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16. Abstract This final report encompasses what is perhaps the broadest dimension of transit marketing -- analysis of service development. Planning and implementation of service improvements cannon be separated from other phases of marketing nor can such developments be isolated from the actual operational features of local systems.

The report suggests that evaluative techniques, specifically twelve evaluation designs, are available to local transit management and city representatives to assess service improvements, based on (1) ridership response; (2) changes in awareness and knowledge of the system; and (3) evaluation of local bus operations. Thus, the efficacy of planned and implemented service improvements at the local level can be ascertained.

The evaluation designs and evaluative studies presented in the report can be utilized by the State Department of Highways and Public Transportation for deriving more comprehensive performance indicators, as a means of assessing system effectiveness for local bus operations, and for comparative appraisals across systems. Unlike other system accounts or approaches for measuring local transit performance which emphasize measures of cost efficiency, this report presents procedures for appraising system effectiveness -- to current patrons and the public-at-large.

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EVALUATION OF TRANSIT SERVICE IMPROVEMENTS: MEASURES OF SYSTEM EFFECTIVENESS

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Technical Report 1052-5F
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Marketing Public and Mass Transportation in Texas

Sponsored by the
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in cooperation with the
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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The

contents do not necessarily reflect the official views on policies of the Urban Mass Transportation Administration or the State Department of Highways and Public Transportation. The report does not constitute a standard, a specification, or a regulation.

SUMMARY OF FINDINGS

The technical study, "Marketing Public and Mass Transportation in Texas", explores strategies for stimulating transit ridership. The intention of this final report is to furnish analytical procedures for appraising effectiveness of planned and implemented service improvements.

Evaluation of transit service features, primarily recently implemented service alterations, provides a means of examining system productivity as well as the success or failure of specific service components. Evaluation of Transit Service Improvements: Measures of System Effectiveness is designed to assist state and local transit representatives in developing and utilizing evaluation capabilities to improve the efficacy of mass transportation.

The report attempts to meet the following objectives:

- Describe potential problem areas and discrepancies arising in the evaluation of service improvements
- Supply a basis for evaluation of system features as well as overall performance
- Provide case examples of transit evaluation research as applied to Texas cities, i.e. the use of performance indicators
- Point to trends in evaluation at different governmental levels and in the area of public transportation service provision
- Portray the significance of measures of transit effectiveness relative to other commonly used criteria of system success
- Provide valid and reliable techniques for measuring effectiveness of transit service plans and improvements
- Furnish appropriate data bases for use in evaluation procedures

TRANSIT PERFORMANCE

While many external factors, including federal guidelines, act to influence the type of mass transit service provided at the local level,

various managerial and operational actions also determine the effectiveness of service delivery on a daily basis. Underlying all discussions of transit performance two different dimensions emerge:

(1) An Efficiency Dimension — a focus on the utilization of available labor and capital resources, with performance based on an implied cost/benefit ratio; and

(2) An Effectiveness Dimension — a focus on quality of service provision, with performance based on the degree to which the local transit system serves riders and meets community needs and goals.

The emphasis of this report is on the effectiveness of public transit services, primarily specific service features that are evaluated in terms of ridership response. Basic performance indicators which emphasize system efficiency, such as revenue/passenger, provide no indication of system performance from the perspective of the rider. The intensified concern with efficiency measures has precipitated an emphasis on operational productivity, which may not be reflected in a positive ridership response.

Potential state and federal roles in evaluation of transit performance are discussed. Additionally, the consultant's role as well as in-house evaluative responsibles are clarified.

EVALUATIVE DESIGNS FOR ASSESSING TRANSIT SERVICE EFFECTIVENESS

Many of the techniques of performance measurement are based upon rigorous data-gathering and explicit performance criteria, while other evaluation designs are "bargain basement" approaches that provide only approximate results. It is difficult à priori to link specific evaluation designs with particular projects or transit service features. The selection of an appropriate design depends on several factors, including:

- Level of funding available

- Use of in-house versus outside evaluators
- Generality of the questions addressed
- Project versus systemwide performance monitoring
- Continuous versus one-shot evaluation
- Existence of prescribed objectives or planned outcomes
- Time span encompassed for evaluation
- Consistency and accuracy of recorded data

In the report, the merits and disadvantages of 12 traditional evaluative designs are presented, followed by brief examples of the designs. The 12 designs are summarized as follows:

I. Formative Evaluation Designs

A. *Plan Evaluation* -- formal evaluation of projected benefits, constraints, and objectives of a planned service improvement or alteration.

B. *Phase Evaluation* -- formal monitoring of a service alteration before continuing to modify the system.

II. Summative Evaluation Designs: Non-Experimental Procedures

A. *After-Only Design* -- static (or one-shot) measurement of impact after the service alteration has been implemented. Two groups or two system portions are compared, one having been exposed to the alteration and the other not exposed.

B. *Comparative Design* -- assessment of differences in service afforded by two or more separate improvements or comparisons among systems regarding a specific service alteration.

C. *The Case Study* -- intensive examination of one route, segment of ridership, or system, with primary data bases including existing records, field observation, or interviewing. No other group or service component is used as a "control" for comparison.

D. *Planned-Actual Performance Comparison* -- widely used measurement approach when explicit goals or standards for system performance are available for comparison with actual service outcomes.

E. *Time-Trend Projection Comparison* -- designed to compare actual post-project data with projections extrapolated from time periods prior to the service alterations. The differences between indicators (a) as they actually are, and (b) as they were estimated to be by the projections, are determined.

III. Summative Evaluation Designs: Quasi-Experimental Procedures

A. *Before-After Design* -- measurement before and after the service improvement to assess impact of the change.

B. *Time Series Design* -- similar to the before-after design, however, several measurements are taken before and after exposure to the service alteration.

C. *Nonequivalent Control Group Design* -- again with this design there is a pretest and a posttest. Additionally, before and after measurements are undertaken not only for the rider segments or portions of the system affected, but also for "control" groups or system components.

D. *Combination Time Series and Nonequivalent Control Group Design* -- a series of data measurements are made before and after the service improvements, on both experimental portions of the system as well as control portions.

IV. Summative Evaluation Designs: Experimental Procedures

A. *Controlled Experiment* -- randomly, portions of a system are assigned to either a treatment or a control grouping. Both groupings are measured before and after the service alteration, which is applied only to the treatment portion of the system.

Each of the designs, with varying degrees of rigor, attempts to address the question: "Did the service alteration or improvement make any difference?"

USE OF EVALUATIVE DESIGNS FOR FOUR TEXAS TRANSIT SYSTEMS

Five of the designs traditionally used to measure service performance were incorporated as examples for analyses in four Texas cities -- Waco, Beaumont, Fort Worth, and Houston. The design category, issue of interest, and respective study sites were as follows:

Evaluation Design	Service Alteration/Improvement	Study Sites
I. Comparative Design	Crowding/Comfort Considerations —— Fare Structure Assessment	Waco, Beaumont, Fort Worth, Houston
II. The Case Study	Transit Signage	Houston
III. After-Only Study	Subscription Service	Fort Worth
IV. Before-After Design	Promotional Strategies	Waco
V. Nonequivalent Control Group Design	Route Alterations	Beaumont

The Comparative Design. Service effectiveness in regard to (1) adequacy of space/comfort features and (2) fare structure was undertaken for four systems, with on-board surveys providing the primary data base. The comparative design provided a useful approach for this examination.

The following generalizations were derived regarding the importance of space in transit vehicles:

- Transit passengers in cities with consistently crowded buses perceive this bus feature as more salient than those riders in cities without high density buses.
- Crowding is a predominant concern for riders of systems who are dependent on transit as a sole means of transportation.
- Satisfaction with the local transit system is significantly related to perceived crowding on buses.

Bus crowding is affected by two aspects of transit decision-making, one an operational dimension regarding headway frequency, peak period service, and route coverage. The second aspect of transit planning and implementation affecting crowding levels and other comfort considerations revolves around the internal physical features of the vehicles in service. Crowding as a bus feature was chosen for evaluation because of ease of comparison across systems, as well as the saliency of the crowding dimension in decisions to utilize the bus as a transportation mode. Planned improvements in the bus fleet, primarily in the purchase of new vehicles, need to incorporate comfort features considered the most critical by bus riders. In addition, route alterations, especially at peak periods, should be geared to crowding problems, with flexibility needed in changing route coverage and headway frequency to meet user needs.

Transit management and city representatives concerned with fare structure have emphasized the need to make decisions regarding: (1) special reduced fares for specific segments; (2) trade-offs between service improvements and fare increases; and (3) optimum fare based on ridership response. The comparative evaluation design furnishes a procedure to examine such fare considerations, with rider surveys in the four Texas cities as the data base. The following findings were obtained from the comparative study:

- Long bus trips can be priced higher than short rides.
- Riders are generally more responsive to increases in fare than to decreases in level of service.
- Fare reductions for special segments receive differential support by riders, based on the characteristics of the existing market in each city.

Case Study Design: Houston Transit Signage. Transit sign symbols and verbal communications must be consistent to be useful to patrons. On-board surveys were used to assess route sign preferences and the rider's understanding of transit signs, including those for specialized services. Many smaller cities are attempting to provide improved bus stop signs. Thus, information provided from this Houston case study should have applicability to other systems. Additionally, the case study furnishes Houston transit representatives with a clearer indication of the effectiveness of signs currently in usage, so that further improvements, as well as public information programs, can be geared to the information needs of bus patrons.

Summarizing the findings of the case study:

- The level of understanding of transit signs by HOUTRAN riders was very low. As examples, only 25 percent correctly identified the HOUTRAN 10¢ zone sign and only 49 percent recognized the express bus stop sign.
- The only characteristic of riders, such as age, sex, socioeconomic status, and riding experience, that significantly explained the lack of understanding was ethnicity. Ethnic minorities consistently had less accurate perceptions of the transit signs than did Anglos.
- The route sign that communicated route names as well as the route numbers was preferred by 83 percent of the respondents.

After-Only Design: Fort Worth Subscription Service. The after-only evaluative framework provided a suitable approach for describing the effectiveness, and demand for, subscription service juxtaposed against conventional services. On-board surveys were disseminated to riders on conventional routes, as well as on subscription buses serving two high employment centers in Fort Worth -- Bell Helicopter and General Dynamics.

Salient findings included the following:

- Comparisons of responses from subscription riders with those of conventional riders showed no marked differences in overall satisfaction with bus service.
- Maximum acceptable fare for conventional riders and subscription passengers differed markedly, with subscription patrons allowing a 30¢ fare increase per trip before they would no longer ride the bus and conventional riders a 75¢ maximum allowable increase.
- Patrons of conventional bus services, riding for work or school trips, were not receptive to use of subscription services for these trip purposes when cost factors were provided to them.

- The mean increase in trip time allowable before passengers would discontinue using the bus was 14 minutes for subscription patrons and 15 minutes for conventional riders.

- Frequency of ridership for passengers using the bus for work trips on conventional routes averaged 24 one-way trips, or 12 days per month; subscription riders averaged 17 days per month, or 34 one-way trips.

- Average distance from residence to bus stops for subscription riders varied from three blocks (for General Dynamics passengers) to 33 blocks for Bell Helicopter's employees, suggesting a maximum of two miles as a subscription route's catchment or coverage area.

- Each morning, 38 percent of the subscription riders drove their own car to a parking location, while 50 percent reached the bus stop by walking and 12 percent arrived as passengers in a private vehicle.

Before-After Study: Waco's Transit Promotional Strategies. The quasi-experimental before-after study in Waco utilized household surveys undertaken in August 1976 with the respondents re-interviewed again in August 1978. Promotions in Waco, undertaken after the 1976 survey, consisted of radio and television advertisements, supplemented by route and schedule maps. The impact of these promotional activities was tested primarily through: (1) changes in ridership; (2) changes in knowledge/awareness levels; and (3) changes in evaluation of the transit system.

Salient findings from the pretest-posttest study of promotional strategies were as follows:

- Ridership has actually decreased in the two-year period, systemwide as well as for the respondents surveyed. Loss of free passes for the elderly and handicapped, as well as recent route changes, may have caused the decline in patronage.

