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Decision Procedures for Paratransit Market Selection and Service Evaluation

May 1982

The cover photo, showing one of Tidewater Regional Transit's Maxi-Ride Vehicles, is provided courtesy of Mr. A. Jeff Becker.

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Final Report
May 1982

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PREFACE

This study represents a departure from current formalized transit evaluation procedures that address fixed route services. Here popular paratransit services that have not attracted similar analytical approaches are addressed, because transit managers who deal with fairly extensive paratransit systems require some form of specialized evaluation strategy.

This report derives from two master's degree theses: Paratransit Service Evaluation by Mary Jo Kunkel, May 1981 and Paratransit Identification and Marketing Procedures by Charles J. Davis, May 1982. Both theses were prepared while Ms. Kunkel and Mr. Davis were being supported by a project entitled Management Decision Procedures for Transit Market Solution and Service Delivery sponsored by the UMTA University Research and Training Program, Office of Policy Research, Urban Mass Transportation Administration, U. S. Department of Transportation.

The authors acknowledge the support of Ms. Judy Meade, UMTA University Research and Training Program for her administrative support throughout the course of the study. We are especially indebted to James Echols and Jeff Becker of the Tidewater Transportation District Commission who collaborated on this project. They remained continually interested and fully participated throughout the duration of the study. Tidewater provided the data for the theoretical development and case studies that demonstrated the relevance of the methods. Jim and Jeff participated in numerous meetings in Norfolk and Charlottesville to review progress and set direction for successive tasks.

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A. Problem Statement

This research addresses the transit manager's basic problem of deciding how to increase transit service availability while at the same time improving its efficiency by implementing new services to attractive market areas and discontinuing existing services to unproductive markets in a timely manner. These decisions depend upon good marketing information on the one hand and good service evaluation data on the other.

This study focuses on both sides of this transit management decision problem, and presents unified procedures that simultaneously deal with both the marketing and service evaluation problems. In the marketing problem, transit service opportunities in growing suburban markets are identified. For the service evaluation problem, the focus is on analysis of existing services and justification of the elimination of unproductive services. A service development process that illustrates the joint use of the evaluation procedures in conjunction with a market analysis is identified.

The specific objectives of this study are as follows:

(1) To develop procedures to identify new transit markets.

(2) To develop procedures for evaluating the productivity of existing services.

(3) To develop unified decision procedures which simultaneously treat the problems of selecting new markets and services and terminating unproductive services.

B. Methodology

The Market Analysis Problem

One major objective of this study is to provide procedures and establish criteria for the implementation of paratransit services. Potential markets are defined for both ridesharing and demand responsive (DRT) services. The concept of a market analysis, as opposed to a demand analysis, is introduced. Markets are described through the use of market profiles. Methods for the evaluation of market profiles provide the ability to establish the actual criteria for the implementation of services. The markets to be analyzed include both:

1. new markets currently not served by paratransit such as low density suburbs or employers without ridesharing programs; and

2. markets affected by a proposed change in service due to a service evaluation such as a failing fixed route bus service or a failing shared-ride taxi service.

The purpose of the market analysis is to determine the size and character of the potential markets so that paratransit services can be implemented and targeted to those market groups which are best served by paratransit. The basis of a market analysis is the construction of a market profile, which consists of a set of market attributes that point out the presence (or non-presence) of potential users of the proposed service. The profile is then evaluated to determine if a market warrants implementation of the proposed service. Due to the diverse nature of paratransit markets and services, separate market analyses are introduced for ridesharing and demand-responsive services.

The Service Evaluation Problem

The first task in preparing an evaluation scheme for transit services is to state the goals for the transportation system. The two most common goals which the federal government has stipulated for all transit systems are (1) to maximize efficiency, and (2) to maximize effectiveness.

Next, objectives for the transit service are specified, also indicating desired results, but usually within a conceivable time period. The goals and objectives can, and often do, conflict, especially between fiscal limits and social, environmental, or political needs.

The next step is to develop indicators and measures. The indicators are the determinants of evaluation, which place the goals and objectives into terms which directly relate to the transit system's performance. For example, a goal to improve mobility of the population would be translated into an accessibility index of the transit route.

Finally, standards for performance are set that serve as a basis for judgment. Values for each measure are calculated in evaluation, and compared to the standards. Decisions about improvement or replacement of services are made with these comparisons.

Service Development Process

A service development process is proposed that illustrates the integrated use of the transit evaluation procedures, as well as the results of the market analysis. The process incorporates the evaluation techniques for both conventional and innovative transit services, on both intramodal and intermodal levels. The market analysis results are the input for intermodal evaluation, where failing services are replaced or new markets are proposed.

Each of the evaluation procedures consists of a set of evaluation indicators, measures, and standards. By comparing the performance of a service with the standards for that particular mode, the evaluator can judge how well the service currently does, or will do in implementation, to meet the travel needs of the users in a particular study area.

In the intramodal evaluation, existing services are assessed through comparison of the measures to the standards to determine if the service is adequate. The "does service pass?" question is answered with the results of this general evaluation, and those that do not, are further analyzed with a set of descriptive indicators that detect specific service deficiencies. For intramodal analysis, both a general and detailed set of indicators are developed for each mode group and are applied to existing services.

The intermodal evaluation of alternative services is a comparison designed for replacement of existing, failing services and for institution of new market services. A set of indicators for each paratransit and transit mode available is used here to choose a service to meet a stated market need. Measures used in the existing service evaluation will be incorporated as much as possible so that data types and amounts will be minimized.

Case Study

The service development process is applied to a case study of the Tidewater Transportation District Commission (TTDC) of Virginia. Market identification procedures, along with intramodal and intermodal evaluation procedures are applied to TTDC's experience to show their utility.

The DRT market analysis procedures are applied to a case study of TTDC's "Maxi-Taxi" services. Both successful and failing services are discussed, as market profiles are described and evaluated following the procedures introduced in this study. The case study shows that the use of the DRT market analysis may have prevented TTDC from implementing services destined for failure.

The intramodal and intermodal evaluation procedures are both applied to a case study of TTDC's experience. In total, two intramodal evaluations and two intermodal evaluations are performed. The TTDC Maxi-Taxi services and vanpool leasing services illustrate the use of the demand-responsive and pooling intramodal evaluations. The intermodal evaluations use case studies of mode changes within a service area in the Tidewater region, with comparison to the no transit service alternative. Maxi-Taxi is compared to local bus service, and the vanpool option is compared to express bus service.

C. Results

The service development process includes steps that illustrate the simultaneous use of the evaluation procedures and the market analysis results. By following the steps recommended in this process, a more cost efficient and effective transit system, with minimum negative societal impact, is achieved.

This study recommended a framework for the analysis of potential paratransit markets. This was followed by suggesting an evaluation method which established decision criteria for the implementation of paratransit services.

TTDC's successful experiences with ridesharing were reviewed. A ridesharing market analysis format was suggested for use in the "initial contact phase" of TTDC's Ridesharing Action Plan.

A case study of TTDC's Maxi-Taxi services was conducted. The case study built market profiles and conducted evaluations for three actual services offered by TTDC.

For potential ridesharing markets, the two most critical "employer" attributes are the number of employees and the compatability of their work schedules. A disaggregation of the employees into "clusters" of employees with the same schedules allows one to judge the actual size of the pools of employees which can be matched together to rideshare. The most critical "employee" attribute is the distribution of the residential density of the employees. For potential demand-responsive transit markets, the critical attributes are the socioeconomic characteristics and the presence of large trip generators. Demand models should not be used as a basis for the decision whether or not to implement DRT in a particular market.

The procedures demonstrated in this report provide a framework for the development of a common paratransit evaluation strategy for application at and between the system level.

The paratransit service evaluation process includes intramodal and intermodal evaluation. Each service is assessed by comparing its performance to a set of preestablished standards that reflect the locality's goals and objectives. Dual standards are recommended because they allow both a minimum and a desirable performance level. These standards, as well as the measures and indicators, may be modified to fit the conditions of any location.

For intermodal evaluation, a market analysis is a prerequisite for the estimation of performance of proposed services. The intramodal evaluation assesses existing services, and requires operating statistics and user surveys as input.

A major hindrance to implementation of both market identification and service evaluation procedures is data availability. This data, because it must be on a service area or route basis, is fairly detailed and requires both time and funding if useful and comprehensive analyses and evaluations are desired. Many transit authorities do not currently collect this data, although the cost of doing so would be compensated with an increase in system efficiency.

CHAPTER 1

INTRODUCTION

1.1 Background

During the past twenty years, transit costs have risen sharply as revenues have only marginally increased, causing transit deficits to continue to rise. Two strategies are available to reduce transit deficits: improve operating efficiency or cut back existing services.

In practice, the transit operator's dilemma is to improve system efficiency, increase transit availability to meet any growing demand, and to minimize transit operating cost.

In order to meet these disparate objectives, the transit manager must address the basic problem of deciding how to increase transit service availability while at the same time improving its efficiency by implementing new services to attractive market areas and discontinuing existing services to unproductive markets in a timely manner. These decisions depend upon good marketing information on the one hand and on good service evaluation data on the other.

This study focuses on both sides of this transit management decision problem, and presents unified decision procedures that simultaneously deal with both marketing and service evaluation problems. In the marketing problem, transit service opportunities in growing suburban markets are identified. For the service evaluation problem the focus is on analysis of existing services and justification of the elimination of unproductive services. A service development process that illustrates the joint use of the evaluation procedures in conjunction with a market analysis is identified.

The specific objectives of this report are as follows:

(1) To develop procedures to identify new transit markets.

(2) To develop procedures for evaluating the productivity of existing services.

(3) To develop unified decision procedures which simultaneously treat the problems of selecting new markets and services and terminating unproductive services.

1.2 Transit Marketing

The function of transit marketing is to understand and respond to consumer needs for services provided. This is accomplished by analysis of the travel needs of present and potential customers; fulfilling these needs in terms of service development, including the development of pricing structures; and by communication to the public through promotions and individual customer service activities. These activities help satisfy customer needs, stimulate patronage of the system and generate an adequate return. (1)

Marketing for mass transit systems embraces two major functions: market research and adjustment of the marketing mix.

1. Market research examines market groups and their needs. It defines market groups, their travel needs, and the effectiveness of existing service and response to service changes.

2. The adjustment of the marketing mix is that function which responds to various market groups that were identified in the market research process. The variables that can be adjusted are: (a) levels of service, (b) fare structure, and (c) promotional activities and user services.

Market segments are groups of individuals who have common transportation needs. Examples of market segments include suburban commuters going to a downtown office complex, senior citizens on shopping trips, and physically handicapped people. If a transit agency has identified its goals, it can identify the market segments which must be served to accomplish these goals. For example, if the goal is to reduce congestion on major arterials in the peak direction during peak hours, the market segment that must be served are commuters who live in the suburbs and travel downtown.

1.2.1 Market Research

Market research is a widely accepted activity in transit and an invaluable management tool. A major purpose of market research is to identify market groups and their travel needs. Market research can reveal:

1. market segments within the population,

2. transportation needs of specified market segments,

3. effectiveness of service, both before and after service changes, and

4. public response to service changes.

Market research is especially important in identifying new transit markets. Without market research, the transit planner cannot verify that market segments (such as elderly citizens) which may be attracted to transit exist. This is especially important when the transit system's goals are to serve such segments as physically handicapped or economically disadvantaged people.

Problem identification can be accomplished through research which may locate deficiencies and prevent future problems. For example, market research may locate areas lacking transportation alternatives which could support some form of public transportation.

1.2.2 The Marketing Mix

Levels of service. Decisions about the quantity and quality of service to be provided should reflect the results of the market research effort. The major service characteristics which can be varied to meet market needs are:

1. route structure, including route configuration and location and spacing of stops.

2. schedules, including frequency of service in peak and off-peak periods, weekends and holidays, and the co-ordination of schedules at transfer points.

3. service reliability, including adherence to schedules and equipment maintenance standards.

4. special services, such as contract services, demand-responsive service, and facilities for the elderly and handicapped.

A market analysis should be a key element in making the decision whether or not to implement a proposed new service. The market analysis is very important as it determines whether a proposed service will provide a "mode to market match." Certain market groups are attracted to particular combinations of travel time, fare, comfort, and convenience. The needs of these groups must be met by a proposed service for the service to be utilized. The purpose of the market analysis is to determine if there are indeed market groups who will be best served by the proposed service.

Fare structure. Many years ago, private transit companies operated for a profit. Presently, however, public transportation offers many approaches to fare collection for the purpose of attaining a broader range of goals than earning a profit. Reduced fares offer increased mobility to low-income persons. At the other end of the pricing spectrum, fares charged to vanpool users may often cover 100% of total costs.

The fare structure includes both the prices charged and the method of collection. Pricing decisions include whether to charge a flat fare or a distance-based fare (based on zones or miles), transfer policies, and special discounts or premium fares for population subgroups or time-of-day travelers. Fares may be collected in cash, through the use of prepayment systems, or by the use of credit or a deferred-payment plan.

Sales communication and user services. Sales communication in the transit industry is a mixture of advertising, public relations, and public information. It contains the element of action in marketing that follows the research and evaluation functions. The marketing process begins with determining what type of product is to be produced, based on what the public wants and what the system can produce. The next step is to analyze the size and character of the market and to determine the best use of the market. The sales effort is the communications link between the product and its market: it is the active force that brings them together. (2)

The primary goals of sales communciation for transit are:

1. to generate public awareness of the programs, operations, and problems of the transit system, and
2. to create public awareness of the benefits to the individual, the community, and the nation from patronizing public transportation. (3)

Sales communication and user services are especially important in promoting a new transit service. Without promotional activities and user services, the target markets will not be aware of transit operations and the benefits that public transportation can provide. If consumers are not informed of the operations and benefits of transit, they will not use the services.

