-9) and "Statistical Regression" (C-10) represent more detailed cost estimation methods, including analysis of daily system operating costs. Method C-13, "Causative Factor Method," is the most detailed of these, estimating annual, daily, or hourly cost by route or submode.

Capital Cost (Annual). (Note: Automobile-oriented measures are covered in the following subsection.) Annualized capital costs are not directly reported under Section 15 and require additional examination of the financial statement of the transit operator. Annualization of capital costs is complicated by the fact that federal and/or state subsidies are typically used for the nonamortized, full-payment purchase of bus vehicles or construction of other capital facilities (maintenance garages, administration buildings, bus shelters, etc.). In some cases, depreciation accounts may be established as a way to capitalize staged replacement of the bus fleet in the future. Where bonds or other financial instruments have been used to finance transit capital improvements, their present annual capital cost should be derived from the annual financial statement.

Under conditions where debt financing is used to undertake equipment or facility capital costs, a simplified methodology is available in one of the Appendix A handbooks for estimating total and annualized cost associated with such a strategy. Amortization periods, interest rates, and associated capital recovery factors are used to establish these cost estimates. Establishing the proportion of total capital costs which may or may not be provided by federal/state subsidy is a major factor affecting the extent of capital cost amortization.

Fare Box Revenue. Average current cash fare passenger should be calculated from monthly or annual unlinked ridership data and associated fare box revenues. This average fare will typically be lower than the fare because it reflects the effects of discount fares for students, the elderly and handicapped, monthly passes, etc. This average fare should be applied to future-year monthly or annual ridership estimates to yield fare box revenue estimates.

Net Annual Cost. Current net annual cost is the difference between fare box revenues and the sum of operating/maintenance costs and annualized capital costs (all as obtained above). It is, in effect, a measure of the level of subsidy required from other governmental funding sources. A commonly used version of this measure is the "operating ratio," which is that proportion of overall transit agency expenses met by fare box revenues (i.e., fare box revenues divided by annual operating and capital costs).

Forecasted net annual costs (or operating ratios) are derived in exactly the same way as for current conditions.

Funding (Local, State, and Federal). As discussed earlier, Section 15 data usually provide adequate information on sources of transit funding.

Comparable information on sources of funding for streets and highways typically is available from the transportation budgets of state and local agencies. The state department of transportation and/or the regional council of governments frequently summarize roadway maintenance, operations, and capital expenditures for individual regions. The annual Transportation Improvement Program (TIP) produced by councils of government provides such a summary and permits direct comparison of transit and highway funding programs over a 5-year period. Intergovernmental transfers are included.

Anticipation of nonfare box revenue assistance from other levels of government is an uncertain undertaking. Transit operating and capital subsidies are subject to annual review by legislative bodies and by agency administrators so that some degree of change from year to year in the availability of such funding assistance seems assured. A first cut at needed or expected funding assistance from different levels of government can be made by taking the net annual cost (previous measure) and applying it to the same proportions of government assistance as received in the current year. This might be adjusted for any proposed shifts in funding legislation recently passed or currently under debate to determine relative changes in required or desired assistance levels. The TIP usually can be consulted for these types of funding projection.

Secondary Indicators

Capital Outlays to Planning Horizon. Total construction cost (or purchase price) for capital facilities and equipment should be available from transit agency financial records. Because capital purchases are relatively infrequent for small-city transit systems, contract prices negotiated for these investments should be well known. Included here are bus vehicles, garages, office buildings, park-n-ride lots, etc.

In the handbooks, Method C-11 is available for estimation of total transit system capital costs. It is based simply on the application of unit costs (adjusted for inflation if appropriate) applied to vehicle or facility quantities. These unit costs in turn should be derived from comparable recent experiences of other transit agencies of the state or region, as well as competitive bid prices offered by manufacturers or construction contractors.

In general, the 5-year TIP is again a convenient source of projected capital outlays for both transit and highway systems. Not only is the first year of the TIP an indication of current capital outlays, but the remaining years summarize additional planned and programmed investment levels. While further capital improvements may be planned beyond this 5-year period, in smaller regions such improvements are likely to be few in number and not firmly committed. A 5-year planning horizon is consequently adequate for modal comparisons. The TIP conveniently permits not only an examination of projected capital costs but associated funding sources as well.

Capital Funds (by Source). The uncertainties associated with forecasting future levels of governmental subsidies that might be available as described under sources of annual funding above, apply equally here. Consequently, the methods for estimating funding sources described there are equally applicable here. TIPs can again be consulted for comparison of transit and highway funding sources over a comparable 5-year period.

Accidents (Automobile-Oriented Measures Covered in Following Section). Accident rates derived from current condition data should be applied to future-year estimates of vehicle-miles and vehicle-hours, assuming that existing safety practices and policies will continue with comparable effectiveness in the future. (Note: Estimation methods for calculating vehicle-miles and vehicle-hours are described elsewhere in this chapter.)

Emissions (Automobile-Oriented Measures Covered in Following Section). Pollutant emission rates, as a function of fuel type used, should be obtained from the EPA, the state environmental agency, the state department of transportation, the regional council of governments, or equipment manufacturers. Pollutants covered here include carbon monoxide, nitrous oxides, sulphur dioxide, and particulates. These emission rates per vehicle-mile then should be multiplied by total system (or route) vehicle-miles, by bus vehicle type, on an annual or daily basis, to estimate total transit vehicle pollutant emissions. As indicated below, these pollutant emissions should be compared against overall transportation pollutant emissions, derived almost entirely from automobile/truck emissions.

Method S-2 in Table A-16 permits the estimation of annual kilograms of pollutants emitted, by type, as a function of average bus speed and total bus miles. This can be applied using emission rates found to be applicable for current conditions, with adjustment for improved emissions controls that may be associated with specific equipment types (particularly recently purchased buses).

Energy Consumption. Method S-1 in Table A-16 deals with the estimation of fuel consumption, at system or route levels, as a function of vehicle type, fuel type, and average bus speed. Adjustments should be made to reflect observed fuel efficiencies, by vehicle type, under current conditions. Any gain expected in fuel efficiency for new vehicle purchases also should be reflected here.

Transit Descriptors

Number of Routes, Hours of Service, Days of Service, Headways (Peak and Off-Peak). These are fundamental characteristics of service typically incorporated in system brochures, system or route maps, route timetables, etc. The latest system service map and associated operating policies should be consulted for current conditions. Changes in these system characteristics for forecasted conditions should be among the first elements considered in designing new transit service alternatives for any urban area. No particular analysis methods apply here, because these system features are a part of defining an alternative in the first place, in terms of specific variations (additions, deletions, modifications) to the existing service pattern.

Buses Required. The number of vehicles required to cover a new, expanded or reduced route system is a function of individual route mileage, average route speed, and peak-hour headway maximums. Vehicle requirements should be calculated on a route-by-route basis, using the following formula:

$$V = F \times d/s$$

where:

V = number of peak-hour vehicles;
F = number of peak-hour buses per hour;
d = round-trip route distance; and
s = average round-trip speed.

The total number of peak-hour vehicles necessary to serve all routes should then be increased by 10 to 15 percent for required spares. (This factor may be increasing because of the greater downtime needs of advanced design buses (ADBs).)

Number of Employees. In general, employees per revenue vehicle or per revenue vehicle-mile should be derived as basic system multipliers for estimating future employee requirements. Using estimates of total fleet size and/or vehicle-miles (as described above), these employment factors should be applied to estimate the number of required employees. If desired, factors could be stratified by employee type.

Annual Vehicle-Hours or Vehicle-Miles. Calculation of the vehicle-hours and vehicle-miles required for serving each route in a transit system is a straightforward operation with the independent variables involved: round-trip distance, round-trip travel time, and number of round trips per hour. The following formulas may be used for calculating these route-by-route characteristics, which then should be aggregated for overall system and daily totals, multiplied by appropriate monthly and annual factors to yield estimates over those time intervals:

$$VMT_{daily} = VMT_{peak} + VMT_{off\text{-}peak}$$
$$VMT_{peak} = F_{peak} \times H_{peak} \times d$$
$$VMT_{off\text{-}peak} = F_{off\text{-}peak} \times H_{off\text{-}peak} \times d$$
$$VHT_{daily} = VHT_{peak} + VHT_{off\text{-}peak}$$
$$VHT_{peak} = F_{peak} \times H_{peak} \times d/S_{peak} \times 60$$
$$VHT_{off\text{-}peak} = F_{off\text{-}peak} \times H_{off\text{-}peak} \times d/S_{off\text{-}peak} \times 60$$

where:

F = number of buses scheduled per hour;
H = daily hours of operation;
d = round-trip route distance; and
S = average round-trip speed.

Fare Structure. Fare structure is another of the fundamental indicators of transit service that is included in system brochures and maps and other public information material. While overall average fare, based on the present mix of base fares, premium fares, discount fares, monthly passes, etc., is useful for estimating future revenue, as a function of ridership, the setting of future fare structure is largely a policy input activity. Rather than being a performance indicator of transit, it is part of defining transit alternatives in the first place. To anticipate potential revenue changes, the number of expected passengers in each specialized fare category must be estimated (based on present ridership patterns) and multiplied by the associated fare. Total expected revenues due to estimated changes in average fare, for any new fare structure, also could be calculated and may be used to generate an overall double-check estimate of potential system revenues.

Transfers. Number of transfers is useful largely from a monitoring perspective. While daily number of transfers issued, by route, can be recorded, the multiple-use of those transfers for more than one vehicle change is usually unrecorded. Field observation of the number of transfers occurring (boarding counts) at particular stops may be necessary to gain a better understanding of this aspect of passenger demand.

Performance Indicators

Two types of performance indicators are included here. The first represents different dimensions of service coverage; that is, the availability of routes and transit stops to various market segments. The geographic distribution of these market segments (minority households, low-income households, etc.) across the overall service area is the key to calculating these measures of service availability.

Second, several different efficiency indices can be derived from cost, system supply, and system ridership measures described previously. Performance indicators of both types would be derived in an identical manner for both present and forecasted conditions.

Percent of Population/Households Served. This measure is tied to the availability of a transit stop within one-half to one-quarter mile (depending on local standards) of surrounding population or households. Data required to calculate the measure include a census tract mapping of existing or planned population and/or household distribution and an overlay on that map of the transit route system, including stops. One-half- to one-quarter-mile radii are drawn around each transit stop, and the number of population or households lying within the station area is calculated. Where census tract boundaries are split, a prorated allocation based on geographic area is made for the population/households lying inside and outside the station service area.

The total population or total households lying within the station service area of all stops is then summed and compared against the total population/households of the urbanized area. In general, addition of routes or stops in higher density neighborhoods will increase this service percentage.

Percent of Minority Households Served. This performance indicator is calculated in the same manner as the previous one, but only for those census tracts containing more than the urban area average of minority households (black, Hispanic, American Indian, Asian, or other).

Percent of Low-Income Households Served. Again, this performance indicator is calculated in an identical manner to the percent of households served, but for only those census tracts having a higher percentage than the urban area average of households below poverty level income. The poverty income level is defined by the U.S. Government; tract statistics are part of the decennial census tabulations.

Percent of No-Auto Households Served. This similarly calculated performance indicator would deal only with those census tracts where the percentage of households owning no automobile exceeds the urban area average. These are referred to as transit-dependent households and, correspondingly, are likely to make significantly greater use of available transit services for both work and nonwork trips.

Percent of Elderly Served. This service coverage index would again be calculated similarly to those above, but only for those census tracts containing a higher percentage of elderly residents than the urban area average. In addition to service via fixed-route/fixed-schedule transit, however, the extent of vehicle-hour and vehicle-mile service available via specialized paratransit or demand-responsive vehicles also should be calculated in relation to tracts with a high proportion of elderly residents.

Percent of Handicapped Served. Because the geographic distribution of handicapped persons is relatively sparse, except for institutional concentrations, the percent of handicapped served is more difficult to calculate. Social service agencies, such as the county health department, the local Easter Seal agency, and the local Association for Retarded Citizens, can provide partial data on this distribution. When mapped by geographic subarea, it can be compared against the pattern of fixed-route/fixed-schedule service to determine relative availability among alternatives. In addition, the availability of demand-responsive and paratransit services (vehicle-miles and vehicle-hours) to these same relative concentrations can also be assessed in a similar manner.

Demand and System Performance Analysis Methods (Table A-14)

- *System-Level (or Route) Ridership Estimates.*

D-1. System Ridership Estimation. This method involves the use of transit ridership propensity curves derived from APTA transit data, selected Iowa cities, and selected Washington cities. These curves match annual revenue bus-miles per capita against annual revenue passengers per capita for a given transit service area. It assumes a direct relationship between service level and ridership. It is intended for use only in ridership estimation for fixed-route, fixed-schedule service.

D-2. Estimating Ridership on Small Systems. An annual trip rate for transit trips per dwelling unit is used in this method, based on transit analyses conducted in three urban areas. This trip rate applies only to dwelling units within one-quarter mile walking distance of a transit route and can be adjusted by route circuity, transfer, and peak-period factors. The effect of increasing service frequency also can be reflected.

D-3. Simplified Aids: Estimating Ridership. This method is based on a linear multiple regression equation that relates total annual system ridership on a regularly scheduled, fixed-route bus system to five independent variables. These variables include automobile availability, service area population, annual revenue-miles of service, average fare, and an index of system improvements. The method is based on an analysis of ridership on fixed-route bus systems in 55 small urban areas.

D-4. Prediction of Bus Mode-Split. Three methods included here are also employed in the analysis of various specific transit service improvement options. They include the marginal disutility modal split model, for which the travel time and travel cost components of transit and auto utilities can be recalculated algebraically and mode splits read from corresponding work-trip and nonwork trip utility curves. The second method involves sensitivity curves for travel time components and fare, showing percent change in each variable against percent change in mode split. The third method involves a separate curve showing percent change in fare versus percent change in patronage.

D-5. Demand Estimating Model for Small Urban Areas. Transit trip generation rates (derived for small cities) for zero to one (plus) auto households are employed. These rates can be adjusted for walking distance to transit, trip length, and headway (minutes between transit vehicles). Curves relating adjustment factors to values for each of these three variables are used.

D-6. Route Ridership Estimation. This method involves the application of a series of curves to estimate ridership for specific fixed-route, fixed schedule transit lines. The number of dwelling units or total population within a one-quarter mile service area of each route is estimated and related to base annual ridership per line. Ridership variations according to population over age 65 are distinguished. Adjustment factor curves are given for the presence of one-way loops, headway length (peak period or base day), and transfer coordination.

D-7. Mode Choice Market Shares. This method is applied to a zonal-based person-trip table for an urban area. One-way airline distances between all zone pairs are measured, and associated auto and transit impedances for these distances are measured from a series of nomographs. Impedances on each nomograph vary according to transit fare, average auto operating speed, parking costs, and auto operating costs. Two final nomographs then match auto-highway impedances against transit impedances to yield percentage transit market share for each zonal trip interchange. These nomographs are for home-based work and homebased nonwork trip purposes.

D-8. Simplified Procedure. This represents one of the earliest attempts to develop a sketch planning approach to systemwide travel demand analysis. Nomographs are used for trip generation, trip distribution, and modal split. Three trip purposes (work, business, pleasure) and three subarea types (major employment areas, residential communities, and activity centers) are included.

- *Analysis of Specific Transit Service Improvements.*

D-9. Analysis of Fare Changes. This method involves use of a marginal disutility modal split model to calculate transit and auto utilities. These utilities are based on trip component travel times and travel costs. A curve matching transit minus auto utility differences against percent of travelers using transit is then inspected to derive mode split. Alternatively curves showing percent change in transit ridership versus percent change in fare (comparison to existing fare) may be similarly inspected to derive estimated mode-split shifts.

D-10. Analysis of Route Interlining. Route interlining eliminates transfers for persons traveling two separate routes that are now combined. A mode split sensitivity curve relating percent change in travel time to percent change in mode split is used. The reduction in wait time yielded by the elimination of transfers is calculated, and mode-split shift for an average trip is taken from the curve.

D-11. Analysis of Bus Speed Improvements. A wide variety of TSM actions could increase bus speed. Simplified graphical techniques are given for estimating speed improvements associated with different actions (such as signal preemption for buses, exclusive lanes for HOV, signalization improvements, etc.). The marginal disutility modal split model or mode shift sensitivity curves can then be used to estimate percentage in ridership change or absolute ridership change.

D-12. Analysis of Frequency Changes. This method converts change in service frequency to impact on waiting time. Either the marginal disutility modal split model may be used to recalculate transit utilities and estimate mode split from a mode split/utility curve, or a wait time sensitivity curve may be used to estimate percent change in mode split.

D-13. Analysis of Service Hour Changes. A table is given that shows typical allocation of transit ridership over hourly intervals throughout the day, based on empirical data. Increases or decreases in service by specific time period would yield the associated increases or decreases in ridership shown for those specific hours.

D-14. Analysis of Demand-Responsive Service. Graphs relating supply of demand-responsive service (in seats per 1,000 persons population) to demand (passengers per 1,000 population in service area) are used to estimate ridership. A range of ridership estimates is shown to reflect uncertainty. A related graph of demand versus productivity (vehicle-hours per 1,000 persons population) is used to further quantify service levels.

D-15. Analysis of Elderly and Handicapped Service. Empirically derived curves relating supply (seats per 1,000 persons population) to demand (passengers per 1,000 persons) are used to estimate ridership. These curves reflect the number of mobility handicapped (typically 30 to 40 per 1,000 persons) in the general population. An accompanying graph relates demand to vehicle-hours.

D-16. System Ridership Estimation, Demand-Responsive Transit (A). A series of graphs based on regression equations relating ridership data to the characteristics of demand-responsive service are utilized. Four types of DRT service are distinguished: no other competing local public transit, competing local fixed-route transit (also including shared-ride taxi), DRT service exclusively for the elderly and handicapped, and zone and feeder DRT services. The graphs relate total fleet size or daily vehicle-hours of service to daily or hourly ridership levels with such supply/demand measures also related to total population or square miles of service area.

D-17. System Ridership Estimation, Demand-Responsive Transit (B). This method utilizes graphs that relate trips per week to fare level. Three graphs are developed for age groups 16 to 24, 25 to 54, and 55 and over, with male and female work and nonwork trips shown on each graph. The application requires determination of population by age and sex in the proposed service area, then applying weekly trip rates to estimate demand.

D-18. Analysis of Route Modifications. Alternative methods for estimating patronage are given here, depending on type of route modification. Methods include applying existing values of passengers per vehicle-mile to shortened routes or changes in route path; applying existing corridor mode split percentages to new coverage areas or for an extended route; utilization of curves relating annual vehicle-miles per capita to annual passengers per capita (experimentally derived from empirical data) for a new route or an extended route; recalculation of transit utilities and application of the marginal disutility modal split model; or application of mode split sensitivity curves that relate percentage change in frequency, speed, or access time to percentage changes in mode split.

D-19. Analysis of Park-n-Ride Lots. The marginal disutility modal split model is used. Changes in transit travel time and/or fare are calculated, reflecting particularly possible express service from a park-n-ride lot. Transit utilities are recalculated, and the curve matching percent using transit against the difference between transit and auto utilities is examined to derive mode split estimates.

D-20. Fringe Parking Demand. The disutility mode choice model is applied to estimate transit ridership for zone-to-zone trip interchanges that could benefit from potential park-n-ride lots. The proportion of projected transit patrons who would arrive by park-n-ride is estimated using a relationship between distance from home to station and access mode chosen, based on data from other park-n-ride lots in actual use.

D-21. Demand for Improved Quality Transit Service. This technique uses small-sample surveys to compare intended use of proposed service improvements by respondents against actual use when these improvements are implemented. Response curves then are developed that relate estimated mode shift to qualitatively improved service (comfort, convenience, safety, other amenities, etc.).

D-22. Dial-a-Bus Demand. This method is based on small-sample surveys of observed rates of use for existing dial-a-bus ridership in a specific community. Use rates are then assumed transferable to small urban areas and suburban communities that are without such services. Use rates are related to service levels provided.

D-23. HOV Lane Demand. This method involves simultaneous solution of binary choice logit mode choice model formulations using district-level trip interchange data. Both travel performance and socioeconomic characteristics are used to estimate transit and shared-ride (carpool, vanpool) ridership levels. The model was calibrated using Shirley Busway data.

- *Specialized Aspects of Demand Analysis.*

D-24. Transit Use by Time of Day. This method involves the application of empirically-derived percentage factors that relate annual average weekday transit volumes to four-hour peak-period volumes, single peak-hour volumes, and peak-hour/peak-direction volumes. Similar conversion factors are also given for total person travel (auto plus transit) by urbanized area size.

D-25. Effects of Urban Travel Policies. Application of direct and cross elasticities derived from a disaggregate logit mode choice model is covered under this method. Elasticities are utilized by calculating percentage changes in transit travel time or travel cost and then applying the elasticity factor to determine expected mode shift. Both work and nonwork purposes are included. Changes in auto service levels (such as increased gasoline taxes) also can be reflected.

D-26. Work Trip Modal-Split Curves. Empirically derived nomographs are given that relate percent of work trips by mode (auto/driver, auto/passenger, transit) to number of autos per household and to annual family income. Either of these nomographs may be used to estimate ridership on a zone-by-zone basis. An adjustment factor that relates percent of work trips made by walking the home-to-work distance for short work trips also is given. Nomographs are applied on a trip interchange (zone-to-zone) basis.

D-27. Trip Generation: Specific Generators. This method involves the application of trip generation rates developed from empirical data for a wide variety of specific land-use types (residential by dwelling unit type, retail by facility type, office, manufacturing, recreational, medical, educational, hotel/motel, etc.). Vehicle-trip rates, person-trips rates, and percent transit trip rates are given.

D-28. Trip Generation: Urbanized Areas. This method is based on empirically derived trip generation rates for urban areas in four different size categories. Person-trip rates per household are distinguished by number of autos per household and by trip purpose.

D-29. Trip Generation: Households. The urbanized area empirical data utilized for the previous method are further stratified by household income ranges and average autos per household. Graphical relationships between average daily person-trips per household and auto ownership and income are also given.

D-30. Trip Distribution. This method involves a manual implementation of the basic steps in the gravity model. Nomographs that relate airline distances between zones to automobile travel, varying by trip purpose and subarea travel connections (CBD-central city, central city-central city, etc.) and by city size and percent of travel on arterials, are the heart of the procedure. Trip distribution factors by trip purpose are also a part of these nomographs and are used to calculate accessibility indices. For each zone pair interchange, these factors are read from the appropriate nomograph and employed in manual calculations of trip interchanges for all zone pairs.

D-31. Market Research. This loosely defined method consists largely of the identification of potential travel and socioeconomic data by which each of 17 different transit market segments could be further detailed. Market segments include, for example, workers-CBD, workers-employment in nearby regional centers, shopping trips (nongrocery), school trips-university students, etc. Appropriate data sources include a wide variety of market surveys (employees, CBD cordon, parking, on-board transit, home interview, telephone, etc.). The method generally consists of defining a market segment, estimating the quantity of travel by this segment, and estimating the share of this travel that will or could use transit services—relying particularly on the use of expert judgment and experience in other cities.

D.32. Latent Travel Demand. This method addresses latent travel demand of the elderly, youth, and low-income population. The method assumes that the maximum latent demand for travel is equal to the difference in trip production rates for individuals who have an automobile available and individuals who have no automobile available. Mobility level curves reflecting this gap are developed for different age and income groups.

D-33. Successive Overlays. Five socioeconomic factors indicative of transit ridership potential are mapped, with high, medium, and low propensities to use transit shaded in. These factors include passenger cars per dwelling unit, average income, females aged 16 to 24 years, persons aged 62 or over, and dwelling units per acre. When five map transparencies covering these indices are successively superimposed, the darkest areas indicate high transit potential. Within this market area, a postcard home interview survey is conducted to further detail potential transit needs.

D-34. Transit Travel Analysis. On-board transit survey data are used to identify current actual transit trips, and emphasis is given to the further identification of subareas with high transit ridership potential (low auto ownership, high residential density, concentrations of the elderly, etc.). A small-sample survey of these areas designed to identify latent transit demand could be conducted. Alternatively, travel data from other regions for these transit-dependent subareas could be utilized. This is one of the first attempts to deal with the latent demand of transit-dependents.

Costs (Table A-15)

C-1. Simplified Aids: Cost Estimating. This method is based on a linear multiple regression equation for estimating annual operating expense, based, in turn, on an analysis of operating expenses of fixed-route bus systems in 55 small urban areas. The independent variables are annual revenue-miles of service, system ownership index, and driver wage rate. This method is intended for use only in preliminary or first-cut analysis of alternative bus systems.

C-2. Prediction of Bus Operating Costs. Costs are allocated to "causative factors"—vehicle-miles, vehicle-hours, and/or drivers for a recent baseline year. Future-year estimated costs by route, time period, or at a system level are made using unit costs applied to these factors. Operating expense accounts are allocated to one or more of these appropriate factors, on a percentage basis if necessary, to derive unit costs. Changes in one or more of the causative factors associated with transit service improvement alternatives are used as a basis for estimating resulting changes in operating costs. A graph of average system speed versus an index of cost per vehicle-mile also is given.

C-3. Analysis of Demand-Responsive Service. The method described in C-2 is used, with a 20 to 25 percent surcharge added to reflect the cost of dispatching.

C-4. Analysis of Elderly and Handicapped Service. Costs are estimated using the C-2 method, plus a 20 to 25 percent surcharge for dispatching.

C-5. Analysis of Bus Speed Improvements. Costs are estimated using the C-2 method.

C-6. Analysis of Frequency Changes. Costs are estimated using the C-2 method.

C-7. Analysis of Service Hour Changes. Costs are estimated using the C-2 method.

C-8. Analysis of Route Modifications. Costs are estimated using the C-2 method. Supplemental unit costs for jitney service also are given.

C-9. Analysis of Park-n-Ride Lots. The C-2 cost estimation method is used.

C-10. Operating Expense Analysis: Direct Factor Methods. Overall unit operating costs per vehicle-mile, per vehicle-hour, per vehicle in peak service, per vehicle operator, per passenger, or per vehicle-hour operated divided by top operators' wage rate are used as "direct cost factors." These are multiplied by the appropriate annual system characteristic to yield cost estimates. Separate unit cost factors are given for conventional bus and dial-a-ride transit operations. Cost multipliers to reflect future inflation rates over a 5-year analysis period are given.

C-11. Operating Expense Analysis: Statistical Regression. A series of linear regression curves is given, based on APTA data, which relate annual operating expenses to annual vehicle-hours operated, top operators' wage rate, vehicles in peak service, vehicle-hours, average daily ridership, and average daily vehicle-hours.

C-12. Single Acquisition of Capital Assets. This method involves the use of appropriate unit costs (per vehicle, per square foot of storage/maintenance facility) and their application to estimate the value of transit property assets.

C-13. Planned Capital Investment in Transit. Once given appropriate local unit cost, fleet size, and maintenance/storage facility size, including high and low estimates, cost multipliers that reflect varying rates of inflation are applied to estimate costs in future investment years. Capital costs are annualized by applying an appropriate capital recovery factor.

C-14. Operation Expense Analysis: Causative Factor Method. This method is based on allocating operating costs by vehicle-miles operated, vehicles in service, or vehicle operators. Operating expense categories are assigned to one or more of these factors on a percentage basis if necessary. This method can be used to analyze individual routes, operations at different times of day, or different transit submodes.

Socioeconomic and Environmental Impact (Table A-16)

S-1. Prediction of Fuel Consumption. Graphs of fuel consumption rates for five vehicle/traffic types versus average speed are used. A 51-passenger diesel bus, 33-passenger diesel bus, 12-passenger gasoline van, heavy-duty gasoline van, mixed traffic (arterial), and mixed traffic (freeway) are considered. Estimated vehicle mileage (by mode) multiplied by fuel consumption rate equals estimated fuel consumtpion.

S-2. Prediction of Air Pollutant Emissions. Graphs of emission rates for different pollutants and vehicle types versus average speed are given. The 1980 pollutant emission rates cover carbon monoxide, hydrocarbons, and nitrous oxides. Carbon monoxide emission rates for trucks, 12-passenger gasoline buses, and 6 to 12-passenger gasoline buses are distinguished. Separate graphs of emission rates versus average speed for diesel engine buses are given. These rates are multiplied against vehicle mileage estimates to yield emission estimates.

S-3. Prediction of Noise Generation. Two variable graphs matching sound level in dBA against hourly traffic volume (by vehicle-type: trucks, buses, autos) are given, derived from the literature. Speed variations for trucks and autos are reflected. Adjustment factors for observer distance, roadway width, highway gradient (truck sounds), road surface, traffic interruption, and vertical displacement are included. An algebraic method is given to combine transportation noises from multiple sources to estimate overall sound level.

S-4 Analysis of Bus Speed Improvements. The methods described above for predicting fuel consumption, air pollutant emissions, and noise generation are included, carried forward as part of an overall integrated analysis procedure.

S-5. Analysis of Frequency Changes. The methods given above for estimating noise generation and air pollutant emissions are used.

S-6. Analysis of Service Hour Changes. The methods given above for estimating fuel consumption, air pollutant emissions, and noise generation are used.

S-7. Analysis of Demand-Responsive Service. The methods given above for estimating fuel consumption, air pollutant emissions, and noise generation are used.

S-8. Analysis of Elderly and Handicapped Service. The methods give above for estimating fuel consumption, air pollutant emissions, and noise generation are used.

S-9. Analysis of Route Modifications. The methods given above for estimating air pollutant emissions, noise generation, and fuel consumption are used, again, as part of an overall integrated analysis procedure.