- An increase in awareness and knowledge of the bus system was evidenced, which may be attributed to promotional activities.

- A decline in support for further informational campaigns occurred, probably because of the perceived costs associated with these activities.

- Residents were increasingly opposed to all forms of subsidization for the bus system.

- Despite decreased interest in providing monetary support for the system, residents gave the bus operations a higher rating in 1978 than they did in 1976.

In sum, the respondents indicated a more positive evaluation of the system, but had less of a "public regarding" attitude toward transit funding, i.e. they were less willing to monetarily support a public transit facility. The effects of this two-pronged evaluation are felt in the area of transit marketing, where more residents have knowledge of the system and a more favorable attitude toward the system because of promotional efforts, but they are inclined to place financial constraints on any further marketing efforts or other service improvements.

Nonequivalent Control Group Design: Impact of Route Alterations in Beaumont. For the evaluative effort undertaken in Waco a before-after study furnished the assessment framework. Measurements were made before and after the Waco marketing program was implemented. However, there was no procedure to control for extraneous effects, such as the discontinuing of free passes and route alterations, both of which were independent of the promotional efforts.

In Beaumont, a more complex design was used to evaluate route changes -- the nonequivalent control group study. With this approach a control portion of the system (i.e. one route) was selected to compare with two routes that had undergone alterations, one a minor route alteration and the second a major change in that two separate routes were subsumed into one new route. While the alterations had been mandated on a cost efficiency basis, it is also worthwhile to note the impact on riders and the public-at-large. The study indicated that:

- Patronage for Route 1 (the case where two original routes were collapsed into one new route) decreased considerably, while Route 2 (the route with a minor extension) showed a slight increase, and Route 3 (the unchanged, "control route") a considerable increase in ridership.

- Likewise, residents surveyed along the routes in 1976 and 1978 showed the same trends -- a decline in patronage for Routes 1 and 2, while Route 3 evidenced increased ridership among those surveyed.
- Route 1 respondents were consistently less favorable to local transit operations on three separate dimensions over the 24-month period, while Route 3 residents had a higher evaluation of the system; Route 2 informants were either unchanged or slightly more favorable on the three items addressed.

Other factors, including the differences in socioeconomic characteristics of residents adjacent to the three routes, may aid in explaining the changes in ridership and evaluation of the system on the three routes. Nevertheless, the results point to the utility of evaluating the effectiveness of service alterations and improvements as well as to the cost efficiency of such projects. The application of the nonequivalent control group design to the case of route reductions in Beaumont suggests that ridership response and evaluations of the bus system are visibly impacted by these service changes.

CONCLUSION

Evaluation research and the use of performance indicators have a well established history in private enterprise. The transition from business to public services has not been easy to implement as most of the criteria of success, such as price/earning ratios and yield on stock, are not readily applicable to public services, where the output is measured in terms of public satisfaction and patronage.

Based on the rigor of the evaluation design and the manner in which the study is undertaken, results can be used not only for the transit system under scrutiny but also by other transit systems. The accountability offered to city councils and to state and federal agencies encourages monetary support and objectively points to specific areas in which financial outlays are most needed.

IMPLEMENTATION STATEMENT

Previous Technical Study 2-10-76-1052 reports have focused on market segmentation, promotional strategies, and on critical factors determining the demand for transit. These three aspects of marketing have been presented to Texas transit systems and portions of recommended marketing techniques are being implemented currently. A fourth report, in publication stages, documents market research techniques to be used by local systems.

This final report encompasses what is perhaps the broadest dimension of transit marketing -- analysis of service development. Planning and implementation of service improvements cannot be separated from other phases of marketing nor can such developments be isolated from the actual operational features of local systems. This report suggests that evaluative techniques, specifically twelve evaluation designs, are available to local transit management and city representatives to assess service improvements, based on (1) ridership response; (2) changes in awareness and knowledge of the system; and (3) evaluation of local bus operations. Thus, the efficacy of planned and implemented service improvements at the local level can be ascertained. The evaluation designs and evaluative studies presented in the report can be utilized by the State Department of Highways and Public Transportation for deriving more comprehensive performance indicators, as a means of assessing system effectiveness for local bus operations, and for comparative appraisals across systems. Unlike other system accounts or approaches for measuring local transit performance which emphasize measures of cost efficiency, this report presents procedures for appraising system effectiveness -- to current patrons and the public-at-large.

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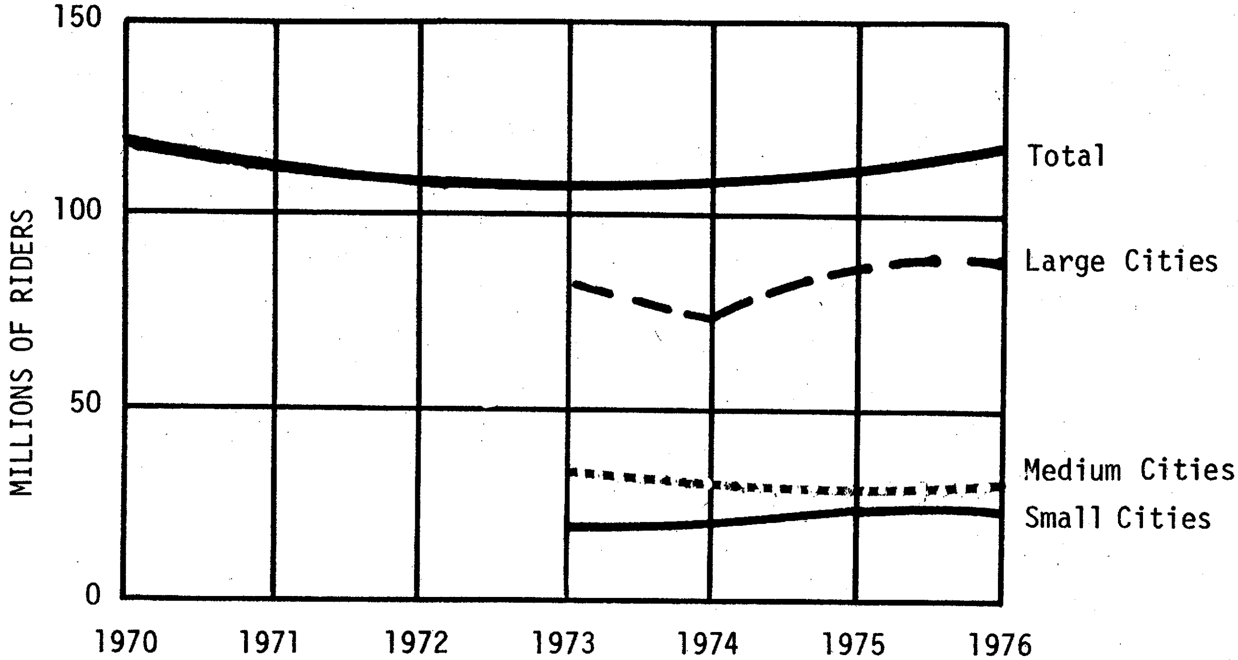
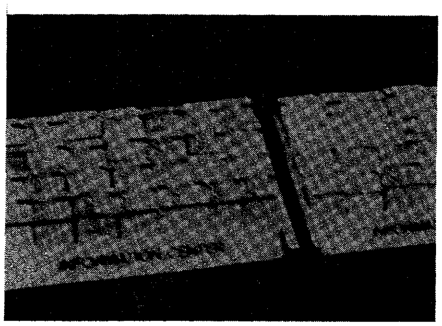
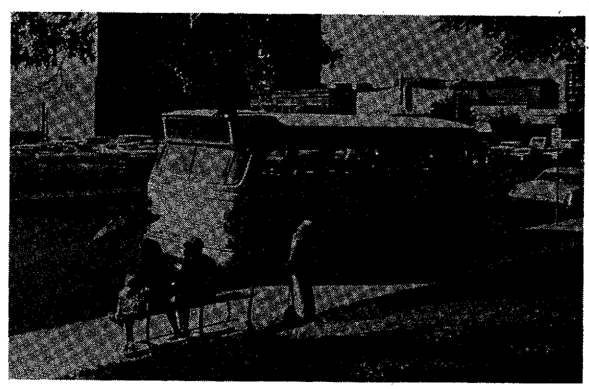
TEXAS RIDERSHIP TRENDS



Measurement of the effectiveness of specific service alterations or improvements includes (a) indicators of ridership response, (b) altered awareness/knowledge levels regarding the bus system, not only by patrons, but also the public-at-large, and (c) changes in evaluation of local transit operations.





CHAPTER I

THE NATURE OF TRANSIT SERVICE EVALUATION

Following decades of decline, urban transit is receiving a great deal of public support, both in monetary terms as well as in patronage. Nevertheless, attitude surveys depict *performance* as the major concern in the provision of mass transportation. Because the public and officials at all levels of government demand some means of determining the productivity of public transit, the importance of measuring system performance has become tantamount.

Between 1970 and 1976 the amount of transit service provided nationally increased by 7.6 percent, from an estimated 1,883,000 to 2,026,000 vehicles miles (Urban Mass Transportation Administration [UMTA], 1977). During the same period, overall ridership levels declined by 4.4 percent to 5,673,000 revenue passengers. While ridership has been increasing in recent months and the local transit systems are improving, they still do not meet the public's aspirations for a transportation mode.

Evaluation of transit service features, especially recently implemented service improvements, provides a means of examining the productivity of the system overall, as well as the success or failure of specific service components. This report is designed to assist state and local transit representatives to develop and utilize evaluation capabilities to improve the effectiveness of public transportation.

Briefly, the report attempts to meet the following objectives:

- Portray the significance of measures of transit effectiveness relative to other commonly used criteria of system success
- Provide valid and reliable techniques for measuring effectiveness of transit service plans and improvements
- Furnish appropriate data bases for use in evaluation procedures

- Describe potential problem areas and discrepancies arising in the evaluation of service improvements
- Supply a basis for evaluation of system features as well as overall performance
- Provide case examples of transit evaluation research as applied to Texas cities, i.e. the use of performance indicators
- Point to trends in evaluation at different governmental levels and in the area of public transportation service provision.

TRANSIT PERFORMANCE

While many external factors, including federal guidelines, act to influence the type of mass transit service provided at the local level, various managerial and operational actions also determine the effectiveness of service delivery on a daily basis. Further, the performance of the system encompasses a wide spectrum of service delivery functions. Soglin (1977:17) has noted:

> Transit performance is not only the ability to move people from Point A to Point B; it is with what quality we move them, how quickly we move them, how expensive it is to move them, how much energy it takes to move them, and how much that movement affects our total human environment.

Loosely defined, evaluation of transit performance includes:

- Assessment of macro level impacts, primarily indirect effects on land use, energy utilization, community development, job opportunities, roadway congestion, pollution levels and other environmental, social, and economic considerations
- System accountability, such as Section 15, with the Financial Accounting, and Reporting Elements (FARE) structure, which provide indicators of overall system performance

- Evaluation of specific product improvements or alterations, such as route changes, provision of shelters, benches, and transit signs, promotional strategies and other salient service improvements or planned alterations.

Underlying all discussions of transit performance, two different dimensions are seen to emerge (see Urban Mass Transportation Administration, 1977:3):

Efficiency - Utilization of available labor and capital resources with performance based on an implied cost/benefit ratio.

Effectiveness - Quality of service provision, with performance based on predetermined community goals and community satisfaction.

The emphasis of this report is on the effectiveness of public transit services, primarily specific service features that are evaluated in terms of ridership response. Basic performance indicators which emphasize system efficiency, such as revenue/passenger, subsidy/passenger trip, and revenue/expense, provide no indication of the system performance from the perspective of the rider. The intensified concern with efficiency measures precipitates the need for operational productivity, which may not be reflected in a positive ridership response. Only in rare cases can transit management take consolation in the fact that "the operation was a success, but the patient (i.e. patronage) died."