1.2.3 Ingredients of Marketing Success

There are three basic, sequential elements that are necessary for constructing any successful marketing plan.

1. setting the objectives of the plan and determining the goals to be achieved,
2. selecting a strategy for achieving the goals and implementing this strategy, and
3. observing progress toward the goals set and evaluating the reasons for the success or failure of the marketing effort.

The use of a formal marketing plan, based on research, will direct marketing efforts toward what is needed and the most effective means of supplying these needs.

However, marketing budget constraints make efficient planning necessary. The best method for making efficient use of marketing money is the use of target markets. Segmenting markets and shopping for media that reach these markets at the lowest cost per capita will usually increase the productivity of marketing dollars. (2) Many ways exist for dividing populations into target marketing groups such as by age, by geographic location, by occupation, etc. Once the target markets have been identified, the problem is how to reach them best and at what cost. Examples of how target-specific campaigns are used include promoting specific commuter routes, smoothing seasonal swings in ridership, and increasing ridership by targeting rider motives.

1.2.4 Summary

The following elements enhance the success of a transit agency's marketing efforts:

1. clearly defined transit system and marketing objectives,
2. support for marketing from top management,
3. integration of the marketing function in the transit organization,

4. carefully designed market research,

5. identification of market segments, and

6. marketing techniques to reach specific segments.

1.3 Transit Evaluation

Transit evaluation is the process of assessing transit alternatives. Performance indicators are compared to established standards based on system goals and objectives. It is composed of three sets of measures that reflect efficiency, effectiveness, and societal impacts. (4) Efficiency measures are given in terms of resource input per output, and reflect resource usage as well as local area characteristics and constraints, such as population density and labor union strength. An example of an efficiency measure is operating cost/vehicle-mile. Efficiency, then, is "doing things right." (5) Effectiveness measures, also called mobility measures, rate the degree to which the transit service achieves the rider's and the community's needs. The percent of population served and the percent of users satisfied with the service reliability are typical effectiveness measures. Effectiveness is "doing the right things." (5)

Impact measures assess the effect of transit services on social well-being, economic development, and environmental quality. Some examples are changes in employment in a neighborhood, and number of crimes per million passenger-miles. In practical applications, specific measures are calculated on a route, or service area basis. Evaluation of transit services is, to a large extent, locality-specific or community needs typically vary between systems. The first task in preparing an evaluation scheme for transit services is to state the goals for the transportation system. The two most common goals, which the federal government has stipulated for all transit systems, are (1) to maximize efficiency, and (2) to maximize effectiveness. Other goals which may be included are conservation of public funds and discouragement of urban sprawl. This set of goals, then, consists of comprehensive statements of desired end results within the community. (6)

Next, objectives for the transit service are specified, also indicating desired results, but usually within a conceivable time period. Often, targets, such as an increase in daily average ridership, are set by a service objective. The goals and objectives can, and often do, conflict, especially between fiscal limits and social, environmental, or political needs.

The next step is to develop indicators and measures. The indicators are the determinants of evaluation, which place the goals and objectives into terms which directly relate to the transit system's performance. For example, a goal to improve mobility of the population would be translated into an accessibility index of the transit route.

Any of several indicators will reflect a particular attribute of a transit service, although some are better than others for use in a specific evaluation. The criteria for making these choices are: (5,7,8)

(1) pertinence; consistency with objectives
(2) conciseness
(3) data availability
(4) personnel time committment and expertise
(5) measurability
(6) minimization of uncontrollable factors
(7) clarity to the users
(8) reliability over an entire range of performance.

Finally, standards for performance are set, that serve as a basis for judgment. Values for each measure are calculated in evaluation, and compared to the standards. Decisions about improvement or replacement of services are made with these comparisons.

While the majority of formalized transit evaluations have been designed to address fixed route services, the popular paratransit services have not attracted similar treatment. This is attributed to the relatively fewer resources that have been consumed by the non-fixed route modes when compared with the fixed route operations in a transportation district.

This study develops a method for specifically evaluating paratransit services. Goal and objective formulation, indicator and measure development, and standard specification are the primary steps in the process. The problem of data availability is addressed, as are the uses and limitations of the indicator set.

1.3.1 Service Development Process

As a preliminary step to the development of the marketing and evaluation procedures for paratransit services, a service development process (See Figure 1) is identified that illustrates the integrated use of the transit evaluation procedures and market analysis methods. The process incorporates the evaluation techniques for both conventional and innovative transit services, on both intramodal and intermodal levels. The market analysis results are the input for intermodal evaluation, where failing services are replaced or new markets are proposed.

Each of the evaluation procedures consists of a set of evaluation indicators, measures, and standards. By comparing the performance of a service with the standards for that particular mode, the evaluator can judge how well the service currently does, or will in implementation, meet the travel needs of the users in a particular study area.

In the intramodal evaluation, existing services are assessed through comparison of the measures to the standards to determine if the service is adequate. The "does service pass?" question is answered with the results of this general evaluation, and those that do not, are further analyzed with a set of descriptive indicators that detect specific service deficiencies. For intramodal analysis, both a general and a detailed set of indicators are developed for each mode group and are applied to existing services.

The intermodal evaluation of alternative services is a comparison designed for replacement of existing, failing services and for institution of new market services. A set of indicators for each paratransit and transit mode available is used here to choose a service to meet a stated market need. Methods for identifying market needs will be examined in the next chapter. Measures used in the existing service evaluation are incorporated into the marketing procedures so that data types and amounts will be minimized.

1.4 Organization of Report

This report is divided into two phases:

(1) Developing decision-making procedures, and

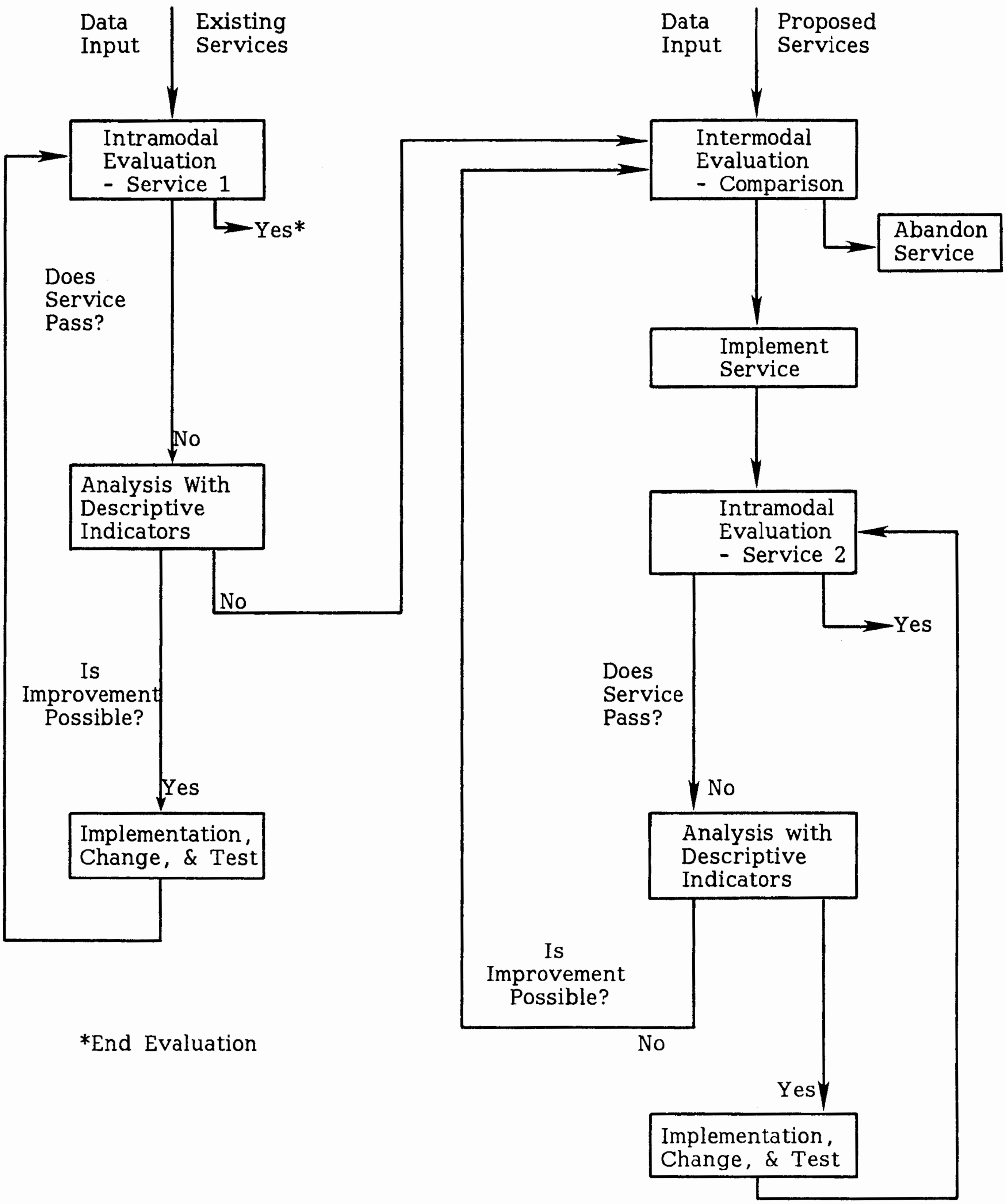


Figure 1. The Paratransit Service Development Process

(2) Case studies illustrating the utility of the decision-making procedures.

The first phase includes Chapters 2 and 3. Chapter 2 describes a framework for the analysis of potential transit markets, including a market profile evaluation method which establishes decision criteria for the implementation of new services. Chapter 3 addresses both intramodal and intermodal service evaluations, respectively. In the intramodal evaluation, existing services are assessed through comparison of the measures to the standards to determine if the service is adequate. The intermodal evaluation of alternative services is a comparison designed for replacement of existing, failing services and for the institution of new services.

The final phase includes Chapters 4 through 6. Chapter 4 applies the market analysis developed in Chapter 2 to a case study of TTDC's "Maxi-Taxi" services. Chapter 5 applies the intramodal and intermodal evaluation procedures to a case study of TTDC. Chapter 6 offers the results and conclusions of this report.

CHAPTER 2

IDENTIFICATION OF MARKET NEEDS

2.1 Introduction

The purpose of this chapter is to provide procedures for the identification of paratransit market needs and to establish criteria for recommending the implementation of new services. Potential markets are defined for both ridesharing and demand responsive services. The concept of a market analysis, as opposed to a demand analysis, will be introduced. Markets are described through the use of market profiles. Methods for the evaluation of market profiles will be provided to establish the actual criteria for the implementation of services. The markets to be analyzed include both:

1. new markets currently not served by paratransit such as low density suburbs or employers without ridesharing programs; and

2. markets affected by a proposed change in service due to a service evaluation such as a failing fixed route bus service or a failing shared-ride taxi service.

The purpose of the market analysis is to determine the size and character of the potential markets so that paratransit services can be implemented and targeted to those market groups which are best served by paratransit. The basis of a market analysis is the construction of a market profile, which consists of a set of market attributes which should point out the presence (or non-presence) of potential users of the proposed service. The profile is then evaluated to determine if a market warrants implementation of the proposed service. Due to the diverse nature of paratransit markets and services, separate market analyses will be introduced for ridesharing and demand-responsive services.

2.2 The Form of the Market Analysis

The general form for a paratransit market analysis includes the following steps:

1. Outline the goals and objectives for the paratransit service.

2. Choose a set of market attributes or indicators which pertain to the attainment of the goals and objectives of the mode.

3. Determine any measures which may be needed to quantify the selected market attributes.

4. Determine what and how much data is needed, then collect the data.

5. Evaluate the market profile.

2.3 Ridesharing Market Analysis

A potential ridesharing market can be defined as a single large employer or a set of employers forming a major activity center (MAC). The major objective of ridesharing to the ridesharing authority is to move more people in fewer cars or vans.

The ridesharing market profile (Table 1) consists of two categories of attributes; "employer" attributes and "employee" attributes. The "employer" attributes are those which can be obtained in an initial contact with the top management of a firm. These attributes describe the suitability of an employer to a new ridesharing program. The two most critical attributes are the number of employees and the compatability of their work schedules. Large employers are best suited to ridesharing, but if employees work on staggered or flexible shifts, ridesharing will be more difficult to implement. The price and availability of parking and the level of peak-hour traffic congestion around the employment center are other "employer" attributes which will point to the suitability of a ridesharing program. Another attribute is the current level of ridesharing at the employment center. If there is already a high level of ridesharing activity, only limited further increases are likely at such a location.

An analysis of the above "employer" attributes for a potential ridesharing market should provide enough information to the employment center and the ridesharing authority to decide whether implementation of a ridesharing program is needed at the employment center. As noted above, the critical "employer" attributes are the total number of employees and the work schedule. A disaggregation of the employees into "clusters" of employees with the same schedules allows one to judge the acutal size of the pools of employees which can be matched together to rideshare. The local ridesharing authority should be able to judge from his locality's experience whether the "clusters" are large enough to match riders together. Figure 2 shows examples of both good and poor candidate ridesharing markets.