S-10. Analysis of Park-n-Ride Lots. The methods given above for estimating fuel consumption, noise generation, and air pollutant emissions are used.

S-11. Analysis of Transit Dependency. This method uses a map overlay technique to identify subareas with high transit orientation or potential. The socioeconomic variables that are mapped include population density, persons per auto, percent population over 65 years of age, percent population between 6 and 12 years of age, ratio of mobility-impaired population, and annual family income. Transit services provided to areas of high transit dependency are qualitatively assessed for adequacy.

Other Analysis Methods

Several different noncomputerized analysis methods for addressing indirect impacts of transit service are brought together here. These methods are not otherwise available in the handbooks reviewed above. Several of these measures, particularly those addressing employment and economic development impacts, not only are difficult to forecast, but also are difficult to analyze in terms of current levels of impact. Both levels of analysis application, existing conditions and forecasted conditions, are covered.

Primary Indicators

Number of Trips Served. In smaller urban regions, the major portion of all travel takes place by automobile. Transit mode splits on a daily basis are only on the order of 1 to 2 percent or less. There are, however, three significant situations where transit mode split percentages are higher, and these contexts should also be made clear.

First, transit travel to the CBD is characteristically higher than to other parts of the region. Second, transit typically serves a higher percentage of work trips than all other trips and an even higher percentage of work trips destined to the CBD. Third, transit generally serves a higher percentage of peak-hour trips than off-peak trips. All of these characteristics should be documented via survey travel data usually available from the state DOT or the regional COG.

Origin-destination survey data can document each of these travel dimensions, as can the basic demand model calibration for whatever highway/urban transportation travel forecasting may have been conducted for the region. The number and percentage of trips of these types, for both transit and automobiles, should be established by consulting these data sources. (See Table A-17.) The total number of transit and automobile trips, by purpose, time of day, and CBD/non-CBD destination, should be determined (including average auto occupancy for each trip purpose).

Table A-17. Illustrative urban area travel characteristics.

	Number of Trips			Percent	Persons
Trip Type	Transit	Auto	Total	Trips by Transit	per Auto
Total Daily Trips	16,500	1,633,500	1,650,000	1.0%	1.5
Peak Period Trips	8,200	24,800	250,000	3.3	1.2
Work Trips	8,000	217,000	225,000	3.5	1.2
CBD Trips	10,900	144,100	155,000	7.0	-
CBD Work Trips	7,000	40,000	47,000	15.0	-

Forecasted automobile trips for work, to the CBD, for work trips to the CBD, and for peak-hour travel (as well as total auto trips), will be available only if a regionwide transportation plan has been completed recently. As a part of that plan, it is likely that the state DOT, regional COG, or city or county planning or engineering departments (i.e., whoever is designated as the Metropolitan Planning Organization by the U.S. Department of Transportation, for urbanized areas over 50,000 population, will have this planning responsibility) will have conducted travel demand forecasts which provide highway travel forecasts, including trip tables and link loadings. The trip tables, by purpose, should be consulted to obtain these forecast year trip volumes and mode split percentages, for both transit and automobile. Automobile occupancy factors should be obtained from the state DOT (as derived from roadside car occupancy surveys) in order to convert person-trips to automobile trips (or vice versa).

Operating and Maintenance Costs. Only user out-of-pocket costs for former automobile travelers, adjusted for automobile occupancy, are considered here. The general idea is to calculate the increased per person trip cost for an average length of 2 to 6 miles that choice transit users would incur if transit service were eliminated and they were forced to travel by automobile. This user cost savings is clearly dependent on the fact that the average transit fare (say 50 cents) is less than the corresponding out-of-pocket automobile operating cost (say $1.00, at 23 cents per vehicle-mile for about 4 miles). The total daily automobile operating cost avoided, aggregated over all former choice transit users, should then be summed at the annual level to permit annual system cost comparisons.

Because the majority of small-city transit riders—on the order of 75 percent—have no automobile available as an alternative mode, they are not, however, regarded as "choice" riders, but as "captive" riders. Where transit service is eliminated entirely, perhaps 15 to 20 percent of these trips (primarily nonwork trips) would be foregone because of no convenient alternative means for making them. Twenty to 25 percent might choose to walk. Another 5 to 10 percent would continue to travel by driving an available automobile, while perhaps the same percentage would opt for the more expensive taxi mode. The remaining 30 to 40 percent would be likely to continue to travel via carpooling or ridesharing (with neighbors, coworkers, friends or relatives, etc.). An average carpool size of 2 to 5 persons might be assumed here.

Because of this emphasis on "captive" ridership as a part of transit system characteristics, the elimination of transit would not yield a dramatic increase in the avoided costs associated with automobile travel. In fact, under these conditions, it is possible that aggregate user costs (transit fares versus carpool/ridesharing shared costs) could be roughly equivalent, after adjusting for the reduction in former transit travel due to the elimination of foregone or discretionary trips. Table A-18 gives an illustrative calculation of user out-of-pocket costs for both choice and captive riders.

Similar analysis procedures should be followed to calculate the automobile operating costs foregone by providing future-year transit service. (Estimated future-year car operating costs per vehicle-mile, available from FHWA, should be converted to current year dollars, ignoring inflation.) Current transit fares should be assumed to continue unchanged. Anticipated reductions in the daily costs of transportation, for choice transit users who otherwise would be forced to travel by auto, could then be calculated as a measure of system benefits.

Table A-18. Illustrative analysis of user out-of-pocket costs.

Trip Type(1)	Number of Daily Trips	Typical Transit User Cost(2)	Typical Automobile User Cost(3)
"Choice" Transit Riders	4,100	$ 2,050	$ 3,770
"Captive" Transit Riders			
Foregone Trips(4)	2,500	1,250	-
Switch to Walking	3,000	1,500	-
Switch to Auto Driver(5)	1,200	600	1,100
Switch to Taxi(6)	1,000	500	4,000
Switch to Carpool/Vanpool(7)	4,700	2,350	1,750
Total:	16,500	$ 8,250	$10,620

(1)Assuming that transit is unavailable.
(2)Average fare of 50 cents.
(3)Twenty-three cents per vehicle-mile, average trip length of four miles.
(4)Trips that would be eliminated due to no convenient alternate mode.
(5)Using an auto not normally available.
(6)Average taxi fare of $4.00.
(7)Average auto occupancy of 2.5.

In contrast with present conditions, under forecasted conditions, it may be assumed that most additional (incremental over present conditions) transit ridership will involve "choice" travel. In this case, the aggregate savings in operating costs (auto out-of-pocket operating costs versus transit fares) would increase, and would likely represent a larger system benefit. More choice riders would save more in user travel costs. Note also that, in contrast to the "present conditions" situation, there is no need to account for the removal of "foregone trips" as a clear and significant disbenefit.

Capital Costs (Annualized). The capital recovery factor (CRF) method is recommended for calculation of the annualized cost of the capital invested in the existing transit system. In slightly oversimplified terms, the CRF method computes the cost of capital for each asset class as if the entire cost of the assets (less salvage value) were borrowed in the first year of their life, and would be repaid over the lifetime of the separate classes of assets. Thus, for example, the cost of a service car would be repaid over its 3-year expected life, the cost of a bus over 12 years, etc. At the end of the expected lifetime, the "loan" is paid off, the asset is worthless, and the cycle begins again with purchase of replacement assets.

After the annualized cost for each asset class has been calculated, the share of cost borne by each jurisdiction can be calculated by prorating. Table A-19a shows a worksheet for calculating the total annualized cost; Table A-19b is a worksheet for calculating prorated shares.

The same basic method should be used to estimate future annualized capital cost, with the appropriate changes in the quantity of capital assets to reflect changes in the service. For simplicity, it is recommended that current capital costs be used rather than attemtping to estimate the inflated cost of assets. However, if it is felt necessary to adjust for the effects of inflation on capital cost, use the following formula:

$AC_n = AC_0 \times (1 + r)^n$, where AC_n is the cost of the asset in year n, AC_0 the cost of the asset in the base year, and r the interest rate.

Table A-19a. Annualized capital cost worksheet.

Asset(1)	Year Acquired(2)	Purchase Price (Lot)(3)	Life Expectancy(4)	CRF(5)	Annualized Cost(6)
Buses	19____	$	12 Years	0.______	$
Buses	19____	$	12 Years	0.______	$
Buses	19____	$	12 Years	0.______	$
Service Car	19____	$	3 Years	0.______	$
Shop Tools	19____	$	15 Years	0.______	$
Garage	19____	$	30 Years	0.______	$
--- (etc.)					

(1)Assets of the same type acquired in different years should be listed separately.

(2)Assets are dropped from the listing once their age exceeds the life expectancy for that class.

(3)The total purchase price paid, not including land on which facilities stand, is given.

(4)Refer to UMTA standards for life expectancies of asset classes not given.

(5)A full table of CRF values can be found in a handbook of mathematical or financial tables. The interest rate chosen should equal the rate the transit system could earn by investing money rather than the rate at which it would have to borrow. This is an opportunity cost.

(6)Multiply purchase price by CRF to compute this amount.

Table A-19b. Capital cost share worksheet.

Asset	Annualized Cost (Total)	Percent Paid by Jurisdiction			Amount Paid by Jurisdiction		
		Local	State	Federal	Local	State	Federal
Buses (19__ Purchase)	$	%	%	%	$	$	$
Buses (19__ Purchase)	$	%	%	%	$	$	$
Buses (19__ Purchase)	$	%	%	%	$	$	$
Service Car	$	%	%	%	$	$	$
Shop Tools	$	%	%	%	$	$	$
Garage	$	%	%	%	$	$	$
... (etc.)	$	%	%	%	$	$	$
Total:	$				$	$	$

Secondary Indicators

Probable Accidents (by Type). Accident rates per million passenger-miles (transit) and per million vehicle-miles (auto) are available from the literature (see Table A-20). The state DOT should be consulted for local automobile (mixed traffic) accident rates, while transit accident rates have already been discussed. Automobile accidents avoided by choice transit passengers can be calculated by converting annual transit passenger-miles to automobile vehicle-miles (adjusting for average automobile occupancy) and applying the appropriate automobile accident rates. Equivalent transit accidents (using per passenger-mile rates) then should be calculated and subtracted to obtain the net value of annual automobile accidents avoided by providing transit service.

Similar analysis procedures should be applied to forecasted

Table A-20. Representative accident rates.

Mode	Accidents per Million Vehicle-Miles						
	Vehicle Accidents				Passenger Accidents		
	Property Damage	Injury	Fatal	Total	Injury	Fatal	Total
Automobile							
Freeway	4.03	0.64	0.02	4.69	1.03	0.02	-
Arterial Street	16.52	1.64	0.03	18.19	2.65	0.03	-
Local Street	16.52	2.48	0.03	19.03	3.65	0.03	-
Bus Transit							
Area Population 0-100,000	-	-	-	82.6	-	-	12.2
Area Population 100-250,000	-	-	-	56.5	-	-	16.1
Area Population 250-500,000	-	-	-	58.8	-	-	17.2

Source: NCTCOG Handbook

proportions of choice transit ridership and transit passenger-miles. Assume that current accident rates will continue, unless transit or highway safety policies are being strengthened.

Emissions (by Type). Air pollutant emissions for transit should be converted to emissions per passenger-mile. Choice rider passenger-miles then should be converted to equivalent automobile vehicle-miles (adjusting for automobile occupancy). Current automobile emission characteristics should be obtained from FHWA or the state DOT (See Figures A-2, A-3, and A-4), and multiplied by the annualized level of automobile vehicle-miles which would otherwise be traveled by present choice transit passengers. Equivalent bus pollutant emissions then should be calculated (emission rates per passenger-miles times choice rider passenger-miles) and subtracted from these automobile emissions. This will yield the net reduction in overall emissions (by type) that can be attributed to provision of transit service (see Table A-21).

Similar analysis procedures should be used for estimating emission reductions due to transit service in a forecast year. Again, simply substitute forecasted estimated transit emissions (for choice riders), and equivalent passenger-related automobile emissions, for current values for these performance characteristics.

Energy Consumption (by Fuel Type). Transit energy consumption is available from data sources described above. Estimates of automobile fuel consumption (largely gasoline) should be made by using automobile fuel efficiency characteristics available from FHWA or the state DOT, adjusted for local conditions. Table A-22 summarizes these fuel consumption characteristics per vehicle-mile. Estimate the equivalent vehicle-miles that choice transit passengers would travel (adjusting for automobile occupancy), and multiply those daily and annual vehicle-miles by associated gasoline consumption rates. Subtract from this foregone automobile energy consumption the prorated energy consumption of bus vehicles (for choice transit riders

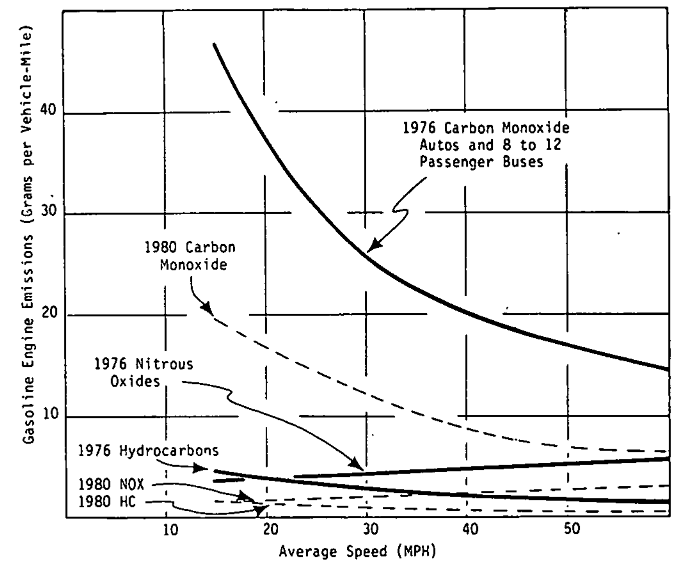


Figure A-2. Representative emission rates for automobiles and small buses. (Source: NCTCOG Handbook)

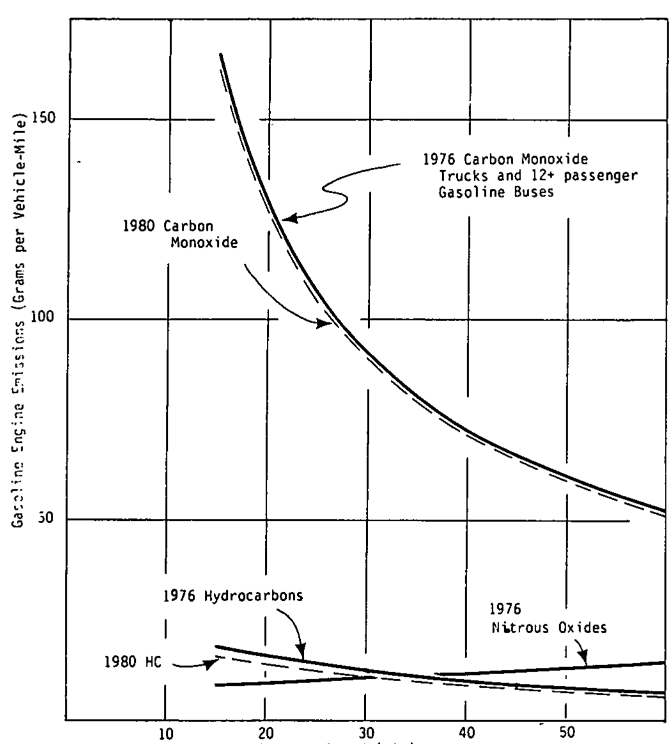


Figure A-3. Representative emission rates for trucks and mid-sized buses. (Source: NCTCOG Handbook)

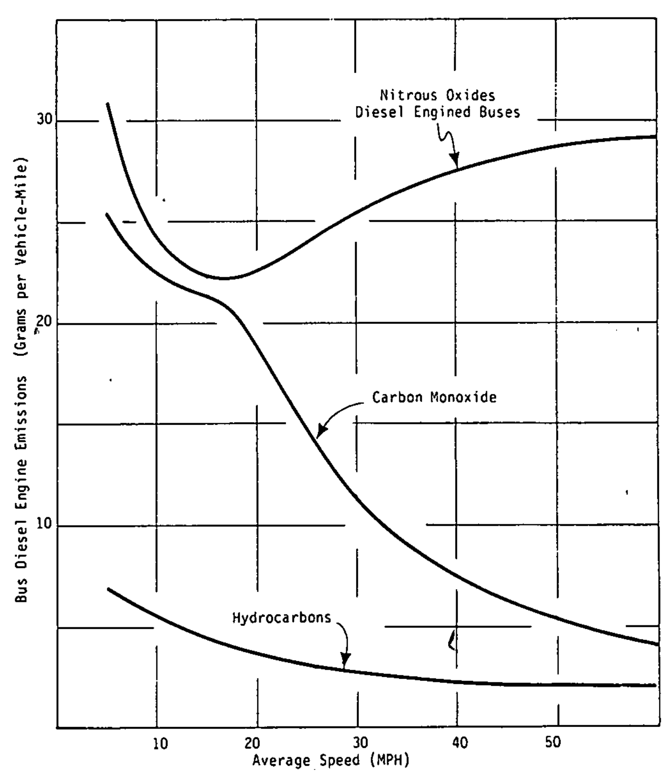


Figure A-4. Representative emission rates for diesel-engined buses. (Source: NCTCOG Handbook)

Table A-21. Illustrative analysis of air pollutant emissions.

Annual "Choice" Rider Passenger Miles (Millions): Number	Percent of Total	Pro-Rated Share of Bus Pollutant Emissions(1): Annual Bus Vehicle-Miles (000)	Carbon Monoxide (Tons)	Hydro-Carbons (Tons)	Nitrous Oxides (Tons)	Automobile Air Pollutant Emissions Avoided(2): Annual Auto Vehicle-Miles(3) (000)	Carbon Monoxide (Tons)	Hydro-Carbons (Tons)	Nitrous Oxides (Tons)
4.9	25%	680	15.7	3.7	16.5	3,270	71.9	6.3	7.2

(1)Average speed of 15 mph assumed, together with bus diesel emission rates of Figure A-4.
(2)Average speed of 25 mph assumed, together with automobile (gasoline engine) emission rates of Figure A-2.
(3)Assumed average auto occupancy of 1.5.

Table A-22. Projected fuel economy by vehicle type.

Vehicle Type	Fuel Economy (Miles/Gallon): 1980	1985	1990	1995	2000
Automobile	14.3	18.2	22.1	NA	28.6
Light Truck	12.7	14.6	16.3	NA	20.4
Transit Bus	3.6	3.3	3.3	NA	3.3
School Bus	7.4	7.6	8.0	NA	8.5

Source: Argonne National Laboratory, *Baseline Projections of Transportation Energy Consumption by Mode: 1981 Update*, by M. Millar, J. Bunch, A. Vyas, M. Kaplan, R. Knorr, V. Mendiratta, and C. Saricks, U.S. Department of Energy, April, 1982.

Table A-23. Illustrative analysis of energy consumption.

Annual "Choice" Rider Passenger-Miles (Millions): Number	Percent of Total	Prorated Share of Bus Consumption(1): Annual Vehicle-Miles (000)	Gallons of Fuel (000)	Automobile Fuel Consumption Avoided(2): Annual Vehicle-Miles(2) (000)	Gallons of Fuel (000)
4.9	25%	680	189	3,270	229

(1)1980 Fuel economies from Table A-22 are assumed.
(2)Assumed average auto occupancy of 1.5.

only). The difference is the net benefit delivered by transit service, in terms of reduced gasoline consumption (see Table A-23).

Again, substitute forecast year values for choice service ridership and equivalent automobile vehicle-miles of travel. As indicated in Table A-22, forecast year automobile fuel efficiencies are projected to increase year by year. Select the automobile fuel efficiency that corresponds to the year of analysis.

Unemployment Effects. The benefits of existing transit systems, in terms of providing access to employment, particularly for employees who do not own an automobile, are difficult to quantify. Nevertheless, a crude estimate is suggested here.

Limited studies suggest that for current captive transit riders, who essentially have no other convenient means to get to work, the elimination of transit services would significantly jeopardize their ability to maintain their jobs. While most such captive riders could work out some other transportation arrangement (carpooling, taxi, vanpooling, etc.), perhaps about 15 percent of current work-trip riders would face the prospect of losing their jobs.

Apply this percentage to the number of daily work-trips currently carried by the local transit system. Multiply that figure by the typical average wage for automobileless households. This might be about $10,000 to $12,000 per year. The resultant figure—which for only 50 persons at risk of losing their job would amount to $500,000 per year—can be regarded as a benefit provided to residents living within a transit service area. While it could be argued that the jobs lost would be filled by other employees who do not have an access problem—since the jobs would still be available in the region—a significant disbenefit would nevertheless accrue to "current" transit dependents. Presumably, those who are able to take the vacated jobs would have some other means to get to work (and might also live outside the transit service area).

Other nonquantifiable employment benefits should be noted and discussed. For example, local transit not only can provide reliable service for the work-trip for employees, but can also provide employers with linkages to the entire city as a potential employment pool. Transit also provides a backup service for employees who normally use other means of travel. There are direct savings to employers in terms of a reduced need for parking space at work locations (for those who take transit by choice, and leave their automobile at home). Costs of absenteeism, turnover, and training also are potentially reduced through the provision of a reliable means for making work trips.

In general, increases in transit ridership which might be associated with improvements in or expansion of service generally involve diversions from automobile travelers. In other words, additional riders represent choice travelers who could have taken their automobile. This is particularly true for work-trips, although more convenient service may lead to additional non-work-trips being made by transit dependents. If it is assumed that employment impact in terms of ensuring job access for transit dependents is largely tied to the "present" pattern of transit service, then the analysis described above for present conditions would be sufficient to assess this impact for forecasted conditions.

It should be recognized, however, that extensions of transit service could potentially bring available jobs within transit access of presently unemployed, automobileless persons, who would now be afforded the mobility to bring them to a wider range of potentially available jobs. This impact is probably a real one, but difficult to quantify.

Economic Development Effects. Limited experience suggests that existing transit service makes a significant contribution to the economic viability of major shopping areas, particularly the central business district (CBD). The percent of all weekday trips made for shopping purposes (typically 15 to 20 percent), and a comparable percentage for Saturday trips (typically 50 percent), should be calculated. If local survey data are available, the average total purchases made on such trips should be estimated. Surveys in other cities suggest a value of $20 to $25 for purchases on each transit shopping trip.

This average expenditure per trip should be multiplied by total annual transit shopping trips to estimate the total retail sales that can be directly attributed to transit riders. Certainly, it is not clear that these expenditures would disappear entirely from the regional economy without transit, but they likely would shift in location, and some portion of them might not be made. The ratio of these transit-related retail sales to total retail sales, for major shopping areas served by transit (such as the CBD), should be calculated. This may be on the order of 10 percent and would represent a potential loss in retail sales volume for such areas. In fact, such a decline in retail sales was experienced in one city when its transit system suspended operations for several months.

Following the same analysis assumptions and methodology above, increases in shopping trips projected for improvements in transit service, particularly for the CBD, can be translated directly to increased sales. While these sales may represent transfers from other shopping areas within the region, they nevertheless represent a benefit to the particular shopping center which is provided better service (and correspondingly, a disbenefit that may accrue to the shopping areas formerly patronized).

Parking Requirements. An additional transportation-related impact that may be attributable to the provision of transit service lies in the reduced number of parking spaces (on-street, surface lots, or parking structure) that may be required. In smaller urban areas, however, this impact may be negligible because (1) the relative availability of surface and on-street parking near major employment centers, including the CBDs, (2) the fact that most current transit riders are captive and would not otherwise be driving an automobile, and (3) the number of former transit riders who would drive an automobile to any specific employment center, including the CBD, is a small percentage of all present drivers. Consequently, resultant impacts are lost in the broader excess of parking space supply over demand that typically occurs, particularly at the fringes of the CBD. Such fringe parking lots/spaces are still within easy walking distance of actual destinations because of relatively small CBD size.

Potential impacts on all-day parking space supply associated with elimination of transit service can be calculated by ascertaining the likely number of new (former transit rider) automobile trips, which would occur to each major employment center. The average peak-hour or work-trip automobile occupancy factor for the region should be applied to translate person-trips to vehicle-trips. Current parking lot and parking facility occupancy ratios during the peak hour at each major employment location then should be surveyed (or existing survey results consulted).

If current occupancy exceeds 85 percent, the cost of additional parking spaces needed to accommodate these increases in vehicle-trips can be calculated (both close-in and peripheral parking at each employment center should be included in the total inventory). A typical land acquisition and paving cost for surface lots (on the order of $1,500 per space for construction only) should be derived, based on local experience. By applying this unit cost to the total number of spaces not required, the indirect benefit (reduction in number of parking spaces) associated with providing transit service can be estimated.

For forecasted year transit travel, the number of choice transit trips made by former auto drivers will increase. Under these conditions, the number of unneeded parking spaces may increase as well. Similar analysis procedures as for current conditions should be followed. However, the planned and programmed number of parking spaces, in both lots and structures, should be included in the inventory for each major employment center.

Travel Time Costs. Because comparative travel time is an important variable in the choice of mode (among travelers who have both automobile and transit available for trip-making), it is useful to assign a dollar value to the cost of travel by each mode, as part of overall user cost. These travel time costs have relevance both for "choice" and "captive" transit riders, and can be included in the evaluation of total transportation costs. In general, choice riders in smaller cities will almost always find that bus transit takes a somewhat longer travel time. The generation of travel time savings, for both choice and captive riders, is consequently associated with comparing the "no action" alternative against other transit service improvement alternatives.

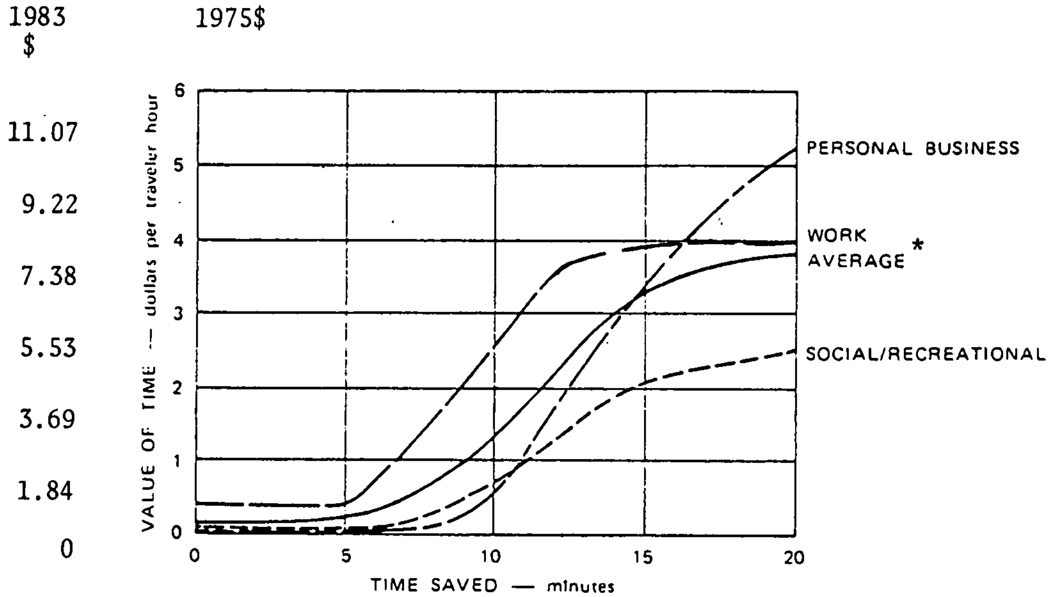
Figure A-5 summarizes user travel time costs as a function of trip purpose and the amount of time savings per trip. Note that the figure implies that a comparison of travel time savings—total minutes saved—between transit alternatives influences the value of the time saved. For example, a work-trip where 15 minutes could be saved would find time valued at $4.00 per hour, whereas if only 5 minutes were saved, the time would only be valued at $0.50 per hour.

A typical average value of time (for 10 to 15 minutes saved) in Figure A-5 appears to be around $5.50 (1983 dollars). This can be used as a general guideline for calculating travel time costs, adjusting for trip purposes if desired. This yields typical transit user travel time cost of about $1.85 to $2.75 per trip, and typical automobile user travel time cost of about $.90 to $1.40. These should be estimated more carefully by calculating average trip length for each mode. Calculation of transit user travel time cost differences would be performed the same under both present conditions and forecasted conditions.

Evaluation Methodology

As with the analysis of impacts, the evaluation of alternative transit options within small urban areas can be separated into two levels: policymaking and managerial.

The process of communication between these two levels of transit decision-making tends to blur any clear distinction between the levels, but there are major, generalized differences. The policymaker examines only a few key measures (perhaps five or six), places considerable reliance on competent supporting analyses and technical details provided by transit managerial staff, and has little need for formalized evaluation or decision-making aids. The manager, on the other hand, may use comparative efficiency and effectiveness measures to assess trade-offs among alternatives, is often responsible for whatever sys-



* The average values are an unweighted arithmetic mean for the other trip categories.

Figure A-5. Value of time as a function of time saved, by trip type, 1975 and 1983 dollars. (Source: D. G. Anderson, D. A. Curry, and R. J. Pozdena, A Manual on User Benefit Analysis of Highway and Bus-Transit Improvements, American Association of State Highway and Transportation Officials, Washington, D.C., 1977)

tematic evaluation of alternatives takes place (reporting only the "recommended" alternative to the policymakers), and may sometimes be able to employ evaluation tools.