EVALUATION OF SERVICE FEATURES

The primary purpose of evaluative efforts is to make available to transit management information that compares performance with some relative or absolute standard of expected effectiveness. With this approach, it is possible to determine the extent to which objectives regarding transit service are being met. To evaluate the effectiveness of transit service, as the concept of "effectiveness" implies, the primary emphasis is on the "value" of particular service or service components. The position taken in this report regarding evaluation of transit effectiveness is reasonably broad and includes the process of securing valid, reliable, and applicable information about service improvements and planned improvements, as well as outcomes and impacts of transit services, to permit administrators to make productive decisions and fulfill their responsibilities for public accountability (see Franklin and Thrasher, 1976:23). Thus, evaluation research is an assessment of the degree to which a service alteration (or the service overall) is meeting its objectives, the problems being encountered, the outcomes in terms of benefits, and the side effects it is creating.

Two types of evaluation predominate -- expert judgment by managers and transit representatives and formal evaluation, normally by a consultant or others outside the local administrative framework. Similar to the medical profession, transit representatives have been given a positive monetary mandate by the public and the legislature, based on the current and potential value of the service rendered. Nevertheless, decision-makers are now asking, "Is the service worthwhile?", "Is the service reliable?" Confronted with these and other questions, transit representatives have had to look beyond their traditional administrative structures to make decisions for service alterations and improvements.

Evaluation research and the use of performance indicators have a well established history in private enterprise (see Underwood, 1978:1-2). The transition from business to public services has not been easy to implement, as most of the criteria of success, such as price/earning ratios and yield on stock, are not readily applicable to public services, where the output is measured in terms of public satisfaction and patronage. As Franklin and Thrasher (1976:1) note:

In an era of heightened public conern about the distribution and management of public funds, at a time of diminished buying power, when an ideology of a "good return on an investment" competes with more charitable and affluent ideologies for ascendancy in the public ethos, evaluation becomes a prominent and visible concern for the managers of public programs. Program evaluation, although certainly a popular term in current management vocabularies, is not a new activity and historically has emerged and developed along with administration as an independent specialty.

To use evaluation research in the measurement of service provision, a continuous monitoring process can be used or a one-shot evaluation undertaken. Ideally, for major service alterations, the continuous evaluation proves most valuable in that needs change rapidly and the response to the service also may fluctuate. Continuous evaluation is rare for monitoring specific service improvements, but will be undertaken on a bi-annual basis to meet the federal accounting requirements under the FARE system. Typically, continuous evaluation has been a responsibility of the management staff, rather than of outside consultants. However, many state transportation agencies and legislatures have evidenced a strong interest in monitoring transit performance on an on-going basis (Yancey, 1978; Underwood, 1978).

One-shot evaluation may involve a study by consultants or researchers outside the parameters of the transit industry or city staff. Particularly when time or resource constraints are involved, a one-shot evaluation is viewed as effective.

Periodic evaluation is a very useful midpoint between continuous and one-shot evaluation, especially in the case of transit where improvements may be phased and where the impact on ridership is slow in emerging. According to Franklin and Thrasher (1976:29):

> ...many of the instruments available for measuring a change are sensitive only to gross changes. In many instances, particularly those requiring measurement of impact, long-term outcome, or prevention, neither continuous evaluation nor one-shot evaluation is adequate, but some type of periodic monitoring is possible, feasible, and necessary.

Local Evaluation of System Effectiveness

Several problems can emerge with evaluation that stems from local city representatives or transit management staffs:

(1) It is difficult for those with the evaluative responsibility to evaluate services administered by those in higher positions of authority.

(2) The use of evaluation guides and scientific methodology required to obtain an accurate and valid assessment may not be incorporated into the evaluation.

(3) Often the evaluation of performance in a negative vein may be viewed as reflecting the local evaluator's own shortcomings, if that person also is responsible for previous policy decisions or operations.

(4) The need to undertake these evaluations as an additional responsibility to the already burgeoning work load may prevent sufficient time, or personnel, to plan the evaluation and collect and analyze the data.

These potential problems at the local level become increasingly apparent as public provision of transit requires the systems to move from an operations to a community orientation (Suchman, 1967:18).

Consultant/Research Evaluations of System Effectiveness

Shortcomings also may be found when evaluation of the system is carried out by a task force not allied with the local transit administration:

(1) The assessment of complex and interfacing service features may be difficult for those outside the transit system who are not acquainted with local conditions and internal situations affecting service outcomes.

(2) Researchers may be so intent upon applying rigorous scientific methods with "control" conditions and experimental treatments that the evaluation cannot meet broader administrative needs for decision-making.

(3) Often evaluation of service performance is mandated by the need for immediate policy-decisions or to assess crisis situations; consultants and evaluation researchers have difficulty in meeting short-term time constraints.

The State's Role in Transit Performance Evaluation

The state transportation agency is tied to the federal process in that the state constitutes the critical link between federal programs and enactments and the actual provision of transit service. According to Gabriel (1976: 17):

> It is no exaggeration to say that without the state playing an active cooperative role, federal programs in many areas literally could not function. Every locality requires at the minimum that the state legislature authorize the locality to participate in the program. Also, it is the state governments that most frequently supply the administrative personnel, the evaluation personnel, the field personnel and the staff personnel whose task it is to actually carry out federal programs. Accordingly, it is clear that without state cooperation, federal programs would in most cases be stillborn.

Problems lie in performance evaluation undertaken by states, however, based on the following:

(1) Evaluation without the ultimate use of these findings may be incurred with state transportation agency evaluation, as local decision-making and operations per se are not subject to alteration by state-level recommendations.

(2) Standardization of evaluation procedures may be evidenced when the evaluator is a state agency, with less concern for local community needs, objectives, and attitudes toward transit service.

The Federal Role in Evaluation

At the national level, the same shortcomings accruing to state involvement in performance measurement can be observed. Additionally:

(1) From the national perspective, evaluation serves different ends for different organizational units within the federal bureaucracy. UMTA, through the FARE system, for example, may use evaluation to justify budget requests and at the same time to assess future directions in policy.

(2) Use of federal or state evaluation guidelines often hinders the development of local in-house service evaluation capabilities.

The American Public Transit Association (APTA) has urged local systems to develop and implement performance measures in order to determine progress toward internal goals and to evaluate the system overall, as well as individual improvements. Communication of these findings to state and federal levels also has been recommended by APTA and the FARE system will make performance data available to legislatures and to governmental agencies, on a comparative basis, within the coming year.

THE RELATIONSHIP BETWEEN OBJECTIVES AND PERFORMANCE

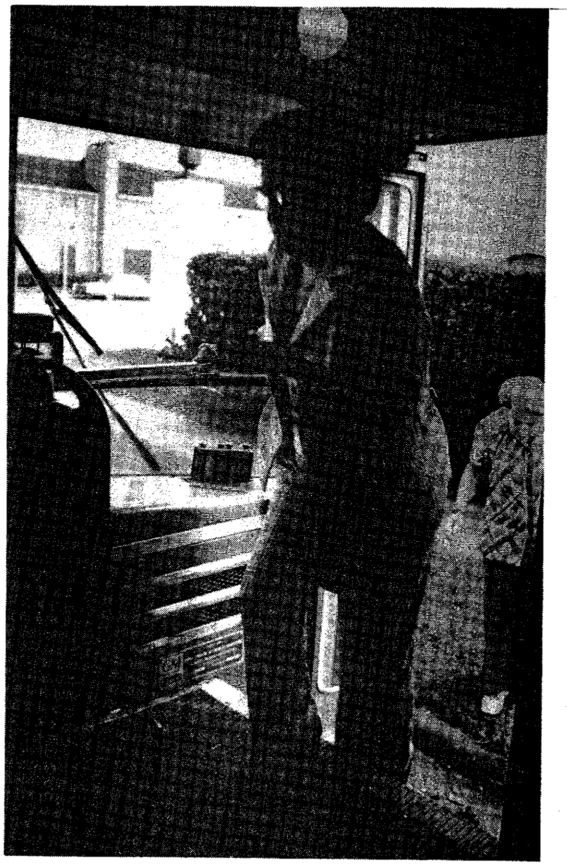
Evaluation of the effectiveness of system improvements or alterations is, in most cases, impossible without some indication as to the objectives of these service features. Public service agencies, such as educational, medical, and social service organizations, continually emphasize actual outcomes relative to planned outcomes or objectives. Before an extensive route alteration is implemented, an estimate of impact upon ridership is developed. Promotional campaigns should not be attempted without some projections as to outcomes, either in terms of ridership increase or of improved awareness of the transit system.

Figure 1 portrays a hypothetical case of the evaluation process involved in a promotional campaign. Included in the evaluation hierarchy are: (1) a portrayal of the relationship between levels of objectives; (2) the link between planned and actual performance; and (3) the stages of evaluation for the promotional campaign.

Critical to the example of Figure 1 is the measurability of the goals outlined, as well as the planned (P) achievement levels at each stage in the objective hierarchy. Having explicit goals provides a basis for objectively evaluating actual outcomes (A). More important, accounting to the public and to the governmental bodies is simpler before as well as after the service alteration if some explicit objectives and activities are prescribed.

FIGURE 1: CASE OF EVALUATION PROCESS INVOLVED IN A PROMOTIONAL CAMPAIGN

Stages of Adoption Based on Promotional Campaign	Hierarchy of Objectives	Planned (Objective) versus Actual Outcomes
IX. Outcome (Output)	Number or proportion increase in ridership levels	$P_{(5\%)} - A_{(2\%)}$
VIII. Adoption	Number or proportion who continue riding transit, either regularly or occasionally	$P_{(5\%)} - A_{(2\%)}$
VII. Trial	Number or proportion who give transit systems a trial	$P_{(10\%)} - A_{(5\%)}$
VI. Evaluation	Number or proportion who react positively i.e. reinforce or change attitudes	$P_{(20\%)} - A_{(17\%)}$
V. Interest	Number or proportion who can recall information	$P_{(35\%)} - A_{(23\%)}$
IV. Awareness	Number or proportion of persons who receive information	$P_{(75\%)} - A_{(75\%)}$
III. Information	Number of media sources utilizing promotional aids and number of uses per source	$P_{(n x k = 6\ 20)} - A_{(n x k = 4 x 15)}$
II. Provision	Number of promotional aids available for distribution to newspapers, T.V., and radio stations, racks, etc.	$P_{(5)} - A_{(5)}$
I. (Input)	Pretesting of promotional aids with focus groups and other population samples	$P_{(3)} - A_{(3)}$



Evaluation designs are broadly used in assessing programs and services provided by private enterprise and by public service agencies. These approaches have wide applicability for salient transit service improvements as a means of measuring performance. Effectiveness of (a) service improvements for the elderly and handicapped, and (b) route alternations or extensions, are special features that may prove to be prime candidates for evaluative efforts.

CHAPTER II

METHODS FOR EVALUATING TRANSIT SERVICE EFFECTIVENESS

Most transit service improvements have multiple objectives. Marketing mass transportation is a case in point, where not only is the aim to increase ridership but also to encourage further public support of transit as a public service. Closer examination of objectives behind planned as well as implemented service improvements reveals that they consist of a mixture of different dimensions -- time, place, procedures, generality, and target population. This multiplicity of objectives is often a source of unproductive disagreement among transit representatives and constitutes a major barrier to successful evaluation (Suchman, 1967:51). Nevertheless, there exists a very salient need to evaluate the effectiveness of various alterations to transit service, so that it may be necessary to evaluate with a blurred picture of the original service objectives.

Programs and improvements that are being evaluated at the federal level range from broad appraisals of the accessibility requirements of conventional buses to more specific concerns, such as monitoring local route changes or the impact of bus shelter placement. Regardless of the level of generality, there must be no confusion as to the degree to which planned outcomes actually represent realistic rather than ideal goals.

Most of the techniques of performance measurement are based upon scientific methods and criteria of experimentation. However, many of the evaluation designs that are described in this chapter are simpler and provide broad estimates. These evaluation designs have been chosen because they were used successfully in previous studies of public services and of projects or programs oriented to the public.