Table 1

Ridesharing Market Profile

I.	Employer attributes:	- number of employees* - work schedules* - price and availability of parking - local traffic congestion - current ridesharing activities
II.	Employee attributes:	- distribution of the residential density of employees (origins)* - distance and travel time of commute - auto availability - income

* Critical attributes

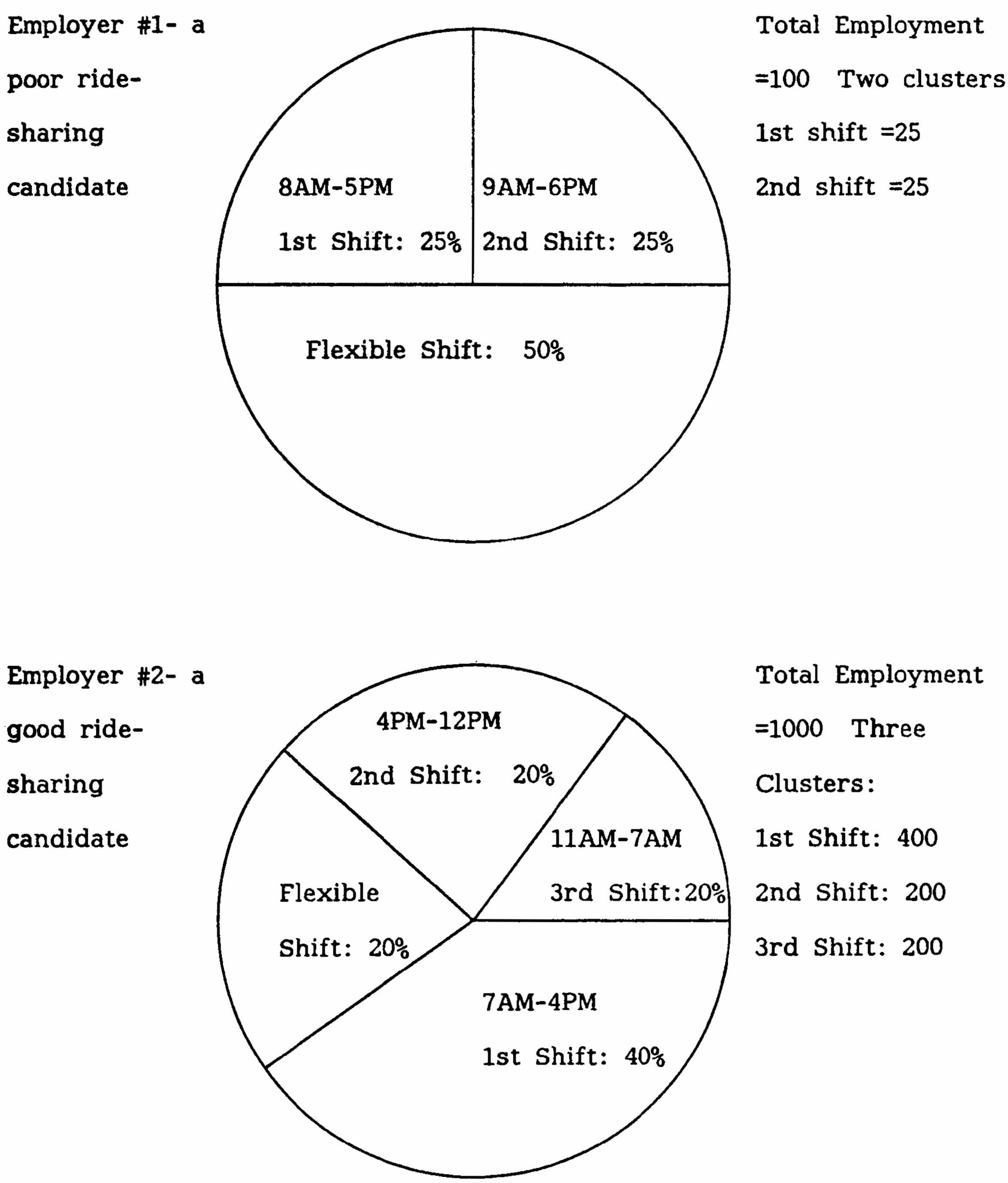


Figure 2. Disaggregation of Employees into Clusters

The actual success of a ridesharing program will depend more upon the "employee" attributes. The most important "employee" attribute is the distribution of the residential density of company employees. Employees must live close enough to one another so that ridesharing does not add a significant amount of travel time to the daily commute. The distance and travel time of the commute are important, as longer distances provide more economic incentives to rideshare. A long "line-haul" portion of the trip will dilute the added time of picking up and dropping off the riders.

2.4 Demand Responsive Transportation Market Analysis

The first step of the market analysis for a proposed demand responsive transportaion service is to outline the objectives of the proposed service. Common objectives for the demand responsive mode are as follows:

1. To serve new markets, thereby providing transit to those who have had little or no service;

2. To serve those with special mobility needs, such as elderly and handicapped persons or those who are economically disadvantaged; and

3. To improve the overall economic results of the system.

A potential market for DRT service is first defined by boundaries forming a service area. Common boundaries used to define a service area include city limits, major highways, bodies of water, neighborhood boundaries, and major streets. Once potential markets have been defined as service areas, market profiles are constructed to determine the size and character of the market, or to establish the potential of the new service.

2.5 Methods for Establishing the Potential of a New Service

To meet goals of effectiveness and efficiency, transit operators frequently base their DRT service evaluations on measures such as passengers per hour and cost per passenger. If the operator could accurately predict the ridership of a proposed new DRT service, it follows that he could predict how effective and efficient the proposed new service would be, and could base his implementation decision on these predictions. Many ridership prediction, or demand models have been built in attempts to predict the effect on DRT patronage of different service areas, vehicle fleet sizes, and fare structures. A review of demand models which have been used to estimate patronage of proposed DRT services follows.

One group of current demand models is the MIT behavioral simulation models. The Rochester model (9) is a detailed computer simulation model incorporating a great deal of behavioral content. Unfortunately, the model requires large computer costs, a huge amount of generally inaccessible data (see Table 2), and the user can expect the results of the model to be in error ± 20-35%. Also, the model is best applied on a system-wide basis as opposed to the more important single route level. Data requirements and computer costs would make the cost of running such a model even more expensive than actually implementing a proposed service on an experimental basis.

Many other modelers have excluded behavioral content to build simpler models. These simpler models are more accessible to planners than simulation models, require fewer data to apply, are more easily understood, and offer results that are no less trustworthy than those of complex models for several basic planning tasks. (10)

Billheimer's group with Systan, Inc. tested six of the simpler models by using data from 5 sample dial-a-ride cities (see Table 3). The six demand models tested are identified as follows:

1. Empirical fit of demand to service area population in 43 cities; (11)
2. Empirical fit of demand density to population in the same 43 cities; 12
3. Empirical fit of demand to both population and population density on several Canadian dial-a-bus operations; (12)
4. Use of nomographs that reflect both the fare and the population density of the service area; (13)
5. The rule of thumb, e.g., 25 passenger trips/day/mile^2; (14)
6. Simultaneous estimates of demand and vehicle supply by the use of nomographs obtained by an empirical fit to dial-a-bus data for 16 cities. (15)

Table 3 shows the actual demand densities observed in each of the five test cities and the demand levels estimated by each of the six models listed

Table 2

Data Requirements for MIT Behavioral Simulation Model

I. Study area characteristics

- A. zonal system (coordinates of zone centroids)
- B. list of zones not served by DRT
- C. zonal areas
- D. zonal populations
- E. zonal employments
- F. work trip matrix
- G. socioeconomic characteristics distributions
  - 1. auto availability
  - 2. household size
  - 3. number of residents over 16 years old
  - 4. number of residents over 64 years old
- H. work trip departure time distribution

II. DRT system characteristics

- A. fleet size during period
- B. vehicle type (passenger car or bus)
- C. free vehicle speed
- D. dispatching system (computer or manual)
- E. fare per passenger
- F. time required for passengers to get on/off vehicle

III. Alternative mode characteristics

- A. times and costs for driving
- B. shared ride auto occupancy

Source: Lerman, et al., p. 14-15

Table 3

Analytical Estimation of Demand Density in Five Test Cities

City	Demand Density (Trips/km^2/hr						
	Actual	Empirical Fit to Population	Empirical Fit to Pop. Dens.	Lea Systems	LEX/TRAN Calculator	L.A. Guidelines	Mitre Nomographs
Naugatuck, Conn.	0.3	0.4	0.77	0.9	1.16	1.12	0.33
Merrill, Wi.	1.3	0.8	1.0	0.4	7.7	1.1	0.7
Danville, Ill.	1.2	0.15	0.31	0.12	1.54	0.58	1.5
Syracuse, N.Y.	0.06	0.31	0.8	0.85	2.7	0.9	0.2
Orange, Calif.	2.0	1.16	1.7	5.2	9.65	1.12	1.8

above. This test shows that empirical approaches to demand prediction performed poorly. Model 6, the Mitre nomograph technique, performed more consistently than the other approaches and sometimes gave very good estimates. However, errors ranged from -46% to +233% even for this method when tested on the five cities. The widely inaccurate estimates of demand models (Table 3) shows that demand models should not be used as a basis for the decision whether or not to implement demand responsive transportation in a particular market.

2.6 The DRT Market Profile Method

As an alternative to demand models, this section will introduce the concept of the market profile method. Instead of relying upon complex mathematical models, the market profile method analyzes the market by examining the attributes which should point to the presence (or non-presence) of market segments which can be expected to utilize the proposed transit service.

The market profile for a proposed DRT service area may be roughly defined as any and all market data available on the service area. The market profile (Table 4) consists of market attributes which describe the market in a way that the operator can determine if a proposed DRT service can indeed fulfill its objectives in the proposed service area. The evaluation of these market profiles (Figure 3) is the decision process which determines which proposed market or markets warrant DRT implementation.

Table 4 outlines the data requirements necessary to build a DRT market profile. The collection of this data is an important part of the market research function discussed in Chapter 1. The critical attributes are the socioeconomic characteristics and the presence of large trip generators. The socioeconomic characteristics point to actual market groups who may be attracted to the service. The presence of low-mobility groups such as those without an automobile, those without a driver's license, the young (under 16) and the elderly can point to groups of potential captive riders. The availability of large trip generators such as shopping centers and hospitals is favorable to demand responsive service.

Other pertinent market attributes include the population and population density of the service area. The population gives the size of the potential market and can be used to determine the size of target markets if socioeco-

Table 4

DRT Market Profile Data Requirements

I. Critical Market Attributes

A. Socioeconomic characteristics
   1. percentage of young and elderly
   2. percentage of households without an auto and with one auto
   3. percentage without driver's license
   4. average income

B. Presence of large trip generators

II. Pertinent Market Attributes

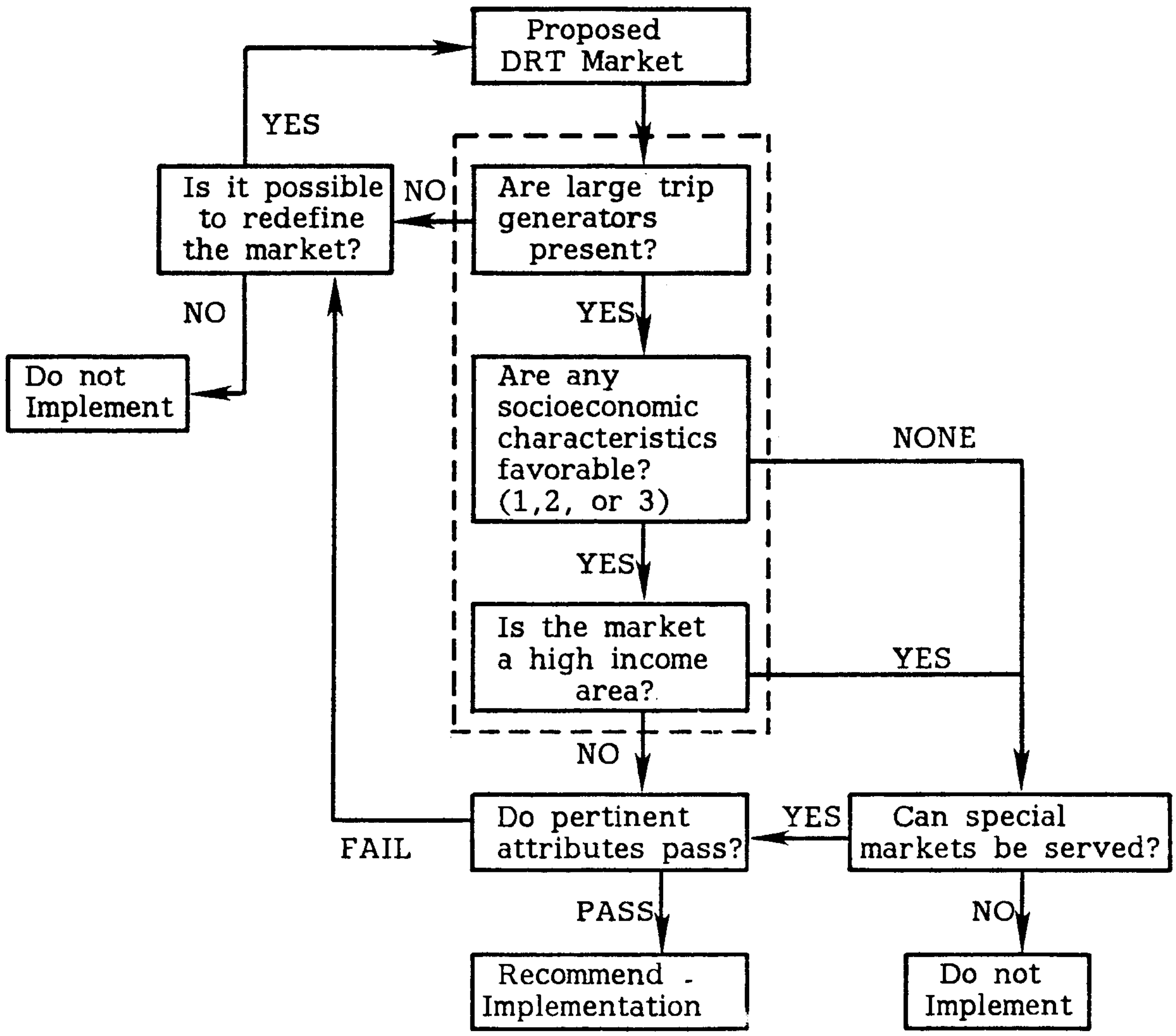
A. Population

B. Population density

C. Other transportation available

III. Special "Locality" Attributes

A. Potential to serve special markets (senior citizen homes, colleges, school children, subscription services)



Note: Dashed lines indicate the critical market attributes.