Thus, there are two ways to evaluate small-city transit options at the policymaking level. The first relies heavily on the manager to perform the technical evaluation and bring the recommended course of action to the policymakers. In this model, the policymakers do not concern themselves to any great extent with the unchosen alternatives, but concentrate on the impacts of the chosen one. They look at the half-dozen key measures, and possibly at some background detail, in making a go/no-go decision about the recommended alternative. If they reject the recommendation, they send the manager back to the drawing board with some insight into the shortcomings of the original option, relative to the key variables.

In the second model, however, the decision-makers want a great deal more detail and usually want to know about several alternatives. They have less faith in the manager's judgment, as compared to those in the first model. A choice among service alternatives may serve as an opportunity for questioning operating decisions and other issues that are traditionally within operating management's purview. Decision-makers may be drawn more directly, then, into considering some of the simplified comparative evaluation measures normally addressed only by the managers.

This subsection is organized around a brief review of the evaluation techniques that have been used, or seem potentially applicable, in small-city transit planning/operations contexts. A summary of reports of actual experience is included. This summary is supplemented by a review of evaluation methodologies employed in a sampling of transit development programs. Again, the perspective of policymakers versus managerial staff indicates major differences.

Potentially Applicable Evaluation Techiques

A review of the literature indicates that three basic approaches to evaluation of transportation improvement alternatives are available, regardless of city size. In each case, the purpose of a more systematic approach to evaluation is to facilitate an overall assessment of alternatives, as compared to the separate examination of specific impact criteria, one at a time or in some other partial, less-than-comprehensive way. Each of the three approaches attempts to determine whether the anticipated benefits of each improvement are worth associated costs and to what comparative extent.

Transit Managers

Where the evaluation of multiple alternatives is delegated to staff, there is still a tendency to respond to the design and assessment of alternatives in a short-term sense. That is, service, operational, and management options are designed in terms of incremental changes to last year's service, rather than in terms of long-term, comprehensive system changes. This, of course, responds to the short-term interests of policymakers. Most of the 15 or 20 performance/effectiveness measures that many managers are interested in are also operational measures, generated on an annual basis. Peer group comparison of such measures, many of which can be derived from Section 15 data, is a common practice among managers. These comparisons typically are not presented to policymakers unless requested.

The short-range time horizon of decision-makers and federal, state, and local budgetary constraints affect the ability to design significantly different service levels compared to the previous year. Most such alternatives will require significant capital investment, either in right-of-way or vehicles or both. As a result, the design of alternatives is largely incremental in nature. These incremental alternatives usually deal with the lengthening or shortening of some routes, changes in hours and days of service, changes in operating maintenance-management staff ratios, fare increases or decreases, etc. Although alternatives of this nature might be created for any given budget year, there is no apparent assurance of comprehensiveness in either their design or their assessment. Much trust is placed in the professional judgment of managerial staff to devise reasonable options, but not too many.

The corresponding evaluation of two or more alternative service levels, some of which may have differing capital investment requirements, has not been methodologically complex. Though not mentioned specifically in reported experience, in other transit development programs reviewed by the research team, simple evaluation matrices were found that compared alternatives against the several relevant efficiency or effectiveness measures. These were not generally referred to in any formal sense as cost-effectiveness matrices, nor was there any need to do so. In many cases, however, the evaluation of multiple alternatives, each of an incremental nature, is likely to also focus on the same five key or six key measures of interest to policymakers. These include, of course, such measures as operating ratio, total subsidy, total passengers, total operating cost, and annual local capital cost.

Economic Efficiency Analysis

Also known as benefit-cost analysis, the primary emphasis of this approach is to assign a monetary or dollar value to the benefits and costs of an alternative. While costs are relatively straightforward, involving total capital costs, annualized capital costs, and annual operating and maintenance costs, the treatment of benefits presents the primary challenge of the method. Potential savings in user costs, as compared to the status quo, and in comparing one alternative with another, represent the primary direct benefits. These can involve out-of-pocket transportation cost (transit fares or auto operating costs), travel time savings (assigned a dollar value), and possibly accident cost savings (again, assigned a dollar value). Assigning a dollar value to other indirect impacts—improvement in air quality, reduction of noise, increase in land value, stimulus to economic development, or visual/aesthetic impacts—is not recommended. These impacts are either difficult to analyze quantitatively, difficult to value monetarily, or both.

Concentrating on Direct Costs Only. There may still be merit in performing economic efficiency analyses that deal *only* with direct user and operator costs. This is how this approach is treated in this report. That is, the potential utility of economic efficiency analysis is considered only in relation to the analysis of direct transportation costs, where reductions in user or operator costs are benefits. If other benefits are also worth analyzing, a cost-effectiveness approach (described below) makes more sense.

In performing overall economic efficiency comparisons of alternatives with regard to direct transportation costs, it is important to compare capital-intensive and labor-intensive options on a consistent basis, particularly in light of the more significant impact that inflation will have on labor-intensive alternatives. In addition, the timing of investment for capital-intensive alternatives also can influence their attractiveness, as can the life expectancy (replacement interval) of major system components, particularly vehicles. As a result, it is generally felt that the calculation of "present value" of all costs, over some multiple-year analysis period represents the fairest way to compare transit improvement alternatives (for example, over an 8-, 10-, 15-, or 20-year analysis period). Application of a discount rate to calculate the present value of all future-year costs is also assumed as a basic methodology. Table A-24 (see also Tables A-25 and A-26) gives an example of calculating present values.

Comparison of Total Transportation Costs. In deriving the benefit-cost ratios for the present value of all costs (user costs, operating and maintenance costs, capital costs) for a set of transit improvement alternatives, it is sometimes felt that the correct approach is one based on calculating the incremental benefit-cost ratio of each alternative, where all alternatives have been ranked in terms of increasing capital cost. In such an approach, reductions in the "sum" of user and operating-maintenance costs are regarded as benefits, while increases in capital cost are regarded as costs. With alternatives ranked in order of lowest capital cost to highest, the incremental decrease (or increase) in the sum of user or operating costs of each successive alternative is regarded as the incremental benefit (or disbeneefit), while the successive increase in capital cost of each alternative is regarded as the incremental cost. Incremental benefit-cost ratios are then compared in turn; the preferred alternative is the successively higher cost alternative that still maintains a benefit-cost ratio greater than 1.0.

Because the calculation of incremental benefit-cost ratios can become confusing, a simpler and more straightforward method will still yield the same result (same preferred alternative). This involves simply the summing of total transportation costs: user, capital (annualized), and operating and maintenance costs. The preferred alternative will have the lowest total cost. Consequently, this comparison of total comparison costs has been recommended in the literature as the preferred approach to economic efficiency analysis. Net benefits can be calculated by comparing the total cost of the preferred alternative (or any alternative) against the do-nothing alternative, where the user and operating and maintenance costs are typically much higher than for any of the transit service improvement options. Table A-27 gives an illustrative analysis example.

Cost-Effectiveness Analysis

The primary difference between economic efficiency and cost-effectiveness analysis lies in the open-ended definition of measures of effectiveness. In general, such measures may be of any quantitative dimension: dollars, person-miles, vehicle-hours, mode split percentages, number of jobs within one-quarter mile, monetary costs, monetary travel time savings, judgmentally scaled ratings of visual impacts, judgmentally scaled ratings of vehicle comfort, etc.

Effectiveness Matrices. Cost-effectiveness analysis can incorporate any and all of the impacts that might be of concern in transit planning. Each indicator should be stated in quantitative (numerical) terms. With such a comprehensive approach, cost-effectiveness analysis tends to require much more information than economic efficiency analysis (and to subsume the latter).

Table A-24. Sample calculation of present values.

Cost Element	Total Capital Cost ($000)	Year Capital Cost Incurred	Adjust for Inflation[1] ($000)	Annual Recurring Cost	Present Value[2]
Purchase of Nine New Buses[3]	$1,704	1987	$1,350	—	$ 921[4]
Purchase of 15 New Buses[3]	3,192	1990	2,250	—	1,155
Modernize Bus Maintenance Garage	250	1989	250	—	141
Annual Operating/Maintenance Cost	—	—	—	$6,250	30,425[5]
Annual User Costs (Fares)	—	—	—	2,130	10,369[5]
Annual User Travel Time Costs[6]	—	—	—	7,500	36,510[5]

[1] Multiply inflated capital cost by $1/(1 + i)^t$, where i = inflation rate assumed and t = number of years from base year.

[2] Multiply base year (e.g., 1983) constant dollar cost estimates, for any future year, by $1/(1 + d)^t$, where d = discount rate and t = number of years from base year.

[3] Base year prices per bus of $150,000 had been inflated by six percent annually to get total price estimates for budgeting purposes.

[4] Sample calculation: $1{,}350 \times 1/(1 + 0.10)^4 = 1{,}350 \times 1/1.464 = 921$, where discount rate = 10 percent, a generally accepted value, and t = 4.

[5] Present value of the sum of a uniform annual series is composed of a different present value for each year. Appendix Table A-25 may be used for various values of d and t. For this example, t = 7, d = 10, and the multiplier (from Appendix Table A-25) = 4.868. Appendix Table A-26 gives similar multipliers for the "single payment" capital cost elements above (buses and bus maintenance garage).

[6] For an average passenger trip of 30 minutes, with time valued at $3.00 per hour, for five million annual riders.

Note: *Present Value* is defined as the value, *expressed in constant base year dollars*, of all future costs or benefits, discounted by an appropriate interest rate to reflect the distance in the future when they would be incurred. The further into the future a given cost would be incurred or benefit realized, the lower its present value.

It has led to the notion of matrix comparison of alternatives, where several alternatives on one axis are matched against multiple measures on the other. The estimates of impact for each measure are filled in as entries in each cell in the matrix. Such a matrix display of impact analysis results provides a convenient way for comparing alternatives.

Such a cost-effectiveness approach, in fact, has been used in the development of small-city transit development programs across the country (see Table A-28). Effectiveness measures have dealt with both direct and indirect impacts and, of course, can include productivity or performance ratios, such as operating and maintenance cost per rider, annualized capital cost per passenger-mile, increase in population served per additional dollar of capital costs, or total transportation costs per passenger-mile. Effectiveness measures, however, most often relate to established goals and objectives for transit service or, more generally, for transportation in an urban area.

There are many different ways in which cost-effectiveness matrices can be and have been employed in transit planning. For example, cost per passenger, revenue per passenger, and subsidy per passenger—each defined as a performance measure—can be used as a way to evaluate a set of existing transit routes. Revenue hours per employee, per driver, or per vehicle can be used as efficiency measures for comparing a given transit system with its peer group. Passengers per revenue-mile, per revenue-hour, per vehicle, or per capita could similarly be used as peer group effectiveness measures, as could operating expense or operating ratio per passenger, per revenue-mile, or per revenue-hour.

Limitations. Cost-effectiveness analysis is still vulnerable to the omission of important decisionmaking factors that have proved difficult to measure—or for which suggested measures lack credibility. Such factors as, for example, political acceptability or perceived security may in fact be significant in comparing alternatives. However, they cannot be quantified and are not likely to be included in a cost-effectiveness matrix. As a result, uncritical use of matrix scores to select a preferred alternative could be misleading. The nonquantifiable factors may be very important to the community and must be accounted for.

In summary, although cost-effectiveness matrix evaluation is a useful organizing technique for examining the technical merits of transit alternatives, it should not be viewed as a tool capable of selecting the best alternative. The limitations of cost-effec-

Table A-25. Uniform series discount factors.

Formula: $USDF = [(1 + i)^n - 1]/i\ (1 + i)^n$

YR	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	YR
1	0.970874	0.961538	0.952381	0.943396	0.934579	0.925926	0.917431	0.909091	0.900901	0.892857	0.884956	0.877193	0.869565	1
2	1.913470	1.886095	1.859410	1.833393	1.808018	1.783265	1.759111	1.735537	1.712523	1.690051	1.668102	1.646661	1.625709	2
3	2.828611	2.775091	2.723248	2.673012	2.624316	2.577097	2.531295	2.486852	2.443715	2.401831	2.361153	2.321632	2.283225	3
4	3.717098	3.629895	3.545951	3.465106	3.387211	3.312127	3.239720	3.169865	3.102446	3.037349	2.974471	2.913712	2.854978	4
5	4.579707	4.451822	4.329477	4.212364	4.100197	3.992710	3.889651	3.790787	3.695897	3.604776	3.517231	3.433081	3.352155	5
6	5.417191	5.242137	5.075692	4.917324	4.766540	4.622880	4.485919	4.355261	4.230538	4.111407	3.997550	3.888668	3.784483	6
7	6.230283	6.002055	5.786373	5.582381	5.389289	5.206370	5.032953	4.868419	4.712196	4.563757	4.422610	4.288305	4.160420	7
8	7.019692	6.732745	6.463213	6.209794	5.971299	5.746639	5.534819	5.334926	5.146123	4.967640	4.798770	4.638864	4.487322	8
9	7.786109	7.435332	7.107822	6.801692	6.515232	6.246888	5.995247	5.759024	5.537048	5.328250	5.131655	4.946372	4.771584	9
10	8.530203	8.110896	7.721735	7.360087	7.023582	6.710081	6.417658	6.144567	5.889232	5.650223	5.426243	5.216116	5.018769	10
11	9.252624	8.760477	8.306414	7.886875	7.498674	7.138964	6.805191	6.495061	6.206515	5.937699	5.686941	5.452733	5.233712	11
12	9.954004	9.385074	8.863252	8.383844	7.942686	7.536078	7.160725	6.813692	6.492356	6.194374	5.917647	5.660292	5.420619	12
13	10.634955	9.985648	9.393573	8.852683	8.357651	7.903776	7.486904	7.103356	6.749870	6.423548	6.121812	5.842362	5.583147	13
14	11.296073	10.563123	9.898641	9.294984	8.745468	8.244237	7.786150	7.366687	6.981865	6.628168	6.302488	6.002072	5.724476	14
15	11.937935	11.118387	10.379658	9.712249	9.107914	8.559479	8.060688	7.606080	7.190870	6.810864	6.462379	6.142168	5.847370	15
16	12.561102	11.652296	10.837770	10.105895	9.446649	8.851369	8.312558	7.823709	7.379162	6.973986	6.603875	6.265060	5.954235	16
17	13.166118	12.165669	11.274066	10.477260	9.763223	9.121638	8.543631	8.021553	7.548794	7.119630	6.729093	6.372859	6.047161	17
18	13.753513	12.659297	11.689587	10.827603	10.059087	9.371887	8.755625	8.201412	7.701617	7.249670	6.839905	6.467420	6.127966	18
19	14.323799	13.133939	12.085321	11.158116	10.335595	9.603599	8.950115	8.364920	7.839294	7.365777	6.937969	6.550369	6.198231	19
20	14.877475	13.590326	12.462210	11.469921	10.594014	9.818147	9.128546	8.513564	7.963328	7.469444	7.024752	6.623131	6.259331	20
21	15.415024	14.029160	12.821153	11.764077	10.835527	10.016803	9.292244	8.648694	8.075070	7.562003	7.101550	6.686957	6.312462	21
22	15.936917	14.451115	13.163003	12.041582	11.061240	10.200744	9.442425	8.771540	8.175739	7.644646	7.169513	6.742944	6.358663	22
23	16.443608	14.856842	13.488574	12.303379	11.272187	10.371059	9.580207	8.883218	8.266432	7.718434	7.229658	6.792056	6.398837	23
24	16.935542	15.246963	13.798642	12.550358	11.469334	10.528758	9.706612	8.984744	8.348137	7.784316	7.282883	6.835137	6.433771	24
25	17.413148	15.622080	14.093945	12.783356	11.653583	10.674776	9.822580	9.077040	8.421745	7.843139	7.329985	6.872927	6.464149	25
26	17.876842	15.982769	14.375185	13.003166	11.825779	10.809978	9.928972	9.160945	8.488058	7.895660	7.371668	6.906077	6.490564	26
27	18.327031	16.329586	14.643034	13.210534	11.986709	10.935165	10.026580	9.237223	8.547800	7.942554	7.408556	6.935155	6.513534	27
28	18.764108	16.663063	14.898127	13.406164	12.137111	11.051078	10.116128	9.306567	8.601622	7.984423	7.441200	6.960662	6.533508	28
29	19.188455	16.983715	15.141074	13.590721	12.277674	11.158406	10.198283	9.369606	8.650110	8.021806	7.470088	6.983037	6.550877	29
30	19.600441	17.292033	15.372451	13.764831	12.409041	11.257783	10.273654	9.426914	8.693793	8.055184	7.495653	7.002664	6.565980	30
31	20.000428	17.588494	15.592811	13.929086	12.531814	11.349799	10.342802	9.479013	8.733146	8.084986	7.518277	7.019881	6.579113	31
32	20.388766	17.873551	15.802677	14.084043	12.646555	11.434999	10.406240	9.526376	8.768600	8.111594	7.538299	7.034983	6.590533	32
33	20.765792	18.147646	16.002549	14.230230	12.753790	11.513888	10.464441	9.569432	8.800541	8.135352	7.556016	7.048231	6.600463	33
34	21.131837	18.411198	16.192904	14.368141	12.854009	11.586934	10.517835	9.608575	8.829316	8.156564	7.571696	7.059852	6.609099	34
35	21.487220	18.664613	16.374194	14.498246	12.947672	11.654568	10.566821	9.644159	8.855240	8.175504	7.585572	7.070045	6.616607	35
36	21.832252	18.908282	16.546852	14.620987	13.035208	11.717193	10.611763	9.676508	8.878594	8.192414	7.597851	7.078987	6.623137	36
37	22.167235	19.142579	16.711287	14.736780	13.117017	11.775179	10.652993	9.705917	8.899635	8.207513	7.608718	7.086831	6.628815	37
38	22.492462	19.367864	16.867893	14.846019	13.193473	11.828869	10.690820	9.732651	8.918590	8.220993	7.618334	7.093711	6.633752	38
39	22.808215	19.584485	17.017041	14.949075	13.264928	11.878582	10.725523	9.756956	8.935666	8.233030	7.626844	7.099747	6.638045	39
40	23.114772	19.792774	17.159086	15.046297	13.331709	11.924613	10.757360	9.779051	8.951051	8.243777	7.634376	7.105041	6.641778	40
41	23.412400	19.993052	17.294368	15.138016	13.394120	11.967235	10.786569	9.799137	8.964911	8.253372	7.641040	7.109685	6.645025	41
42	23.701359	20.185627	17.423208	15.224543	13.452449	12.006699	10.813366	9.817397	8.977397	8.261939	7.646938	7.113759	6.647848	42
43	23.981902	20.370795	17.545912	15.306173	13.506962	12.043240	10.837950	9.833998	8.988646	8.269589	7.652158	7.117332	6.650302	43
44	24.254274	20.548841	17.662773	15.383182	13.557908	12.077074	10.860505	9.849089	8.998780	8.276418	7.656777	7.120467	6.652437	44
45	24.518713	20.720040	17.774070	15.455832	13.605522	12.108402	10.881197	9.862808	9.007910	8.282516	7.660864	7.123217	6.654293	45
46	24.775449	20.884654	17.880066	15.524370	13.650020	12.137409	10.900181	9.875280	9.016135	8.287961	7.664482	7.125629	6.655907	46
47	25.024708	21.042936	17.981016	15.589028	13.691608	12.164267	10.917597	9.886618	9.023545	8.292822	7.667683	7.127744	6.657310	47
48	25.266707	21.195131	18.077158	15.650027	13.730474	12.189136	10.933575	9.896926	9.030221	8.297163	7.670516	7.129600	6.658531	48
49	25.501657	21.341472	18.168722	15.707572	13.766799	12.212163	10.948234	9.906296	9.036235	8.301038	7.673023	7.131228	6.659592	49
50	25.729764	21.482185	18.255925	15.761861	13.800746	12.233485	10.961683	9.914814	9.041653	8.304498	7.675242	7.132656	6.660515	50

Table A-26. Single payment discount factors.

Formula: $SPDF = 1/(1 + i)^n$

YR	3%	4%	5%	6%	7%	8%	9%	10%	11%	12%	13%	14%	15%	YR
1	0.970874	0.961538	0.952381	0.943396	0.934579	0.925926	0.917431	0.909091	0.900901	0.892857	0.884956	0.877193	0.869565	1
2	0.942596	0.924556	0.907029	0.889996	0.873439	0.857339	0.841680	0.826446	0.811622	0.797194	0.783147	0.769468	0.756144	2
3	0.915142	0.888996	0.863838	0.839619	0.816298	0.793832	0.772183	0.751315	0.731191	0.711780	0.693050	0.674972	0.657516	3
4	0.888487	0.854804	0.822702	0.792094	0.762895	0.735030	0.708425	0.683013	0.658731	0.635518	0.613319	0.592080	0.571753	4
5	0.862609	0.821927	0.783526	0.747258	0.712986	0.680583	0.649931	0.620921	0.593451	0.567427	0.542760	0.519369	0.497177	5
6	0.837484	0.790315	0.746215	0.704961	0.666342	0.630170	0.596267	0.564474	0.534641	0.506631	0.480319	0.455587	0.432328	6
7	0.813092	0.759918	0.710681	0.665057	0.622750	0.583490	0.547034	0.513158	0.481558	0.452349	0.425061	0.399637	0.375937	7
8	0.789409	0.730690	0.676839	0.627412	0.582009	0.540269	0.501866	0.466507	0.433926	0.403883	0.376160	0.350559	0.326902	8
9	0.766417	0.702587	0.644609	0.591898	0.543934	0.500249	0.460428	0.424098	0.390925	0.360610	0.332885	0.307508	0.284262	9
10	0.744094	0.675564	0.613913	0.558395	0.508349	0.463193	0.422411	0.385543	0.352184	0.321973	0.294588	0.269744	0.247185	10
11	0.722421	0.649581	0.584679	0.526788	0.475093	0.428883	0.387533	0.350494	0.317283	0.287476	0.260698	0.236617	0.214943	11
12	0.701380	0.624597	0.556837	0.496969	0.444012	0.397114	0.355535	0.318631	0.285841	0.256675	0.230706	0.207559	0.186907	12
13	0.680951	0.600574	0.530321	0.468839	0.414964	0.367698	0.326179	0.289664	0.257514	0.229174	0.204165	0.182069	0.162528	13
14	0.661118	0.577475	0.505068	0.442301	0.387817	0.340461	0.299246	0.263331	0.231995	0.204620	0.180677	0.159710	0.141329	14
15	0.641862	0.555265	0.481017	0.417265	0.362446	0.315242	0.274538	0.239392	0.209004	0.182696	0.159891	0.140096	0.122894	15
16	0.623167	0.533908	0.458112	0.393646	0.338735	0.291890	0.251870	0.217629	0.188292	0.163122	0.141496	0.122892	0.106865	16
17	0.605016	0.513373	0.436297	0.371364	0.316574	0.270269	0.231073	0.197845	0.169633	0.145644	0.125218	0.107800	0.092926	17
18	0.587395	0.493628	0.415521	0.350344	0.295864	0.250249	0.211994	0.179859	0.152822	0.130040	0.110812	0.094561	0.080805	18
19	0.570286	0.474642	0.395734	0.330513	0.276508	0.231712	0.194490	0.163508	0.137678	0.116107	0.098064	0.082948	0.070265	19
20	0.553676	0.456387	0.376889	0.311805	0.258419	0.214548	0.178431	0.148644	0.124034	0.103667	0.086782	0.072762	0.061100	20
21	0.537549	0.438834	0.358942	0.294155	0.241513	0.198656	0.163698	0.135131	0.111742	0.092560	0.076798	0.063826	0.053131	21
22	0.521893	0.421955	0.341850	0.277505	0.225713	0.183941	0.150182	0.122846	0.100669	0.082643	0.067963	0.055988	0.046201	22
23	0.506692	0.405726	0.325571	0.261797	0.210947	0.170315	0.137781	0.111678	0.090693	0.073788	0.060144	0.049112	0.040174	23
24	0.491934	0.390121	0.310068	0.246979	0.197147	0.157699	0.126405	0.101526	0.081705	0.065882	0.053225	0.043081	0.034934	24
25	0.477606	0.375117	0.295303	0.232999	0.184249	0.146018	0.115968	0.092296	0.073608	0.058823	0.047102	0.037790	0.030378	25
26	0.463695	0.360689	0.281241	0.219810	0.172195	0.135202	0.106393	0.083905	0.066314	0.052521	0.041683	0.033149	0.026415	26
27	0.450189	0.346817	0.267848	0.207368	0.160930	0.125187	0.097608	0.076278	0.059742	0.046894	0.036888	0.029078	0.022970	27
28	0.437077	0.333477	0.255094	0.195630	0.150402	0.115914	0.089548	0.069343	0.053822	0.041869	0.032644	0.025507	0.019974	28
29	0.424346	0.320651	0.242946	0.184557	0.140563	0.107328	0.082155	0.063039	0.048488	0.037383	0.028889	0.022375	0.017369	29
30	0.411987	0.308319	0.231377	0.174110	0.131367	0.099377	0.075371	0.057309	0.043683	0.033378	0.025565	0.019627	0.015103	30
31	0.399987	0.296460	0.220359	0.164255	0.122773	0.092016	0.069148	0.052099	0.039354	0.029802	0.022624	0.017217	0.013133	31
32	0.388337	0.285058	0.209866	0.154957	0.114741	0.085200	0.063438	0.047362	0.035454	0.026609	0.020021	0.015102	0.011420	32
33	0.377026	0.274094	0.199873	0.146186	0.107235	0.078889	0.058200	0.043057	0.031940	0.023758	0.017718	0.013248	0.009931	33
34	0.366045	0.263552	0.190355	0.137912	0.100219	0.073045	0.053395	0.039143	0.028775	0.021212	0.015680	0.011621	0.008635	34
35	0.355383	0.253415	0.181290	0.130105	0.093663	0.067635	0.048986	0.035584	0.025924	0.018940	0.013876	0.010194	0.007509	35
36	0.345032	0.243669	0.172657	0.122741	0.087535	0.062625	0.044941	0.032349	0.023355	0.016910	0.012279	0.008942	0.006529	36
37	0.334983	0.234297	0.164436	0.115793	0.081809	0.057986	0.041231	0.029408	0.021040	0.015098	0.010867	0.007844	0.005678	37
38	0.325226	0.225285	0.156605	0.109239	0.076457	0.053690	0.037826	0.026735	0.018955	0.013481	0.009617	0.006880	0.004937	38
39	0.315754	0.216621	0.149148	0.103056	0.071455	0.049713	0.034703	0.024304	0.017077	0.012036	0.008510	0.006035	0.004293	39
40	0.306557	0.208289	0.142046	0.097222	0.066780	0.046031	0.031838	0.022095	0.015384	0.010747	0.007531	0.005294	0.003733	40
41	0.297628	0.200278	0.135282	0.091719	0.062412	0.042621	0.029209	0.020086	0.013860	0.009595	0.006665	0.004644	0.003246	41
42	0.288959	0.192575	0.128840	0.086527	0.058329	0.039464	0.026797	0.018260	0.012486	0.008567	0.005898	0.004074	0.002823	42
43	0.280543	0.185168	0.122704	0.081630	0.054513	0.036541	0.024584	0.016600	0.011249	0.007649	0.005219	0.003573	0.002455	43
44	0.272372	0.178046	0.116861	0.077009	0.050946	0.033834	0.022555	0.015091	0.010134	0.006830	0.004619	0.003135	0.002134	44
45	0.264439	0.171198	0.111297	0.072650	0.047613	0.031328	0.020692	0.013719	0.009130	0.006098	0.004088	0.002750	0.001856	45
46	0.256737	0.164614	0.105997	0.068538	0.044499	0.029007	0.018984	0.012472	0.008225	0.005445	0.003617	0.002412	0.001614	46
47	0.249259	0.158283	0.100949	0.064658	0.041587	0.026859	0.017416	0.011338	0.007410	0.004861	0.003201	0.002116	0.001403	47
48	0.241999	0.152195	0.096142	0.060998	0.038867	0.024869	0.015978	0.010307	0.006676	0.004340	0.002833	0.001856	0.001220	48
49	0.234950	0.146341	0.091564	0.057546	0.036324	0.023027	0.014659	0.009370	0.006014	0.003875	0.002507	0.001628	0.001061	49
50	0.228107	0.140713	0.087204	0.054288	0.033948	0.021321	0.013449	0.008519	0.005418	0.003460	0.002219	0.001428	0.000923	50

Table A-27. Illustrative comparison of total transportation costs.

	Present Value of All Costs ($000)			
Alternative	User Costs[1]	Operating and Maintenance Costs	Capital Costs	Total Transportation Cost
1. Do Nothing (i.e., continue to operate current system)	$55,000	$26,000	$ 307	$81,307
2. Service Cutback	58,000	22,000	—	80,000
3. Modest Service Expansion	46,879	30,425	1,268	78,572
4. Major Service Expansion	42,300	35,000	2,217	79,517

[1] Including both direct user costs (fares) and user travel time costs.

Note: In this example, Alternative 3 has the lowest total transportation cost and would be preferred.

Table A-28. Illustrative comparison of system alternatives.

Impact Measure	Alternative 1	Alternative 2	Alternative 3
System Description			
Number of Routes	14	15	16
Route Mileage	150.2	156.7	170.7
Peak Period On-Road Fleet	21	24	25
Off-Peak On-Road Fleet	17	20	21
Evening and Saturday On-Road Fleet	11	12	18
Weekly Route Mileage	20,264.0	22,888.6	27,542.3
Percent Change from 1981 Operations	− 13.5	− 2.3	+ 17.5
Five-Year Operating Miles	5,270,000	6,014,000	7,084,000
System Performance			
Five-Year Operating Expense[1]	$12,458,000	$14,229,000	$16,796,000
Five-Year Total Ridership[1]	11,067,000	12,034,000	13,484,000
Five-Year Fare Box Revenue	$4,232,000	$4,787,000	$5,168,000
Five-Year Other Revenue	$123,000	$123,000	$123,000
Five-Year Operating Deficit[1]	$8,103,000	$9,319,000	$11,505,000
Five-Year Operating Ratio[1]	0.35	0.34	0.32

[1] Key measure of interest to policymakers.

tiveness matrices must be kept in mind at all times by their users.