It is difficult à priori to link specific evaluation designs with particular projects or transit service improvements. The selection of an appropriate design depends on several factors, including:

- Level of funding available
- Use of in-house versus outside evaluators
- Generality of the questions addressed
- Project versus systemwide performance monitoring
- Continuous versus one-shot evaluation
- Existence of prescribed objectives or planned outcomes
- Time span encompassed for evaluation
- Consistency and accuracy of recorded data

In this chapter, the advantages and disadvantages of twelve traditional designs are presented, to be followed by five evaluation studies in the forthcoming chapter.

EVALUATION DESIGNS

At the outset, two types of evaluation procedures should be distinguished: formative evaluation and summative evaluation. Formative evaluation designs have a place in providing diagnostic analyses during the planning or implementation stages of service improvements. Procedures to assess tentative service alterations include plan evaluation and phase evaluation. Summative evaluation usually provides the basis for determining the impact of particular improvements, as well as the system's performance overall, and draws out the value of services being rendered.

Formative Evaluation Designs

Plan Evaluation. While there can be no generalized procedures for including evaluation in the planning process, a check-list of planning activities can be easily identified and used, as shown in Table 1. The outline presented

Table 1. Model of a Planning Process

1. Preliminary Recognition and Definition of Problems
   - 1.1 Surveillance and analysis of relevant problems.
   - 1.2 Comparison of existing and forecast conditions, in order to identify problems requiring examination.
   - 1.3 Assessment of problem significance.
2. Decision to Act and Definition of the Planning Task
   - 2.1 Decision to investigate the problems and alternative courses of action.
   - 2.2 Definition of the purpose of the planning task.
   - 2.3 Formulation of goals for the plan.
   - 2.4 Formulation of approach to the study and to the design and evaluation of alternative plans.
3. Data Collection, Analysis, and Forecasting
   - 3.1 Collection and analysis of data relevant to the planning problems.
   - 3.2 Forecasting the scope for change.
   - 3.3 Determination of evaluation data requirements.
4. Determination of Constraints and Objectives
   - 4.1 Determination of constraints.
   - 4.2 Determination of objectives for the plan.
5. Formulation of Operational Criteria for Design
   - 5.1 Formulation of measures for the objectives.
   - 5.2 Collection of evidence on the relative importance of objective achievements.
6. Plan Design
   - 6.1 Selection of one or more design methods.
   - 6.2 Use of design criteria to prepare alternative plans.
7. Testing of Alternative Plans
   - 7.1 Testing for internal consistency.
   - 7.2 Assessment of feasibility with respect to constraints.
8. Plan Evaluation
   - 8.1 Measurement of levels of achievement of objectives.
   - 8.2 Appraisal of the evidence produced.
   - 8.3 Setting down of findings in a logical framework.
   - 8.4 Making of recommendations to decision-takers.
9. Decision-Taking
   - 9.1 Collaboration and debate among decision-takers.
   - 9.2 Collective choice of the preferred plan.
10. Plan Implementation
    - 10.1 Establishment of machinery for implementation.
    - 10.2 Initiation of planned developments.
11. Review of Planned Developments Through Time
    - 11.1 Observation of consequences of the adopted plan.
    - 11.2 Comparison with predicted outcomes, and appraisal of the significance of any unanticipated consequences.
    - 11.3 Identification of new problems arising.

Source: Revised from Nathaniel Lichfield, <u>et al.</u>, <u>Evaluation in the Planning Process</u>. Oxford: Pergamon Press, 1975, p. 20.

characterizes activities that can be undertaken from the time the problem or needed improvement is identified through to implementation of the actual project or service improvement. In a model including plan evaluation, the work of the evaluator is staged in a linear process.

An example of the use of plan evaluation is afforded by the proposed provision of bus shelters. The assessment of the benefits of the shelters is required for grant applications, as well as the objectives and constraints regarding bus shelter provision locally. Data requirements must be met and locational criteria determined. Assessment of alternative locations are then undertaken including a ranking of heavily used bus stops. At this point, plan evaluation appraises the effectiveness of the intended bus shelter project in meeting service objectives. These findings are provided as a defense for or against the acquisition of bus shelters and recommendations are made accordingly.

Phase Evaluation. During the implementation stages of a service alteration, there is often a need to assess impacts before continuing to modify the system. *In the cases of bus shelter location or of bus stop sign placement, it may be appropriate to examine the impacts of locational considerations for the first few placements, so that final implementation of the shelters or signs proves effective in terms of public use.*

The phase evaluation consists of observations of measurements (O_1 O_2 O_3 O_4 O_i) during the implementation stage. A tentative comparison of predicted outcomes can be undertaken, as well as appraisal of the significance of unanticipated consequences and identification of any problem arising from these improvements.

Summative Evaluation Designs: Non-Experimental Procedures

After-Only Design. Among the summative designs, one that may be termed a "bargain basement" approach is the *after only* design (Franklin and Thrasher, 1976:69). This design is static in that only one measurement is made after the service improvement or alteration has been implemented. Two (or more) groups are compared in this approach, one having been exposed to the transit improvement and the other not exposed, as shown by

	Exposure to Alteration	Measurement After
Exposed Group	X	0_1
Control Group		0_2

The design is frequently used in the case of medical treatments, with one segment (0_1) receiving the treatment and a second group (0_2) with no such treatment. If the exposed group shows a significantly higher incidence of the desired condition, it is assumed to be attributable to the treatment. However, this procedure affords no way of evaluating that the two groups were equivalent *before* the treatment, although selective matching of the two population segments is strongly recommended (Suchman, 1967:95).

For example, two or more routes with similar service characteristics and clientele served can be compared to assess the ridership response to shortened headways on one of the two routes. The test of effectiveness is indicated by the significance of the difference between 0_1 *and* 0_2.

Comparative Designs. Evaluating differences in service afforded by two or more separate improvements is helpful in assessing the relative effects of these improvements. At a macro level, comparisons among systems matched as closely as possible by service levels and population/city characteristics has been stressed as useful by proponents of standardized performance indicators. Comparative designs are thus utilized in a wide variety of ways, with some procedures being very specific and other approaches not amenable to diagramming by measured effects on units of observation (0_1, 0_2, 0_i). Comparative designs normally compare projects or systems rather than similar elements, such as routes.

For instance, two or more marketing strategies may be attempted simultaneously for attracting patrons to park'n'ride lots. One approach is the dissemination of a route leaflet to all residences within a "catchment area" and the second procedure entails telephone contacts to a sample of the residents in a second residential area who do not receive leaflets. The relative advantages measured by increased use of the two park'n'ride lots provides one means of measuring relative outcomes or the effectiveness of two distinct marketing strategies.

Comparative designs are employed in building measures of effectiveness for which no precise standards currently exist. Systemwide effectiveness as measured by performance indicators such as accessibility to routes, travel time, and proportion of service area population using the system, point to the relative merits of the local system compared to other similar systems. Franklin and Thrasher (1976:62) provide an example of the comparative evaluation procedure:

> Ideally, the logic of comparative designs is straightforward. If two or more programs are similar in all aspects but one and differ in effectiveness, it is plausible to assume that the one aspect on which they differ accounts for the difference in effectiveness. For example, if a large number of mental health programs that rely on chemotherapy are more effective in reducing length of hospitalization, the investigator is likely to conclude that chemotherapy reduces the length of hospital stay. If this finding holds across numerous programs that are identical in all other important aspects, impressive evidence points to the effectiveness of chemotherapy in reducing length of stay in mental hospitals. In this instance other program elements and aspects are ruled out as possible factors in reducing length of hospitalization in the sense that there were common to all programs and variations in ongoing programs that, theoretically, could provide alternative explanations for the dependent variable were also absent.

Comparative designs build standards of effectiveness in cases where localized transit objectives are ambiguous or undeveloped. Such approaches provide a critical base for ruling out many assumptions regarding service that may not be correct. A persistent problem with the comparative design is adequate matching of similar systems or programs within systems.

The Case Study. Case studies observe intensively one or only a few selected routes, rider segments, or the systems as a whole. Examination may involve the use of existing records, interviewing, or field observation. Case studies seldom entail the rigor expected of more formalized experimental designs. Often soft data is utilized or the performance measures may be used, such as matching routes or systems for comparison purposes. If any comparisons are made, they are normally implicit rather than an actual measurement of differences between systems or routes. The most commonly used form of case study in the literature is the "success story" which documents the effectiveness of a specific service improvement.

Examples of the case study include appraisals of (1) the usefulness of computerized route/schedule information systems; (2) the effectiveness of subscription services; and (3) the monitoring of ridership for specialized services.

Such case studies provide an impetus for the implementation of similar successful service features in other systems. In addition, an effort has been made to describe the effectiveness of the service alteration so that a city council or other governmental bodies have an account of the advantages of the program.

Planned-Actual Performance Comparison. Similar to the comparative design, "planned-actual performance" comparisons are used to classify a wide variety of evaluation approaches. As all improvements in the mass transportation arena should have specific projected consequences, a comparison of outcomes with the original objectives of the improvement should be undertaken routinely.

In specific situations, however, explicit standards to measure system performance may already exist.

For example, city councils normally are not willing to approve funds for additions to the bus fleet without some estimate of previous responses to such investments. Similarly, increases in fare structure or alterations in fares by zones need to be predicated on estimated changes in ridership levels. An evaluation of ridership levels after fare increases or fare zone alteration can then be compared to previously formulated projections.

After-the-fact comparisons of how an improvement affected ridership relative to what had been expected from the change are still surprisingly rare (Hatry, et al., 1973:62-63). If transit managers or city transit representatives establish goals or targets that are expressed in terms of effectiveness measures, evaluations of actual performance could be undertaken. As this approach has no "controls" against which to measure achievement, however, there is no guarantee that the changes occurring over a prescribed time period are due solely to the improvement being evaluated. Thus, evaluation should extend to all possible explanations other than the specified improvements to discern reasons why the planned targets have, or have not, been reached.

Time-Trend Projection Comparison. While the actual versus planned performance evaluation just described is only loosely termed a scientific design, the time-trend projection procedure provides a stronger basis for measuring the success of specific transit improvements. This design compares actual post-project data with projections extrapolated from previous years. Changes in performance indicators before and after the project implementation are identified. The differences between these indicators (a) as they actually are and (b) as they were estimated to be by the projections if the improvement had not been instituted also are compared, as shown by:

$$P - O_2 = \text{Project's Effect}$$

where P = projected performance based on previous trends

and O_2 = actual performance at the projected period after implementation of the improvement.

The time-trend projection comparison has been useful where there appears to be a consistent trend over previous measurable time periods which would seem likely to have continued if the service alteration had not been introduced. If data for previous time periods are unstable or fluctuating greatly, however, statistical projections may not be meaningful. Further, if there are indications of external factors affecting performance, other than the service alteration, the projection procedure should probably not be utilized.

An example of the use of a time-trend projection comparison design can be found in raising fares from 35¢ to 40¢, as shown in Figure 2. Ridership for the 16 months prior to fare increase is plotted by route. Projected ridership is depicted, assuming no alteration in fare structure. Actual changes by route and for the total ridership after the fare increase are also plotted. The differences between actual and projected figures are then derived.