Figure 3. DRT Market Profile Evaluation

nomic characteristic distributions are available. Population density can be important, as there are population densities at which paratransit service is the most cost effective.

Another pertinent market attribute is the availability of other competing transportation. Other public transportation and taxi services provided within the proposed service area should be accounted for before implementing DRT. In areas where transit and taxi currently provide services, the DRT operator should determine if these modes are adequately serving the market. A proposed DRT service must be able to compete with these modes in terms of level of service and fare.

Some localities will have other special attributes which should be included in a market profile. These refer to the potential of DRT to serve special markets by coordinating services with institutions such as senior citizen homes, schools, colleges or day care centers.

Data limitations. The availability of data for building DRT market profiles will certainly vary among transit systems and can constrain the market analysis. The critical socioeconomic attributes are most likely to be difficult to obtain and quantify. If quantitative distributions are not available for the socioeconomic attributes, the transit manager should at least state a qualitative indication of how the proposed market area compares to other DRT markets in terms of the critical attributes. The evaluation of DRT market profiles can then be based on these qualitative statements if no quantitative data exists.

2.7 DRT Market Profile Evaluation

Figure 3 shows a suggested format for evaluating a DRT market profile and deciding whether or not to recommend implementation of the proposed service. The evaluation is based on the "critical" market attributes and also considers the "pertinent" and "special" market attributes in reaching a decision on implementation.

Large trip generators. Once a proposed DRT market has been defined as a service area, the first critical market attribute to be analyzed is the presence of large trip generators. Regional shopping centers, large hospitals, etc. must be included in a proposed service area to meet the travel needs of the market groups identified by the socioeconomic attributes. If the proposed service area does not include any of these major destinations, it is a poor candidate market. If the market area can not be redefined to include major activity centers, service should not be implemented. If the market area is redefined, the analyst must make the proper corrections in the market profile and readdress the profile evaluation from the top of Figure 3.

Socioeconomic characteristics. If the analyst determines that large trip generators are indeed present in a proposed service area, then the next critical market attributes to be analyzed are the socioeconomic characteristic distributions. The following three socioeconomic variables should point to the presence (or non-presence) of low mobility market groups who may be attracted to DRT service.

1. The percentage of young and elderly: The young (under 16) can not drive automobiles due to their age and many of the elderly (over 64) can not drive automobiles due to their physical limitations. Both groups, especially the elderly, may be well served by DRT service.

2. The percentage of households without an automobile or with just one automobile: No-auto households may be captive riders of public transportation and one-auto households may be partially dependent on public transportation.

3. The percentage without a driver's license: This group must depend upon modes of transportation other than the automobile and are good candidates to be users of DRT.

The analyst must determine if the above socioeconomic characteristic distributions are "favorable" in the proposed service area. This is best done by comparing the service area distributions to similar distributions for the entire urban area under the jurisdiction of the transit authority. The analyst could define a "favorable" percentage as being equal to or greater than the average percentage for the entire urban area.

If the analyst judges any one of the three socioeconomic percentages to be favorable then the service area has a good chance of being suitable for DRT service. Figure 3 shows that the analyst should next consider the average income of the service area. If none of the percentages are favorable, then "special" market groups must be identified for the market to receive further consideration for implementation.

Average income. If the average income in the service area is significantly higher than the regional average, then the proposed service area is probably unsuited for DRT service, and special market groups must be identified for the area to receive further consideration. If the income level is around or below the regional average, the service may be needed.

Special markets. If an area does not have any favorable socioeconomic percentages or is a high income neighborhood, it is a poor candidate market. These markets should not receive any further consideration for implementation unless specific special market groups have been identified. If special market groups (senior citizen homes, colleges, day care centers, etc.) are found then the area should be reconsidered. These markets are risky, and the transit agency may wish to be guaranteed passengers through subscription or contract services to be coordinated with the institution in question.

Other pertinent attributes. If the analyst determines that the market has passed the critical attribute requirements, the next step is to check that the market's other pertinent attributes are satisfactory. The population must be large enough to support the service. It has been shown that DRT is the most cost-effective mode for population densities under 1500 persons/mile^2. Other competing transportation must be accounted for. Judging the proper levels for these attributes is best left to the local transit operator. These attributes will be discussed in more detail in Chapter 4, the TTDC DRT case study. If an analyst fails an otherwise suitable market because of these attributes, he should make an attempt to redefine the market and do another market profile and evaluation. If these attributes are at favorable levels, then the analyst can recommend the service area as being suitable for demand responsive service.

2.8 Markets Affected by a Service Evaluation

Transit markets are often affected by a proposed change in service due to an existing service failing a service evaluation. When a service evaluation of a transit service shows a service to be failing, the operator must consider service changes which will help the operator better attain the effectiveness and efficiency goals of the transit system. Figure 4 shows that the operator's choices are to:

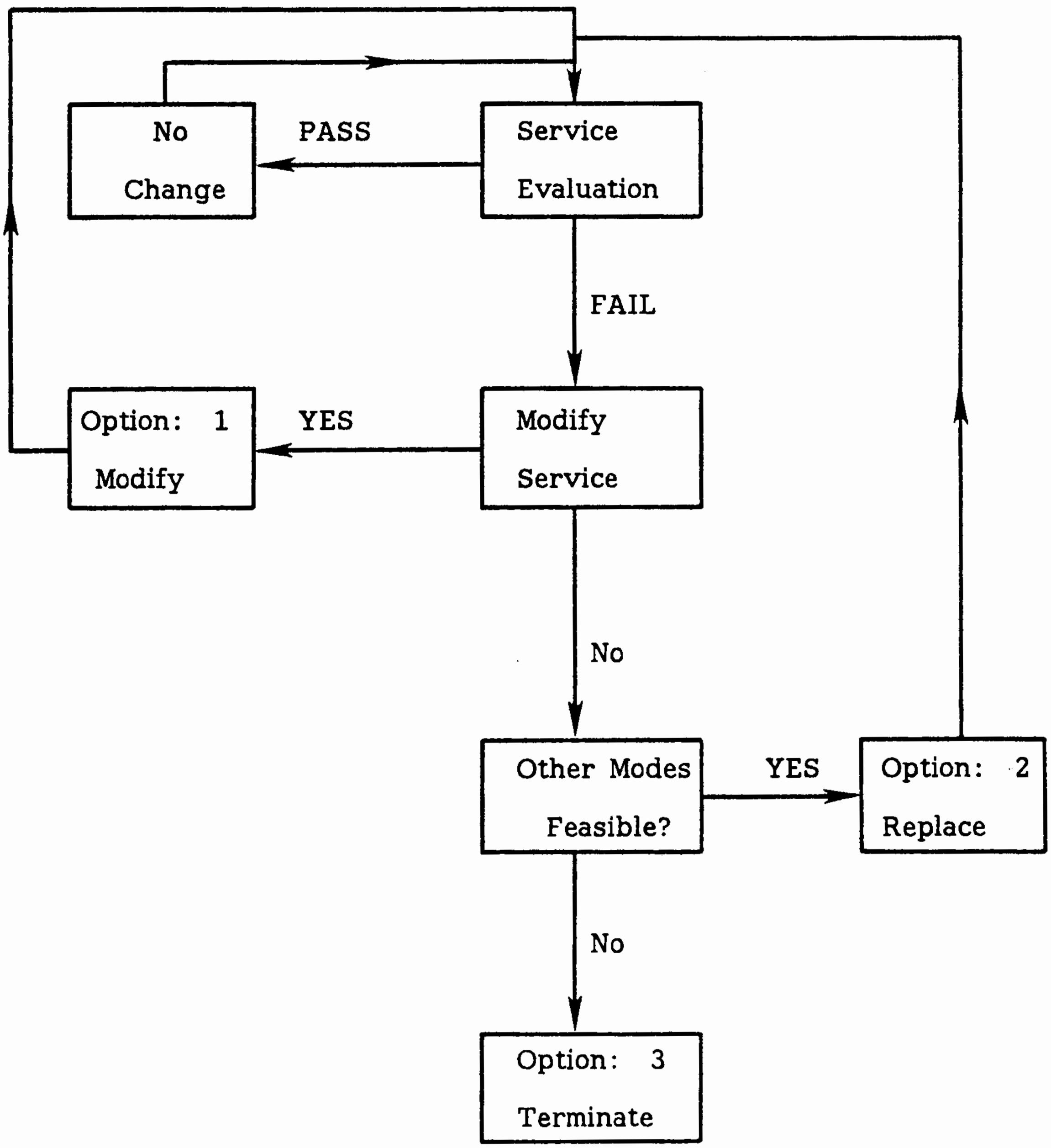


Figure 4. General Flowchart for Markets Affected by a Service Evaluation

1. modify the existing service,

2. replace the current service with another mode,

3. terminate the current service and provide no public transportation.

These options will be discussed for each transit mode along with the role of market profiles in evaluating the alternatives.

2.9 The Failure of Fixed Route Service

Figure 5 shows that the failure of a fixed route bus route may lead a transit operator to consider a non-fixed route mode such as DRT. Other modes should be considered when the operator believes that there are no modifications to the fixed route service such as frequency, route structure or fare which will make the service passable.

A possible replacement mode for fixed route service is demand responsive transit or shared-ride taxi. DRT service offers the transit operator an opportunity to:

1. continue serving the fixed route riders,

2. provide door-to-door service which may attract new riders, and

3. reduce the cost of providing public transportation to the area.

Once the operator has decided that modifications will not revive a failing fixed route service, his decision is whether to implement a demand responsive service or to provide no public transportation at all. The operator must undertake a DRT market analysis to make this decision.

The operator should build a market profile similar to that for a new market which has not recently had transit service. The same market attributes should be examined as with a new market in developing a market profile. An important attribute which is not available for new markets is the fixed route ridership which the area generated. Many ex-fixed route riders can be expected to use a replacement DRT service, as they may be captive riders dependent upon public transportation.

An on-board survey of riders of a failing fixed route service could be used to test possible consumer response to a replacement DRT service. Generally, the use of surveys to estimate demand is not advisable, because it has been shown that there is a large difference between what consumers say

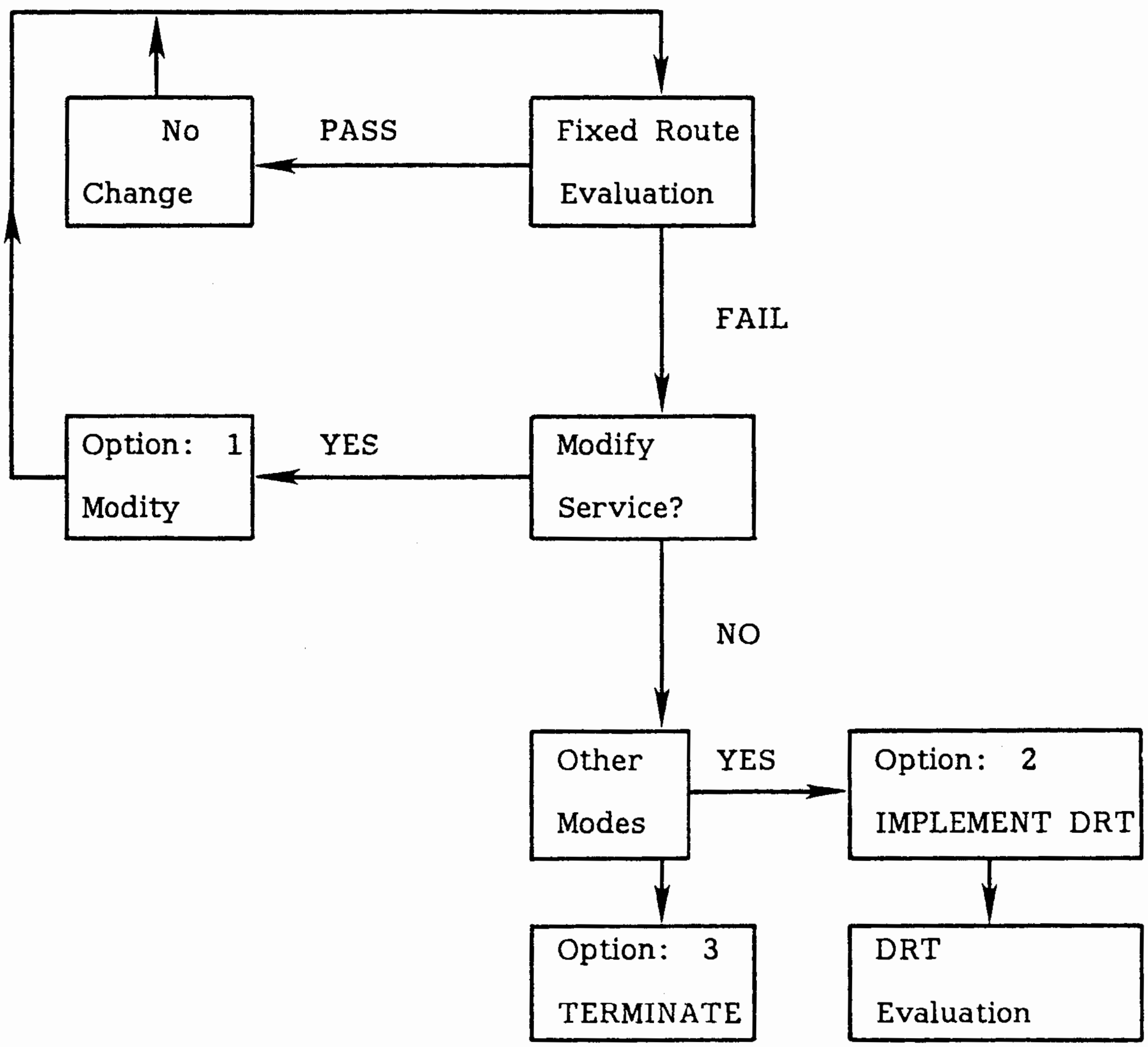


Figure 5. Fixed Route Service Evaluation Flowchart

they will do when service is offered and what they actually do after the service is implemented. However, a survey of fixed-route riders may be useful because these consumers have already shown a disposition towards using transit.