Evaluation Methods Applied in Actual Circumstances

Apparently, formal evaluation tools are little used. There do seem to be some areas for methodological improvement but it is important to keep in mind that several basic and continuing constraints will limit the need for additional structuring of the decision-making process.

- There is little sensitivity to or concern for long-range impacts. Transit issues are largely operational in nature, focused on next year's transit budget (and subsidy requirements).
- Alternatives are generally only incremental in nature, focused on operating strategies, and most often only two alternatives are considered by policymakers: the status quo and some modification to it that has been presented by staff for decision-making.
- While a recommended alternative may be the result of a staff evaluation of still other options, even these are largely operational/financial/managerial in nature.
- Capital investment decisions are relatively rare in small cities, and many of these have to do with equipment alternatives (small bus versus big bus, when to buy used or new buses, when to replace aging fleet, etc.).
- Even capital budget decisions are approached in terms of the impact they will have next year in terms of changing service levels. Multiple-year, cumulative life cycle cost impacts are not fully addressed.

Within this context of constraints on the need for complex evaluation tools, it continues to be useful to distinguish between "policymaker" and "managerial" roles in evaluation. To a large extent, where policymakers and staff have established a good working relationship, and working relationship is stable enough for policymakers to have confidence in the professional capabilities of staff, much of the real work in the evaluation of options is delegated to staff. This has a very important influence in determining the market for improved evaluation techniques—*that market largely lies with transit management.*

Policymakers

When it is remembered that policymakers are basically interested in only five or six key measures for assessing service options, it comes as no surprise that supporting evaluation tools are essentially unneeded. Policymakers prefer to judgmentally array these decision-making factors on their own. They wish to preserve their own discretion in subjectively resonding to and comparing such measures. While decisionmakers seem to have little use for or trust in measures of indirect transit benefits, they nevertheless are willing to assign such benefits "judgmental" importance if that seems fitting. However, they have little use for benefit-cost indices.

When only two alternatives (the status quo and some incremental improvement) are typically considered for decision, and only five or six key measures are weighed, any tables that might bring these measures together is a simple one. It is not necessary to glorify such a table with terms like cost-effectiveness matrix, since this does not facilitate the subjective trade-offs that are, in fact, undertaken. In general, policymakers in small urban areas seem quite content with the empirical approach to evaluation.

APPENDIX B

EDUCATIONAL PACKAGE

The purpose of the educational package is to provide material that demonstrates the use of recommended impact measures and communications techniques to help secure approval for a good alternative. The materials developed are designed to be used with minimal need for modification in a variety of small-city settings. A three-part presentation has been developed for use in (1) orienting decision-makers to the general role and benefits of transit in small cities, (2) explaining the impact measures and variables used to evaluate alternatives, and (3) presenting information in both decision-making and monitoring contexts.

PART ONE—GENERAL ORIENTATION

The first part of the educational package is an audiovisual presentation (Exhibit 1) designed as an introduction to transit in small cities. It addresses three basic issues:

1. Whom does transit serve?
2. How do we know when transit is doing its job?
3. What kinds of transit can we use effectively in our community?

This presentation is appropriate for use in orienting new transit board members (or other LEOs) and citizen advisory committee members to transit's general setting and potentials. It is anticipated that the presentation would be used each year as part of the introduction of new transit decision-makers to their duties. Ideally, the presentation should be given at a time when no decision needs to be made. It is intended for general orientation and not as an aid in resolving a specific issue.

A set of slides to accompany the presentation is available from the NCTRP. (Inquiries regarding purchase or loan of a set of slides should be made to the Director, Cooperative Research Programs, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418.) Cities are encouraged to substitute local views for the stock slides and to modify the script as appropriate for their own circumstances. The description of the transit industry is, of necessity, quite general. Specifics for a given city could be added for comparison purposes.

PART TWO—MEASURES AND VARIABLES

The second part of the educational package describes the measures that are used to indicate the costs and benefits of alternative systems and to describe those systems and their performance. This part is designed for presentation just prior to presenting LEOs with descriptions and performance scores for specific alternatives under consideration. The material is to be prepared by local staff, possibly using formats from Part Three of the educational package. Part Two is designed to establish a common vocabulary for discussion of alternatives.

Appendix A described two distinct situations and recommended different measures and material for each: (1) a *system* "justification" circumstance in which consideration is being given to providing transit where none now exists, stopping transit service, or making a major change in the amount of coverage or service and (2) a more "routine" (typically, end-of-the-year) consideration of minor changes in operation. Two recommended sequences of presentation materials and verbal accompaniment follow, one for each of these situations. (See Exhibits 2 and 3.)

The System Justification Circumstance

The material that follows assumes that follow-on local material will present what happens under two sets of circumstances: if no action is taken or if the recommended alternative is adopted. The material could be adapted to a follow-on presentation that includes a "do-nothing" and two or more alternatives. Minor revisions in the verbal material could accommodate such a change. It is assumed that broad general concepts are being discussed; specific details would follow in material in the next part of the presentation or perhaps in hand outs to the elected officials.

Exhibit 1—NOTE: This draft script is provided here to give the reader an indication of the nature and content of the audiovisual package. A final version of the script will be provided with the slides.

DRAFT SCRIPT

PART ONE—EDUCATIONAL PACKAGE

TRANSIT OPTIONS IN SMALL URBAN AREAS

AUDIO	VISUAL
IN PROVIDING PUBLIC TRANSPORTATION SERVICES IN A SMALL CITY, THE TRANSIT INDUSTRY FACES A DIVERSE SET OF	BUSES LOADING AT A STOP.
ISSUES AND HAS A NUMBER OF CHOICES ABOUT WAYS TO PROVIDE SERVICE.	VAN WITH WHEELCHAIR LIFT DEPLOYED.
THIS INTRODUCTION IS INTENDED TO SET THE STAGE FOR BETTER UNDERSTANDING OF TRANSIT ISSUES.	TAXICAB WITH SEVERAL RIDERS.
WE WILL EXPLORE THREE BASIC QUESTIONS:	
WHO DOES TRANSIT SERVE?	??DEMAND FOR SERVICES?? (word slide)
HOW DO WE KNOW WHEN TRANSIT IS DOING ITS JOB?	??PERFORMANCE?? (word slide)
WHAT KINDS OF TRANSIT SERVICE CAN WE USE EFFECTIVELY IN OUR COMMUNITY?	??OPTIONS?? (word slide)
THE ULTIMATE GOAL OF PUBLIC TRANSPORTATION IS TO SERVE THE COMMUNITY'S TRAVEL NEEDS.	LARGE NUMBER OF PEOPLE WAITING AT BUS STOP.
BUT WHO DOES TRANSIT REALLY SERVE?	(OPTION FOR LOCAL INSERTION: SHOT OF COMMUNITY LANDMARK LIKE CITY HALL.)
IN SMALLER CITIES, MOST TRANSIT USERS ARE PEOPLE WHO HAVE NO CHOICE: THE SO-CALLED "TRANSIT DEPENDENTS."	TRANSIT DEPENDENTS (word slide)
WHETHER THROUGH POVERTY,	
HANDICAP,	WHEELCHAIR PASSENGER ON LIFT.
YOUTH, OR	CHILDREN BOARDING BUS.
OLD AGE,	SENIOR CITIZENS ON VAN OR BUS.
MANY PEOPLE CANNOT AFFORD, OPERATE, OR HAVE ACCESS TO PRIVATE AUTOS. FOR THEM, PUBLIC TRANSIT REPRESENTS THE ONLY INEXPENSIVE, CONVENIENT WAY TO MEET THEIR TRAVEL	BUS PICTURE.
NEEDS. THESE PEOPLE HAVE A VITAL STAKE IN PUBLIC TRANSIT PLANNING AND OPERATION.	VAN PICTURE.
THE REMAINDER OF TRANSIT RIDERS ARE GENERALLY REFERRED TO AS "CHOICE RIDERS." ALTHOUGH THEY HAVE ACCESS TO PRIVATE AUTOS, THEY CHOOSE TO USE TRANSIT TO SAVE MONEY, TO AVOID	PICTURE OR SKETCH OF WELL-DRESSED, UPPER MIDDLE-CLASS RIDERS.

DRAFT SCRIPT

AUDIO	VISUAL
CONGESTION, OR FOR OTHER REASONS OF CONVENIENCE. IN SMALL CITIES, HOWEVER, VERY FEW TRANSIT USERS ARE CHOICE RIDERS. UNCONGESTED STREETS,	PICTURE OF WIDE STREET, LITTLE TRAFFIC, 5:00 P.M.
AMPLE PARKING,	PICTURE OR SKETCH: SIGN POINTING TO MUNICIPAL PARKING, MANY SPACES.
AND SHORT DISTANCES MAKE AUTOS MUCH MORE ATTRACTIVE THAN IN BUSTLING LARGE CITIES.	
IN SHORT, THEN, SMALL-CITY TRANSIT SERVES MOSTLY THE TRANSIT DEPENDENT: THOSE WHO HAVE NO CHOICE. HOW WELL TRANSIT DOES ITS JOB MUST BE DECIDED LARGELY IN TERMS OF HOW WELL IT SERVES THE TRANSIT DEPENDENT.	TRANSIT DEPENDENTS (word slide)
PART TWO OF THIS PRESENTATION SHOWS SOME OF THE WAYS COMMONLY USED TO MEASURE PERFORMANCE OF THE TRANSIT SERVICE IN A SMALL CITY.	
FOR NOW, LET'S LOOK AT SOME OF THE OPTIONS AVAILABLE FOR PROVIDING TRANSIT SERVICE IN SMALL CITIES AND SOME OF THE FACTORS AFFECTING THE PROVISION OF SERVICE.	SKETCH GRAPHIC: BIG BUS, SMALL BUS, TAXI.
MOST PEOPLE ASSOCIATE TRANSIT WITH BUSES. CERTAINLY, BUSES HAVE BEEN THE TRADITIONAL MODE OF SMALL-CITY TRANSIT AND REMAIN SO TODAY.	BUS PICTURE: EXTERIOR.
WHERE ENOUGH RIDERS ARE AVAILABLE, BUSES CAN PROVIDE VERY EFFICIENT PUBLIC TRANSIT.	BUS PICTURE: INTERIOR, OVER HALF FULL.
HOWEVER, WHERE RIDERSHIP IS LOW, OTHER MODES MAY BE MORE EFFECTIVE.	BUS PICTURE: INTERIOR, TWO RIDERS.
RECENT TRANSIT INNOVATIONS PROVIDE SEVERAL ALTERNATIVES TO TRADITIONAL BUS SERVICE ON FIXED ROUTES AND SCHEDULES. DEMAND-RESPONSIVE SERVICES INCLUDE "DIAL-A-RIDE" AND SHARED-RIDE TAXI SERVICES. THEY USE	PICTURE OF DIAL-A-RIDE VEHICLE. PICTURE OF TAXI IN SHARED-RIDE SERVICE.

DRAFT SCRIPT

AUDIO	VISUAL
SMALLER, LESS COSTLY VEHICLES AND CAN BE MORE COST-EFFECTIVE IN SERVING DISPERSED, SPARSELY-POPULATED AREAS. IN THESE AREAS, RIDERSHIP LEVELS ARE USUALLY TOO LOW TO SUPPORT THE COST OF PROVIDING REGULAR, SCHEDULED SERVICE WITH LARGE VEHICLES.	AERIAL PHOTO OF SPRAWLING SUBURB. PICTURE OF LARGE BUS IN REMOTE AREA.
PARATRANSIT IS ANOTHER OPTION FOR SMALL COMMUNITIES. PARATRANSIT SERVICES INCLUDE CARPOOLS, VANPOOLS, AND BUSPOOLS.	WORD SLIDE: PARATRANSIT. PHOTO: HIGHWAY SIGN ABOUT CARPOOLS. PHOTO: MARKED VANPOOL VEHICLE. PHOTO: MARKED POOL BUS (MAY HAVE TO USE ARTWORK).
IN EACH CASE, USERS PAY MOST OF THE COST INVOLVED, AND A POOL MEMBER RATHER THAN A TRANSIT EMPLOYEE DRIVES THE VEHICLE.	PHOTO: POOL VEHICLE DRIVER.
THE TRANSIT SYSTEM CAN PLAY A ROLE IN POOLED TRAVEL BY HELPING AREA RESIDENTS WISHING TO FORM VEHICLE POOLS. SOME SYSTEMS EVEN PROVIDE VEHICLES FOR PARATRANSIT USE.	PHOTO: CARPOOL INFO PHONE NUMBER.
SOME FACTS ABOUT SMALL-CITY TRANSIT SERVICE HELP PROVIDE A PERSPECTIVE WHEN DECISIONS ABOUT TRANSIT SERVICE MUST BE MADE. FIRST, NOW THAT WE KNOW WHO USES TRANSIT, HOW IMPORTANT IS TRANSIT IN THE OVERALL TRAVEL NEEDS OF A TYPICAL SMALL CITY?	"JUST THE FACTS, MA'AM" (word slide)
ON THE AVERAGE, ONLY ONE TO THREE PERCENT OF ALL TRIPS MADE IN CITIES OF UNDER 200,000 POPULATION ARE MADE BY TRANSIT.	PIE CHART SHOWING PERCENTAGE OF TRIPS BY TRANSIT.
OF THOSE TRIPS, 40 TO 70 PERCENT ARE WORK TRIPS, 10 TO 20 PERCENT ARE FOR SHOPPING, FIVE TO 40 PERCENT FOR SCHOOL, AND FIVE TO 10 PERCENT FOR PERSONAL BUSINESS, INCLUDING MEDICAL TRIPS, IN A TYPICAL SMALL CITY.	PIE CHART SHOWING TRIP PURPOSE PERCENTAGES.

DRAFT SCRIPT

AUDIO	VISUAL
FIFTEEN TO 20 PERCENT OF RIDERS ARE SENIOR CITIZENS, AND 70 PERCENT OF RIDERS ARE FEMALE, IN A TYPICAL SMALL-CITY TRANSIT SYSTEM.	BAR CHART, TWO BARS: SHOWING PERCENT SENIORS AND PERCENT FEMALE.
(NOTE: LOCAL DATA MAY BE INSERTED HERE AT LOCAL OPTION FOR COMPARISON.)	
THE LOCAL TRANSIT INDUSTRY, IN 1982, EMPLOYED 197,000 WORKERS, PAID OUT $7.6 BILLION IN OPERATING COSTS, AND INVESTED $3.5 BILLION IN NEW CAPITAL PLANT AND EQUIPMENT.	WORD SLIDE WITH SKETCH GRAPHICS.
OF THOSE TOTALS, OVER 10,000 EMPLOYEES WORKED IN CITIES OF UNDER 200,000 POPULATION, AND SMALL CITY TRANSIT EXPENDITURES WERE $70 TO $100 MILLION FOR OPERATING COSTS AND $200 TO $250 MILLION FOR CAPITAL.	SIMILAR SLIDE WITH NUMBERS FOR SMALL CITIES.
THE AVERAGE FLEET SIZE FOR A SMALL-CITY TRANSIT SYSTEM IS 37 BUSES. VANS ARE OPERATED BY 27 PERCENT OF SMALL-CITY TRANSIT SYSTEMS, WITH AN AVERAGE FLEET OF FOUR VEHICLES. OF COURSE, HUMAN SERVICE AGENCIES OFTEN PROVIDE TRANSPORTATION SERVICES FOR THEIR CLIENTS, AND THOSE SERVICES ARE NOT COUNTED IN THE TOTALS GIVEN.	GRAPHIC OF FLEET OF BUSES. GRAPHIC OF VAN FLEET.
LABOR AND FUEL ARE MAJOR COMPONENTS OF TRANSIT OPERATING COST. IN 1982, LABOR COSTS WERE 65 PERCENT OF SMALL-CITY TRANSIT OPERATING COSTS, AND FUEL REPRESENTED 13 PERCENT. OVER THE PAST FEW YEARS, THE THE PRICE OF THESE INPUTS HAS RISEN SHARPLY. SO HAVE TRANSIT DEFICITS.	GRAPHIC OF WORKERS AND FUEL PUMPS. PIE CHART SHOWING LABOR, FUEL, OTHER PERCENT OF OPERATING COSTS. GRAPHIC SHOWING TRANSIT WAGE COST INDEX, 1975-1983; DITTO FOR FUEL COST INDEX, DEFICIT INDEX.
ON THE AVERAGE, TRANSIT FARES NOW PAY ONLY 26 PERCENT OF OPERATING COSTS FOR SMALL-CITY TRANSIT SYSTEMS. THE REST COMES FROM FEDERAL, STATE, AND LOCAL SUBSIDIES.	PIE CHART SHOWING REVENUE SOURCES: FARE BOX AND SUBSIDY.

Exhibit 1—Continued

DRAFT SCRIPT

AUDIO	VISUAL
IN GENERAL, OPERATING COSTS HAVE GROWN FASTER THAN SYSTEMS HAVE BEEN ABLE TO INCREASE REVENUE EITHER BY ATTRACTING MORE RIDERS OR BY RAISING FARES. THIS IS WHY TRANSIT DEFICITS HAVE GROWN.	BAR CHART SHOWING OPERATING COST FOR EACH OF SEVERAL YEARS, WITH FARE BOX REVENUE AS A DECREASING PERCENT OF TOTAL COST OR REVENUE.
IT IS GENERALLY DIFFICULT TO ATTRACT MORE RIDERS BECAUSE OF OVERALL LOW DENSITIES IN SMALL CITIES, BECAUSE OF DISPERSION OF EMPLOYMENT OPPORTUNITIES AWAY FROM THE CENTRAL AREAS OF SMALL CITIES, AND BECAUSE OF THE FACT THAT AUTO TRAVEL TIMES ARE GENERALLY MUCH SHORTER THAN TRANSIT TRAVEL TIMES IN SMALL CITIES.	WORD SLIDE: DENSITIES DISPERSION TRAVEL TIME
AS A RESULT, MANY SMALL CITIES FIND THEY MUST CHOOSE THAT LEVEL OF SERVICE AND THAT LEVEL OF DEFICIT THAT BEST BALANCES THE NEEDS OF THE TRANSIT-DEPENDENT RIDERS WITH THE MONEY AVAILABE TO PAY FOR SERVICE.	TIMETABLE WITH A QUESTION MARK SUPERIMPOSED. BUDGET WITH QUESTION MARK SUPERIMPOSED. BALANCE SCALE WITH VEHICLE IN ONE SIDE AND PILE OF COINS IN THE OTHER.
ANOTHER PRESENTATION WILL BE GIVEN AT A LATER MEETING TO DESCRIBE SOME OF THE MEASURES USED TO HELP MAKE THE DECISION.	

The verbal material and the slides furnish illustrations to describe the contents of a comparison-evaluation process like that recommended in Appendix A, Section 5, cost-effectiveness analysis. The measures are grouped into four categories: primary (measurable) costs and benefits, secondary costs and benefits, descriptive (of the system) measures, and performance measures.

The Routine, End-of-Year Circumstance

As with the justification circumstance, the presentation assumes that specific local material will follow to present the actual values of the measures for continuation of current operations and one or more changes for the coming year.

In contrast to the justification situation, only the primary, descriptive and performance measures are presented. The overall cost and benefit or evaluation question is assumed *not* to be under consideration. Put differently, the continuation of a system is not the issue; marginal change is.

A second contrast to the justification situation is the frequent use of comparisons to prior and current years when presenting projected (or planned) measures, rather than comparisons to the "do-nothing" or some other alternative.

Exhibit 2—NOTE: This draft script is provided here to give the reader an indication of the nature and content of the audiovisual package. A final version of the script will be provided with the slides.

DRAFT SCRIPT

SUGGESTED SCRIPT FOR JUSTIFICATION CIRCUMSTANCE

AUDIO	VISUAL
FOUR GROUPS OF CRITERIA AND MEASURES ARE USED TO DESCRIBE ALTERNATIVE TRANSIT SYSTEMS: • ANNUAL COST OF ALTERNATIVES • POTENTIAL BENEFITS, BOTH TO THE USER AND TO THE PUBLIC IN GENERAL • DESCRIPTION OF EACH ALTERNATIVE • PERFORMANCE OF EACH ALTERNATIVE THE BENEFITS AND COSTS OF ALTERNATIVE TRANSIT SYSTEMS (OR OF THE NO-BUILD OR DO-NOTHING ALTERNATIVE) ARE BASED ON ESTIMATES OF THE NUMBER OF PEOPLE WHO WOULD USE THE SYSTEM, THEIR AUTOMOBILES, OR SOME OTHER MODE OF TRAVEL, UNDER THE CIRCUMSTANCES OF EACH ALTERNATIVE.	WORD SLIDE: COST BENEFITS DESCRIPTION PERFORMANCE
BENEFITS AND COST MAY BE VIEWED FROM TWO POINTS OF VIEW: THAT OF THE USER AND THAT OF THE GENERAL PUBLIC. FOR THE USER, THE BENEFIT IS IN MAKING THE TRIP TO WORK, TO SHOP, OR FOR SOME OTHER PURPOSE, AND THE COST BASICALLY IS THE FARE INVOLVED OR THE COST OF OPERATING AN AUTO. FOR THE PUBLIC, THE BENEFITS MAY BE IN PROVIDING MOBILITY TO CITIZENS OF THE CITY OR IN REDUCED EMISSIONS OR ENERGY USE, WHILE THE COST IS MEASURED BY THE DIFFERENCE BETWEEN ANNUALIZED COST OF OPERATING THE SYSTEM AND THE INCOME FROM THE FARE BOX.	WORD SLIDE: USER / PUBLIC Benefits: Trip / Mobility, Conservation Costs: Fare or Operating Cost / Public Subsidies
GENERALLY THERE ARE TWO GROUPS OF USERS, EACH OF WHICH REACTS QUITE DIFFERENTLY TO THE PROVISION OF TRANSIT SERVICE OR TO MAJOR CHANGES IN SERVICE: THOSE WITH AN AUTO (OR ACCESS TO AN AUTO) AND THOSE WHO HAVE NO AUTO.	
WITHIN CITIES THE SIZE OF OURS, OVER 90 PERCENT OF ALL TRAVEL IS MADE AS A DRIVER OR PASSENGER IN AN AUTOMOBILE. ABOUT FIVE PERCENT IS BY SOME OTHER MODE, USUALLY WALKING	PIE CHART: TRAVEL BY MODE (PERCENT).

DRAFT SCRIPT

AUDIO	VISUAL
OR BICYCLE, AND ABOUT THREE PERCENT IS BY TRANSIT WHERE A REASONABLY GOOD SYSTEM IS IN OPERATION.	
OF ALL TRIPS MADE BY AUTO, ABOUT ONE-THIRD ARE TO WORK, WHILE THE OTHER SINGLE MAJOR PURPOSE IS SOCIAL OR RECREATIONAL. IN CONTRAST, HOWEVER, OVER ONE-HALF OF ALL TRIPS MADE BY TRANSIT ARE TO WORK, AND THE SHARE OF TRIPS TO SCHOOL IS MUCH LARGER THAN IT IS FOR AUTOS. OTHER PURPOSES ALL DECREASE COMPARED TO THEIR VALUES WHEN AN AUTO IS USED.	TWO BAR CHARTS: TRAVEL BY MODE (PERCENT). COMPARE AUTO TRIPS BY PURPOSE TO TRANSIT TRIPS BY PURPOSE.
PEOPLE WHO LIVE IN HOUSEHOLDS WITH AUTOMOBILES MAKE MORE TRIPS THAN THOSE WHO LIVE IN HOUSEHOLDS WITHOUT CARS, EVEN WHEN A TRANSIT SYSTEM IS AVAILABLE. AS ONE WOULD EXPECT, TRANSIT TRIPS MADE BY THOSE WITHOUT CARS ARE MORE CONCENTRATED IN WORK AND SCHOOL.	TWO BAR CHART: TRIPS PER PERSON, HOUSEHOLDS WITH CARS, AND TRIPS PER PERSON, HOUSEHOLDS WITHOUT CARS HAVING TRANSIT AVAILABLE.
PEOPLE WITHOUT AUTOMOBILES, FOR WHOM TRANSIT IS NOT AVAILABLE, MAKE EVEN FEWER TRIPS THAN THOSE WHO CAN RIDE A BUS. THESE ARE PEOPLE WHO BENEFIT DIRECTLY FROM THE ACCESSIBILITY PROVIDED BY TRANSIT TO JOBS, STORES, MEDICAL AND OTHER SERVICE FACILITIES, AND EVEN FRIENDS AND ENTERTAINMENT.	THREE BAR CHART: AS ABOVE, ADDING A BAR FOR HOUSEHOLDS WITHOUT CARS, TRANSIT NOT AVAILABLE.
THE FIRST GROUP OF MEASURES USED TO COMPARE ALTERNATIVE SYSTEMS IS THE COSTS. USUALLY THE COSTS, WHETHER BY AUTO OR BY TRANSIT, ARE DIVIDED INTO CATEGORIES: OPERATIONS AND MAINTENANCE ON THE ONE HAND, AND CAPITAL AND CONSTRUCTION ON THE OTHER.	
FOR HIGHWAYS, FEDERAL, STATE, AND LOCAL GOVERNMENTS GENERALLY COVER MAINTENANCE AND CONSTRUCTION COSTS, WHILE USERS PAY THE CAPITAL AND OPERATING COSTS OF VEHICLES IN THE OPEN MARKET.	BAR CHART: HIGHWAY MAINTENANCE COSTS, DIVIDED INTO FEDERAL, STATE, LOCAL SOURCES OF FUNDS; HIGHWAY CONSTRUCTION COSTS, SIMILARLY DIVIDED.

Exhibit 2—Continued

DRAFT SCRIPT

AUDIO	VISUAL
TRANSIT OPERATING COSTS ARE COVERED BY A COMBINATION OF FARES PLUS FEDERAL, STATE, AND LOCAL ASSISTANCE. CAPITAL COSTS GENERALLY ARE PAID BY FEDERAL, STATE, AND LOCAL FUNDS.	
THE CONTRAST IN AMOUNTS OF FUNDS FOR THE TWO DIFFERENT MODES IS STRIKING. THE FIGURE SHOWS RELATIVE MAGNITUDE, NOT SPECIFICS FOR ANY PARTICULAR CITY.	
THE NEXT SLIDE SHOWS THE DISAGGREGATION OF TRANSIT COSTS AND REVENUES MORE CLEARLY.	BAR CHART, AS ABOVE, FOR TRANSIT.
GENERALLY, OPERATING COSTS RUN TWO TO TWO AND A HALF TIMES ANNUALIZED CAPITAL COSTS. LOCAL FUNDS AND FARES MAKE UP ABOUT 50 TO 70 PERCENT OF OPERATING COSTS IN MOST CITIES, WITH FEDERAL AND, IN SOME PLACES, STATE ASSISTANCE PAYING THE BALANCE.	
THE LOCAL SHARE OF CAPITAL COST VARIES FROM 10 TO 20 PERCENT DEPENDING ON STATE PARTICIPATION. (HERE A COMMENT ABOUT STATE ASSISTANCE IN YOUR PARTICULAR LOCATION MAY BE INSERTED.)	
USUALLY OVER HALF OF OPERATING AND MAINTENANCE COSTS GOES TO SALARIES, WAGES, AND FRINGE BENEFITS FOR EMPLOYEES. ONLY ABOUT 40 PERCENT TYPICALLY IS SPENT FOR FUEL, TIRES, PARTS, AND OTHER MISCELLANEOUS NON-SALARY ITEMS.	PIE CHART SHOWING PERCENT DISTRIBUTION OF TRANSIT OPERATING COST DOLLAR.
WHAT ARE THE BENEFITS?	
FOR USERS, MOBILITY, ACCESS TO WORK, SHOPPING, MEDICAL, DENTAL, RECREATION, AND SOCIAL ACTIVITIES.	