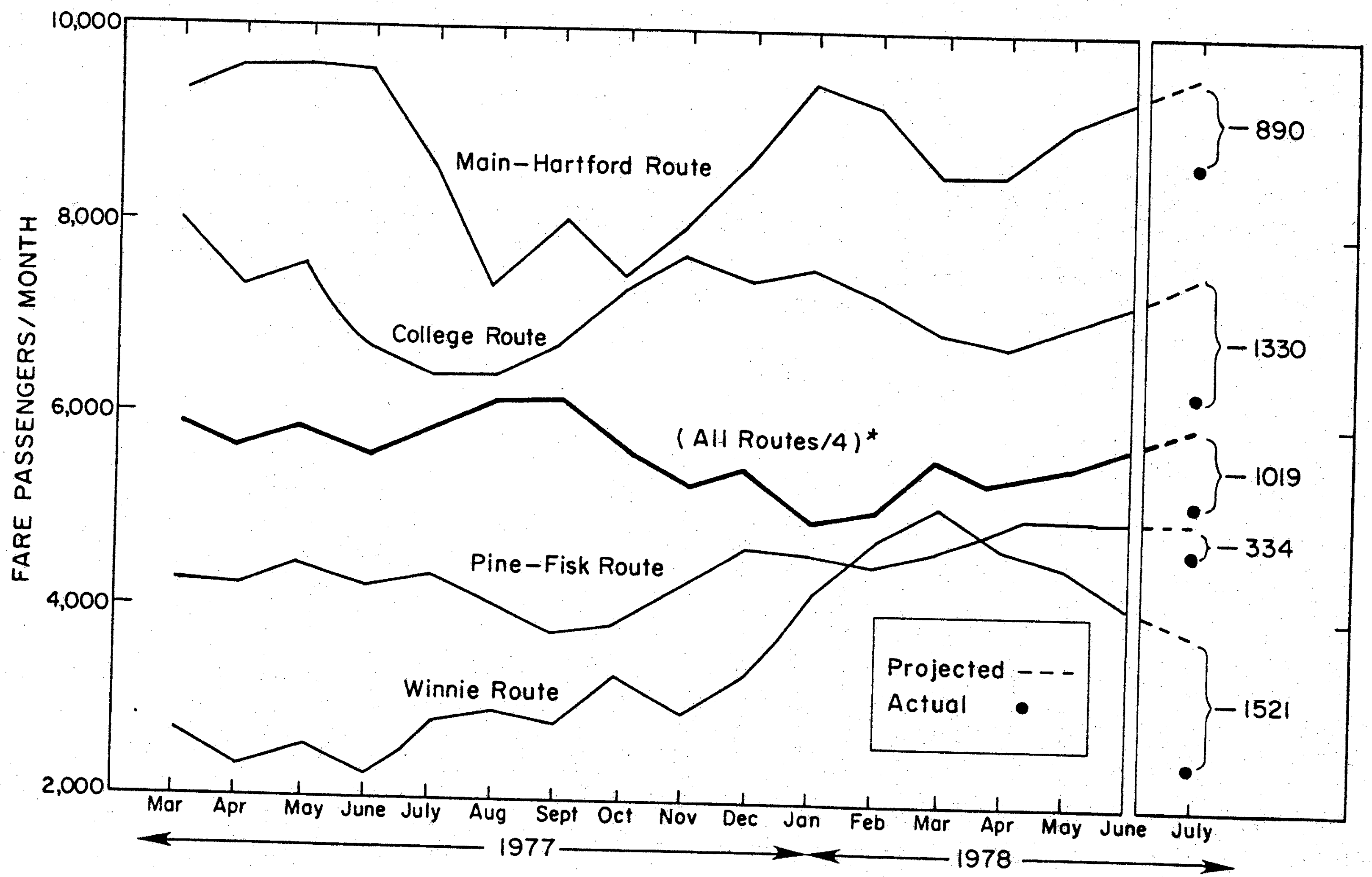
Summative Evaluation Designs: Quasi-Experimental Procedures

Before-After Design. In this evaluative procedure, a measurement of performance is undertaken prior to a service alteration, followed by the same measurement after the conclusion of the project:

Measurement Before	Exposure to Alteration	Measurement After
O_1	X	O_2

This design is most appropriate when the project's duration is short and of narrow scope. Such circumstances make it less likely that non-project related factors which might also affect the performance indicators will occur during during the period encompassed in the evaluation (Hatry, et al., 1973:43).

Figure 2. Time-Trend Projection Comparison: A Hypothetical Case of This Evaluative Procedure Using the Appraisal of a Fare Increase



*The four routes in this small transit system are aggregated and divided by four to obtain an average

The before-after design is very common and does not require comparison with a portion of the system (or a second system) not undergoing the prescribed change. For this reason, however, this procedure is the least capable of separating the effect of project activities from other influences.

A suitable use of the before-after design is the evaluation of promotional strategies employed to increase ridership and raise awareness levels of the general public. Radio, television, and newspaper advertisements with identical promotional themes provide the basis for assessing the impact of this strategy. The evaluation framework, including specific indicators to measure the success of the promotions such as daily ridership and altered perceptions and knowledge levels, should be developed prior to program implementation. The actual measurement entails the use of rider counts and a small sample telephone survey, with data collection procedures to be undertaken both before and after the promotions. Careful pre-project data gathering provides the basis for adequate performance evaluation.

Time Series Design. This procedure consists of a series of measurements before exposure to the service alteration and a series of measurements after exposure. The design is diagrammed as follows:

Measurements Before	Exposure to Alteration	Measurements After
0_1 0_2 0_3	X	0_4 0_5 0_6

Post-project measures are compared with pre-project measures to determine the effectiveness of the service alteration. If there have been fluctuations in the performance indicators used, a series of measurements before and after project implementation aids in obtaining more reliable data, and in being able to isolate the impact of the improvements.

Surveys are not useful for this procedure because of the necessity for repeated interviewing. Time series designs are particularly suitable where performance indicators are routinely reported, such as passengers/vehicle mile and passengers/route. While transit systems often have such information, the time series designs are not used as often as the available data permits. A key potential problem lies in changes in data-gathering procedures and altered definitions of performance indicators through time. The present emphasis on developing and improving management information systems and the FARE system promises to provide fertile data bases for time series designs.

A major route alteration or a route extension can be assessed with the use of time series designs. Ridership counts can be easily obtained for the salient routes, as well as fare box revenues per route over a series of specified days and time periods to evaluate the effect of the route alteration or route extension.

Nonequivalent Control Group Design. This procedure consists of a pretest and a posttest where there is one portion of the service undergoing a change and a second portion treated as a "control." The controlled portion and the altered portion are not randomly assigned, however, so that a true experimental situation does not exist. This general scheme can be applied to different portions of the transit system, as described above; two sections of a city, one in the service area and one outside; two ridership segments; or two similar services. The design consists of the following:

	Measurement Before	Exposure to Improvement	Measurement After
Experimental Portion or Group	0_1	X	0_2
Control Portion or Group	0_3		0_4

The term "nonequivalent" refers to the lack of random assignment to the experimental portion and to the control portion, so that the two groupings cannot be assumed to be identical or equivalent at the outset, but are treated as if they were equivalent or matched.

Ridership response to routes with reduced headways can be compared with the ridership on unaltered routes. The market for specialized public transportation services for the elderly and hanciapped can be discerned by comparison of residents served by a new program versus those who are not yet provided the specialized service.

Because the control and experimental groupings are not randomly selected, it is normally appropriate to match the two on as many characteristics as possible. In most evaluation studies there are no means of controlling which portion of a system or the riders are assigned to one grouping or another. Whereas before-after designs without control groups tend to overestimate project effectiveness, the nonequivalent control group designs may underestimate the impact of the service improvement (see Deniston and Rosenstock, 1973).

Combination Time Series and Nonequivalent Control Group Design. The time series design and the nonequivalent control group design each have advantages which can be utilized to obtain a more rigorous means of evaluating service improvements. The combination is diagrammed as:

	Before Measurements	Exposure to Alteration	After Measurement
Experimental Portion	0_1 0_2 0_3	X	0_4 0_5 0_6
Control Portion	0_A 0_B 0_C		0_D 0_E 0_F

The time series design makes use of routinely-reported data, and is especially suitable in cases where flucuations among measurements may exist. Adding a control grouping provides a basis for comparing the altered experimental grouping, so that the effects of the service alteration are more easily interpreted. The examples applicable to the time series and nonequivalent control group designs should be pertinent to this combined design. The procedure is one of the most stringent designs and is especially useful in assessing the impact of programs established for some subunits and not in similar others (Franklin and Thrasher, 1976:60).

<u>Summative Evaluation Designs: Experimental Procedures</u>

Controlled Experiment. The controlled experiment, in its simplest form, consists of selecting two samples at random, measuring selected characteristics of both groupings, exposing one of these to a service alteration, and remeasuring the selected characteristics of both. The design is diagrammed as:

		Measurements Before	Exposure to Alteration	Measurements After
Random Assignment	Experimental Grouping	0_1	X	0_2
	Control Grouping	0_3		0_4

Unlike the previously discussed procedures, the control and experimental groupings, having been randomly selected, should be closely similar and any differences would not be arbitrarily caused. The experiment requires a fairly large sample so that riders, routes, or other units of observation would be suitable for evaluation.

An appropriate use of the controlled experiment would be the evaluation of exact change fare boxes placed randomly on buses and routes. The impact of the exact fare could be evaluated before installment of the new fare boxes on the entire bus fleet.

The effect of the service alteration is considered to be the difference between any changes that occur in the experimental group $(0_2 - 0_1)$ and any that occur in a control grouping $(0_4 - 0_3)$, or Impact of Service Change = $(0_2 - 0_1) - (0_4 - 0_3)$.

Although powerful in producing accurate answers to the question: "What effect did the service alteration have?", experimental designs are costly, politically sensitive, and often impractical (Franklin and Thrasher, 1976:54). The most often cited reason for non-use of this design is that the establishment of randomized control and experimental groupings frequently means the withholding of services to some segment of the ridership. It would be difficult, for instance to provide reductions in monthly passes for one selected group of patrons, while excluding other eligible patrons. The controlled experiment is rigorous, producing highly reliable results if utilized correctly, and there is little doubt left about the effectiveness of a service alteration, whether a success or failure. Therefore, there is the potential threat of this design in that "the administrator may have no place to hide" (Stanley, 1972:67). Thus there are many ethical, political, and administrative reasons why classical experimentation is rare in public service evaluation (Franklin and Thrasher, 1976:54).

SELECTION OF AN EVALUATION DESIGN

In assessing service alterations, or in developing a systemwide monitoring program, the overall objective is to determine the effects of separate activities, programs, and improvements. Any external factors influencing the performance of the system also must be acknowledged. Often the service alteration being evaluated determines the design to be used, in that certain types of data are required or available and there are prescribed time and funding constraints. The controlled experiment provides the most rigorous means of evaluating system performance, but can rarely be undertaken because of various limitations mentioned. For the conscientious transit representative, the choice then becomes one of either designing the best possible evaluation, given the constraints, or of not appraising the impact of system alterations at all.

In this chapter, twelve evaluation designs were discussed:

I. Formative Evaluation

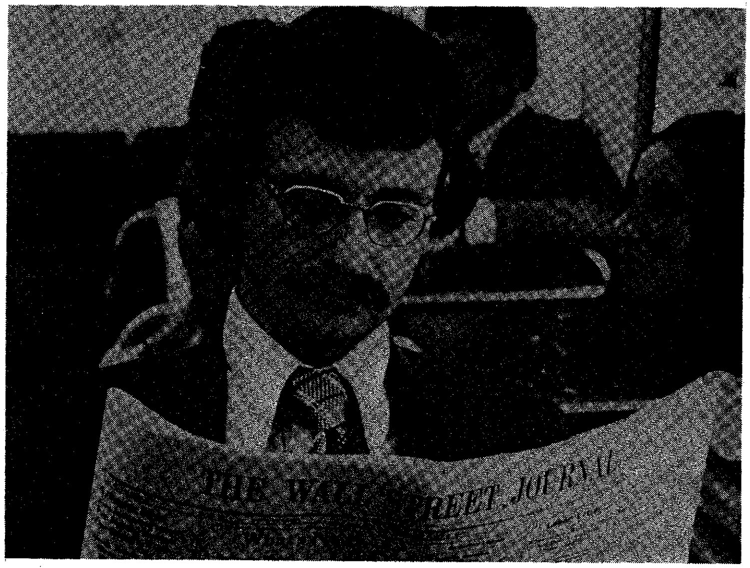
- Plan Evaluation
- Phase Evaluation

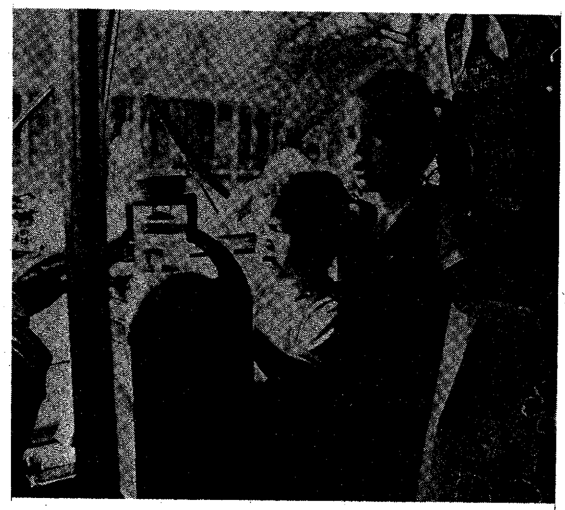
II. Summation Evaluation: Nonexperimental Designs