2.10 The Failure of DRT Service

Figure 6 shows that if a service evaluation rates a DRT service as failing, the operator's options are generally limited to modify the service or terminate it. The only replacement service suitable in case of a termination would be some sort of subscription paratransit for riders with special needs. Possible modifications of a DRT service which may bring improved performance include:

1. changes in the definition of the service area,
2. changes in the fare structure, or
3. changes in the number of vehicles operating in the service area.

If modifications of the service will not improve performance, the only choice is to terminate the service.

2.11 Summary

This chapter has provided procedures and established criteria for the implementation of ridesharing and DRT services. The market profile method was offered as an alternative to demand analysis. Market attributes were defined and a market profile evaluation procedure was provided. In Chapter 4, TTDC's experiences with DRT services will show the utility of the market profile method.

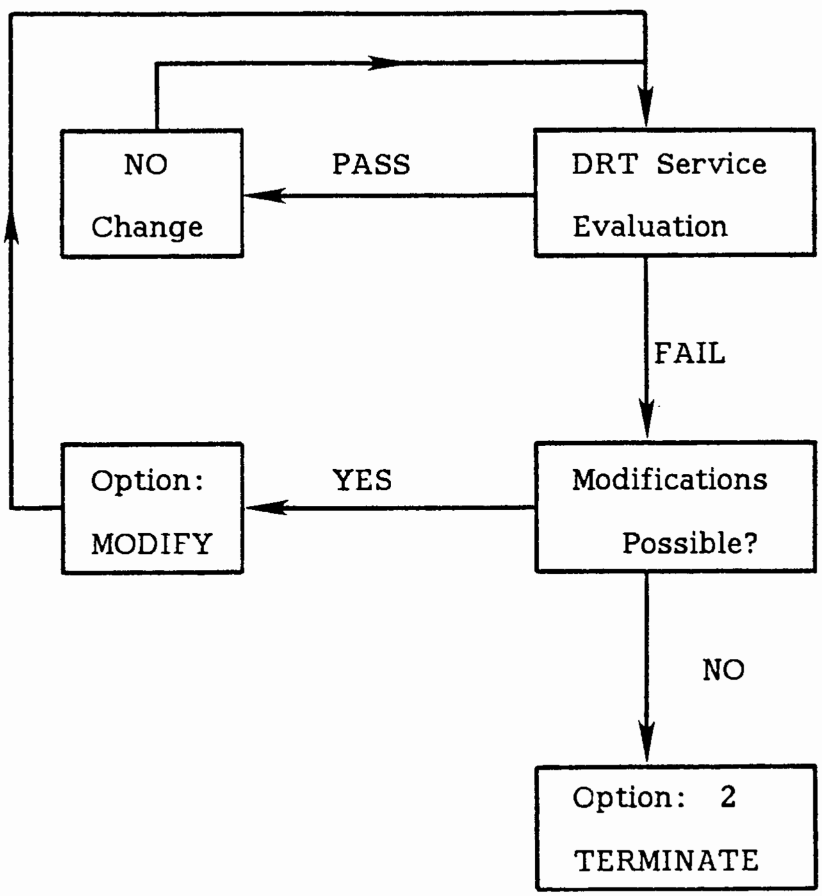


Figure 6. DRT Service Evaluation Flowchart

CHAPTER 3

INTRA AND INTERMODAL EVALUATION OF SERVICES

3.1 Introduction

The transit and paratransit evaluation process, as depicted in Figure 1, described several sets of evaluation indicators, for both intramodal and intermodal assessment. The intramodal sets are developed and detailed, for use by a transit authority that offers both demand responsive transit and ride-sharing leasing arrangements.

In developing these indicator sets, certain aspects of the locality's transportation objectives and transit authority composition, that are generally common, are specified. The intent is to present a procedure that is useful in many transit systems, but modifications can easily be made to this evaluation procedure to fit the conditions at any location. By following through the given steps, and making substitutions as needed, the basic procedure can be tailored to fit any set of conditions.

The establishment of standards is illustrated in Chapter 5, in the application of the evaluation procedures to the TTDC Services. Because they are the variables by which final evaluation decisions are made, they must be chosen by the transit management, and so are excluded from this general development.

The intermodal evaluation is used by the transit manager to choose a mode to fill an established market need, differing from the intermodal evaluation, which monitors the efficiency and effectiveness of an existing service. The market need is determined either by failure of an existing service, as found in the intramodal evaluation, or by a market analysis as described in Chapter 2 of this report. Once the market group is identified, the transit alternatives for fulfilling the market needs can be selected from all possible transit services, and a comparison based on the system's objectives results in the best option being selected. A broader set of objectives than for the intramodal evaluation is used in this evaluation, incorporating the reduction of external disbenefits with the effectiveness and efficiency goals. Along with maximization of cost efficiency and service effectiveness, fuel efficiency, pollutant emission minimization, and conservation of public funds are included.

These objectives represent the goals of society, as an addition to the user mobility and the operator efficiency goals.

The evaluation method designed here assumes that a reasonable amount of data exists, or is obtainable, and that staff commitment is at a moderate level. The indicators and measures are chosen with emphasis on objective pertinence and data conciseness.

3.2 Intramodal Evaluation

For intramodal evaluation, only effectiveness and efficiency goals are used, so that uncontrollable factors in evaluation are reduced. The operator, for example, has little influence on the level of pollution within a mode, so this, and the other externality reduction goals are omitted from the intramodal evaluation. The operator's maximization of efficiency and the user's maximization of effectiveness are the basis for evaluation of the individual paratransit mode.

The objectives, then, are two-fold. The cost efficiency objective determines whether the total expense per output within the service area under study is reasonable for that type of service. The effectiveness objective deals with service utilization, which is closely correlated with the degree to which transit fulfills the user's transportation needs. Service utilization indicators, then, can be used to determine what aspects of service are failing.

At this point, further disaggregation is needed, so that specific indicators and measures can be chosen on a modal basis. The two modal evaluations developed next are for demand-responsive transit and for pooling services.

3.2.1 Demand Responsive Services

The demand-responsive transit evaluation, as shown in Table 5, is applicable for the shared-ride taxi, subscription van, and dial-a-ride van modes. The market groups are commuters (in low density areas), shoppers, and elderly and handicapped riders, and the indicators reflect the objectives for each market group, as well as the operational characteristics of the service.

Table 5

Demand-Responsive Transit Evaluation

Objectives	Indicators	Measures
Cost Efficiency	Expense per produced output	Cost per passenger-mile
	- Labor productivity	Vehicle hours per employee
	- Vehicle utilization	Vehicle hours per vehicle
	- Administrative efficiency	Office personnel per vehicle
	- Pricing	Revenue per cost
	- Ridesharing ratio	Passenger occupancy
Service Effectiveness and Utilization	Consumed output	Average number of passengers per hour of operation
	- Travel time	Transit trip time per auto trip time
	- User cost	Fare
	- Directness of service	Number of passengers transferring per total passenger trips
	- Safety	Number of accidents per 100,000 miles
	- Vehicle comfort and cleanliness	Inspection results
	- Driver courtesy and skill	Number of complaints
	- Vehicle access	Wheelchair accessibility
	- Public awareness	Percent market group answering positively in survey

The indicators for each objective pertain to the aspects of the service that affect its performance. For instance, labor productivity is one of the operational factors in cost efficiency. The service effectiveness and utilization objective has more components because of the varied user needs, although the indicators may not be equally important. For example, travel time generally is more important than driver courtesy. However, any indicator aspect may influence the user's satisfaction with the service, so they must all be included into a comprehensive evaluation.

3.2.2 Ridesharing Services

In Table 6, the intramodal evaluation for ridesharing is detailed, which is applicable particularly for a vanpooling leasing program, but may also evaluate an organized carpool or buspool program. The market group is primarily the commuter. The objectives are the same as in demand-responsive transit evaluation, but the indicators differ considerably. Different factors influence the cost efficiency of the vanpooling modes, because the operational characteristics are substantially-different; the driver is also a user, and the pricing is such that costs are covered. Trip length is a primary factor in vanpooling efficiency, as it serves as a descriptive indicator for cost efficiency. The success of the ridesharing program, as measured by the percent of pools surviving a twelve month trial period, is used as the effectiveness indicator.

In the intramodal evaluation, indicators and measures are categorized as either general or descriptive. The general indicators correlate directly to the objectives, and are used in periodic evaluation of existing services. In Tables 5 and 6, the general indicators are given at the top of each list of indicators which describe the objectives. The descriptive indicators follow each general indicator, and break down the general indicators into the component attributes. The descriptive indicators are not applied on a regular basis; only when a service fails evaluation is the data needed for the analysis collected and analyzed.

Once standards have been established, the periodic monitoring of a service consists of calculating the current value for the measure, and comparing it to the standard. A performance rating of P (passing), I (investigation warranted), or F (failing) is then assigned, based on how well the service values meet the standards.

Table 6

Ridesharing Evaluation

Objectives	Indicators	Measures
Cost Efficiency	Expense per produced output	Cost per passenger-mile
	- Trip length	One-way trip mileage
	- Seat utilization	Riders per vehicle occupancy
Service Utilization and Effectiveness	Success rate	Percent of pools surviving a twelve month trial period
	- Travel time	Transit trip time per auto trip time
	- User cost	Fare
	- Reliability	Wait time (lateness)
	- Vehicle comfort and cleanliness	Percent of users satisfied with vehicle condition
	- Safety	Percent of users satisfied with safety
	- Public awareness	Percent of market group answering positively in survey

A dual standard system will enable the transit manager to evaluate services against both permissible and desirable standards. A minimum standard, below which no service may rank, serves as the cut-off for a failing or investigation warranted rating. The range between the permissible and desirable standard warrants investigation, as the transit manager should continue efforts to improve the service performance until the desirable standard is reached. Any measure achieving or exceeding the desirable standard will be rated as passing the evaluation, for that measure.

The data needs for these evaluations are in three categories, based on the anticipated source. Operator statistics will provide the input for many of the measures (see Table 7). The transit authority, who is not necessarily the provider, supplies additional information, and the remaining is collected through user and general public surveys.

3.3 Intermodal Evaluation

Once a market group has been identified, a limited set of transit alternatives that are to be considered in the comparison can be listed, as is done in Table 8. A worksheet, showing both the alternatives and the indicator categories is then constructed, Table 9, to present a concise summary of the benefits and weaknesses of each mode possibility.

The scoring for each indicator, and for each alternative, is based on how well the service would meet the standards for performance as determined by the transit authority. Each indicator, then, is quantified by a measure of performance. Table 10 lists these indicators and measures.

Two scoring systems are recommended for the alternatives comparison. The first scheme applies for the set of indicators that are based on modal factors, specifically the cost efficiency, effectiveness, and public funds conservation categories. For the measures in these categories, a point system based on comparison of the service value to the standard is used. Again, both desirable standards, which reflect the targets set for the system, and a permissible standard setting the lowest allowable level of performance are established, or carried over from the intramodal evaluation. The same scoring allocation is used here as was in the intramodal evaluation. Note that the effectiveness objective consists of three components. The sum score of these must be divided by three before insertion of the effectiveness value into the evaluation table, so that no preliminary biasing of indicators is imposed.

Table 7

Data Requirements for Paratransit Evaluation

Demand-Responsive Transit (by service area)

Operator Statistics

- cost per passenger-mile
- vehicle hours per employee
- vehicle hours per vehicle
- office personnel per vehicle
- revenue, cost, passenger occupancy ratio
- number of passengers, total service hours
- accident total, miles logged
- vehicle inspection
- number of complaints, per driver
- percent of vehicles accessible to wheelchairs

Transit Authority

- auto trip times for survey routes
- fare
- number of passengers transferring and passenger trips

Surveys (riders, public)

- quality of service perception
- origin and destination, total transit time
- wait time
- awareness of services

Ridesharing (by employer location)

Operator Statistics

- trip length
- percent of seats utilized
- origin and destination, trip time
- fare

Transit Authority

- percent of pools surviving twelve month trial period
- auto trip time

Survey (riders, public)

- quality of service perception
- wait time

Table 8

Transit Alternatives by Market Group

Commuter Line-Haul	Low-Density (commuter, shopper, nonrestricted E&H)	Restricted E&H
Conventional transit	Conventional transit	Subscription van
Demand-responsive	Demand-responsive	Demand-responsive
Pooling - car - van - bus	Pooling - car - van	Status quo
	Subscription van	
Status quo (no transit service)	Status quo	

Table 9

Intermodal Evaluation Worksheet

Service Type	INDICATOR SCORES: Cost Efficiency W =	Service Effectiveness W =	Conservation of Public Funds W =	Fuel Efficiency W =	Pollution Level W =	Rating = WI
Conventional transit						
Demand - responsive						
Car-pooling						
Van-pooling						
Bus-pooling						
Status Quo						

Optimum mode chosen = 1
Others = 0

Table 10

Intermodal Evaluation - Scoring Description

Indicator Categories	Measures	Maximum Possible Score
1) Cost efficiency	Cost per passenger-mile	1.0
2) Effectiveness		
- Travel time	Transit trip time per auto trip time	1.0 } 3.0 ÷ 3 = 1.0
- User cost	Fare	1.0 }
- Reliability	Wait time	1.0 }
3) Conservation of public funds	Revenue per cost	1.0
4) Fuel efficiency	Passenger-miles per gallon	1.0
5) Pollutant Minimization	Grams per passenger-mile	1.0

The second scoring is used for the intermodal factors of comparison. Because standards for a transit mode within the fuel efficiency and air pollutant emissions objectives is not practicable on a small scale, an intermodal comparison is recommended. Based on manufacturers estimates, as given in Tables 11 and 12, and estimated ridership levels, an optimum mode can be chosen for each of these two indicators. One point is given to this optimum mode and all others receive 0.0 for that indicator.