DRAFT SCRIPT

AUDIO	VISUAL
FOR THE PUBLIC, IN SOME CITIES WHERE USE IS HIGH OR IN SELECTED LOCATIONS, REDUCED CONGESTION ON THE STREETS AND HIGHWAYS AND REDUCED ENERGY CONSUMPTION, ACCIDENTS AND EMISSIONS.	WORD SLIDE: USER BENEFITS—MOBILITY ACCESS TO WORK SHOPPING MEDICAL SERVICES SOCIAL AND RECREATIONAL ACTIVITIES.
ANOTHER GROUP OF BENEFITS, WHICH IS DIFFICULT TO QUANTIFY, OCCURS IN SPECIFIC EMPLOYMENT, PARKING REDUCTION, AND IN TRADE AND DEVELOPMENT.	SKETCH SLIDE: HIGHWAY CONGESTION (SKETCH OF ONE BUS AND 12 AUTOS). BAR CHART (GENERAL, NO NUMBERS) FUEL: GALLONS PER PERSON-MILE (COMPARING AUTO AND TRANSIT). BAR CHART (GENERAL, NO NUMBERS) ACCIDENTS PER MILLION PERSON-MILES (COMPARING AUTO AND TRANSIT). BAR CHART (GENERAL, NO NUMBERS) EMISSIONS PER PERSON-MILE (COMPARING AUTO AND TRANSIT ON HYDROCARBONS, CO AND NO_x).
TRANSIT PROVIDES THE ABILITY TO GET TO WORK FOR SOME PEOPLE IN A COMMUNITY, AND THEIR LOSS IN WAGES, WHEN THEY ARE UNEMPLOYED, FREQUENTLY IS USED AS A MEASURE OF THE VALUE OF THEIR EMPLOYMENT TO THE PUBLIC AT LARGE. TRANSIT ALSO BENEFITS THE EMPLOYER BY OFFERING ACCESS TO A LARGER POOL OF EMPLOYEES AND THROUGH REDUCED ABSENTEEISM.	
IN DENSE CONCENTRATED LOCATIONS, SUCH AS DOWNTOWN AREAS OR LARGE EMPLOYMENT CENTERS, TRANSIT CAN REDUCE THE NEED FOR PARKING SPACES.	
TRANSIT ALSO CAN FOCUS TRADE, FOR EXAMPLE IN A CBD, ALTHOUGH THE EFFECT IS VERY SMALL IN CITIES OF OUR SIZE, AND THE EFFECT ON DEVELOPMENT IS LIKELY TO BE NEGLIGIBLE.	
THE NUMBER OF TRIPS SERVED, OR PASSENGERS BOARDING, IS A FUNDAMENTAL MEASURE OF TRANSIT SYSTEM PERFORMANCE.	

Exhibit 2—Continued

DRAFT SCRIPT

AUDIO	VISUAL
EARLIER, CAPITAL COST WAS PRESENTED ON AN ANNUALIZED BASIS, AS A MEASURE OF SYSTEM COST FOR COMPARISON TO OPERATING COST AND OTHER ANNUALIZED BENEFITS. THIS FIGURE SHOWS TYPICAL CAPITAL COSTS OVER A 10-YEAR PERIOD. THE SCENARIO ASSUMED REFLECTS INITIAL EQUIPMENT PURCHASE AND GARAGE CONSTRUCTION, VERY LITTLE CAPITAL EXPENDITURE FOR SEVERAL YEARS THEREAFTER, AND THEN A PROGRAM OF EQUIPMENT REPLACEMENT AND SLOW EXPANSION BEGINNING IN THE FIFTH OR SIXTH YEAR.	BAR CHART: ONE BAR PER YEAR; DIVIDED INTO LOCAL, STATE, AND FEDERAL SHARES.
THE SYSTEM FREQUENTLY IS DESCRIBED IN TERMS OF A BASIC ROUTE MAP THAT GIVES AN IDEA OF THE PORTION OF THE SERVICE AREA COVERED BY THE SERVICE PROVIDED. THE DAYS AND HOURS OF SERVICE INDICATE NOT ONLY WHEN SERVICE IS AVAILABLE, BUT ALSO SHOW THE PEAK SERVICE PERIOD, ALONG WITH OFF-PEAK, EVENING, AND WEEKEND SERVICE, INDICATING THE LEVEL OF SERVICE, WHICH REFLECTS THE HIGHER DEMAND FOUND IN THE MORNING AND AFTERNOON.	ROUTE MAP: STYLIZED SKETCH. BAR GRAPH SHOWING SERVICE PERIODS BY DAY OF WEEK.
THE NUMBER OF BUSES IN OPERATION IN VARIOUS PERIODS, AND THE USE OF SUPPLEMENTARY BUSES IN PEAKS ON SOME ROUTES, ALSO ILLUSTRATES THE LEVEL OF SERVICE AND THE SIZE OF THE SYSTEM.	BAR GRAPH: SEPARATE BARS SHOWING NUMBER OF BUSES SCHEDULED IN A.M. PEAK, P.M. PEAK, MIDDAY, EVENING, SATURDAY, SUNDAY. (NOTE: SHOULD BE GENERALIZED; NO NUMBERS.)
THE NUMBER OF EMPLOYEES IS ANOTHER MEASURE OF THE SIZE OF THE SYSTEM, ALSO REFLECTS THE CONTRIBUTION OF THE SYSTEM TO EMPLOYMENT IN THE COMMUNITY, AND SHOWS THE RELATIVE NUMBER OF EMPLOYEES IN SYSTEM MANAGEMENT, MAINTENANCE, SUPERVISION, AND ACTUAL OPERATION ON THE STREETS.	BAR GRAPH: NUMBER OF EMPLOYEES (GENERALIZED), SHOWING OPERATORS, MAINTENANCE, AND GENERAL AND ADMINISTRATIVE ON SEPARATE BARS.

DRAFT SCRIPT

AUDIO	VISUAL
PERHAPS THE MAJOR MEASURE OF SYSTEM SIZE AND SERVICE IS THE VEHICLE-MILE OR VEHICLE-HOUR—ONE BUS TRAVELING ONE MILE OR ONE HOUR. TYPICALLY, A BUS WOULD BE IN SERVICE FOR 1,500 TO 2,000 HOURS A YEAR AND WOULD TRAVEL 20,000 to 25,000 MILES.	WORD SLIDE: VEHICLE-MILE OR HOUR = ONE BUS TRAVELING ONE MILE OR HOUR IN REVENUE SERVICE.
TYPICAL FARES INCLUDE A BASE FARE, A TRANSFER CHARGE, AND REDUCED RATES FOR CHILDREN, ELDERLY, OR HANDICAPPED. SOMETIMES HIGHER PEAK FARES ARE USED AND PASSES, WHICH OFFER A REDUCED RATE ON ON A PER-RIDE BASIS, ARE MADE AVAILABLE FOR FREQUENT USERS.	BAR GRAPH: FARE STRUCTURE (GENERALIZED); SEPARATE BARS FOR PEAK FARE, TRANSFER CHARGE, OFF-PEAK FARE, SCHOOL, ELDERLY, WEEKLY, AND MONTHLY PASS (PER RIDE BASED ON X RIDES).
THE PERFORMANCE OF A PARTICULAR ALTERNATIVE CAN BE COMPARED TO OTHER ALTERNATIVES THROUGH SEVERAL MEASURES.	
ONE IS THE PERCENT OF HOUSEHOLDS SERVED, ASSUMING A REASONABLE WALKING DISTANCE MEASURES COVERAGE OF THE ROUTES AND SERVICE. THIS MEASURE MAY BE REFINED BY COUNTING THE PERCENTAGE OF MINORITY GROUPS, ELDERLY, LOW INCOME, OR HANDICAPPED PERSONS SERVED BY THE SYSTEM, IF DATA ARE AVAILABLE.	PIE CHART: PERCENT OF HOUSEHOLDS SERVED.
PERHAPS THE KEY MEASURES OF PERFORMANCE ARE THE COST PER PASSENGER AND THE FARE BOX REVENUE PER PASSENGER. THESE ARE SIMPLY THE TOTAL COST, DIVIDED BY THE NUMBER OF PASSENGERS WHO BOARD THE SYSTEM, OR TOTAL REVENUE, ALSO DIVIDED BY THE NUMBER OF PERSONS BOARDING.	BAR GRAPH: COST PER PASSENGER TWO BARS: ONE FOR COST PER PASSENGER, ONE FOR REVENUE PER PASSENGER (GENERALIZED, NO NUMBERS).
A PRODUCTIVITY MEASURE THAT IS USEFUL IN COMPARING ALTERNATIVE SYSTEMS IS THE NUMBER OF PASSENGERS PER VEHICLE-HOUR OR PER VEHICLE-MILE.	BAR GRAPH: PASSENGERS PER VEHICLE-HOUR PASSENGERS PER VEHICLE-MILE.

Exhibit 3—NOTE: This draft script is provided here to give the reader an indication of the nature and content of the audiovisual package. A final version of the script will be provided with the slides.

DRAFT SCRIPT

SUGGESTED SCRIPT FOR ROUTINE CIRCUMSTANCES

AUDIO	VISUAL
THREE GROUPS OF CRITERIA AND MEASURES COMMONLY ARE USED TO COMPARE CHANGES IN A TRANSIT SYSTEM FROM YEAR TO YEAR: A GROUP OF PRIMARY MEASURES, INCLUDING COSTS AND NUMBER OF PASSENGERS CARRIED; A SET OF SYSTEM DESCRIPTIVE MEASURES COMPARING NEXT YEAR'S SYSTEM TO CURRENT AND PRIOR YEARS; AND, FINALLY, A SET OF PERFORMANCE MEASURES.	WORD SLIDE: PRIMARY MEASURES DESCRIPTIVE MEASURES PERFORMANCE MEASURES.
ALL OF THESE MEASURES COMMONLY ARE SHOWN FOR THE CURRENT YEAR AND FOR THE PAST YEAR AS WELL AS FOR THE PROJECTED OR EXPECTED YEAR.	BAR GRAPH (GENERALIZED) SHOWING BARS FOR LAST YEAR, CURRENT YEAR, NEXT YEAR.
THE COSTS OF THE SYSTEM USUALLY ARE DIVIDED INTO TWO CATEGORIES: OPERATIONS AND MAINTENANCE, ON THE ONE HAND, AND CAPITAL AND CONSTRUCTION ON THE OTHER.	BAR CHART: TRANSIT MAINTENANCE COSTS, DIVIDED INTO FEDERAL, STATE, LOCAL SOURCES OF FUNDS; TRANSIT CONSTRUCTION COSTS, SIMILARLY DIVIDED.
OPERATIONS AND MAINTENANCE COSTS ARE COVERED BY A COMBINATION OF FARE PLUS FEDERAL, STATE, AND LOCAL ASSISTANCE. CAPITAL COSTS GENERALLY ARE PAID BY FEDERAL, STATE, AND LOCAL FUNDS.	
GENERALLY, OPERATING COSTS RUN TWO TO TWO AND A HALF TIMES CAPITAL COST. LOCAL FUNDS AND FARES MAKE UP 50 TO 70 PERCENT OF OPERATING COST IN MOST CITIES, WITH FEDERAL AND, IN SOME PLACES, STATE ASSISTANCE PAYING THE BALANCE. THE LOCAL SHARE OF CAPITAL COST VARIES FROM 10 TO 20 PERCENT DEPENDING ON STATE PARTICIPATION. (HERE A COMMENT ABOUT STATE ASSISTANCE IN YOUR PARTICULAR LOCATION MAY BE INSERTED.)	
USUALLY, OVER HALF OF OPERATING AND MAINTENANCE COST GOES TO SALARIES, WAGES, AND FRINGE BENEFITS FOR EMPLOYEES. ONLY ABOUT 40	PIE CHART SHOWING PERCENT DISTRIBUTION OF TRANSIT OPERATING COST DOLLAR.

DRAFT SCRIPT

AUDIO	VISUAL
PERCENT TYPICALLY IS SPENT FOR FUEL, TIRES, PARTS, AND OTHER MISCELLANEOUS NON-SALARY ITEMS.	
THE SYSTEM FREQUENTLY IS DESCRIBED IN TERMS OF A BASIC ROUTE MAP THAT GIVES AN IDEA OF THE PORTION OF THE SERVICE AREA COVERED BY THE SERVICE PROVIDED. THE DAYS AND HOURS OF SERVICE INDICATE NOT ONLY WHEN SERVICE IS AVAILABLE, BUT ALSO SHOW THE PEAK SERVICE PERIODS, ALONG WITH THE OFF-PEAK, EVENING, AND WEEKEND SERVICE, INDICATING THE LEVEL OF SERVICE, WHICH REFLECTS THE HIGHER DEMAND FOUND IN THE MORNING AND AFTERNOON.	ROUTE MAP: STYLIZED SKETCH. BAR GRAPH SHOWING SERVICE PERIODS BY DAY OF WEEK.
THE NUMBER OF BUSES IN OPERATION IN VARIOUS PERIODS, AND THE USE OF SUPPLEMENTARY BUSES IN PEAKS ON SOME ROUTES, ALSO ILLUSTRATES THE LEVEL OF SERVICE AND THE SIZE OF THE SYSTEM.	BAR GRAPH: SEPARATE BARS SHOWING NUMBER OF BUSES SCHEDULED IN A.M. PEAK, P.M. PEAK, MIDDAY, EVENING, SATURDAY, SUNDAY. (NOTE: SHOULD BE GENERALIZED; NO NUMBERS).
THE NUMBER OF EMPLOYEES IS ANOTHER MEASURE OF THE SIZE OF THE SYSTEM, ALSO REFLECTS THE CONTRIBUTION OF THE SYSTEM TO EMPLOYMENT IN THE COMMUNITY, AND SHOWS THE RELATIVE PROPORTION OF EMPLOYEES IN SYSTEM MANAGEMENT, MAINTENANCE, SUPERVISION, AND ACTUAL OPERATION ON THE STREETS.	BAR GRAPH: NUMBER OF EMPLOYEES (GENERALIZED), SHOWING OPERATORS, MAINTENANCE, AND GENERAL AND ADMINISTRATIVE ON SEPARATE BARS.
PERHAPS THE MAJOR MEASURE OF SYSTEM SIZE AND SERVICE IS THE VEHICLE-MILE OR VEHICLE-HOUR—ONE BUS TRAVELING ONE MILE OR ONE HOUR. TYPICALLY, A BUS WOULD BE IN SERVICE FOR 1,500 TO 2,000 HOURS A YEAR AND WOULD TRAVEL 20,000 to 25,000 MILES.	WORD SLIDE: VEHICLE-MILE OR HOUR = ONE BUS TRAVELING ONE MILE OR HOUR IN REVENUE SERVICE.
TYPICAL FARES INCLUDE A BASE FARE, A TRANSFER CHARGE, AND A REDUCED RATE FOR CHILDREN, ELDERLY, OR HANDICAPPED. SOMETIMES HIGHER PEAK FARES ARE USED AND PASSES, WHICH OFFER A REDUCED RATE ON ON A PER-RIDE BASIS, ARE MADE AVAILABLE FOR FREQUENT USERS.	BAR GRAPH: FARE STRUCTURE (GENERALIZED); SEPARATE BARS FOR PEAK FARE, TRANSFER CHARGE, OFF-PEAK FARE, SCHOOL, ELDERLY, WEEKLY, AND MONTHLY PASS (PER RIDE BASED ON X RIDES).

Exhibit 3—Continued

DRAFT SCRIPT

AUDIO	VISUAL
PERFORMANCE FROM YEAR TO YEAR CAN BE COMPARED THROUGH SEVERAL MEASURES.	
ONE IS THE PERCENT OF HOUSEHOLDS SERVED, ASSUMING A REASONABLE WALKING DISTANCE MEASURES COVERAGE OF THE ROUTES AND SERVICE. THIS MEASURE MAY BE REFLECTED BY COUNTING THE PERCENTAGE OF MINORITY GROUPS, ELDERLY, LOW INCOME, OR HANDICAPPED PERSONS SERVED BY THE SYSTEM, IF DATA ARE AVAILABLE.	PIE CHART: PERCENT OF HOUSEHOLDS SERVED.
PERHAPS THE KEY MEASURES OF PERFORMANCE ARE THE COST PER PASSENGER AND THE FARE BOX REVENUE PER PASSENGER. THESE ARE SIMPLY THE TOTAL COST, DIVIDED BY THE NUMBER OF PASSENGERS WHO BOARD THE SYSTEM, OR TOTAL REVENUE, ALSO DIVIDED BY THE NUMBER OF PERSONS BOARDING.	BAR GRAPH: COST PER PASSENGER TWO BARS: ONE FOR COST PER PASSENGER, ONE FOR REVENUE PER PASSENGER (GENERALIZED, NO NUMBERS).
A PRODUCTIVITY MEASURE THAT IS USEFUL IN COMPARING ALTERNATIVE SYSTEMS IS THE NUMBER OF PASSENGERS PER VEHICLE-HOUR OR PER VEHICLE-MILE.	BAR GRAPH: PASSENGERS PER VEHICLE-HOUR PASSENGERS PER VEHICLE-MILE.

PART THREE—SPECIFIC SYSTEM INFORMATION

The last part of the educational package is a format for presenting specific information pertaining to an individual transit system to that transit system's decision-makers. It consists of a series of templates that can be used to organize and present alternatives; either a transit/no transit decision in the case of system justification or adoption of a recommended plan for the coming year in the case of routine decision-making. The templates are presented as reproducible artwork in this report. A transit system having access to a dry copier that accommodates sheet or roll acetate can easily reproduce the templates on acetate and then use a grease pencil to fill in the appropriate numbers and/or lines on each to supply specific information. The same acetate templates can be used over and over again for periodic presentations.

System Justification

System justification templates are presented as comparison of two alternatives, which for most general applicability are labeled "Alternative 1" and "Alternative 2." They may be described by the user as transit versus no transit or status quo versus recommended alternative, as appropriate. The general format simply contains boxes arranged in columns headed Alternative 1 and Alternative 2, with the rows naming the specific indicators or measures under discussion. The user is expected to insert the appropriate numerical values (absolute or percent, as indicated) in the boxes. Table B-1 lists the headings and row names to be used for these templates.

Routine Decisions

The presentation format for routine decisions differs from that for system justification. In most cases, comparisons are to be made between the last year, the current year, and the coming year (under conditions of the recommended alternatives). The system templates give the option of presenting information in numerical form only, with absolute values and percent changes, or in graphic form. Table B-2 indicates the nature of information to be furnished. Templates are provided for systemwide comparisons from year to year and also for comparisons between individual routes in the system.

Monitoring

It is more difficult to recommend template formats for monitoring, because different transit systems present different information in the periodic monitoring package, and LEOs in different systems have varied interest. One sketch of a template is presented to illustrate a concept for drawing LEOs' attention to ongoing system performance. In actual application, a number of other variables could be presented as well, and therefore a blank format allowing a local transit system to fill in variable names as well as the chart bars appears the most suitable device with general applicability.

Table B-1. List of templates for system justification.

Template Number	Heading	Row Names (Column Names are Alternative 1 and Alternative 2 unless noted.)
1	System Benefits	Accidents Emissions (HC) Emissions (CO) Emissions (NO_x) Energy
2	Costs and Revenues	Operating and Maintenance Cost Annualized Capital Cost Fare Box and Other Revenue Net Public Cost
3	Sources of Funding	Net Public Cost Federal State Local: Source ____________ Local: Source ____________
4	Capital Cost to ______ Year Horizon	Total Capital Cost Federal State Local Other
5	System Benefits—Qualitative	Employment Economic Development Parking
6	System Descriptors	Number of Routes Number of Buses Required Number of Employees Annual Vehicle-Miles Annual Vehicle-Hours
7	Hours and Days of Service	Weekdays Saturdays Sundays/Holidays Special
8	Fare Structure	(Note: This template has a non-standard format. At top, one box labeled Average Fare. Below, two columns headed $ and Percent of Passengers. Row headings are: Peak Time Non-Peak Elderly Student Discount: ____________(type) ____________(type)
9	Percent of Households Served	All Minority Low Income Non-Auto-Owning Elderly and Handicapped
10	Performance Measures	Transit Cost per Passenger Transit Revenue per Passenger Passengers per Vehicle-Hour Passengers per Vehicle-Mile

Table B-2. Use of templates for routine decisions.

Heading	Template*	Detail Presented (Graph Only)
Passengers Carried	A or C, 1	Total, Full-Fare, Seniors, Students, etc.
Operating Costs and Revenues	C, 2	Total Operating Cost, Total Operating Revenue, Net Public Cost, Sources of Public Funding
Number of Routes	A or C, 3	Full-Time, Peak-Period Only
Hours and Days of Service	Special, 4	Boxes for fill-in showing operating hours for weekdays, Saturdays, Sundays/Holidays, other, in columns for proposed, current year, last year.
Buses Required	A or C, 5	Peak, Off-Peak, also by vehicle type (van, minibus, lift-equipped, etc.)
Number of Employees	A or C, 6	By function: transportation, maintenance, administrative
Annual Vehicle-Miles Annual Vehicle-Hours	A or C, 7 A or C, 8	By time period: weekday, Saturday, Sunday/Holiday, etc.
Fare Structure		Refer to Table B-1, Type 8.
Percent of Households Served	Special, 9	See rough sketch.
Cost per Passenger Revenue per Passenger	C, 10	Can combine on Type C; must separate if using Type A.
Passengers per Vehicle-Hour	C, 11	Total, Full-Fare, Seniors, Students, etc.
Passengers per Vehicle-Mile	C, 12	Total, Full-Fare, Seniors, Students, etc.

*Numbers refer to RD template number.

System Benefits

	Alternative 1	Alternative 2
	(________)	(________)
Accidents		
Emissions (HC)		
Emissions (CO)		
Emissions (NO_x)		
Energy		

Costs and Revenues

	Alternative 1	Alternative 2
	(________)	(________)
Operating and Maintenance Cost		
Annualized Capital Cost		
Fare Box and Other Revenues		
Net Public Cost		

Sources of Funding

	Alternative 1	Alternative 2
	(________)	(________)
Net Public Cost		
Federal		
State		
Local: Source ________________		
Local: Source ________________		

Capital Cost to ______ Year Horizon

	Alternative 1	Alternative 2
	(______)	(______)
Total Capital Cost		
Federal		
State		
Local		
Other		

System Benefits—Qualitative

	Alternative 1	Alternative 2
	(________)	(________)
Employment		
Economic Development		
Parking		

System Descriptors

	Alternative 1	Alternative 2
	(________)	(________)
Number of Routes		
Number of Buses Required		
Number of Employees		
Annual Vehicle-Miles		
Annual Vehicle-Hours		

Hours and Days of Service

	Alternative 1	Alternative 2
	(________)	(________)
Weekdays		
Saturdays		
Sundays/Holidays		
Special		

Fare Structure

AVERAGE FARE PAID		$.
	$ Fare	**Percent of Passengers**
Peak Time		%
Non-Peak Time		
Elderly		
Student		
Discount: ____________		
____________		
____________		

TEMPLATE SJ-8

Percent of Households Served

	Alternative 1	Alternative 2
	(________)	(________)
All		
Minority		
Low Income		
Non-Auto Owning		
Elderly and Handicapped		

Performance Measures

	Alternative 1	Alternative 2
	(________)	(________)
Transit Cost per Passenger		
Transit Revenue per Passenger		
Passengers per Vehicle-Hour		
Passengers per Vehicle-Mile		