- After-Only Design $\begin{bmatrix} X\ 0_1 \\ 0_2 \end{bmatrix}$ or $[0_2 - 0_1]$
- Comparative Design
- Case Study
- Planned versus Actual Performance $\begin{bmatrix} X\ 0_2 \\ P(\text{planned}) \end{bmatrix}$ or $[p - 0_2]$
- Time Trend Projection Comparison $\begin{bmatrix} X\ 0_2 \\ P(\text{projected}) \end{bmatrix}$ or $[P - 0_2]$
- Before-After Design $[0_1 \quad X \quad 0_2]$ or $[0_2 - 0_1]$
- Time Series $[0_1\ 0_2\ 0_3 \quad X \quad 0_4\ 0_5\ 0_6]$
- Nonequivalent Control Group $\begin{bmatrix} 0_1 & X & 0_2 \\ 0_3 & & 0_4 \end{bmatrix}$ or $[(0_4 - 0_3) - (0_2 - 0_1)]$
- Time Series, Nonequivalent Control Design $\begin{bmatrix} 0_1\ 0_2\ 0_3 & X & 0_4\ 0_5\ 0_6 \\ 0_A\ 0_B\ 0_C & & 0_D\ 0_E\ 0_F \end{bmatrix}$

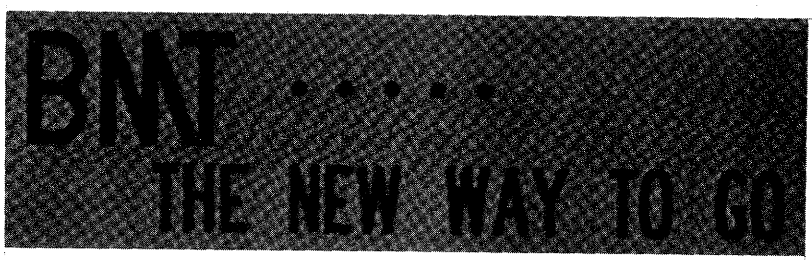
• Controlled Experiment Random Selection $\begin{bmatrix} O_1 & X & O_2 \\ & & \\ O_3 & & O_4 \end{bmatrix}$ or $[(O_4 - O_3) - (O_2 - O_1)]$

Each of the designs, with varying degrees of rigor, attempts to address the question: "Did the service alteration or improvement make any difference?" Based on the approach chosen, the results may be used not only by the system undertaking the evaluation, but also by other transit systems. The accountability offered to city councils and to state and federal agencies encourages financial support, while objectively pointing to specific areas in which financial outlays are most needed.





Applications of evaluative designs are presented in this chapter for six service features or service improvements. Fare structure assessment, subscription services, and route alterations are among the service features addressed.



CHAPTER III

USE OF EVALUATIVE DESIGNS IN FOUR CITIES: MEASUREMENT OF TRANSIT PERFORMANCE

The evaluation designs discussed in Chapter II have been used successfully in previous evaluative studies of public services and of programs oriented to the public. Five of the designs used to measure service performance will be discussed further in this chapter, with examples provided in each case. These evaluation procedures and respective study sites include:

(1) The Comparative Design -- Waco, Beaumont, Fort Worth, and Houston

(2) The Case Study -- Houston

(3) The After-Only Design -- Fort Worth

(4) The Before-After Design -- Waco

(5) The Non-equivalent Control Group Design -- Beaumont

THE COMPARATIVE DESIGN

The comparative design is not as easily diagrammed as are the more experimental designs and has been referred to as a "bargain basement" approach to assessing the effectiveness of service improvements. Comparative designs are suitable for evaluating the relative merits, advantages, or effectiveness of improvements without benefit of experimental isolation or randomization.

Service effectiveness was examined in four Texas cities (1) to determine the adequacy of space/comfort features and (2) to assess fare structure across systems. The comparative design provided a useful approach for this examination.

This design supplies the foundation for developing empirically based standards against which the systems under study, as well as additional systems, can measure the effectiveness of specific aspects of service provided. As a second use, the performance of the four systems can be considered indicative of Texas transit systems as a whole in regard to crowding features and adequacy of fare structure. Other systems that are either above or below prescribed norms can then be compared as to system effectiveness. Thus, the comparative design provides the basis for establishing an expected standard and, additionally, secures a mean or norm by which systems can evaluate their performance.

On-board surveys were utilized on twelve routes, for both peak and off-peak periods, in Waco, Beaumont, Fort Worth, and Houston.[1] The four systems differed in terms of service levels, as shown in Table 2, and in selected population characteristics. Crowding, fare structure and other service features are perceived as more salient by some riders than others. Thus, the differences among the four cities in rider characteristics on the routes selected are useful in explaining differential satisfaction with these transit features.

Age. Almost 50 percent of the Houston ridership sample were under 25 years of age, as shown in Table 3. In Waco, however, 50 percent of the patrons surveyed were 55 or older.

Sex. In all four cities, the riders averaged 61 percent female. However, the sample was biased by two subscription service routes in Fort Worth which were utilized primarily by male patrons. Beaumont, Waco, and Houston had, respectively, 81 percent, 71 percent and 62 percent female riders (see Table 3).

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[1] One route selected in Houston provided express bus service for which only a peak period bus was utilized in the survey. Therefore, twenty-three buses were included in the on-board surveys.

Table 2. Transit System Characteristics and Population Characteristics for Waco, Beaumont, Fort Worth and Houston

	Waco	Beaumont	Fort Worth	Houston
Transit System Characteristics:				
Total Passengers (1977)	660,580	1,010,996	4,145,841	39,863.600
Buses in Regular Service	15	13	88	360
Number of Routes	11	5	42[a]	66[b]
Average Peak Headways (minutes)	45	30	15	7
Average Off-Peak Headways (minutes)	60	42	38	20
Percent of Population Within 1/4 Mile of a Route	80 (est.)	68	78	43[c]
Population Characteristics (1970):				
Population Size	95,326	115,965	393,463	1,232,407
Population Density of Incorporated Area (persons per square mile)	1,624	1,642	1,919	2,841
Percent of Adult Population 65+	12.8	9.3	9.6	6.5
Percent of Adult Population in Blue Collar Occupations	47.3	51.3	49.6	45.6
Percent of Households with Automobiles Available	85.8	84.5	---	88.4

[a]There are 26 conventional routes with 16 subscription service routes.
[b]There are 66 split routes and 33 through-routes.
[c]43 percent in City of Houston service area.

Table 3. Background Characteristics of Riders in Sample (in percentages)

Characteristic	Houston	Beaumont	Waco	Ft. Worth
Age Group	(N=192)	(N=104)	(N=56)	(N=147)
6-17	6	14	0	7
18-24	41	19	14	14
25-34	27	11	18	10
35-44	7	10	7	16
45-54	11	23	11	33
55-64	8	8	27	11
65+	2	15	23	9
Sex	(N=192)	(N=103)	(N=56)	(N=144)
Male	38	19	29	57
Female	62	81	71	43
Ethnicity	(N=183)	(N=108)	(N=56)	(N=147)
Anglo	42	2	43	58
Mexican-American	6	0	0	1
Black	45	98	55	36
Other	7	0	2	5
Education	(N=192)	(N=103)	(N=54)	(N=145)
9th grade or less	12	24	26	13
10th or 11th grade	15	22	11	7
High school graduate	19	41	28	23
Some college	24	11	20	27
College graduate	21	1	9	14
Some graduate school	9	1	6	16
Occupation	(N=167)	(N=67)	(N=52)	(N=138)
Retired	2	8	13	4
Unemployed	2	10	0	2
Housewife	2	8	29	4
Student	13	19	10	7
Private Household Worker	5	25	21	2
Service Workers	17	15	13	11
Laborers	1	3	0	1
Operatives	2	3	1	3
Craftsmen, Foremen, and Kindred Workers	2	1	1	4
Clerical and Kindred Workers	25	6	0	21
Sales Workers	5	0	4	3
Managers and Administrators	3	0	1	3
Professional and Technical Workers	21	1	4	35

Ethnicity. Wide variations among groups were found on the routes sampled in the four cities. Table 3 points to Fort Worth as having the greatest proportion of Anglos, 58 percent, with Beaumont the lowest number, two percent. Houston had the largest proportion of Mexican-Americans sampled, six percent, with Beaumont having 98 percent blacks in the on-board survey.

Education. Beaumont and Waco riders evidenced the lowest educational levels, with 46 and 37 percent, respectively, having less than a twelfth grade education (see Table 3). In both Houston and Fort Worth, on the other hand, 30 percent of the riders in the sample were college graduates.

Occupational Ranking. Although the income of the rider or the rider's family was not requested, occupational categories were obtained, as shown in Table 3. Waco had a larger proportion of the retired population and of housewives than did other cities. Fifty-two percent of the Waco riders surveyed were either retired, unemployed, housewives, or students relative to 17 percent for Fort Worth, 19 percent in Houston, and 45 percent for Beaumont. Fort Worth and Houston had the greatest number of professional and technical workers. Thirty-four and 40 percent, respectively, of Waco and Beaumont riders had jobs as private household or service workers.

Ride Frequency. Waco showed the lowest usage of any system of repetitive riders, with 61 percent classifying themselves as patrons (Table 4). Beaumont and Houston, on the other hand, had 81 and 80 percent, respectively riding the transit systems on a regular basis.

Time Span as a Rider. Pronounced differences were found among riders sampled in the four cities regarding the number of years these individuals had been using the bus system (see Table 4). In Fort Worth and Houston, 67 and 61 percent, respectively, had been riding the bus for four years or less, pointing to the impact of improved transit services in these two cities. In

Table 4. Ridership Characteristics of Bus Patrons in Sample

(in percentages)

Characteristic	Houston	Beaumont	Waco	Ft. Worth
Ride Frequency	(N=193)	(N=101)	(N=59)	(N=154)
Regularly	80	81	61	77
Frequently	9	17	22	16
Occasionally	8	1	12	5
Seldom	3	1	5	1
Years As A Rider	(N=183)	(N=92)	(N=54)	(N=144)
0-4 years	61	24	33	67
5-9 years	12	9	6	6
10-14 years	9	15	13	7
15-19 years	2	4	13	2
20-24 years	5	9	9	3
25-29 years	4	5	4	3
30-34 years	3	13	4	5
35-39 years	0	4	7	3
40+ years	4	16	11	5
Trip Purpose	(N=178)	(N=80)	(N=55)	(N=153)
Work	81	65	37	71
School	5	6	4	9
Shopping	7	17	28	8
Medical	0	0	19	3
Other	7	11	10	8

the two smaller cities patrons had consistently used the system over a long time span in many cases, with 47 percent in Beaumont having patronized the bus service for 20 years or longer. Thirty-five percent in Waco had ridden buses for at least two decades.

Trip Purpose. Houston and Fort Worth riders in the sample showed a higher utilization of the bus for work trips, at 81 percent and 71 percent respectively. Waco evidenced fewer journeys to work by transit, but shopping and medical trip purposes received a higher ranking than in other cities, purposes normally considered as promoting off-peak transit use.