The final step in this comparison, after entering the indicator scores into the worksheet, is to determine the weights for each indicator category. As standards, the transit authority must set these weights to parallel the community's preferences. A smaller community may not be as concerned about pollution from transit vehicles as it is about the overall mobility level, whereas a larger industrial city with a pollution problem may want to set a higher weight for the pollution indicator. This system gives the transit evaluator the flexibility to accurately reflect the community goals.

The perfect score for this evaluation is 1.0, and is attained when all evaluation objectives have been fully met. This condition rarely occurs, so the mode receiving the best score is chosen. The no-transit-service alternative would receive the minimum allowed score in the evaluation, so very poor ratings on the transit alternatives would eliminate these marginal services from consideration.

The data requirements for the alternative services comparison intentionally include those for intramodal evaluation. This provides the most concise evaluation procedure, and minimizes the cost. However, in the case where future services are compared, ridership, cost, and level of service values must be provided by reliable transit forecasting models.

Indicator sets have been developed for a comparative evaluation of several options. In Chapter 5, a case study will show how both the intramodal and intermodal sets are used by a transit manager in evaluation of existing services.

Table 11

Fuel Efficiencies of Transit and Paratransit Vehicles

Mode	Vehicle Occupancy	MPG	Pax-Miles Gallon
Average Auto	1.6 1.9 5.0	13 13 13	21 25 65
Subcompact Auto	1.6 1.9 4.0	22 22 22	35 42 88
Van	10 12 15	10 10 10	100 120 150
Transit Bus	16 (commuter use) 11 (avg daily use) 44 (pooling)	4 4 4	64 44 176

Source: Bellomo, et al., p. 361

Table 12

Air Pollutant Emissions of Transit and Paratransit Vehicles

Mode	Vehicle Occupancy	Grams / Pax-Miles (CO+HC+NO)
Auto	1.6 1.9 4.0 5.0	22.3 18.8 9.0 7.2
Van	10 12 15	5.2 4.3 3.5
Transit Bus (diesel)	16 11 44	3.6 5.0 1.2

Source: Bellomo, et al., p. 361

CHAPTER 4

THE TIDEWATER "MAXI-TAXI" CASE STUDY

4.1 Introduction

The DRT market analysis in Chapter 2 is applied to a case study of TTDC's "Maxi-Taxi" services. The purpose of the case study is to illustrate the utility of the DRT market profile method. Both successful and failing services will be discussed, and market profiles will be described and evaluated following the procedures introduced in Chapter 2. The case study will show that the use of the Chapter 2 DRT market analysis may have prevented TTDC from implementing services destined for failure.

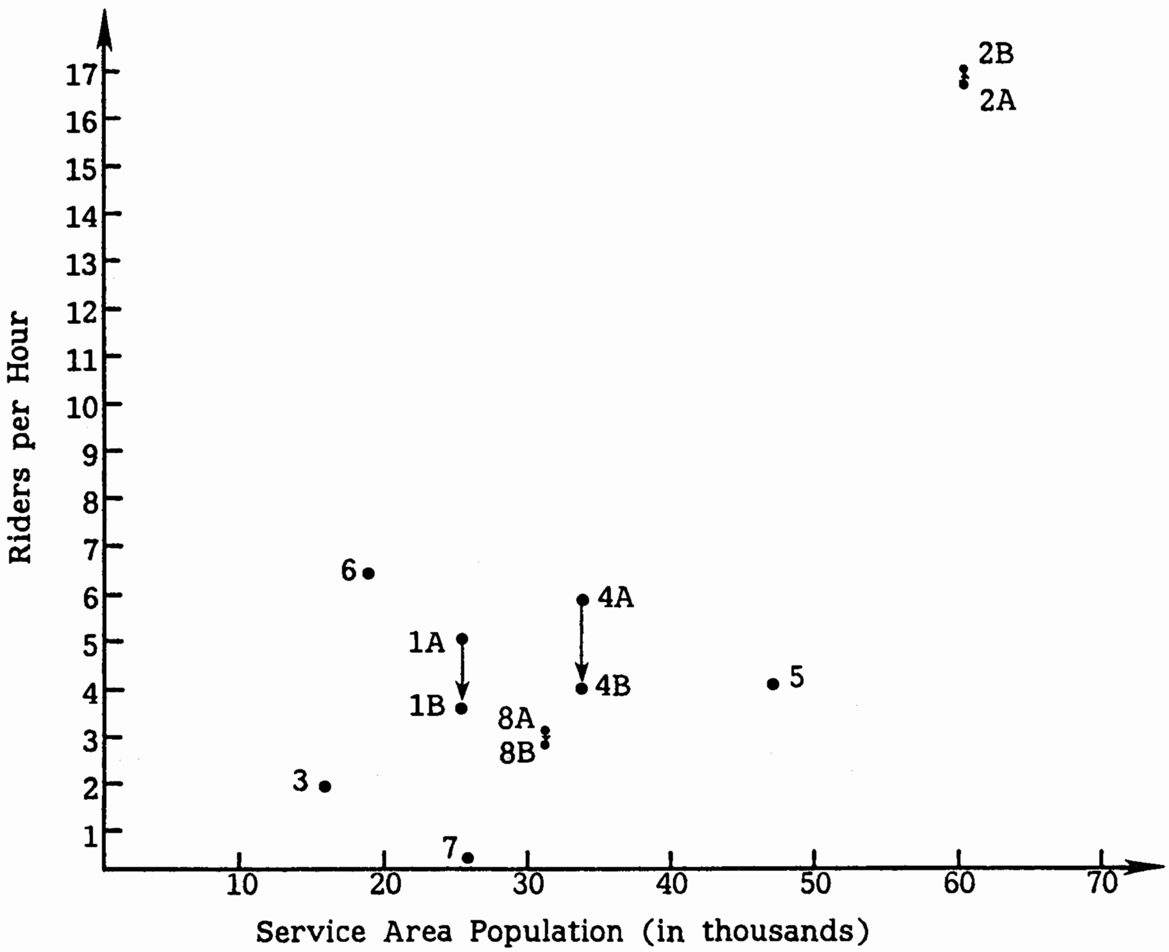
TTDC's Maxi-Taxi services are shared-ride taxi services, with requests for rides made by telephone. TTDC presently contracts these services to local private taxi companies. Service has been implemented in a variety of areas. For example, service area populations have ranged from 700 to 60,000, population densities from 110/mi^2 to 6000/mi^2, and areas from 5.5 mi^2 to 37 mi^2.

Ridership has varied widely among the service areas. Figures 7 and 8 show the wide range of demands tapped by Maxi-Taxi. The graphs also show that simple models based on population or population density would be poor predictors of demand.

Table 13 presents a summary of operational and ridership data describing TTDC's Maxi-Taxi services between December 1980 and May 1981. Service was reduced in some areas during this time period by reducing the number of vehicles operating in the area. For these areas, the ridership data is separated to reflect the response to service cutbacks. The last three cases (7-9) in the table show services which were terminated due to failing service evaluations.

4.2 Tidewater Data Limitations

Major sources of market data are urban and regional planning authorities. In Tidewater, the Southeastern Virginia Planning District Commission has planning and land use data disaggregated into "statistical areas". This data available by statistical area includes population, area, housing units, residential acres and employment. The commission has incomplete data on age



<u>Key:</u>

1 - Churchland

2 - Portsmouth Night Service

3 - Bowers Hill/Tower Mall

4 - Hampton Blvd.-Colonial Place

5 - Bayview-East Ocean View

6 - Deep Creek/Tower Mall

7 - College Park

8 - Great Bridge/Greenbrier

Figure 7. Maxi-Taxi Riders per Hour vs. Service Area Populations

Key

1 - Churchland

2 - Portsmouth Night Service

3 - Bowers Hill/Tower Mall

4 - Hampton Blvd.-Colonial Place

5 - Bayview-East Ocean View

6 - Deep Creek/Tower Mall

7 - College Park

8 - Great Bridge/Greenbrier

Figure 8. Maxi-Taxi Demand Density vs. Service Area Population Density

Table 13

Maxi-Taxi Operational and Ridership Data

ROUTE	POP	AREA	DENS	FARE	HR	VEH	D/W	R/DAY	R/HR	R/HR/MI²
1A	25,272	26.89	940	$1.00	13	2	6	68.56	5.27	0.196
B						1	6	43.77	3.37	0.125
2A	60,272	14.61	4126	0.50	3	4	6	50.12	16.71	1.144
B						3	6	51.37	17.12	1.172
3	16,427	21.45	766	1.00	13	1	6	26.46	2.04	0.097
4A	33,428	5.52	6053	0.50	5	2	7	30.07	6.01	1.089
B						1	7	19.68	3.94	0.714
5	47,031	7.88	5968	0.50	10	1	7	42.93	4.29	0.544
6	19,222	19.06	1001	1.00	13	1-2	6	83.83	6.45	0.338
7	25,560	6.55	3905	1.00	16	1	6	5.26	0.33	0.050
8A	31,441	37.62	836	1.00	9.5	2	6	29.39	3.09	0.080
B						1	6	27.14	2.86	0.076
9A	3,650	15.0	243	1.50	9	1	2			
B	1,400	5.6	250	1.50	9	1	2			
C	700	6.4	109	1.50	9	1	2			

Route Key

1-Churchland
2-Portsmouth Night Service
3-Bowers Hill/Tower Mall
4-Hampton Blvd.-Colonial Place
5-Bayview-East Ocean View
6-Deep Creek/Tower Mall
7-College Park
8-Great Bridge/Greenbrier
9-Rural Suffolk Service

Column Key

POP-Population
AREA-Area served in square miles
DENS-Population density
FARE-One-way fare charged
HR-Hours of service per day
VEH-Vehicles operating in area
D/W-Days of service per week
R/DAY-Riders per day
R/HR-Riders per hour
R/HR/MI²-Demand density in riders per hour per square mile

and income distributions, which are critical attributes needed for market profile. The lack of quantitative socioeconomic distributions obliges the transit manager to make qualitative judgments for these attributes. For example, the TTDC Service Development Manager has suggested that one could simply drive around a proposed DRT service area and make qualitative judgments about income and automobile ownership levels. Meetings with community leaders and civic groups could help the transit manager make qualitative statements on the presence of senior citizens, those without a driver's license, or other special markets which can be served by DRT.

The rest of this chapter will offer individual examples of TTDC's Maxi-Taxi services, both successful and failing. Market profiles are described and evaluated illustrating the utility of a DRT market analysis.

4.3 The Deep Creek/Tower Mall Maxi-Taxi

The Deep Creek/Tower Mall service is an example of Maxi-Taxi replacing a failing, fixed-route bus service. Table 14 is an abbreviated market profile for the area, as no socioeconomic data was available. With this failing fixed-route service ($4.75 deficit per passenger), TTDC had the choice of replacing it with Maxi-Taxi or providing no public transportation at all. The decision to implement Maxi-Taxi was justified, as Table 14 shows that a very large trip generator was present (Tower Mall) and that over 1100 passengers per month had been served by fixed route service. TTDC management felt that public transportation could be provided to this area in a more economical manner by Maxi-Taxi.

The Deep Creek/Tower Mall Maxi-Taxi has been a successful service, as indicated by Table 15. Maxi-Taxi is currently transporting about twice as many passengers as the fixed route service and the deficit per passenger has been cut by more than one-half.

4.4 The College Park Maxi-Taxi

This Maxi-Taxi service was a resounding failure, as the deficit per passenger was $23 in the final month of operation, which was its best performance. Table 16 is a market profile of the College Park area. The TTDC Service Development Manager here made a qualitative statement that College Park is an upper-middle to high income area. This fact, the lack of large trip generators, and the presence of fixed route service (TRT Route #15,

Table 14

Deep Creek DRT Market Profile

I. <u>Critical Attributes</u>

A. No Socioeconomic data is available.

B. Tower Mall is a large regional shopping center which is a major destination for Deep Creek shoppers.

II. <u>Pertinent Attributes</u>

A. The population is 19,222.

B. The area is 19.06 mi^2, therefore the population density is 1001 persons/mi^2.

C. The Deep Creek area of the City of Chesapeake was served by fixed route service, TRT routes #41-Cradock and #43-Deep Creek-Westhaven. Over 1100 passengers per month were served by these routes.

Table 15

Deep Creek Fixed Route vs. Maxi-Taxi

	Number of passengers	Cost	Revenue	Deficit	Deficit per passenger
Aug., 1979 bus routes #41 & 45	1,134	$5,786	$ 396	$5,390	$4.75
April, 1980 Maxi-Taxi	1,150	3,276	1,150	2,126	1.85
March 1981	2,356	7,681	2,356	5,325	2.26

Table 16

College Park DRT Market Profile

I. Critical Attributes

A. No socioeconomic data is available, but the transit manager reports that College Park is an upper-middle to high income area.