Passengers Carried

+/– %

Proposed

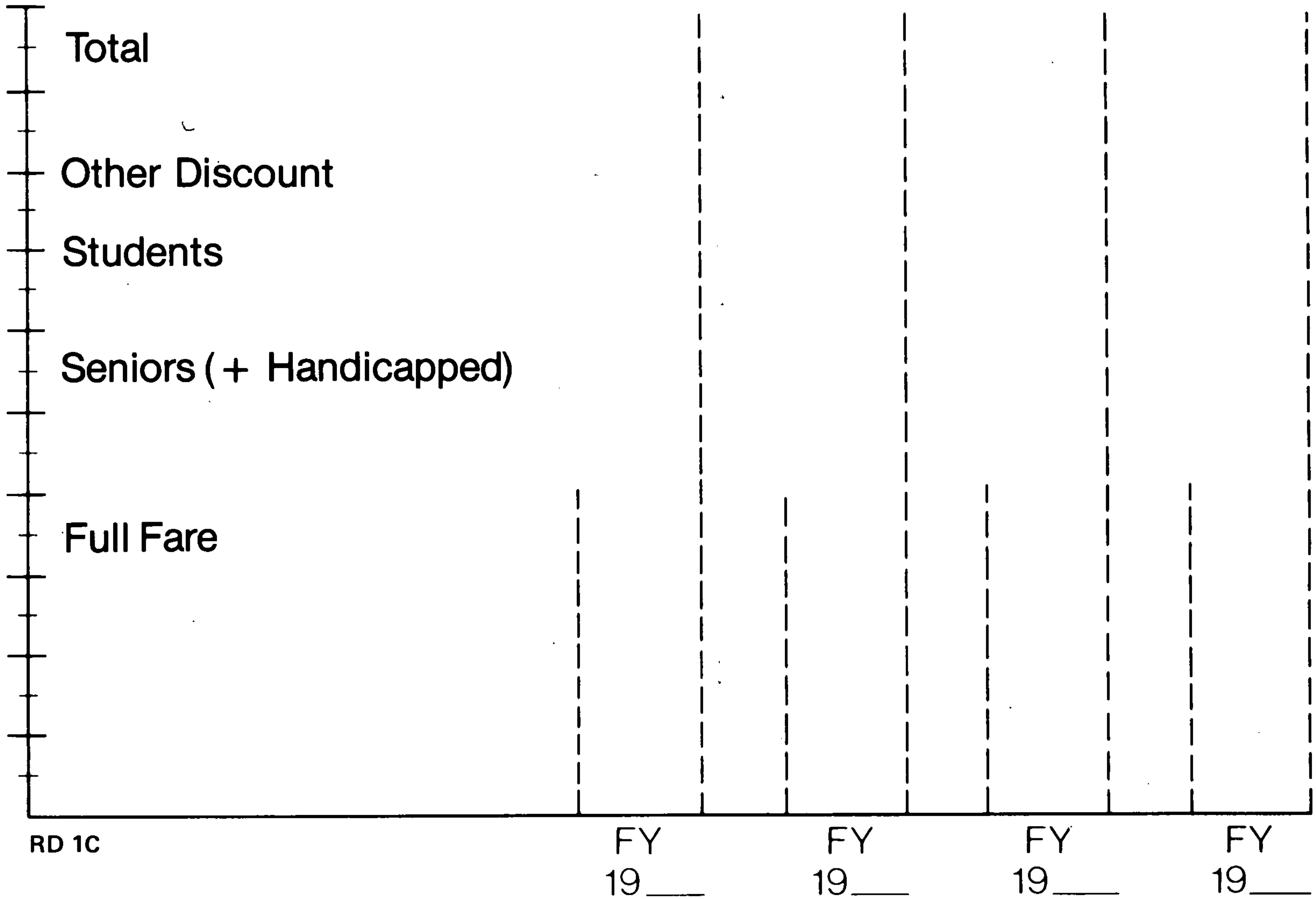
This Year

+/– %

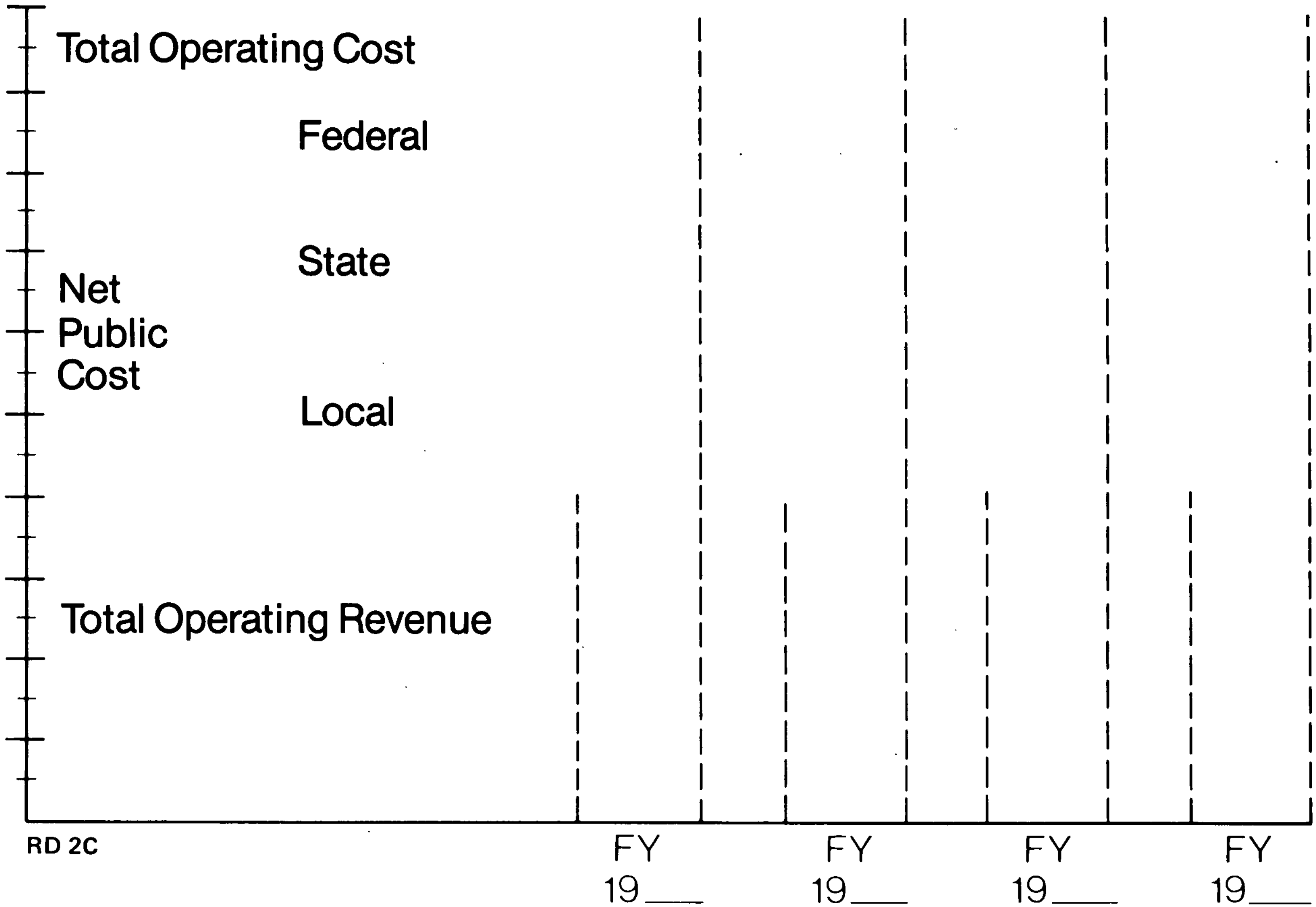
Last Year

RD 1A

Passengers Carried

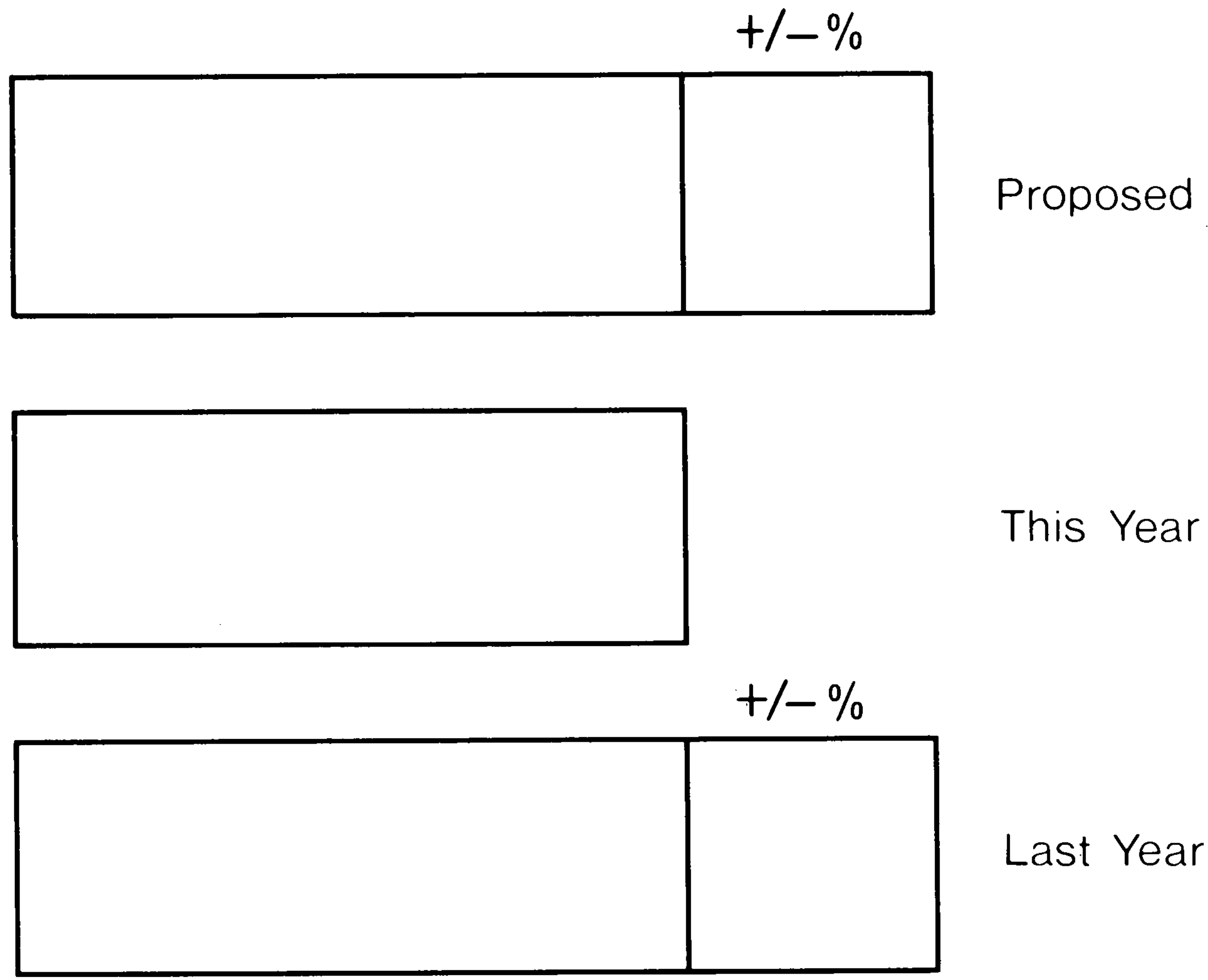


Operating Costs and Revenues



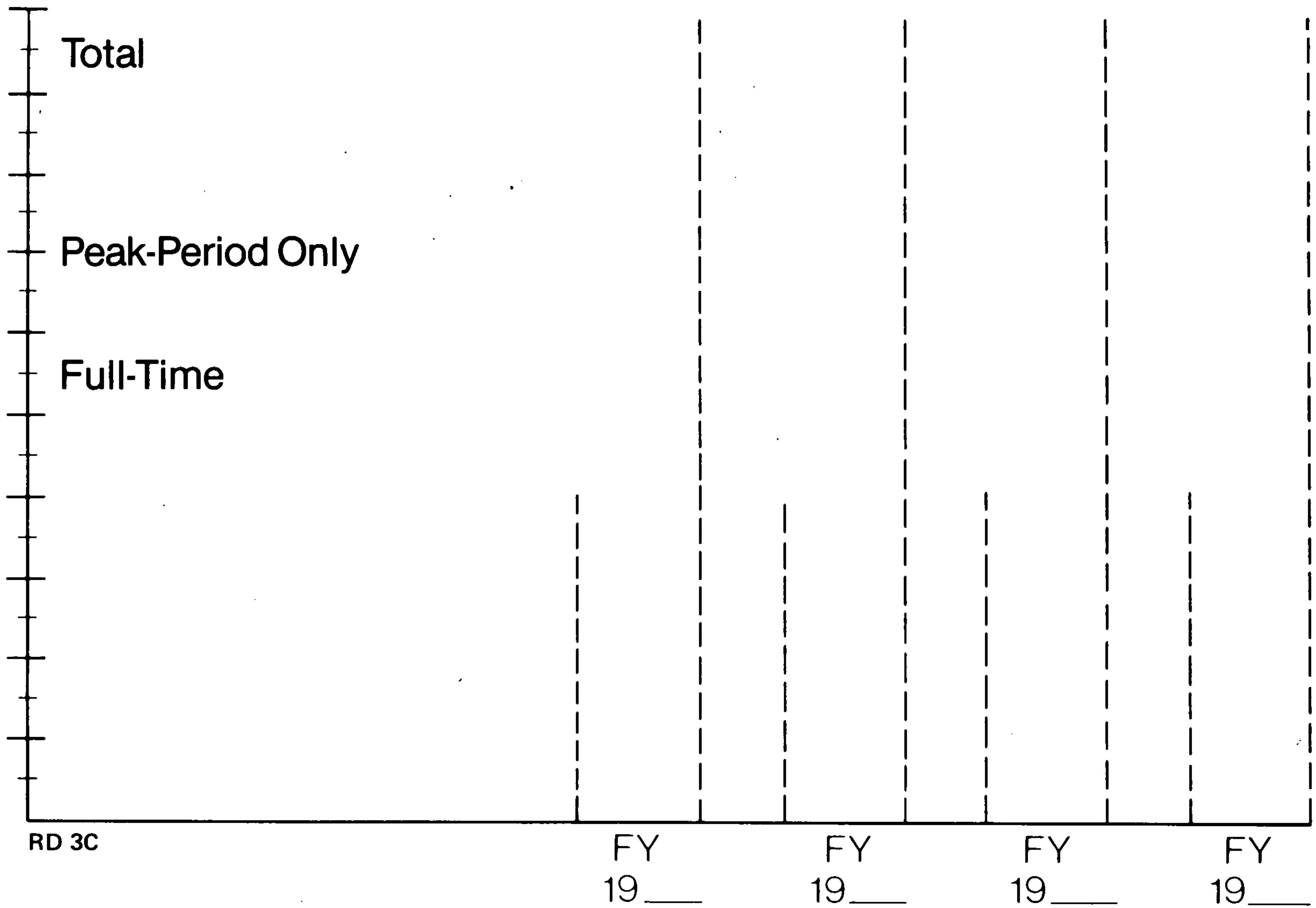
RD 2C

Number of Routes



RD 3A

Number of Routes



RD 3C

Hours and Days of Service

	Proposed		Current Year		Last Year	
Weekdays	____AM	____PM	____AM	____PM	____AM	____PM
Saturdays	____	____	____	____	____	____
Sundays/Holidays	____	____	____	____	____	____
Other	____	____	____	____	____	____