Application of the Comparative Design to Crowding/Comfort Considerations

Bus crowding is affected by two aspects of transit decision-making, one an operational dimension regarding headway frequency, peak period service, and route coverage. The second aspect of transit planning and implementation determining crowding levels and other comfort considerations revolves around the physical characteristics of the vehicles in service. Crowding as a bus feature was chosen for evaluation because of ease of comparison across systems, as well as the saliency of the crowding dimension in decisions to utilize the bus as a transportation mode. Planned improvements in the bus fleet, primarily in the purchase of new vehicles, need to incorporate comfort features considered the most critical by bus riders. In addition, route alterations, especially at peak periods, should be geared to crowding problems, with flexibility needed in changing route coverage and headway frequency to meet user needs.

Crowding on buses was a persistent problem on specific routes in three of the four cities examined. Peak and off-peak crowding also varied in the four cities. To examine transit performance as a function of crowding and related comfort features, respondents on three peak and three off-peak buses in each city were questioned about five aspects of personal space on transit vehicles.

Passengers on the Beaumont Municipal Transit system were more concerned about space and comfort features related to crowding than were respondents in the other three cities (see Table 5). A large proportion of the Beaumont riders were private household and service workers, heavily dependent on the system as a sole means of transportation. The provision of these space-providing features was not as salient a concern in Waco in that a greater proportion of respondents "disagreed" or "strongly disagreed" that the five interior improvements were needed. However, Waco evidenced the lowest levels of crowding for the cities sampled, as shown in Table 5. Beaumont and Houston patrons in the sample perceived significantly higher levels of crowding than did Waco or Fort Worth respondents. Traditionally, lower bus occupancy has been evidenced in Waco and Fort Worth, so that these findings are consistent with on-board passenger counts. Beaumont and Houston, on the other hand, have greater bus density levels, primarily at peak periods.

The crowding problems on peak period vehicles in Houston and Beaumont may attribute to the degree of satisfaction with the bus trip, as depicted in Table 6. In Houston and Beaumont, respectively, 57 and 81 percent of the riders suggested they were "very satisfied" or satisfied" with the bus trip, whereas in Waco and Fort Worth, with lower density levels, 93 percent were satisfied with the bus service for the particular trip. Other important bus features, as well as comfort, were suggested as needing improvement in the four cities:

- Houston -- operational characteristics including more dependable, faster service, and physical maintenance and amenities received top ranking.

Table 5. Evaluation of Crowding/Comfort Features by Bus Patrons in Four Texas Cities

(in percentages)

Characteristic	Houston	Beaumont	Waco	Ft. Worth
I. Should Buses Have:				
Individual Seats with Arm Rests	(N=154)	(N=69)	(N=55)	(N=138)
Strongly Agree	17	23	14	11
Agree	21	23	18	12
Not Sure	15	23	13	18
Disagree	32	27	53	50
Strongly Disagree	15	3	2	9
Wider Seats	(N=152)	(N=74)	(N=53)	(N=143)
Strongly Agree	26	28	17	26
Agree	40	20	15	27
Not Sure	8	20	15	9
Disagree	19	28	53	32
Strongly Disagree	5	3	0	6
More Storage Space	(N=143)	(N=70)	(N=53)	(N=139)
Strongly Agree	18	29	15	8
Agree	27	20	24	14
Not Sure	20	20	15	18
Disagree	26	31	45	51
Strongly Disagree	9	0	0	9
Wider Aisles	(N=154)	(N=75)	(N=53)	(N=138)
Strongly Agree	23	49	13	38
Agree	33	13	19	27
Not Sure	14	12	11	7
Disagree	23	25	57	24
Strongly Disagree	6	0	0	4
More Leg Room	(N=154)	(N=71)	(N=52)	(N=144)
Strongly Agree	31	41	19	38
Agree	32	13	15	27
Not Sure	17	17	11	7
Disagree	16	28	52	24
Strongly Disagree	4	1	2	4
II. Is Bus Crowded?	(N=184)	(N=88)	(N=56)	(N=142)
Yes	31	39	5	7
No	47	45	91	80
Somewhat	22	16	4	13

Table 6. Rider Satisfaction in Four Texas Cities (in Percentages)

Characteristic	Houston	Beaumont	Waco	Ft. Worth
Satisfaction	N=178	N=91	N=54	N=144
Very Satisfied	14 } 57	41 } 82	26 } 93	38 } 93
Satisfied	43	41	67	55
Neutral	24	8	4	5
Unsatisfied	13	4	2	1
Very Unsatisfied	6	7	2	1
Suggestions For Improvement	N=271	N=63	N=56	N=151
Comments concerning:				
Drivers	6	2	5	4
Fare	3	0	2	2
Amenities	8	3	5	17
Crowding	10	5	0	5
Physical Maintenance	7	0	0	5
Information Dissemination	1	0	7	1
Operations	63	56	61	44
Comments Expressing Satisfaction	1	35	20	22

- Beaumont -- operational characteristics, driver qualities, and comfort features were the three primary concerns.
- Waco -- operational characteristics, information needs, driver qualities, and amenities received top priority.
- Fort Worth -- operational characteristics, amenities, and physical maintenance were accorded the top rankings.

In sum, the application of a comparative design to examine space and comfort requirements of transit passengers leads to the conclusion that crowding is a salient concern for many riders, while insignificant to others. Further, significant differences among cities emerge in analyzing perceptions of crowding and of needed comfort features. The following generalizations can be made regarding the importance of space in transit vehicles:

- Transit passengers in cities with consistent crowding problems perceive this bus feature as more salient than those riders in cities without high density buses.
- Crowding is a predominant concern for riders of systems who are dependent on transit as a sole means of transportation.
- Satisfaction with the local transit system is significantly related to the perceived crowding on buses.

Further, as more people seek alternatives to congestion, especially in the case of Houston, the existing bus systems will evidence even higher levels of crowding. Space requirements of passengers needs to be included in local evaluations of service effectiveness as well as in plans for near-term service improvements and fleet acquisitions. Nevertheless, other operational characteristics, such as faster and more reliable service, driver qualities, and physical maintenance normally supercede concerns for personal space on mass transportation vehicles. When operational characteristics are not considered problematic by the riders, crowding and comfort features ascend in importance.

Application of the Comparative Design to Fare Structure Assessment

Transit management and city representatives concerned with fare structure emphasize the need to make decisions regarding: (1) special reduced fares for specific segments; (2) trade-offs between service improvements and fare increases; and (3) optimum fare based on ridership response. The comparative evaluation design furnishes a procedure to examine such fare considerations, with rider surveys in the four Texas cities as a data base.

The distribution of fares paid by riders responding to the on-board surveys is depicted in Table 7. Until recently Waco and Fort Worth provided free passes for the handicapped, thus explaining the proportion of riders paying no fare for the trip during which the survey was taken. Zone structures also aid in explaining the distribution of fares; however, fare zones per se were not appraised in this particular study.[2]

Mean fare paid on the study routes differed in the four cities, with Houston riders evidencing the highest fares and Beaumont having the lowest mean fares. Distances travelled in Houston provide one rationale for explaining the fare differentials, since long rides normally can be priced higher than short rides.

In the four cities sampled, passengers were queried as to the highest fare they would be willing to pay for the trip. Such a decision on the part of the respondent requires consideration of alternative modes available, costs of the alternative, value of time constraints, and other salient factors. It was difficult for riders to respond to the question, with several replying "I'd pay whatever I'd have to, since I have no other means of transportation."

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[2]It is difficult to draw conclusions on a comparative basis of zone fare structure, so that this aspect of fare assessment was not included in the analysis.

Table 7. Fare Structure Considerations in Four Texas Cities (in percentages)

	Houston	Beaumont	Waco	Ft. Worth
Fare Paid	(N=186)	(N=96)	(N=57)	(N=77)[a]
.00	.5	1	7	5
.05		1		
.10	.5	5		
.15		17		
.20	4		14	14
.25			3	
.30		38		1
.35	.5	34		
.40	18	1	42	79
.45	.1		33	
.50	51			
.55	.5			
.60	24	1		
.65		1		
Highest Fare Rider Would Pay	(N=166)	(N=79)	(N=49)	(N=77)[a]
0 - .25	4	11	12	2
.26 - .50	57	80	79	18
.51 - .75	37	7	2	9
.76 - 1.00	3		4	20
1.01 - 1.25				11
1.26 - 1.50				
1.51 - 1.75			2	1
1.76 - 2.00				15
2.01 - 2.50				17
2.51 - 2.75				
2.76 - 3.00				1
Preference for:	(N=182)	(N=83)	(N=56)	(N=145)
Same fare as now, better service	81	70	73	54
Same service as now, lower fare	19	30	25	45
Neither			2	1
Special Reduced Fares	(N=189)	(N=98)	(N=57)	(N=81)[a]
Poor	45	56	60	52
Elderly	70	63	70	64
Handicapped	70	57	61	68
Children	49	30	40	57
None	7	6	12	10

[a]Fort Worth subscription riders omitted from this tabulation.

Others provided cursory answers that reflected little awareness of the factors involved in fare consideration. Nevertheless, the distribution of highest allowable fares were analyzed, pointing to a much greater fare increase acceptable to Fort Worth patrons. It should be stressed that a categorized fare item was included in the Fort Worth survey, with the smallest category being 5¢ and the largest category listed as $1.60. This fixed choice item was not used for the other three cities; rather an open-ended question was asked in Houston, Beaumont, and Waco.[3] Thus, with the exception of Fort Worth, the vast majority fell in the 26¢ to 50¢ range in suggesting highest allowable fares. The mean highest fares acceptable differed in the four cities, but generally showed a 5¢ to 10¢ increase for the non-subscription riders, or an increase of 10 to 28 percent. Elasticity of demand for bus transportation is shown to vary by system and by routes within systems. Generally, the patrons finds reliability and access considerations more salient than cost concerns. These factors are especially evident in the responses of Fort Worth's subscription riders.

Queries of preference for the same fare with better service as juxtaposed against the same service and lower fares pointed to the overall importance of level of service provided the respondents. Passengers were more responsive to increases in level of service than to reductions in fare. While differences emerged among population segments, the city comparisons showed a consistent pattern with level of service relatively inelastic.

The structure of the existing market often determines the willingness of patrons to support fare reductions for specific market segments. For example, in Houston, where a large portion of white collar workers are bus

[3]The fixed choice categories were utilized in Fort Worth because two routes were comprised of subscription riders, who are excluded from Table 7, and comparability among Fort Worth respondents was needed. The highest additional fare riders were willing to pay was added to their current fare in Fort Worth.

riders, there was less support evidenced for discounts for low income market segments. Significant differences did not emerge in comparing cities on riders' support for reduced fares for older persons and those with physical disabilities. On the other hand, in Beaumont where approximately 36 percent of the bus riders are school children, only 30 percent of the sample favored discounts for children, relative to 40 percent in Waco, 49 percent in Houston, and 57 percent in Fort Worth.

Several general observations can be made from this comparative assessment of fare structure in the four Texas cities:

- Long bus trips can be priced higher than short rides.
- Riders are generally more responsive to increases in fare than to decreases in level of service.
- Fare reductions for special segments receive differential support by riders, based on the characteristics of the existing market in each city.

The effectiveness of current fare structure thus can be evaluated as to acceptable fares deemed appropriate by current riders. Fare differentials, or discounts for specific segments, allowable by the existing market in these four cities also provide a useful foundation for appraising fare structure.

CASE STUDY DESIGN: HOUSTON TRANSIT SIGNAGE

The case study is an evaluative design utilized when more rigorous procedures are not possible. In assessing the effectiveness of transit signs, stipulation of the functions signs fulfill for bus patrons is needed. For example, the use of one set of signs on selected routes and a different series of signs on the other routes is not feasible and, in most cases, would be confusing to the ridership. Thus, transit sign symbols and verbal communications must be consistent to be useful to patrons. The City of Houston has been evaluating HOUTRAN's route signs, bus stop signs and markers, as well as signs for identifying specialized service. As a part of this evaluation process, focus groups were interviewed regarding their preferences toward route signs, including symbols used, color, inclusion of route names as well as numbers, and route termination points.

TTI used the on-board surveys in Houston to assess route sign preferences and the rider's understanding of signs used by HOUTRAN. Three representative routes were selected; peak and off-peak buses on each route were included in the survey sample. On one route, as noted earlier, only express bus riders were given a survey, so that passengers on five buses comprised the population sampled.