B. There are two small to medium-sized shopping centers, neither of which are major regional attractions.

II. Pertinent Attributes

A. The population is 25,560.

B. The area is 6.55 mi^2, therefore the population density is 3900 persons/mi^2.

C. TRT Route #15-Crosstown operates as fixed route service in the area.

which was not terminated when Maxi-Taxi was implemented) would have warned the transit manager not to implement Maxi-Taxi had he followed the Figure 3 market profile evaluation suggested in Chapter 2. The consequences were that a $16,228 deficit was incurred serving only a total of 421 passengers over more than three months. The average deficit per passenger was $38.55 for this ill-fated service.

4.5 The Rural Suffolk Maxi-Taxi

This Maxi-Taxi example will illustrate the importance of the noncritical, or "pertinent" and "special" attributes in a DRT market analysis. In an effort to identify areas deficient in transportation, TTDC identified three subservice areas in the City of Suffolk where the operation of some form of public transportation might be practical. Chapter 1 outlines the market identification process used in these areas and Table 17 is the market profile. Unfortunately, this experimental service failed miserably. TTDC did not even retain ridership data as the Service Development Manager reported that the service attracted "hardly any passengers."

The intentions of TTDC were good, as they believed they had located "special" markets which had previously not been served by transit. However, TTDC learned that the populations and population densities were just far too small to support any form of public transportation. This experience shows the importance of the "pertinent" attributes and that bottom limits should be set for populations and population densities. This case suggests that populations under 5000 and densities under 300 persons/mi^2 will not support DRT service.

4.6 Case Study Conclusions

Maxi-Taxi has proven to be most successful when used as a replacement mode for failing fixed-route services. It offers the transit agency an opportunity to both cut costs and provide a higher level of service to communities which can not support fixed-route service.

Maxi-Taxi has also been implemented both in areas where fixed-route transit is supportable and in suburban or rural communities where it is the only form of public transportation available. The case study shows that these rural services are more likely to fail, so a careful market analysis is especially important for these areas. The Tidewater experience with these areas shows:

Table 17

Rural Suffolk DRT Market Profile

I. Critical Attributes

A. No socioeconomic data was available.

B. Service would feed to either downtown Suffolk or Churchland Shopping Center, two fairly large destinations located outside of the proposed service areas.

II. Pertinent Attributes

A. Populations of sub-service areas:

1. Chuckatuck/Crittenden - 3650
2. Holland - 1400
3. Whaleyville - 700

B. Population densities:

1. Chuckatuck/Crittenden - 234 persons/mi^2
2. Holland - 250 persons/mi^2
3. Whaleyville - 109 persons/mi^2

III. Other Special Attributes

Meetings with civic groups, etc., indicated that public transportation was needed for elderly persons. The total lack of public transportation in these areas forces residents to rely on private automobiles. Residents indicated that they must travel outside their towns for almost any need, be it medical service, shopping, or employment.

1. High income neighborhoods are not likely to use DRT service.
2. A DRT service should feed to truly large trip destinations.
3. DRT and fixed-route service can not coexist in some communities.
4. Lower limits should be set on population and population densities for DRT to even have a chance to succeed.

CHAPTER 5

THE TIDEWATER SERVICE EVALUATION CASE STUDY

5.1 Background

In total, two intramodal evaluations and two intermodal evaluations are illustrated. TTDC Maxi-Taxi services and vanpool leasing services reflect the use of the demand-responsive and pooling intramodal evaluations. The intermodal evaluations use case studies of mode changes within a service area in the Tidewater region, with comparison to the no transit service alternative. Maxi-Taxi is compared to local bus services, and the vanpool option is compared to express bus service.

5.2 Indicator and Measure Variations for the TTDC Case Study

In applying the general evaluations, changes are made in the indicator and measure sets that sensitize the procedures to the TTDC case study. These variations reflect market group specification and data limitations within the TTDC organization.

The major change in the demand-responsive service evaluation is the substitution of cost per passenger for cost per passenger-mile. Although federal reporting requirements include a passenger-mile value, transit authorities only report a system average that is based on sample data. The passenger trips value is determined to be an adequate output measure for the Tidewater Maxi-Taxi service, since the service areas are relatively small. The trip length component of the passenger-mile measure, then, is not considered a factor in cost efficiency for this service.

Other changes in the Maxi-Taxi evaluation are the measures for the descriptive indicators. For labor productivity, cost per hour is used since labor costs are represented by an hourly figure. Cost per mile is used for vehicle utilization, and cost per vehicle for administrative efficiency, for similar reasons. The TTDC transit manager considered all other measures suggested here as obtainable at reasonable cost levels.

The indicator for vehicle accessibility is eliminated in the Maxi-Taxi evaluation. Tidewater provides a Special Transportation Service for the transportation disadvantaged citizens in the region, and wheelchair accessible vans are available through the STS. Transportation for the elderly and handicapped is not provided by Maxi-Taxi.

No substitutions are made for the vanpooling evaluation. Although few of the measures are currently available, the transit authority is capable of obtaining all suggested measures in an increased data collection effort.

Tables 18 and 19 summarize the intramodal evaluations, defining the objectives, indicators, measures, and standards for both Maxi-Taxi and vanpooling.

For the intermodal evaluations, the major substitution is for the effectiveness indicators. Rather than computing travel time ratio, fare, and wait time values for each alternative, the effectiveness indicators used in the intramodal evaluations are used. Maxi-Taxi is assessed, then, on passengers per hour, and vanpooling is rated on the (see 3.3) success rate, for the effectiveness objective. This method is simpler for existing service evaluation, although the three component effectiveness measure may be a better choice for predicted service attributes, depending on the existing market forecasting models.

5.3 Standards - Intramodal Evaluation

As the first step in fitting the evaluation procedures to a transit region, standards must be chosen that reflect the community's objectives and goals. In the Tidewater District, policy is not in a form that can be translated into evaluation standards, which prevents the use of policy as a basis. For this study, then, the standards are derived from system and industry averages.

For the general evaluation of the intramodal procedure, ranges about the system averages for each measure are used as standards. The desirable standard is set at the mean, giving the result of improvement in the long run, since the standard adjusts as the overall level of service improves. The permissible standard is set at the mean plus or minus the standard deviation of the mean, allowing for a more liberal level of performance. The standard, then, is based on both the current performance of the overall system, and the sensitivity of the measure to variance in the average. Such a standard design is needed for a transit system that has a wide range in levels of performance, as is the case with the Tidewater region.

The standards for the Maxi-Taxi general indicators are as shown in Table 20. The statistics are calculated from TTDC data file information.

Table 18

Intramodal Evaluation for the TTDC Maxi-Taxi

Objectives	Indicators	Measures	Standards
1) Cost efficiency	Expense per output	Cost per passenger-mile	1
	- Labor productivity	Cost per hour	1
	- Vehicle utilization	Cost per mile	1
	- Administrative efficiency	Cost per vehicle	1
	- Ridesharing level	Riders per vehicle occupancy	1
	- Pricing	Revenue per cost	1
2) Service Utilization and Effectiveness	Consumed output	Passengers per hour	1
	- Travel time	Trip time ratio	2
	- User cost	Fare comparison to drive alone auto costs	D 80% P 100%
	- Directness of service	Number of passengers transferring per total trips	2
	- Reliability	Wait time	2
	- Vehicle comfort & cleanliness	Inspection results	2
	- Safety	Number of accidents per 100,000 miles	2
	- Driver courtesy & skill	Number of complaints	2
	- Public awareness	Percent of market group answering positively in survey	2

1 -- $P = \bar{x} + s$

$D = \bar{x}$

2 -- Industry average, as used in conventional services

Table 19

Intramodal Evaluation for the TTDC Vanpool Service

Objectives	Indicators	Measures	Standards
1) Cost efficiency	Expense per output	Cost per passenger-mile	1
	- Modal efficiency	Trip length	1
2) Service Utilization and Effectiveness	Success rate	Percent pools surviving a twelve month trial period	1
	- Travel time	Trip time ratio	2
	- User cost	Fare	D 80% drive alone auto cost P 100% drive alone auto cost
	- Vehicle comfort & cleanliness	Percent of users satisfied	2
	- Safety	Percent of users satisfied with driver skill	2
	- Public awareness	Percent of market group answering positively in survey	2

1 -- $P = \bar{x} \pm x$

$D = \bar{x}$

2 -- Industry average, as used in conventional services

Table 20

Maxi-Taxi General Indicator Standards

Measure	$\bar{x}$	s	$\bar{x} \pm s$	$\bar{x}$
Cost per passenger	\$4.59	\$1.16	\$5.75	\$4.59
Passengers per hour	2.8	.8	2.0	2.8

$\bar{x}$ = average

s = standard deviation

Table 21

Vanpooling General Indicator Standards

Measure	$\bar{x}$	s	$\bar{x} + s$	$\bar{x}$
Cost per passenger -mile	3.79¢	0.7¢	4.5¢	3.8
Percent of pools surviving	89	7	82	89

The standards for vanpool general indicators are compiled in Table 21. The cost per passenger-mile statistics are calculated from a sample of operating characteristics for the TTDC vanpools, as was available at the TTDC office. The percent failure values, however, are assumed as representative because data of this type has not been collected. The assumed failure rates are verified as reasonable and representative by the service development manager at the TTDC. This is one of the required data needs for the transit authority.

For the descriptive indicators in both intramodal evaluations, TTDC has little or no data currently available for the paratransit modes. Many of the same measures are used for conventional bus services, and so are considered in cost and facility for other services. Because of the data availability problem, though, standards cannot be set and services cannot be tested here at the descriptive indicator level.

Tables 18 and 19 contain the suggested form for the recommended standards for the descriptive measures. Many indicators are easily quantified, and a range about the mean can be used to set the permissible and desirable standards. Other indicators are quantified in user surveys, and by measures that are commonly used in the transit industry. For these indicators, standards may be set at TTDC bus evaluation levels. And where needed, standards for paratransit evaluation are based on comparative values of competing alternatives.

5.4 Intramodal - Maxi-Taxi Evaluation

The TTDC currently operates the Maxi-Taxi service in seven communities in the Tidewater area. Varying levels of success have been realized in these service areas, so both good and poor services are presented here for evaluation.

The modified evaluation for demand-responsive services is used to evaluate three service areas - Deep Creek, Great Bridge/Greenbrier, and Churchland. The general evaluation is performed to determine if the service is meeting the standards, and thereby, the operating criteria of the transit management and the needs of the user. The results are summarized in Table 22.

Table 22

Maxi-Taxi Evaluation Results

- Deep Creek (January - March 81)

Measure	Value	Standards	Performance*
Cost per passenger	3.49	P 5.75 D 4.59	P
Passengers per hour	4.1	P 2.0 D 2.8	P

- Churchland (January - March 81)

Measure	Value	Standards	Performance*
Cost per passenger	5.03	P 5.75 D 4.59	I
Passengers per hour	2.8	P 2.0 D 2.8	P

- Great Bridge/Greenbrier (December 80 - February 81)

Measure	Value	Standards	Performance*
Cost per passenger	9.63	P 5.75 D 4.59	F
Passengers per hour	1.5	P 2.0 D 2.8	F

*P = Pass

I = Investigation Warranted

F = Fail

The Deep Creek service evaluation shows that both of the service performance statistics achieve the desirable standard limit, and therefore is passed in both categories. No further evaluation is required for this service.

The Churchland service passes the evaluation for the effectiveness category, but rates an I on the efficiency category. The service is sufficient, because it surpasses the permissible standard limit, yet an investigation of the service is warranted. Changes in the service may improve its efficiency. Descriptive indicators, such as vehicle productivity, labor productivity, ridesharing level, administrative efficiency, and pricing, should be checked to determine the high cost factor, with efforts to improve this aspect following.

The Great Bridge/Greenbrier evaluation shows a service that fails in both efficiency and effectiveness. In this case, changes in the existing service should be sought, followed by an intermodal comparison if sufficient improvement cannot be achieved within the service mode. The transit manager, in this particular example, reduced the hours of service by cutting the service fleet two vans to one van, and the performance indicators both adjusted to within the acceptable ranges. The cost per passenger dropped to $5.33, and the number of passengers per hour increased to 3.0.

5.5 Intramodal - Vanpool Leasing Service

TTDC transit policy encourages ridesharing in all forms, from conventional bus service to carpooling. As a program under this policy, the Commission promotes the vanpooling option through contact with employers, so in this evaluation, the market groups are organized by employer. The three main groups that are studied here are the General Electric plant in Portsmouth (GE), the Norfolk Naval Shipyard (NNSY), and the Newport News Ship Building and Dry Dock (NNSB & DD).

The intramodal evaluation for pooling is used to evaluate vanpooling. Two perspectives are considered in this modal evaluation - that of the leaser/organizer (TTDC) whose objective is to provide the most cost efficient service possible, and the users (including the operators). The general indicators are cost per passenger-mile, and percent of pools surviving the twelve month trial period.

As with Maxi-Taxi evaluation, the general evaluation is performed to assess the adequacy of the service by comparing the operating characteristics to the standards. The results are as shown in Table 23 for the three employers mentioned.

The performance ratings show that this service is satisfactory for the NNSB & DD vanpoolers, sufficient but not yet satisfactory for the GE vanpoolers, and poor for the NNSY vanpoolers. The high failure rate of this last group indicates that the service is not meeting the needs of the users. The descriptive indicators would identify the problem attributes of vanpooling in this market area, for both the effectiveness and efficiency indicators. But, again, the data needed for the application of the descriptive indicator set is not available at this time at the TTDC. A recommendation for collection of these characteristics is included in the last section of this chapter.