RD 4

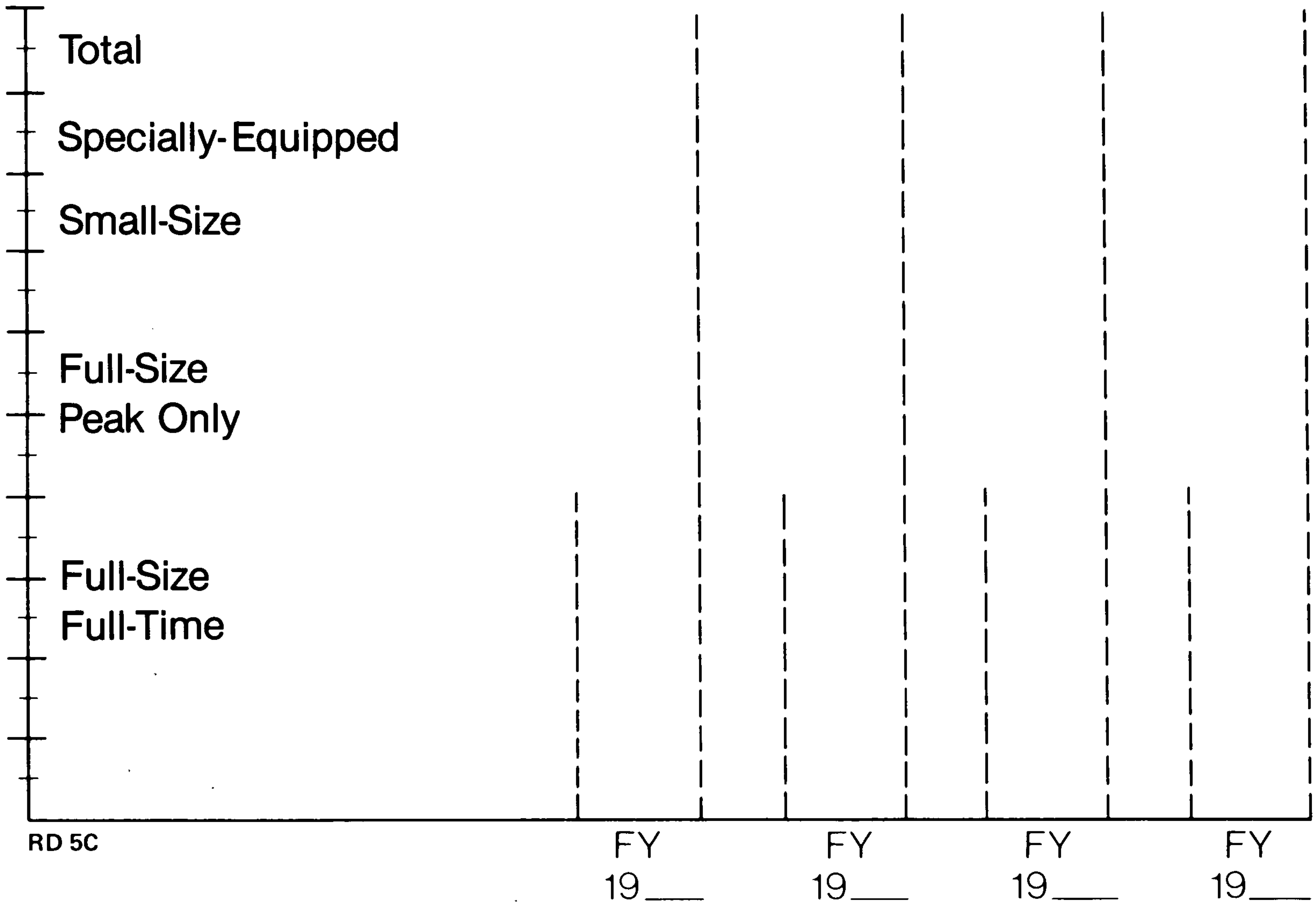
Buses Required

	+/– %	
		Proposed
		This Year

	+/– %	
		Last Year

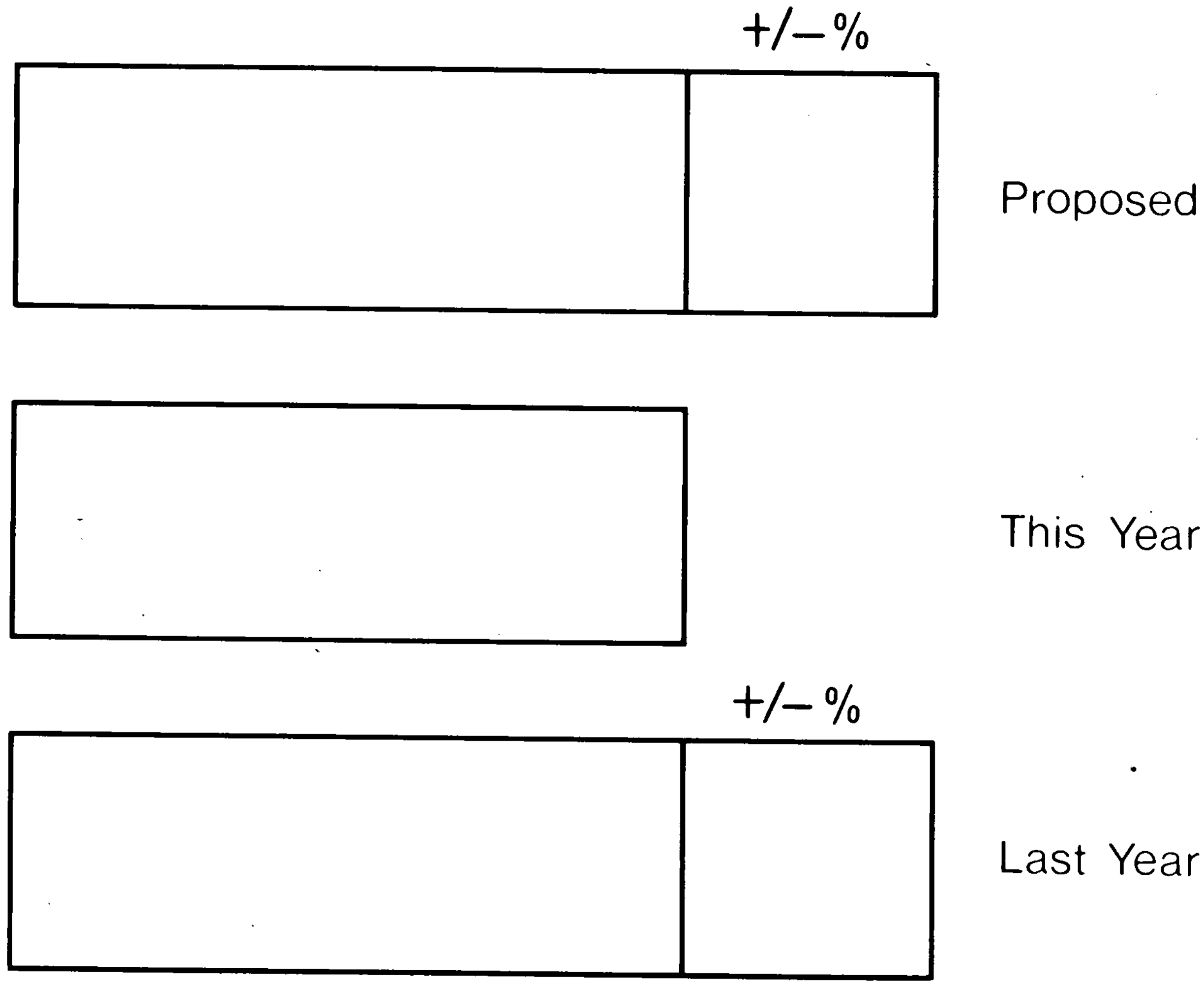
RD 5A

Buses Required



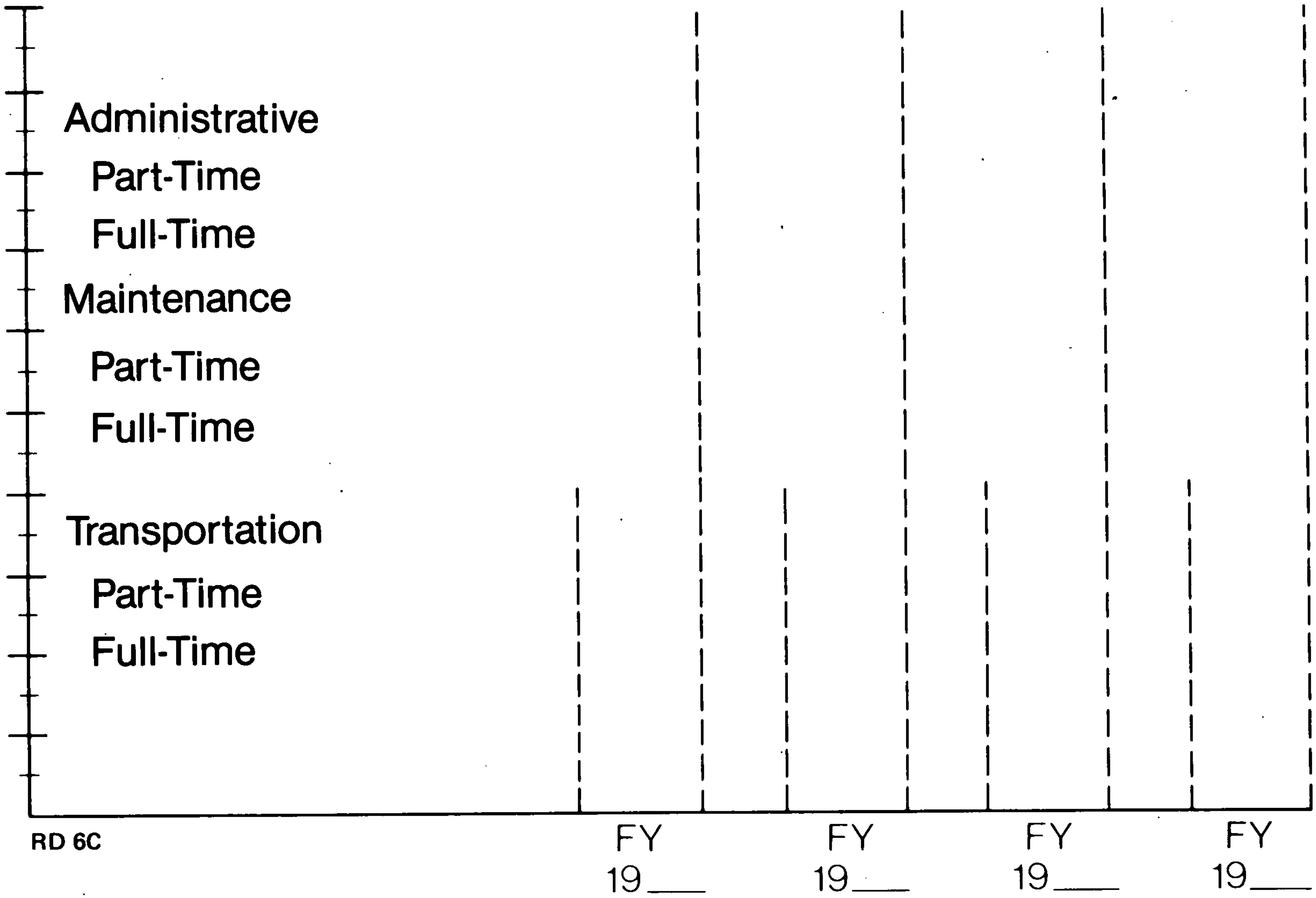
RD 5C

Number of Employees



RD 6A

Number of Employees



RD 6C

Annual Vehicle-Miles

+/– %

Proposed

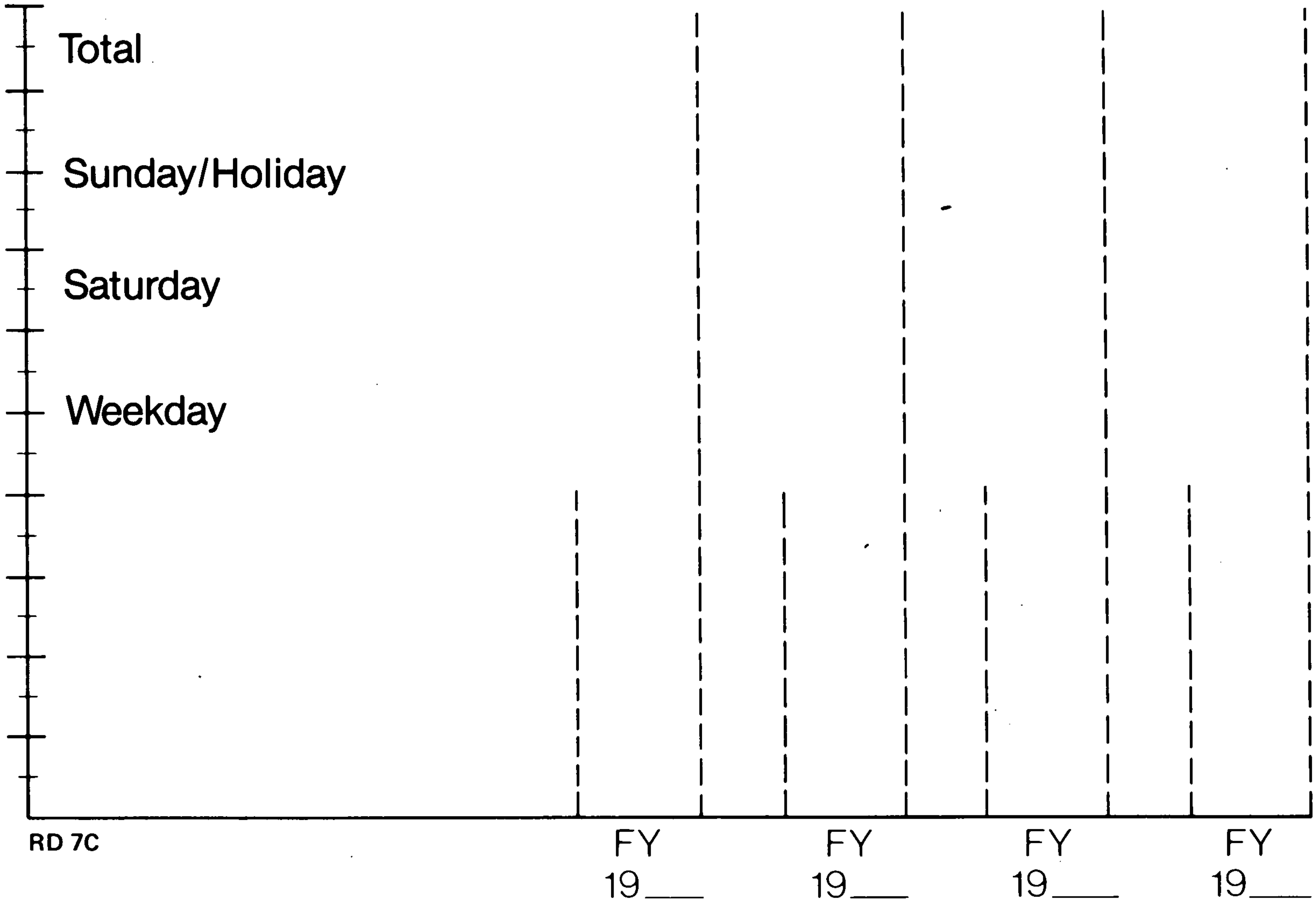
This Year

+/– %

Last Year

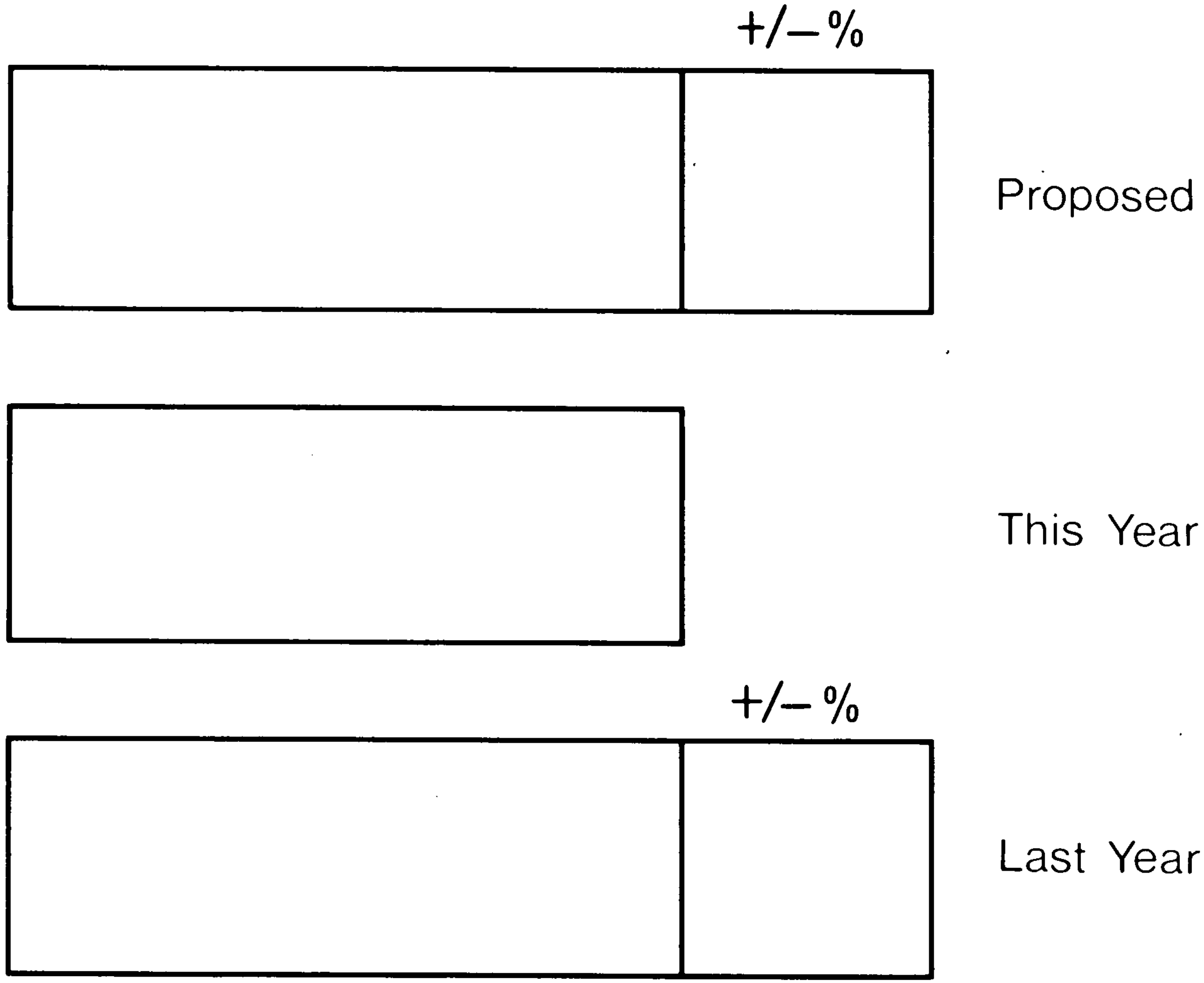
RD 7A

Annual Vehicle-Miles



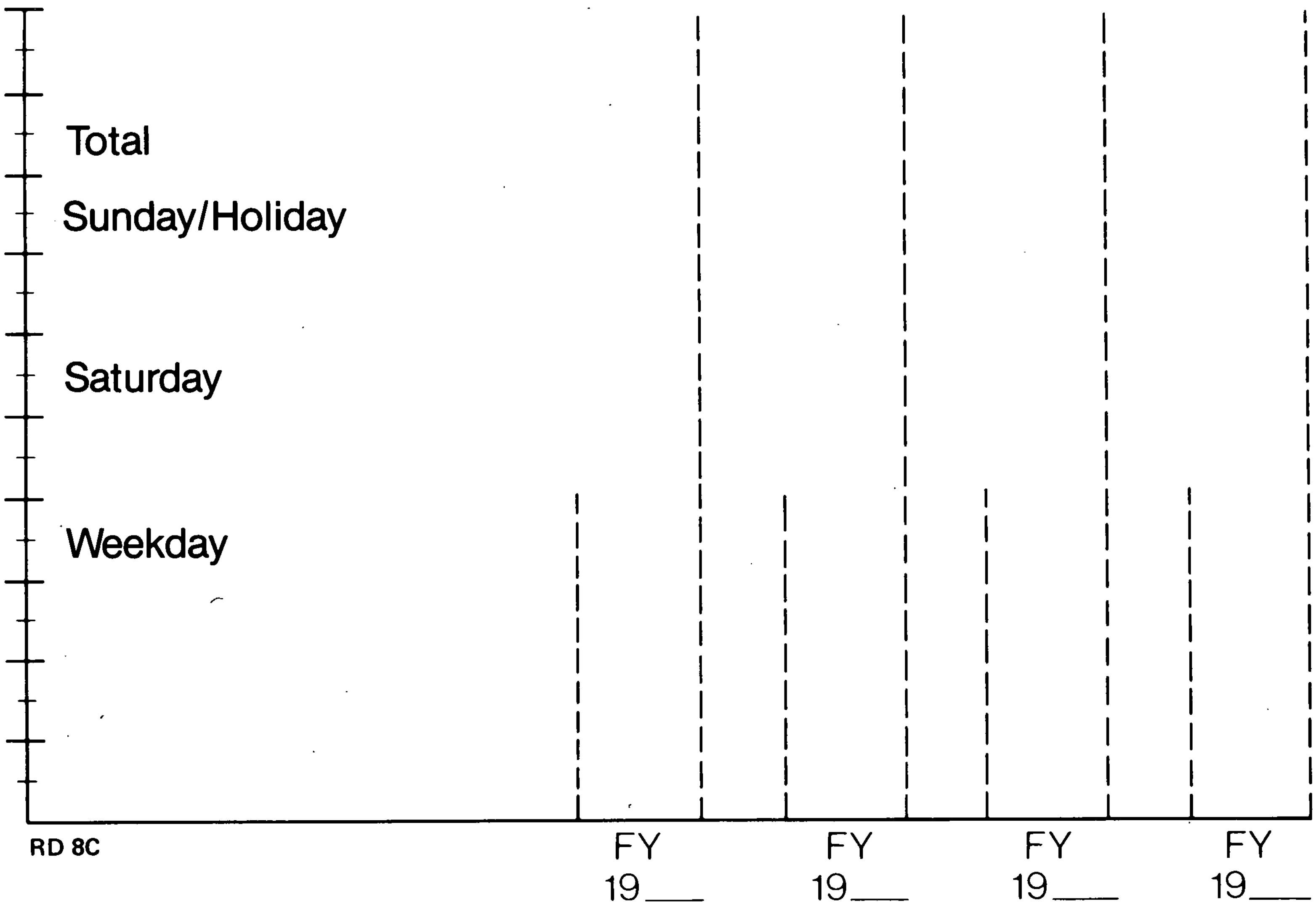
RD 7C

Annual Vehicle-Hours



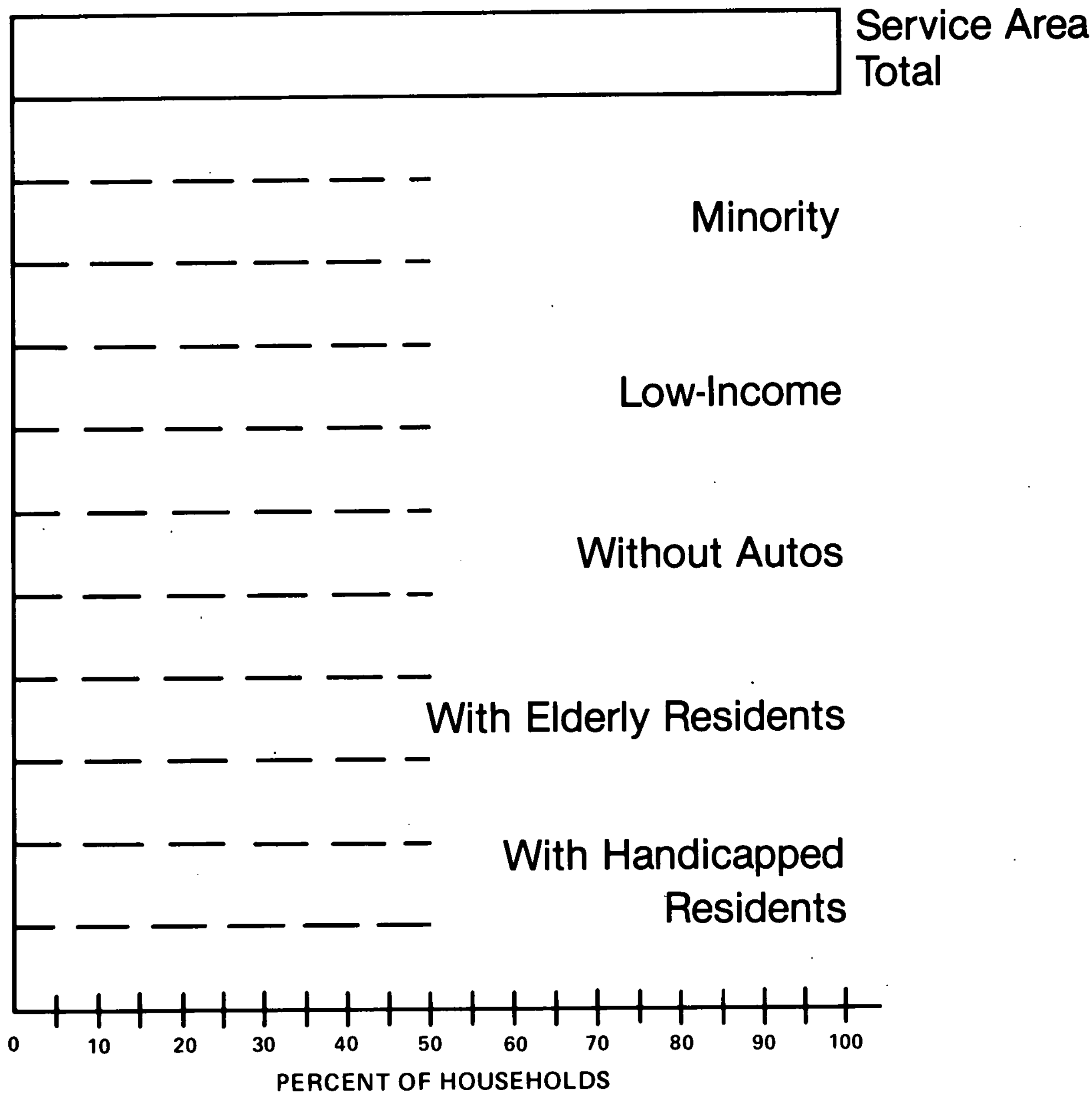
RD 8A

Annual Vehicle-Hours

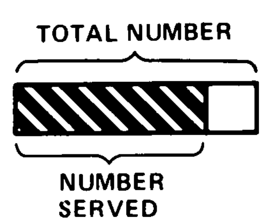


RD 8C

Percent of Households Served



RD 9



Cost per Passenger
Revenue per Passenger

+/– %

Proposed

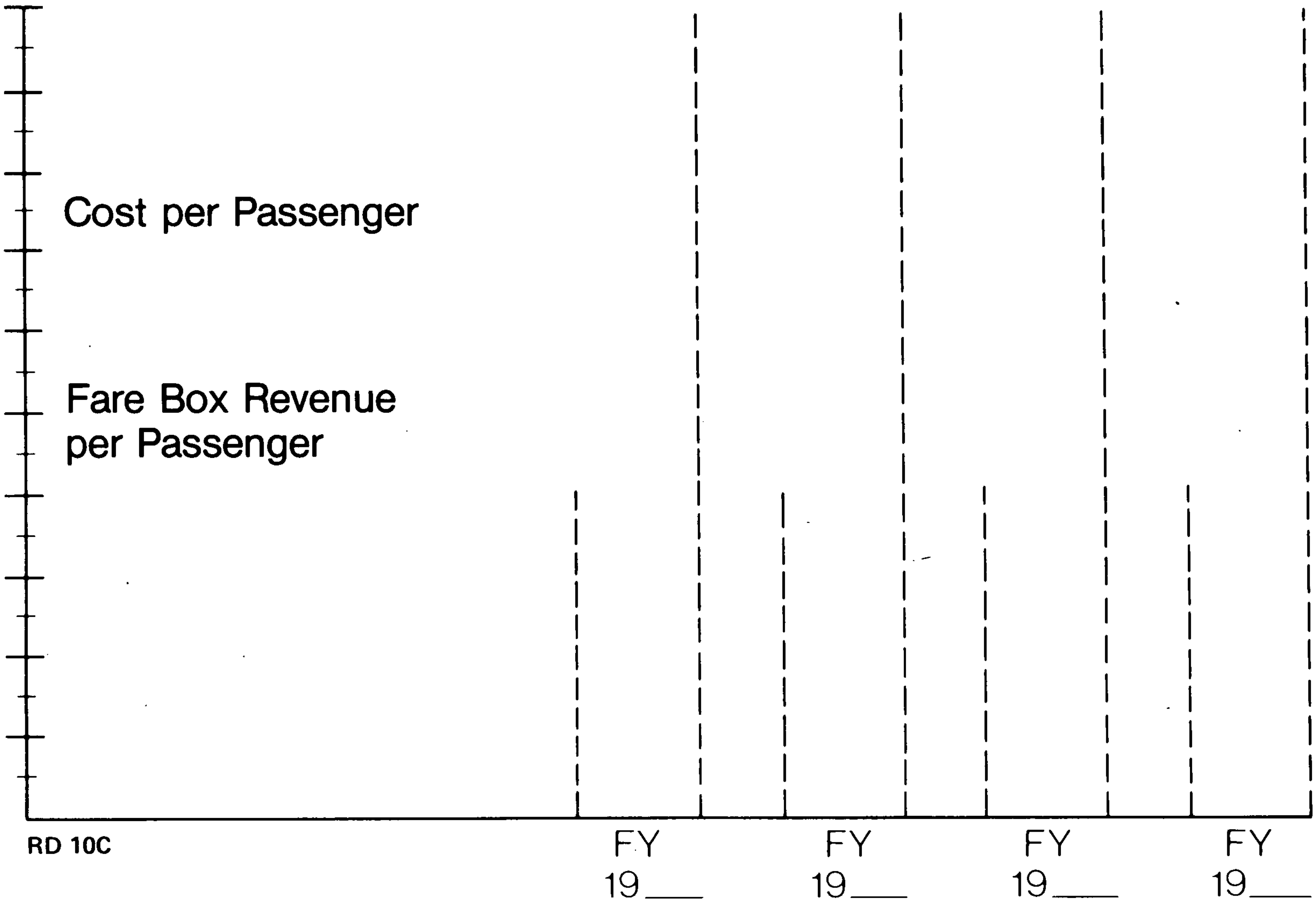
This Year

+/– %

Last Year

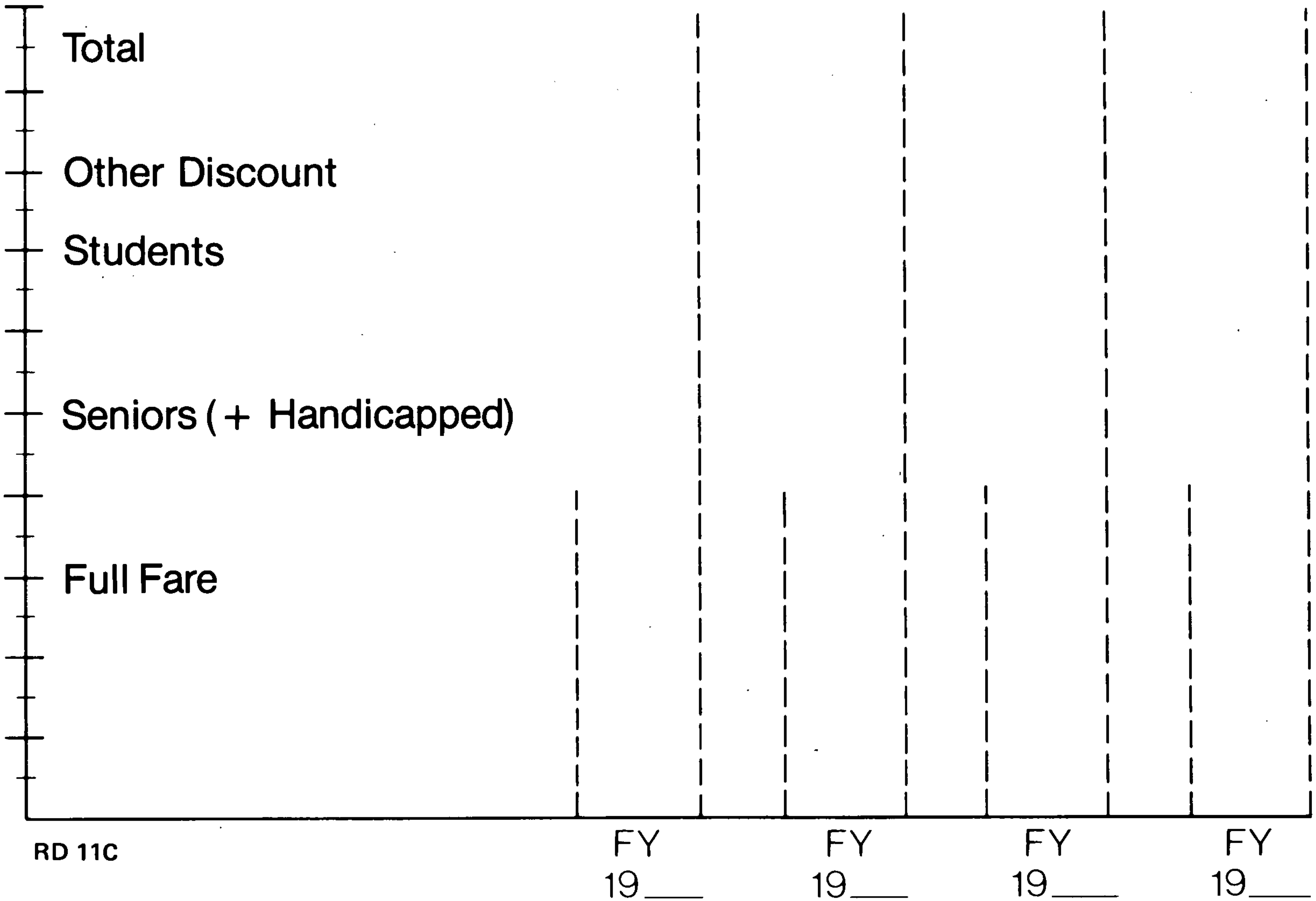
RD 10A

Revenue per Passenger
Cost per Passenger

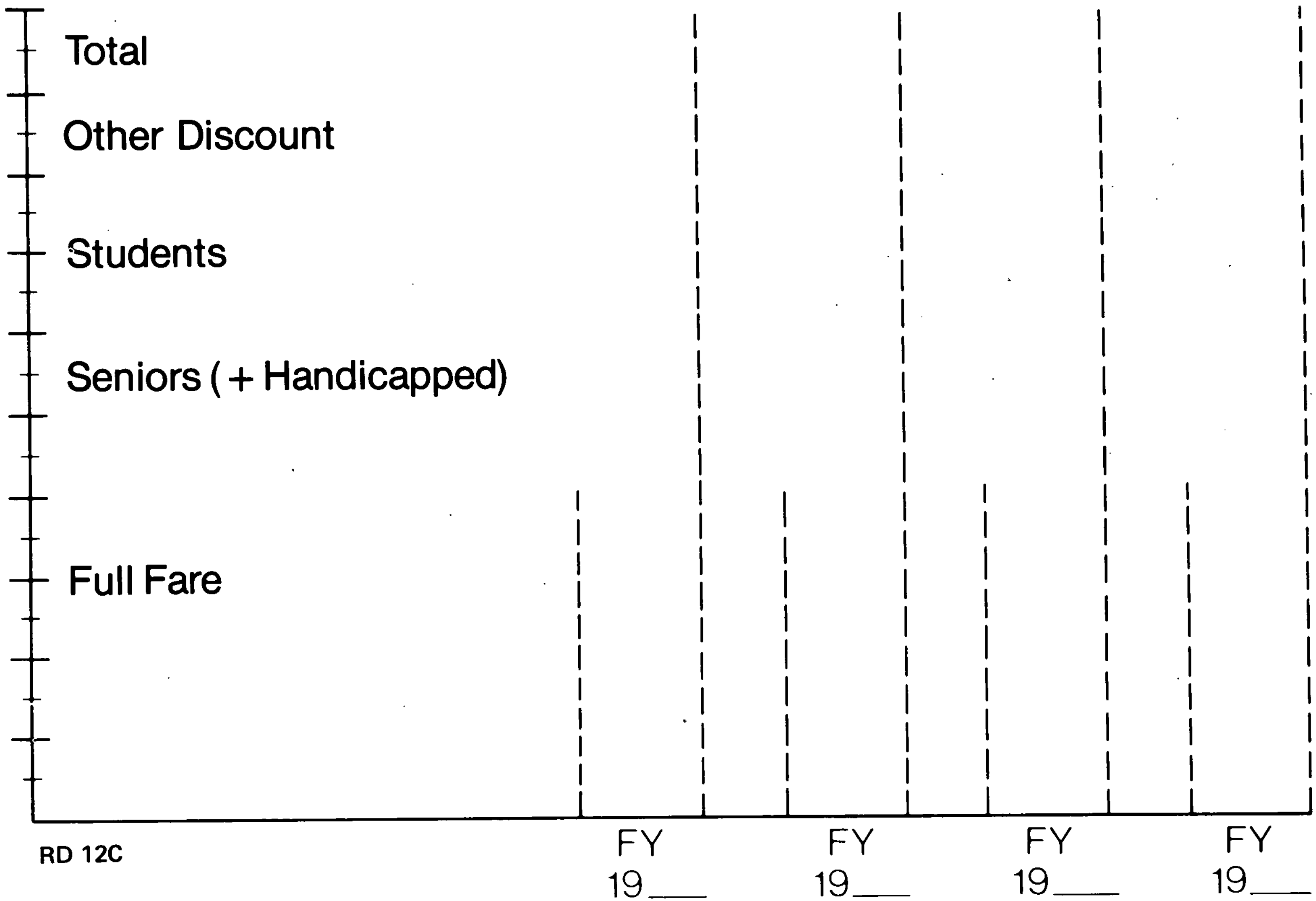


RD 10C

Passengers per Vehicle-Hour

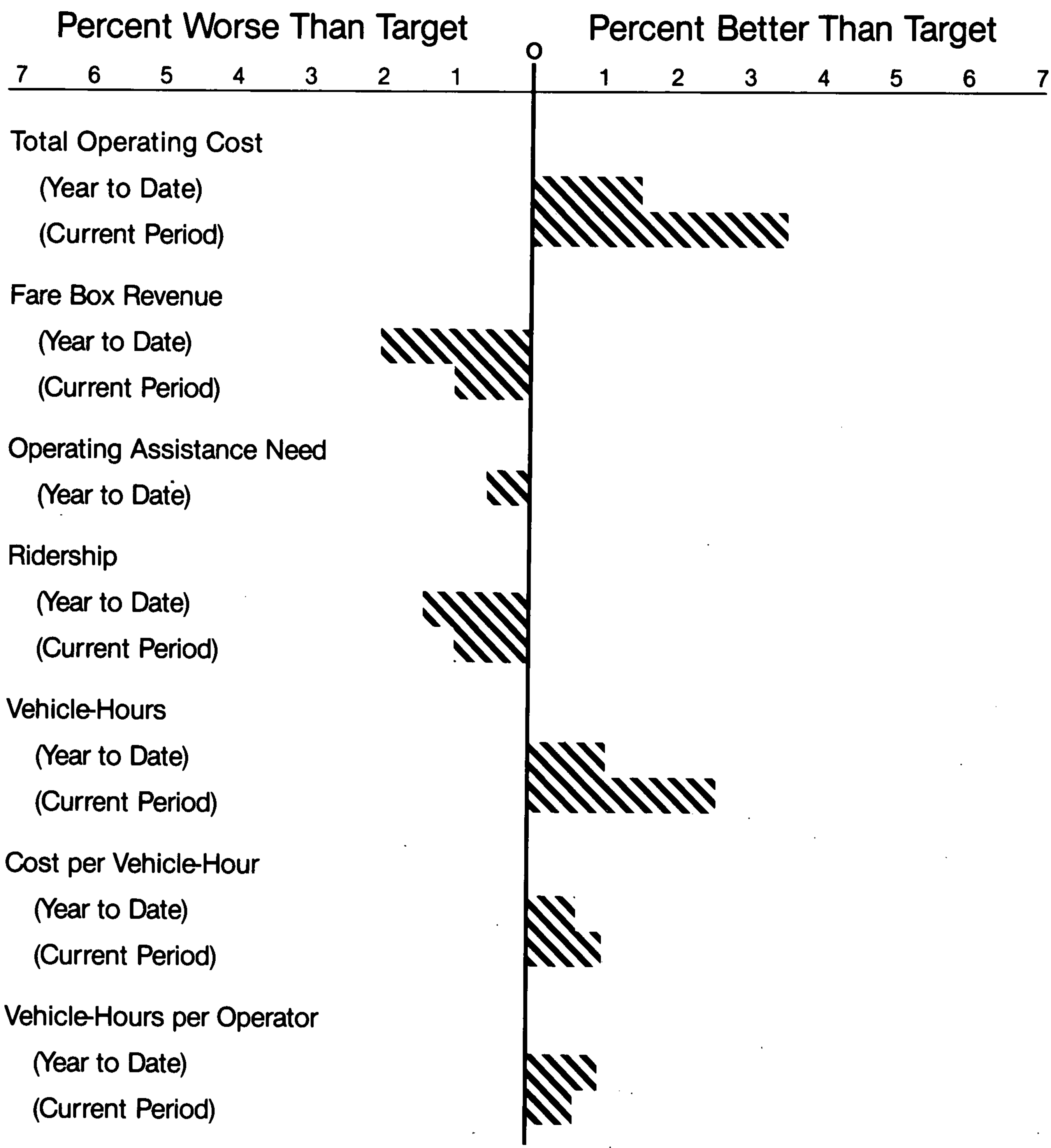


Passengers per Vehicle-Mile



RD 12C

Example of Format for Presenting Monitoring Information



APPENDIX C

LOCAL GOVERNMENT DECISION-MAKING BEHAVIOR

The question of how decisions are actually made by governmental units has been a central concern to political scientists and public administrators for decades. Local governmental decision-making in particular has been examined from a number of perspectives, including community power structure and local political process; local government institutional arrangements; the conduct of certain administrative functions, such as budgeting and planning; the use of management science-oriented techniques; and the roles and behavior of governing bodies, chief executives, and professional administrators. This appendix examines the nature of decision-making in small and medium-size local jurisdictions, roughly in the range of 25,000 to 200,000 population. It begins by presenting some alternative decision-making models in general and then moves to a discussion of characteristics of local communities and policy issues that explain in part how decisions are made in specific circumstances.

Table C-1. Chief characteristics of decision-making models.

Characteristic	Comprehensive-Rational	Incremental
Goals	Goals and objectives clearly defined. Constraints identified; priorities established.	Goals and objectives may evolve along with constraints. Priorities perhaps clarified.
Alternatives	All alternatives identified in comprehensive search.	Only a few marginally different alternatives considered.
Consequences	Full range of consequences predicted; both immediate and longer-term consequences considered.	More limited set of consequences considered, usually on a short-term basis.
Analysis	Comprehensive analysis in terms of objectives and constraints. Trade-offs identified. Formal techniques employed.	Limited analysis intertwined with goal determination. Expert judgment, "back of envelope" approach used more often.
Decision	Preferred alternative identified based on complete "objective" assessment.	Choice based on more "subjective" assessment of feasibility. Serial process with decisions reconsidered and adjusted.

GENERAL DECISION-MAKING MODELS

Over the years, a substantial literature has been accumulated concerning both how public sector decisions should be made and how they actually are made. The major theme has been rationality, how decision situations should be structured to produce the most rational decisions in terms of maximizing the public interest as opposed to more limited approaches in which this is not guaranteed.

The two extremes of hypothesized general approaches to decision-making are the comprehensive-rational model and the incremental model, which have been contrasted in much of the literature (*1*). The rational model is best thought of as a normative model of how one school of thought might argue that decisions should be made, if possible. The incremental model—sometimes referred to as "muddling through"—is more a descriptive model of how decision-making actually takes place. It is worth comparing them briefly, however, because the chief characteristics on which they differ reflect both the key elements of decision-making in general and the concerns one must understand in trying to determine how decisions related to transit are made.

The Comprehensive-Rational Model

Table C-1 presents the chief characteristics of both the comprehensive-rational and the incremental models. The rational model has its roots in management science, particularly operations research, and is recognizable as the general systems analysis approach to problem solving in which an analytical procedure is used to optimize an objective function within a given set of constraints and available resources.

The rational model is characterized first by the definition of goals and objectives to be satisfied, along with the establishment of priorities among objectives and identification of the preferred trade-offs among objectives to be pursued simultaneously when they may be in conflict. This clear-cut sense of purpose and priorities is seen as essential because this is the basis on which decisions will be made rationally. Second, a comprehensive search of all possible alternatives is conducted, with each alternative described in terms of required resources and implementation particulars and also in terms of the kind of outcome it is geared to produce. Third, rigorous analysis is undertaken for each alternative that is comprehensive in terms of both the full range of consequences that might ensue and in predicting these consequences in the long term as well as in the immediate future. Formal analytical tools such as simulation models, forecasting techniques, and benefit/cost analysis are used to evaluate the alternatives.

Finally, the preferred alternative is identified based on this "objective" analysis of comparative strengths and weaknesses, with the assumption that the choice of any other alternative would represent an inferior decision.

In theory, the rational model makes sense if it can be assumed that in making major decisions, governmental jurisdictions (1) can develop a consensus on goals and objectives and, more important, on priorities and trade-offs among them and (2) have the time, resources, and analytical capability to carry out all the steps included in this rational decision-making process. In practice, however, local government units usually do not follow this process. Lineberry and Sharkansky (*3*) point out why urban decision-making rarely follows this comprehensive-rational process:

1. The sheer pressure of time.
2. The costs of obtaining complete information.
3. The mixture of sometimes incompatible or incommensurable goals.

4. Structural features that frustrate coordinated and coherent policies.
5. The constraints of political feasibility.

In short, decision situations rarely lend themselves to this rational approach. The rational model is best suited for more technical decisions about program operation where objectives are very clear and major variables easily quantifiable. Major policy decisions, on the other hand, are characterized by much greater complexity. Goals may be in conflict with one another with no clear-cut solutions. Furthermore, the rational model, with its consideration of *all* alternatives, strains the notion of feasibility. What is feasible is what is familiar; incremental changes are feasible because they are not so threatening to vested interests.

The Incremental Model

As reflected in Table C-1, the incremental model is at opposite poles from the rational model in every respect. The incremental model is behavioralist, describing how decisions actually are made in practice (*3*). First enunciated some 20 years ago, it has received very little criticism in terms of accuracy. It holds that the rational model simply is not feasible in practice and that decisions are actually made through a set of limited comparisons within the context of more vague notions of what the goals and objectives really are. In practice, goals are often not determined beforehand, but rather goal determination and analysis are intertwined in the decision-making process. Alternatives are analyzed (at least loosely) and goals are refined simultaneously so that the real objectives are sometimes revealed only in a de facto way.

In contrast to the comprehensiveness of the rational model, only a limited set of alternatives typically is considered according to the incremental model, ordinarily those that differ only marginally from existing policy. Neither is the analysis comprehensive; not all consequences are identified, and the approach tends to forsake longer term consequences for more immediate impacts. Finally, while decisions are made based on these limited comparisons, they are often not thought of as either optimal or final in the sense of being long lasting. Rather, serial analysis is used in a continuing decision-making process in which decisions are frequently revised in order to achieve successive approximation to objectives.

The incremental approach is based on the recognition that many policy problems are far too complex to understand fully, much less to master. The mode of policy-making is really to try to cope with problems rather than to solve them. The incremental model is used in practice because it is less demanding on both intellectual and analytical ability, more conservative, safer in terms of avoiding radically different alternatives with possibly unpredictable consequences, and more likely to lead to politically acceptable decisions. Political scientists and practitioners alike consider the incremental approach—or the art of muddling through—to constitute a valid method in its own right and not simply as the practical failure of the rational approach. The incremental approach is used in practice because it works, which translates into political survival for public sector decision-makers.

Limited Rationality Models

A middle ground between these two polar extremes consists of theories of limited rationality in decision-making, including both normative and positive models. Approaches such as mixed scanning (*4*) have been suggested as a way of moving toward the rational model within the constraints of feasibility. In general, these models are characterized by some screening of broad alternatives and then more detailed analysis of a few of the more promising ones, leading to solutions that are at least satisfactory if not optimal. Such models have been discussed in the literature as possibilities but have not been carefully developed or put into practice.

Generally, however, much of the main thrust of modern professional public administration has been concerned with rendering decision-making and administration more rational on some limited basis. Indeed, the evolution of planning, beginning with comprehensive land-use and master planning in the 1950s and the shifting emphasis toward more specialized program planning subsequently, exemplifies the move toward increased rationality. The trend toward improved decision-making in the field of public administration consists loosely of (1) attempts to identify goals and objectives where practical, (2) collection and analysis of data on many policy issues, (3) use of performance measures where appropriate, and (4) injection of the objective information thus derived as an additional input into decision-making. It needs to be understood that these trends have not been aimed at taking the politics out of decision-making, but rather at helping the essentially political decision-making process become better informed (*5*).

This general movement toward increased rationality is reflected in the use of numerous management tools in municipal government. For example, in budgeting, these developments include the use of performance budgeting, program budgeting, and zero-base or target budgeting, and as Lee and Johnson argue, much of the history of such budget reforms reflects the continuing tensions between the rational and incremental approaches to decision-making (*6*). Similarly, in management the use of such techniques as management-by-objectives, appraisal-by-objectives, and, particularly, the widespread implementation of management information systems also is part of the general move toward increased rationality. In program planning and evaluation, the use of needs assessment tools, benefit/cost analysis, performance monitoring, and program evaluation are all aimed at contributing to better decision-making within the given political context by providing relevant information as one more input.

Current Use of Management Technology by Cities

In 1976, the International City Management Association (ICMA) conducted a mail-out survey of municipal governments to determine, in part, the extent to which they employed various management tools. The results indicated that significant numbers of local jurisdictions in all size classes and regions of the country were using such techniques as program budgeting, management-by-objectives, and management information systems. The fact that many of these systems were reported as having been implemented within the past 12 months suggested that the prevalence of these tools was increasing (*7*). This would not be unexpected, given the capacity sharing program of the U.S.

Department of Housing and Urban Development and other efforts on the part of states and professional associations to encourage and help cities improve management capabilities.