5.6 <u>Standards - Intermodal Evaluation</u>

For the intermodal evaluation, the same standards are used as in intramodal evaluation. This allows for inherent varying levels of service between modes. For example, bus passengers per hour should not be compared to Maxi-Taxi passengers per hour levels. Maxi-Taxi, then, has the same standards for the cost per passenger and passenger per hour measures. Vanpooling evaluation at the intermodal level uses the same standards for the cost per passenger-mile and percent success measures.

Fixed-route, conventional bus service standards for these measures must be calculated for the intermodal evaluation. The statistics, as calculated from performance data of all routes in the Tidewater region, are presented in Table 24.

Revenue per cost is a measure of public funds conservation. The actual ratios, with an upper limit of 1.0, for a service that at least equals the cost with the revenues, are used as both the measure and the point allotment in the evaluation. A direct comparison is used because a low operating ratio is not an acceptable condition, and for this objective, the highest ratio is always optimal.

The fuel efficiency and air pollutions indicators are also not compared to standards. The optimum mode is chosen for each measure, and the total score is allotted to that mode.

Table 23

Vanpool Evaluation Results

- GE

Measure	Value	Standards	Performance*
Cost per passenger-mile	4.0¢	P 4.5 D 3.8	I
Percent of pools surviving	86	P 82 D 89	I

- NNSY

Measure	Value	Standards	Performance*
Cost per passenger-mile	3.96¢	P 4.5 D 3.8	I
Percent of pools surviving	80	P 82 D 89	F

- NNSB & DD

Measure	Value	Standards	Performance*
Cost per passenger-mile	3.35¢	P 4.5 D 3.8	P
Percent of pools surviving	97	P 82 D 89	P

*P = Pass
I = Investigation warranted
F = Fail

Table 24

Conventional Bus General Indicator Standards

Measure	$\bar{x}$	s	$\bar{x} \pm s$	$\bar{x}$
Cost per passenger	$1.43	$1.24	P $2.67	D $1.43
Passengers per hour	26.9	13.9	P 13.0	D 26.9

The no-transit-service alternative should be chosen whenever the sum of the weighted indicator scores is below some minimum acceptable level. To reasonably assure that any newly implemented service will be successful, in this study, a minimum of 0.20 is chosen. The transit service that met two or more criteria to a partial degree could be chosen. Any service ranking below this minimum, even if it is the optimum, has a doubtful chance for success, and would at best have a marginal operation. Any deficit funding, as well as administrative effort, would be better spent on another service.

5.7 Intermodal - Maxi-Taxi and Local Bus

The intermodal evaluation is a comparison of alternative services, and is designed to help the transit manager choose the best service to fill a market need. To avoid the need for presently unavailable forecasted data, case studies were chosen from TTDC's recent paratransit experience for application of the evaluation.

The weights for the indicator categories in Tables 26 and 28 represent TTDC policy. Equal emphasis is placed on efficiency, effectiveness, and public fund conservation, with slight weights for fuel efficiency and air pollution minimization.

In November 1980, a Maxi-Taxi service was instituted in the Ocean View/Bayview area of Norfolk, replacing Bus Route #14. The statistics for each of these services, along with the intramodal standards and scoring, are summarized in Table 25. Also noted are the comparative indicators, with the distributed scores. Table 26, then, organizes the scores, weights, and ratings for each alternative and the no-transit-service alternative. Maxi-Taxi is clearly the superior alternative, with the no-service alternative the second choice. Based on this evaluation, conventional bus should not be implemented in this service area with the stated level of service, for it meets no objectives of the transit operator, user, or community.

5.8 Intermodal - Vanpooling and Express Bus

The NNSY is served by two express bus routes, #45 and #47, as well as 22 TTDC-owned vehicles. The intermodal evaluation is applied to this case study to test the pooling modes. The statistics are compiled in Table 27 for both modes, and then incorporated into the intermodal worksheet in Table 28.

Table 25

Intermodal Evaluation Indicator Ratings - Ocean View/Bayview

Cost Efficiency	Effectiveness	Conservation of public funds	Fuel Efficiency	Pollutant Minimization
<u>Fixed Route Bus</u> M Cost/PAX V 5.32 S D 1.43 P 2.67 Score = 0	M PAX/Hour V 5.6 S D 26.9 P 13.0 Socre = 0	M Rev/Cost V 0.06 Score = 0.06	M PAX-Mile/Gal Score = 1.0	M Grams/PAX-mile Score = 0.0
<u>Maxi-Taxi</u> M Cost/PAX V 3.81 S D 4.59 P 5.75 Score = 1.0	M PAX/Hour V 4.0 S D 2.0 P 2.8 Score = 1.0	M Rev/Cost V 0.10 Score = 1.0	M PAX-Mile/Gal Score = 0.0	M Grams/PAX-Mile Score = 1.0

Table 26

Intermodal Evaluation Results - Ocean view/Bayview

Service Type	Cost Efficiency	Service Effectiveness	Conservation of Public Funds	Fuel Efficiency	Pollution Level	Rating = WI
	W = 0.3	W = 0.3	W = 0.3	W = 0.5	W = 0.5	
Maxi-Taxi (DRT)	1.0	1.0	0.10	0.0	1.0	0.68
Conventional Transit	0.0	0.0	.06	1.0	0.0	0.068
Status Quo (no service)						0.20

Table 27

Intermodal Evaluation Indicator Ratings - NNSY

Cost Efficiency	Effectiveness	Conservation of Public Funds	Fuel Efficiency	Pollutant Minimization
Express Bus				
M Cost/PAX	M PAX/Hour	M Rev/Cost	M PAX-Mile/Gal	M Grams/PAX-Mile
V 0.60	V 37.8	V 0.46		
S D 2.67 P 1.43	S D 26.9 P 13.0			
Score = 1.0	Score = 1.0	Score = 0.46	Score = 0.0	Score = 0.0
Vanpooling				
M Cost/PAX-Mile	M % Surviving	M Rev/Cost	M PAX-Mile/Gal	M Grams/PAX-Mile
V 3.96¢	V 80	V 1.07		
S D 3.8 P 4.5	S D 89 P 82			
Score = 0.5	Score = 0.0	Score = 1.0	Score = 0.0	Score = 1.0

Table 28

Intermodal Evaluation Results - NNSY

Service Type	Cost Efficiency	Service Effectiveness	Conservation of Public Funds	Fuel Efficiency	Pollution Level	Rating = WI
	W = 0.3	W = 0.3	W = 0.3	W = 0.5	W = 0.5	
Vanpools	0.5	0.0	1.0	1.0	0.0	0.50
Express Bus	1.0	1.0	0.46	0.0	1.0	0.74
No Transit Service	--	--	--	--	--	0.20

The results of the evaluation show that in this case, express bus is the superior mode for the market group. Vanpooling, however, has a fair rating, so this alternative can also be offered for those commuters who are adverse to bus transit.

5.9 Data Requirements for Paratransit Evaluation in the TTDC

The Tidewater Transit Authority maintains a sizeable data file on both conventional transit and paratransit services, which enabled the application of the general evaluations to case study examples. As found in this chapter, gaps exist for the general indicator sets, and a much greater lack of data exists for the descriptive indicator sets. Additional data collection, then, is required in the Tidewater evaluation procedures.

For the general evaluation, the Maxi-Taxi data needs were fulfilled. The efficiency indicator would be better measured by a passenger-mile output, but the cost and difficulty in obtaining this measure on a service area basis is prohibitive. No recommendations for data base expansion, then, is made.

The vanpool general indicators, however are only partially sufficient. The efficiency statistics are calculated for a sample of 30 vanpools. As the entire system data file becomes available, it is recommended that the mean and standard deviation be recalculated. The values for the success rate of vanpooling for the employer groups is also essential for the general evaluation application.

Other services that may be evaluated by these procedures, such as the Special Transportation Services, will require equivalent data. The operating characteristics and user survey results compiled for Maxi-Taxi would also have to be compiled for STS, with only slight changes in indicator and measure sets.

Some additional data is needed for application of the descriptive indicator evaluation. The amount can be limited by collecting the required survey information only in service areas where the general evaluation indicators fail. Most of the cost efficiency data is collected for fixed route bus service, so the extension to paratransit services should cause no problem. Some expansion in effectiveness indicator data base is anticipated.

CHAPTER 6

SUMMARY AND CONCLUSIONS

6.1 Introduction

Transit evaluation and marketing are management procedures that assess existing services, identify new areas to be served and compare service alternatives for a specific market need. Procedures for paratransit market analysis and service evaluation are developed, and a service development process describes their use in transit system management.

The service development process includes steps that illustrate the simultaneous use of the evaluation procedures and the market analysis results. By following the steps recommended in this process, a more cost efficient and effective transit system is achieved.

6.2 Market Analysis

The purpose of the market analysis is to determine the size and character of the potential markets so that paratransit services can be implemented and targeted to those market groups which are best served by paratransit. The basis of a market analysis is the construction of a market profile, which consists of a set of market attributes which should point out the presence (or non-presence) of potential users of the proposed service. The profile is then evaluated to determine if a market warrants implementation of the proposed service. Due to the diverse nature of paratransit markets and services, separate market analyses were introduced for ridesharing and demand responsive services.

For potential ridesharing markets, the two most critical "employer" attributes are the number of employees and the compatability of their work schedules. A disaggregation of the employees into "clusters" of employees with the same schedules allows one to judge the actual size of the pools of employees which can be matched together to rideshare. The most critical "employee" attribute is the distribution of the residential density of the employees. For potential demand-responsive transit markets, the critical attributes are the socioeconomic characteristics and the presense of large trip generators. Demand models should not be used as a basis for the decision whether or not to implement DRT in a particular market.

6.3 Service Evaluation

The procedures demonstrated in this report provide a framework for the development of a common paratransit evaluation strategy for application at and between the system level.

The paratransit service evaluation process includes intramodal and intermodal evaluation. Each service is assessed by comparing its performance to a set of preestablished standards that reflect the locality's goals and objectives. Dual standards are recommended because they allow both a minimum and a desirable performance level. These standards, as well as the measures and indicators, may be modified to fit the conditions of any location.

For intermodal evaluation, a market analysis is a prerequisite for the estimation of performance of proposed services. The intramodal evaluation assesses existing services, and requires operating statistics and user surveys as input.

6.4 Data Considerations

A major hinderance to implementation of both market identification and service evaluation procedures is data availability. This data, because it must be on a service area or route basis, is fairly detailed and requires both time and funding if useful and comprehensive analyses and evaluations are desired. Many transit authorities do not currently collect this data, although the cost of doing so would be compensated with an increase in system efficiency.

BIBLIOGRAPHY

1. Public Technology, Inc. Transit Marketing. Washington, DC: Urban Consortium for Technology Initiatives, July 1978.

2. Transportation Research Board, Urban Transportation Economics: Proceedings of a Workshop or Measuring the Effectiveness of Transit Marketing. Special Report 181. Washington, DC: Commission on Sociotechnical Systems, 1978, 173-196.

3. Rothenberg, M. J., Public Transportation: An Element of the Urban Transportation System. U.S. Department of Transportation, February 1979.

4. Tomazinis, A. R., Productivity, Efficiency, and Quality in Urban Transportation Systems. Lexington, MA: Lexington Books, 1975.

5. Fielding, G. J., R. E. Glauthier, and C. A. Lave, Development of Performance Indicators for Transit, U. S. Department of Transportation, Report No. CA-11-0014-4, December 1977.

6. Cravens, D. W., et al., Market Opportunity Analysis for Short-Range Public Transportation Planning, Goals and Policy Development, Institutional Constraints, and Alternative Organizational Arrangements, Report 211. Washington, D C: National Cooperative Highway Research Program, October 1979.

7. Heaton, C., "Designing a Transit Performance Measurement System," Transit Journal, 6-2 (Spring 1980) 49-56.

8. Tyson, W. J., "The Role of Evaluation Indicators in Transport Planning," Transportation Planning and Technology, 4 (1977) 37-45.

9. Lerman, S. R., et al., "A Model System for Forecasting Patronage on Demand Responsive Transportation Systems." Transportation Research. February 1980, 13-24.

10. Billheimer, J. W., Lucas, G. R., and Wilmuth, R. W., "Review and Assessment of Paratransit Models." In Current Paratransit and Ride-Sharing Activities. Washington, DC: Transportation Research Board, 1979.

11. Chung, C. C. and Ferrantino, J. R., Mitre Corporation. Demand-Responsive Transportation Planning Guidelines. Urban Mass Transportation Administration, U.S. Department of Transportation, October 1976.

12. Lea, N. D. and Associates, "Transit Demand Fleet Size and Cost Estimates (Ready Reckoners)." Vancouver, British Columbia, September 1976.

13. Lex Systems, Inc., "LEX/TRAN Calculator." Menlo Park, CA.

14. "Guidelines for Planning and Administrating Dial-a-Ride Service in the City of Los Angeles." Los Angeles Department of Public Utilities and Transportation, May 1977.

15. Arrillaga, B. and Medville, D. M., "Demand, Supply, and Cost Modeling Framework for Demand-Responsive Transportation Systems." In Demand-Responsive Transportation, TRB, Special Report 147, 1974, pp. 32-48.

16. Bellomo, S., S. Liff, and M. Cheng, "Energy and Air Pollution in Urban Transportation Decision Making," in Urban Transportation Efficiency, New York, N.Y.: American Society of Civil Engineering, 1977.

NOTICE

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TECHNOLOGY SHARING

A PROGRAM OF THE U.S. DEPARTMENT OF TRANSPORTATION