Current research on municipal management conducted independently at the Institute of Public Administration, Pennsylvania State University (*16*) also made use of a mail-out survey, which in part replicated portions of the 1976 ICMA instrument. Table C-2 shows summary results from each of these surveys in terms of the percentage of the cities responding that reported using seven of these management tools. Generally, the figures show that use of these tools has increased substantially over the intervening six years. It should be noted that of the 460 cities responding to the 1982 survey, 425 were cities with between 25,000 and 250,000 population. Thus, the results are largely representative of the smaller and medium-size cities, which are the focus of this current research.

What makes these findings noteworthy with respect to the present study is the conventional wisdom that presumes that jurisdictions that employ these techniques will be making decisions more rationally, although there has been little hard research on this to date. It would appear, however, that more and more cities are moving toward a limited rationality model of decision-making in which the use of objective information hopefully contributes to better decision-making. As a final note along these lines, the city managers and other chief executives who responded to the survey tended overwhelmingly to indicate that they thought that use of these techniques was at least somewhat effective as an aid to sound program administration and decision-making. For example, the proportion indicating that the tool was "very effective" in this respect was 42 percent for program budgeting, 35 percent for management-by-objective, 48 percent for management information systems, and 28 percent for performance monitoring.

Table C-2. Reported use of selected management tools.

	Percent Reporting Use	
Technique	1976 ICMA Survey[1]	1982 IPA Survey[2]
Program, Zero-Base, or Target-Base Budgeting	50%	77%
Management by Objectives	41	59
Management Information Systems	42	67
Performance Monitoring	28	68
Management Incentive Program	16	47
Productivity Bargaining	10	22
Productivity Improvement	43	67
Total Sample Size	N = 404	N = 460

[1] Rackham S. Fukuhara, "Productivity Improvement in Cities," *The Municipal Year Book*. 1977, pp. 193-200.
[2] Survey conducted in November, 1982, by Theodore H. Poister and Robert P. McGowan at the Institute of Public Administration at the Pennsylvania State University (Ref. 16).

Characteristics of Local Decision-Making Behavior

- Formal authority and responsibility for making decisions resides with governing bodies such as city councils and boards of directors and with other elected officials such as mayors.
- These parties are continually making decisions, even in situations where avoiding a decision automatically means retaining existing policy.
- The decisions to be made typically range from major policy issues to specific operational decisions; jurisdictions are likely to treat different levels of decisions in different ways.
- In making decisions, elected officials obviously will be influenced by political pressures in terms of public opinion at large and specific interest groups to the extent that pressure is brought to bear.
- City managers, department heads, program managers, and other professionals always will be involved in the decision-making process. Certain classes of decisions are likely to be delegated to them routinely, whereas with respect to decisions reserved by elected officials, the professional managers will participate through providing information, making proposals, and reacting to alternative decisions.

Paraphrasing Ref. 8, prevailing theory holds that power in urban government is shared by private sector influentials, elected officials, and municipal bureaucracies which, with civil service and union protections, are seen by some as the new machine to replace the older political party machines of an earlier period. In smaller and medium-size cities, these bureaucracies are less powerful because control is less decentralized, but the power of managers is likely to increase commensurately. Yet, the role of each of these sources of power will vary, and beyond the generalizations set forth above, there is greater diversity in local government decision-making processes.

Decisions that are delegated to professional administrators in some cities may be dealt with directly by the city council in others; some councils may want to have certain kinds of information available, which in other cities will be ignored; external and conflicting political pressures may be brought to bear on certain decisions in some communities, while in other communities there is a strong consensus or little interest in the matter. In addition to this kind of variation among cities, it also must be recognized that within the same jurisdiction the decision process may vary according to the issue or policy area and that decision-making behavior may well change over time. (For a discussion of the varying roles played by executives, councils, and bureaucrats in municipal level decision-making, see Ref. 1, Chapter 3, "Urban Policy-Making." Selected articles examining working relationships among these parties include Richard Stillman, "The City Manager: Professional Helping Hand or Political Hired Hand," *PAR*, Vol. 37, No. 6; Arthur Mendonsa, "Council-Manager Relations and the Changing Community Environment," *Public Management*, Vol. 55, September 1977; Glenn Abney and Thomas P. Lanth, "Influence of Chief Executives on City Line Agencies," *PAR*, Vol. 42, No. 2, pp. 135-143; Glen Abney and Thomas P. Lanth, "Councilmanic Intervention in Municipal Administration," *Administration and Society*, Vol. 13, No. 4, 1982.)

Community Characteristics

Clearly there is wide variety in decision-making behavior, and each community has its unique characteristics. Therefore, before moving to any generalities concerning local transit decision-making, it is helpful to identify characteristics of local jurisdictions that are likely to influence how decisions are made. It must be understood, however, that local decision-making is a complicated and multifaceted process; at best, relationships between structural characteristics and decision-making behavior may be consistent if everything else is constant.

First, size obviously is an important factor. Larger municipalities typically provide a broader range of functions and have much larger budgets. Many more decisions have to be made and are often more complicated; thus, governing bodies may delegate more decisions to professional administrators and also solicit more information relating to decisions they make themselves. The greater complexity of many issues in larger jurisdictions, along with the difficulty of generating consensus on objectives, tends to defy a rational approach to decision-making. Offsetting this to some extent is the greater tendency for larger units to employ the kinds of management tools discussed previously.

Cities also vary widely in terms of community power structure and the local political climate. Researchers have studied local power structures for years and found everything from a monolithic power elite that controls most decisions from behind the scenes to the more common pluralist pattern and even hyperpluralism where numerous interest groups hold the balance of power in specific issue areas in the absence of a central source of political power to act as broker (*9*). Thus, the pattern of interest groups and the extent to which they directly exert influence on policy also varies from place to place.

Cities also vary in the degree to which local public decisions become political issues. Communities with fairly homogenous, usually middle-class, populations tend less to generate political controversy over local government services and regulations. Where the population consists of more diverse factions, on the other hand, issues tend to become more politicized and rationality may be more difficult to define.

Governmental Structure

Formal governmental structure also may have a lot to do with how decisions are made. First, whether the jurisdiction making the decisions is a general purpose unit of government or a special district will influence decision-making behavior. This is particularly relevant for mass transit in smaller and medium-size cities because, while many systems are operated by separate transit authorities, others are operated by line departments of city governments.

Special districts, such as transit authorities, traditionally have been created for several reasons, including (1) the need for a regional entity to provide service, (2) the ability to borrow capital funds beyond the limits of the city debt ceiling, and (3) the desire to manage an enterprise service on a more businesslike basis and to take the politics out of a governmental function. Compared with city councils and the numerous and diverse array of issues confronting them, authority boards face a much narrower range of decisions, tend more to be promoters of the service they are responsible for, are somewhat insulated from the political process, and might be expected to arrive at decisions in a more rational manner (*10*). City councils typically are more sensitive to political pressures and necessarily are concerned with competing demands for many different services, all of which makes it less feasible to approximate the rational model.

Looking at general municipal governments only, the form of government also makes a difference (*11*). Municipalities with the city-manager plan, the most prevalent, are professionally managed to a greater extent, at least by reputation, and thus might be expected to make decisions more rationally. Cities with a strong mayor type of government, the other reform model, also can be expected to have more rational decision-making than cities with a weak mayor or commission form of government. Everything else equal, city councils elected in at-large and/or nonpartisan elections may take a more comprehensive view of local issues and be less influenced by political factions than councils elected in partisan elections with ward systems. Again, the reform cities—at-large nonpartisan elections—might be expected to be somewhat more rational in decision-making.

Within a specific form of government, of course, the division of power among city council, chief executives, and appointed officials may vary greatly depending on individuals' interests and political resources. When mayors and professional city managers play a more central role in the policy-making process, there may well be a more coherent framework for making decisions, contributing to a more rational process—again, everything else equal.

Fiscal Status

Much of the recent literature on urban management has focused on fiscal distress and managing cities in an era of declining resources (*12*). The pressures on local decision-makers in jurisdictions that are fiscally distressed, usually the product of a more basic economic decline locally or regionally, can be enormous. Shrinking tax bases and shrinking revenues are obviously a problem; even stable revenue means a significant loss of purchasing power, given recent inflation rates. This whole problem has been further aggravated by a loss of federal and sometimes state funds in many areas. Furthermore, in areas with declining population, the remaining population tends to be more dependent on public services, so that the demand for services does not diminish accordingly. In trying to cope with these problems, officials are well aware of strong public sentiment against tax increases and are also pressured by unions to pay cost-of-living increases in wages (*13*).

Of course, not all municipalities are experiencing fiscal distress. The important point here is that the nature of decision-making is likely to differ considerably between jurisdictions operating in a cutback mode as opposed to stable or growth conditions. Cut-back management creates an imperative for productivity improvement which, in turn, focuses attention closer to effectiveness and efficiency (*14*). The other standard responses to fiscal distress—across-the-board or selective service cuts, reduction in force, diversification of revenue sources, reduced capital investment, and deferred maintenance—all have their attendant political or economic costs (*15*). In general, the choices to be made in a cutback mode are tougher decisions with more immediate and far-reaching ramifications; thus, policymakers are inclined to involve themselves more deeply in decision-making and to consider the options more carefully.

Policy Issues

As noted previously, within a given jurisdiction decision-making will not always proceed the same way. In part, this will vary with the nature of the issues being decided. Generally, decisions regarding programs or services that are seen as having high priority will be treated more seriously by the governing body, while lower priority decisions are more likely either to be delegated to managers or decided by a council more quickly and based on less information. Issues with high political saliency in the community obviously will be given more attention by a council than issues of lesser interest; the degree of rationality inherent in such decisions will depend primarily on the degree of consensus on objectives and strategies among interest groups concerned with the issue. Finally, decisions about programs whose funding is largely external are more likely to be left to managers and, therefore, based on more technical or rational criteria.

REFERENCES

1. MORGAN, D. R., *Managing Urban America.* Duxbury Press, North Scituate (1979) pp. 96–103.
2. LINEBERRY, R. L., and SHARKANSKY, I., *Urban Politics and Public Policy.* Third Edition, Harper & Row, N.Y. (1978) pp. 204–205.
3. LINDBLOM, C., "The Science of 'Muddling Through'." *Public Administration Review* (Spring, 1959) pp. 79–88. Also Lindblom, C. E., "Still Muddling, Not Yet Through," *Public Administration Review,* Vol. 39, No. 6, pp. 517–526.
4. ETZIONI, A., "Mixed Scanning: A 'Third' Approach to Decision-Making." *PAR* (Dec. 1967) pp. 385–392.
5. VAUPEL, J. W., "Muddling Through Analytically." *Improving the Quality of Urban Management,* W. Hawley and D. Rogers (Eds.), Sage Publications, Beverly Hills (1974) pp. 187–209. Also see the symposium on "Policy Analysis in State and Local Government," *PAR,* Vol. 39, No. 1, Mark Schneider and David Swintons (Eds.) pp. 12–45.
6. LEE, R. D., JR., and JOHNSON, R. W., *Public Budgeting Systems.* Third Edition, University Park Press, Baltimore (1983) p. 18.
7. FUKUHARA, R. S., "Productivity Improvement in Cities." *The Municipal Year-Book—1977,* International City Management Association, Washington, D.C., pp. 193–200.
8. LINEBERRY, R. L., and SHARKANSKY, I., *Urban Politics and Public Policy.* Third Edition, Harper & Row, N.Y. (1978) pp. 172–203.
9. HUNTER, F., *Community Power Structure,* University of North Carolina Press, Chapel Hill (1953). DAHL, R. A., *Who Governs,* Yale University Press, New Haven (1961). WIRT, F., *Power in the City,* University of California Press, Berkeley (1975).
10. ADRIAN, C. R., and PRESS, C., *Governing Urban America.* Fifth Edition, McGraw-Hill Book Company, N.Y. (1977) pp. 232–237.
11. ADRIAN and PRESS, op. cit., pp. 150–179.
12. LEVINE, C. H. (Ed.), *Managing Fiscal Stress,* Chatham House Publishers, New Jersey (1980). Burchell, W. and Listokin D. (Eds.), *Cities Under Stress,* Center for Urban Policy Research, Rutgers University (1981).
13. BAHL, R., (Ed.), *The Fiscal Outlook for Cities: The Implications of a National Urban Policy.* Syracuse University Press (1978).
14. PLANT, J. F., and WHITE, L. G., "The Politics of Cutback Budgeting: An Alliance Building Perspective." *Public Budgeting and Finance* (Spring 1982) pp. 65–71.
15. BAHL, R., "The Fiscal Health of State and Local Governments: 1982 and Beyond." *Public Budgeting and Finance* (Winter 1982) pp. 5–22.
16. POISTER, T. H., and MCGOWAN, R. P., "The Use of Management Tools in Municipal Government: A National Survey." *Public Administration,* Vol. 44, No. 3 (May–June 1984) pp. 215–223.

APPENDIX D

BIBLIOGRAPHY

Adler, Thomas J; Stearns, S. Russell; and Stephanedes, Yorgos J. Thayer School of Engineering, Hanover, New Hampshire. *Techniques for Analyzing the Performance of Rural Transit Systems,* Vol. 1. Sponsored by the U.S. Department of Transportation Research and Special Programs Administration, Office of University Research, Washington, D.C., October, 1980.

Allen, William G. Jr.; and Grimm, Lewis G. *Development and Application of Performance Measures for a Medium-Sized Transit System.* Barton-Aschman Associates, Inc., Washington, D.C. Prepared for presentation at the 59th Annual Meeting of the Transportation Research Board, Washington, D.C., January, 1980.

Altshuler, Alan, et al. *The Urban Transportation System: Politics and Policy Innovation.* Cambridge, Massachusetts: The MIT Press, 1979.

Anderson, S.C.; and Fielding, G.J. *Comparative Analysis of Transit Performance.* University of California—Irvine. Sponsored by the U.S. Department of Transportation, Urban Mass Transportation Administration, January, 1982.

Attanucci, John; Burns, Imogene; and Wilson, Nigel. *Bus Transit Monitoring Manual, Volume 1, Data Collection Design.* Multisystems, Inc. Cambridge, Massachusetts, and ATE Management and Service Co., Cincinnati, Ohio. Sponsored by the Urban Mass Transportation Administration, Department of Transportation, Washington, D.C., August, 1981.

____________. *Bus Transit Monitoring Manual, Volume 2, Sample Size Tables.* Multisystems, Inc. Cambridge, Massachusetts, and ATE Management and Service Co., Cincinnati, Ohio. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., August, 1981.

Attanucci, John, et al. *Design of Bus Transit Monitoring Programs.* Submitted to the Tranportation Research Board, August, 1981.

Barton-Aschman Associates, Inc. *An Approach to Transit Planning in Small Urban Areas.* A Research Report.

____________. *Guidelines for New Systems of Urban Transportation, Volume I, Urban Needs and Potentials.* Prepared for the U.S. Department of Housing and Urban Development, May, 1968.

____________. *Guidelines for New Systems of Urban Transportation, Volume II, A Collection of Papers.* Prepared for the U.S. Department of Housing and Urban Development, April, 1968.

____________. *Transit Service and Ridesharing Plan, Linn County, Iowa.* Prepared for the Linn County Regional Planning Commission, February, 1982.

Barton-Aschman Associates, Inc., and R.H. Pratt and Co. Division. *Traveler Response to Transportation System Changes,* Second Edition. Prepared for the U.S. Department of Transportation, Federal Highway Administration, Washington, D.C., July, 1981.

Becker, A. Jeff and Talley, Wayne K. "Alternative Methodologies for Measuring Transit Benefits" (abridgement). *Transportation Research Record,* No. 735, pp. 15-17.

Becker, A. Jeff, et al. *Prototype Bus Service Evaluation System.* Tidewater Transportation District Commission. Sponsored by the Urban Mass Transportation Administration, Washington, D.C., April, 1981.

Bennewitz, Eckhard. *Productivity Handbook for State and Local Government* (Ch. 29, Mass Transit). New York: John Wiley and Sons, 1980.

Bevilacqua, D. et al. *Evaluation of the Cincinnati Transit Information System (TIS).* DeLeuw Cather & Co., San Francisco, California. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., August, 1979.

Boyle, Daniel K. "Effects of Small-Scale Transit Improvements on Saving Energy." *Transportation Research Record,* No. 761, pp. 27-33.

Burke, Alinda C., et al. *Transit Performance: An Assessment of the State-of-the-Art.* Public Technology, Inc. Presented at the Annual Meeting of the American Society of Civil Engineers, Chicago, Illinois, October, 1978.

Catanese, Anthony J. *Planners and Local Politics: Impossible Dreams.* Beverly Hills: Sage Publications (Sage Library of Social Research, v. 7), 1974.

Cervero, Robert. A Multistage Approach for Refining Transit Cost Estimates. Presented at the 61st Annual Meeting, Transportation Research Board, Washington, D.C., December, 1981.

Collura, John, et al. "Evaluation of the Barnstable County Public Transportation Demonstration Project." *Transportation Research Record,* No. 761, pp. 58-65.

Cook, Charles W. *Transit System Management Evaluation Report.* Berkshire County Regional Planning Commission. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., October, 1979.

Fielding, Gordon J., et al. "Organization Theory and the Structure and Performance of Transit Services." *Transportation Research Record,* No. 761, pp. 17-20.

Flusberg, Martin; Kruger, JoAnn; and Curry, James. *Bus Transit Monitoring Study: Interim Report 1, Data Requirements and Collection Techniques.* Multisystems, Inc., Cambridge, Massachusetts and ATE Management and Service Co., Cincinnati, Ohio. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., April, 1979.

Forkenbrock, David J. "Local Support and Public Transit Financing." Technical Report No. 123, Institute of Urban and Regional Research. Presented at the 1980 Annual Meeting, Transportation Research Board, Washignton, D.C.

____________. "Transit Performance Measures and Local Objectives: State-Level Policy Considerations." *Transportation Research Record,* No. 813, pp. 23-26.

Fuller, Ernest. *Performance Measures for Public Transit Service.* California Department of Transportation, Division of Mass Transportation, Sacramento, California. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., December, 1978.

Gephart, Rex and Woodhull, Joel. *A Bus Line Costing Model Derived from Disaggregate Data.* Prepared for the Annual Meeting of the Transportation Research Board, Washington, D.C., January, 1982.

Gilbert, Gorman, et al. *Measuring the Performance of Transit Services.* Working Paper No. 5, Transit Evaluation Project. University of North Carolina, Chapel Hill, North Carolina, July, 1975.

Golenberg, Marvin and Pernaw, Steven. "Demand-Estimating Model for Transit Route and System Planning in Small Urban Areas." *Transportation Research Record,* No. 730, pp. 14-22.

Gray, George E. and Hoel, Lester A., eds. *Public Transportation: Planning Operations and Management.* Englewood Cliffs, New Jersey: Prentice Hall, 1979.

Guenthner, Richard P. and Sinha, Kumares C. *Maintenance Schedule Reliability, and Transit System Performance.* Presented at the 61st Annual Meeting, Transportation Research Board, Washington, D.C., January 18, 1982.

Hobeika, Antoine G. and Chu, Chaushie. "Equilibration of Supply and Demand in Designing Bus Routes for Small Urban Areas." *Transportation Research Record,* No. 730, pp. 7-13.

Holec, James M et al. *Use of Federal Section 15 Data in Transit Performance Evaluation—The Michigan Program.* Peat, Marwick, Mitchell & Co., Washington, D.C. Prepared for presentation at the 59th Annual Meeting of the Transportation Research Board, Washington, D.C., January, 1980.

Institute of Transportation Engineers, ITE Committee 6F-22. "A Summary Measuring Transit System Productivity and Performance." Technical Council Information Report. *ITE Journal.* November, 1982.

Intercity Bus Service in Virginia. Virginia Highway and Transportation Researcn Council, August, 1981.

Kemp, Michael A; Beesley, Michael E; and McGillivray, Robert G. "Bus Costing Information in Short-Range Planning: Surveys of Principles and Practice." *Transportation Research Record,* No. 799, pp. 28-32.

Larwin, Thomas and Stuart, Darwin G. "Transportation Management Strategies: Prospects for Small Cities." *Transportation Research Record,* No. 603, pp. 49-54.

Mundle, Subhash R. and Cherwony, Walter. "Diagnostic Tools in Transit Management." *Transportation Research Record,* No. 746, pp. 13-19.

NCHRP-146. Alternative Multimodal Passenger Transportation System Comparative Economic Analysis. Highway Research Board, 1973.

Neff, Pamela J. "The Incidence of Public Bus System Costs and Benefits." *Transportation Quarterly.* Vol. XXXVI, No. 2, April, 1982, pp. 301-16.

Ortner, James D. "Value of Urban Transit Operating Cost Models as Forecasting Tools." *Transportation Research Record,* No. 761, pp. 40-47.

Peat, Marwick, Mitchell & Co. and J.H.K. & Associates. *Measures of Effectiveness for Multimodal Urban Traffic Management.* Volume 2, Office of Research and Development, Federal Highway Administration, December, 1979.

Peat, Marwick, Mitchell & Co. *Simplified Aids for Transportation Analysis: Estimating Annual Ridership and Operating Expense for Fixed-Route Bus Systems in Small Urban Areas.* Prepared for the U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Planning Methods and Support, Washington, D.C., January, 1979.

____________. *Simplified Aids for Transportation Analysis Transit Route Evaluation,* Washington, D.C. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., January, 1979.

____________. *Statewide Transit Evaluation in Michigan.* Prepared for the Michigan Department of Transportation, Washington, D.C., July, 1981.

____________, in association with James, D.H. *Analyzing Transit Options for Small Urban Communities, Volume Two: Analysis/Methods.* Prepared for the U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Planning Methods and Support, Washington, D.C., January, 1978.

____________, in association with James, D.H. *Analyzing Transit Options for Small Urban Communities, Volume Three: Summary of Management and Operations Experience.* Prepared for the U.S. Department of Transportation, Urban Mass Transportation Administration, Office of Planning Methods and Support, Washington, D.C., January, 1978.

Poister, Theodore H. *Public Program Analysis: Applied Research Methods.* Baltimore: University Park Press, 1978.

Poister, Theodore H. and Larson, Thomas D. "Administering State Mass Transportation Programs in Pennsylvania." *Transportation Research Record,* No. 603, pp 1-7.

Public Technology, Inc. *Transit Actions: Techniques for Improving Productivity and Performance.* Washington, D.C., U.S. Government Printing Office, 1979. Supported by the U.S. Department of Transportation Administration, Office of Transit Management, and Office of the Secretary, Office of Intergovernmental Affairs.

Pyhrr, Peter A. *Zero-Base Budgeting.* New York: John Wiley & Sons, 1973.

Simpson & Curtin, Division of Booz, Allen & Hamilton, Inc. *Management Audit of the Decatur Public Transit System.* Prepared for the Illinois Department of Transportation, April, 1981.

Sinha, K.C. et al. *A Comprehensive Analysis of Urban Bus Transit Efficiency and Productivity Executive Summary.* Purdue University, West Lafayette, Indiana. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., December, 1978.

Sinha, K.C. and Bhandari, A.S. *A Comprehensive Analysis of Urban Bus Transit Efficiency and Productivity: Part III. Analysis of Options to Improve Urban Transit Performance.* Purdue University, West Lafayette, Indiana. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., December, 1978.

Sinha, K.C. and Dobry, Jr., D.B. *A Comprehensive Analysis of Urban Bus Transit Efficiency and Productivity: Part II. Labor Aspects of Urban Bus Transit Productivity.* Purdue University, West Lafayette, Indiana. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., December, 1978.

Sinha, K.C. and Jukins, D.P. *A Comprehensive Analysis of Urban Bus Transit Efficiency and Productivity: Part I. Definition and Measurement of Urban Transit Performance.* Purdue University, West Lafayette, Indiana. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., December, 1978.

Sinha, Kumares C.; Jukins, David P; and Bevilacqua, Oreste M. "Stratification Approach to Evaluation of Urban Transit Performance." *Transportation Research Record,* No. 761, pp. 20-27.

Sinha, K.C. and Guenthner, R.P. *Field Application and Evaluation of Bus Transit Performance Indicators.* Purdue University, West Lafayette, Indiana. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., March, 1981.

SMD Briefs 1-8, Reports on Mass Transit Service and Methods Demonstration Projects, Washington, D.C. Sponsored by the Service and Methods Demonstration Program of the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., January, 1980; February, 1980; April, 1980; August, 1980; November-December, 1980; April, 1981.

Smerk, George M. et al. *Handbook for Management Performance Audits: Vol: I, Theory and Techniques, Vol 2: Field Guide.* Institute of Urban Transportation, Bloomington, Indiana. Sponsored by the U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, D.C., October, 1980.

Smerk, George M. and Gerty, Rosemary B. (Editor). *Mass Transit Management: A Handbook for Small Cities,* 2nd Edition, Revised. Institute of Urban Transportation, Bloomington, Indiana. Sponsored by the U.S. Department of Transportation, Urban Mass Transportation Administration, Washington, D.C., September, 1980. Part I: Goals, Support, and Finance; Part II: Management and Control; Part III: Operations; Part IV: Marketing.

Stephanedes, Yorgas. *Techniques for Analyzing the Performance of Rural Transit Systems: Performance Indicators and Policy Evaluation in Rural Transit, Volume II.* Thayer School of Engineering, Hanover, New Hampshire. Sponsored by the U.S. Department of Transportation, Research and Special Programs Administration, Office of University Research, Washington, D.C., October, 1980.

Stuart, Darwin G. "Evaluating Alternative Plans." *Planning Advisory Service Report* No. 366, American Planning Association, 1978.

____________. "Evaluating Regional Plans and Community Impacts, ASCE." *Journal of the Urban Planning Division,* March, 1974 (coauthor).

____________. *Systematic Urban Planning.* New York: Praeger, 1976.

Transportation Research Board, Commission on Sociotechnical Systems. *Urban Transportation Economics: Proceedings of Five Workshops on Pricing Alternatives, Economic Regulations, Labor Issues, Marketing, and Government Financing Responsibilities.* Special Report 181. Washington, D.C., National Academy of Sciences, 1978.

____________. National Research Council. *Quick-Response Urban Travel Estimation Techniques and Transferable Parameters.* National Cooperative Highway Research Program Report No. 187. Sponsored by the American Association of State Highway and Transportation Officials in cooperation with the Federal Highway Administration, Washington, D.C., 1978.

____________. National Research Council. *Travel Estimation Procedures for Quick Response to Urban Policy Issues.* National Cooperative Highway Research Program Report No. 186. Sponsored by the American Association of State Highway and Transportation Officials in cooperation with the Federal Highway Administration, Washington, D.C., 1978.

Turnquist, Mark A. "Strategies for Improving Reliability of Bus Transit Service." *Transportation Research Record,* No. 818, pp. 7-13.

Urban Mass Transportation Administration, U.S. Department of Transportation. *Proceedings of the First National Conference on Transit Performance.* Norfolk, Virginia, September, 1977.

Voorhees, Alan M. and Associates, Inc. *Transportation System Management: Handbook of Manual Analysis Techniques for Transit Strategies.* Prepared for the North Central Texas Council of Governments. Sponsored by the Planning Research and Evaluation Division, Office of Planning Assistance, Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., reprinted May, 1981.

Vuchic, Vukan R. *Urban Public Transportation Systems and Technology.* Englewood Cliffs, New Jersey: Prentice Hall, 1981.

Wagner, Fred A. and Gilbert, Keith. *Transportation System Management: An Assessment of Impacts.* Alan M. Voorhees, Inc., McLean, Virginia. Sponsored by the Urban Mass Transportation Administration, U.S. Department of Transportation, Washington, D.C., November, 1978.

Wildavsky, Aaron. *Budgeting: A Comparative Theory of Budgetary Processes.* Boston: Little, Brown, and Company, 1975.

Winfrey, R. *Economic Analysis for Highways.* International Textbook Co., 1969.

THE TRANSPORTATION RESEARCH BOARD is a unit of the National Research Council, which serves the National Academy of Sciences and the National Academy of Engineering. The Board's purpose is to stimulate research concerning the nature and performance of transportation systems, to disseminate information that the research produces, and to encourage the application of appropriate research findings. The Board's program is carried out by more than 200 committees, task forces, and panels composed of more than 3,300 administrators, engineers, social scientists, attorneys, educators, and others concerned with transportation; they serve without compensation. The program is supported by state transportation and highway departments, the modal administrations of the U.S. Department of Transportation, the Association of American Railroads, the National Highway Traffic Safety Administration, and other organizations and individuals interested in the development of transportation.

The National Research Council was established by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and of advising the federal government. The Council operates in accordance with general policies determined by the Academy under the authority of its congressional charter of 1863, which establishes the Academy as a private, nonprofit, self-governing membership corporation. The Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in the conduct of their services to the government, the public, and the scientific and engineering communities. It is administered jointly by both Academies and the Institute of Medicine.

The National Academy of Sciences was established in 1863 by Act of Congress as a private, nonprofit, self-governing membership corporation for the furtherance of science and technology, required to advise the federal government upon request within its fields of competence. Under its corporate charter the Academy established the National Research Council in 1916, the National Academy of Engineering in 1964, and the Institute of Medicine in 1970.

TRANSPORTATION RESEARCH BOARD
National Research Council
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

ADDRESS CORRECTION REQUESTED

NON-PROFIT ORG.
U.S. POSTAGE
PAID
WASHINGTON, D.C.
PERMIT NO. 42970

000015M001
JAMES W HILL
RESEARCH SUPERVISOR
IDAHO TRANS DEPT DIV OF HWYS
P O BOX 7129 3311 W STATE ST