Since new route signs as well as the original blue route signs were observed on the routes, one of the chief concerns was to separate out preferences for the two signs (depicted in Figure 3). A second objective in the case study was the determination of riders' understanding of major signs used by the transit system.

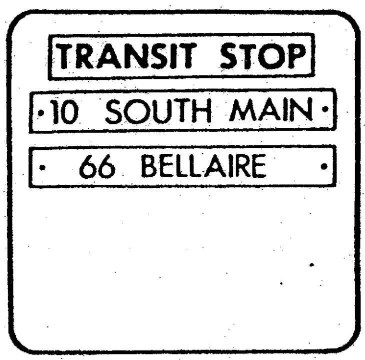
Many smaller cities are attempting to provide improved bus stop signs; therefore, information provided in this case study should have applicability to other systems. Additionally, the case study furnishes Houston transit planners with a clearer indication of the effectiveness of signs currently in usage, so that further sign improvements as well as public information programs can be geared to the information needs of bus patrons.

The case study is often used to intensively observe the impact of a service improvement when rigorous experimental approaches cannot be attempted. In contrast to the comparative design, the case study may entail few explicit comparisons with what could have been done, or with what was accomplished in other cities. Further, it is often impossible to project, à priori, the effectiveness of a system alteration, such as sign improvements, so that no predicted outcomes are specified in advance.

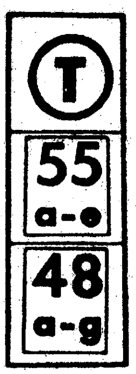
The preferences of Houston riders to a new route sign and an older route sign were examined, as shown in Figure 3. It was discovered that 83 percent preferred the older blue, white, and black sign that retained the route name as well as the number of each route. Only 16 percent chose the white and yellow sign with black lettering that contained route numbers and the differential route destinations or final points of departure, the latter being a more informative sign.

Figure 3. Bus Stop Sign Preferences by Riders in Houston Sample

(in percentages)



Blue Route Sign



Yellow Route Sign

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Preferences for Blue or Yellow Route Sign

Response	Percentage (N=174)
Blue Sign	83
Yellow Sign	16
Neither	1

HOUTRAN riders were questioned about four different transit signs in common use throughout the service area, with accurate sign color representations included in the survey. The route sign, Sign A, depicted in Figure 4 has the transit "T" symbol with the number surrounded by either the color yellow or orange. It was recognized as "Bus Route 66, with destinations 'a' through 'h' by 48 percent of the respondents. Forty-six percent were unsure of the sign's meaning and six percent of the riders sampled thought it was a train route sign.

Figure 4 also portrays the black and white bus stop sign. Thirty-eight percent correctly identified the sign as a stop sign for conventional buses, while 22 percent suggested that the sign represented a stopping point for downtown mini-buses only. Two percent felt the sign was used for the yellow school bus system, while 38 percent were unsure as to the sign's meaning.

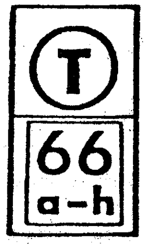
The third item, Sign C, was the express bus stop sign, which is black and white with a red strip highlighting the word "express." Forty-nine percent of the riders surveyed recognized this sign as denoting an express bus with a limited number of stops, which was the largest proportion correctly identifying any one sign.

The HOUTRAN 10¢ zone sign, Sign D, was identified by 37 percent as denoting all bus rides within the downtown area. One-fourth of the respondents, however, suggested that the sign applied to mini-buses only, and a quarter of the sample also interpreted the sign as a boundary point into a suburban zone, with 10¢ added to the fare.

Because of the low level of understanding of these commonly used transit signs by Houston passengers, further analysis of the characteristics of riders with little knowledge of bus signage was undertaken. A simple additive scale of the four items dealing with identification of signs was developed,

Figure 4. Houston Transit Sign and Perceived Meaning of Signs by Respondents

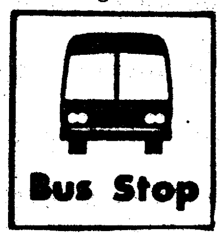
Sign A



MEANING OF SIGN A

Response	Percentages (n=177)
Train Route 66, with destinations "a" through "h"	6
Bus Route 66, with destinations "a" through "h"	48
I am not sure	46

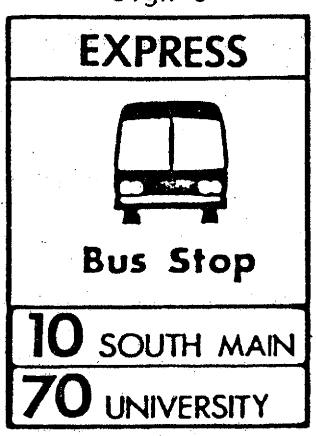
Sign B



MEANING OF SIGN B

Response	Percentages (n=175)
Bus Stop for downtown mini-bus system only	22
Bus for regular buses	38
Bus Stop for yellow school buses	2
I am not sure	38

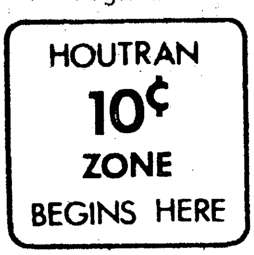
Sign C



MEANING OF SIGN C

Response	Percentages (n=173)
Express bus for which cars must get out of the way	3
Express bus that is allowed to drive faster	6
Express that does not stop until final destination is reached	13
Express bus that stops a limited number of times	49
I am not sure	28

Sign D



MEANING OF SIGN D

Response	Percentages (n=174)
You are now passing through a sub-urban zone, so there is 10¢ added to your fare	25
All bus rides in the downtown area are 10¢	36
Mini-buses <u>only</u> are 10¢ in the downtown area	14
I am not sure	25

which ranged from 0 (referring to no correct responses) to 4 (implying accurate answers to all four items).

No differences on the Transit Signage Understanding Scale by age groups emerged. No significant differences by socioeconomic status, either in occupational ranking or in educational level, were observed in level of understanding of the signs. Further, frequency of patronage and number of years respondents had been riding the bus also were not significant predictors of level of understanding of the four transit signs.

However, critical distinctions among ethnic groups were found on the Transit Signage Understanding Scale, in that a larger proportion of minorities had inaccurate perceptions of the signs than did Anglos. In addition, females appeared to understand the signs to a slightly more pronounced extent than did males. Those riders ranking high on the Scale had visited or called the Houtran Information Center to a slightly greater extent than those not attempting to obtain transit route and schedule information, but the differences were not significant.

In sum, the level of understanding of transit signs in Houston was surprisingly low. However, only one segment of the bus-riding public was found to significantly differ from other riders in understanding of transit signage -- ethnic minorities. To improve ridership frequency and attract new patrons to the system, transit signs must be more effectively presented to the public. Consistency in transit signage both within and between cities is desirable. With standardization of transit signs in Texas, educational programs through media and other sources could be utilized regarding the use and meaning of the signs.

AFTER-ONLY DESIGN: FORT WORTH SUBSCRIPTION SERVICE

Subscription bus service at peak periods to two high employment centers in Fort Worth -- Bell Helicopter and General Dynamics -- has provided an alternative transportation mode for approximately 660 employees, primarily engineers, clerks, and technicians. The subscription buses have been operating for 4 years and pick up riders at an average of 4.5 locations on each mini-route. There are 6 routes to Bell and 12 routes to General Dynamics which reach these industrial sites one time in the morning and return at one fixed time in the evening. Two routes, one to each of the plants, were selected for on-board surveys. Each route originates in the same residential sector of southwest Fort Worth. The time span encompassed in picking up riders on the mini-route is approximately 20 minutes, with the remainder a non-stop trip to the industrial sites taking almost 15 minutes.

Two conventional routes at both peak and off-peak periods also were selected for on-board surveys in Fort Worth. One of these routes covered the same residential area as did the two subscription routes, while the second originated in a lower socioeconomic section of the city.

Measuring the effectiveness of CITRAN's subscription service provides an objective base for successfully developing the service in other cities, as well as for improving or expanding the service in the Fort Worth service area. The study design for the evaluative frame was an after-only design, discussed in the previous chapter, and is diagrammed as:

	Change to System	Measurement After Change
Treatment Portion ⟶	X	O_1
Control Portion ⟶		O_2

where X signifies the service change, and O_1 represents the program or treatment group, in this case, subscription riders, and O_2 represents the control group, or patrons of conventional bus services in Fort Worth. The design assumes that two groups in the population were similar before one group participated in a program, such as the subscription bus service. Thus, any differences between conventional and subscription riders in satisfaction with bus operations, fares, and time factors associated with bus travel, as well as differences in frequency of use, are assumed to be a result of the different bus services utilized. While it cannot be suggested that the two groups are totally comparable, careful selection of a control group of conventional bus riders increases the utility of this "after-only" design. Ideally, the two rider groupings would have been surveyed before as well as after implementation of the subscription service program.

Along with careful selection of a control ridership group, the choice of relevant evaluation criteria is critical to obtain valid feedback regarding the subscription service. In this case, the following factors are compared for riders using conventional buses for work trips and for subscription riders travelling to work:

1. Relative overall satisfaction with the bus trip
2. Maximum acceptable fare increases
3. Maximum acceptable increases in time spent on the bus for work trips
4. Frequency of bus ridership

No significant differences existed between Bell Helicopter and General Dynamics bus riders regarding satisfaction with the bus trip. Similarly, comparisons of subscription riders with conventional passengers showed no marked differences in overall satisfaction with the bus trip.

Maximum acceptable fare for conventional and subscription bus riders differed markedly, with subscription patrons prescribing a 30¢ allowable increase and conventional riders a 75¢ maximum increase (see Table 8). Riders on conventional routes have a willingness to pay approximately double the current base fare. However, these patrons, who were riding for work or school purposes, were not receptive to having subscription service for these trips. Forty-three percent stated that they would not utilize a subscription service if the one-way trip cost $1.00. Likewise, 48 percent and 65 percent suggested they would not patronize a subscription bus service for weekday work or school trips if the costs were $1.50 and $2.00, respectively. Passengers on conventional routes were not responsive to subscription services when cost factors for these services were provided as constraints.

No significant differences were observed between subscription and conventional bus patrons in the maximum acceptable time increase before these riders would discontinue using the bus (see Table 8). The mean time increase tolerated by the two rider groupings was 14 and 15 minutes, respectively.

Frequency of ridership for passengers using the bus for work trips on conventional routes differed significantly from the subscription riders. Conventional route patrons utilizing the bus for work trips on the day of the on-board survey made an average of 24 one-way trips or used the bus 12 days per month, whereas subscription riders suggested they used the bus an average of 17 days per month, or 34 one-way trips.

Other features of interest in subscription service utilization were the differences in the two routes:

(1) On the General Dynamics route, average distance from residence to bus stop was three blocks, where 33 blocks was professed as the mean distance for Bell riders;

Table 8 . Trip Frequency, Perceptions of Fare and Value of Time Factors for Subscription and Conventional Bus Patrons

	Maximum Acceptable Increase in Fare (Mean Response)	Maximum Acceptable Increase in Time Spent on Bus (Mean)	Average Trip Frequency Per Month
Subscription Riders	29.6¢	14 minutes	34 trips
Conventional Riders	74.8¢	15 minutes	24 trips

(2) Thirty-eight percent of the subscription riders drove their own car to a parking location to board the bus, while 12 percent were passengers in an automobile to the bus stop, and 50 percent walked.

(3) Ninety-four percent purchased monthly passes at a cost of $15.00 or $17.50 (based on route) whereas 6 percent paid a fare;

(4) Convenience (including not having to fight traffic and no transfers required) was provided by 28 percent as the prime reason they found the subscription service satisfactory, followed by 11 percent stating economical features as the predominant advantage; and

(5) When requested to provide the least satisfactory aspects of the service, 34 percent suggested there were "none", followed by 7 percent who disliked new drivers unfamiliar with the route.

The after-only evaluative design has provided a suitable framework for describing the effectiveness of subscription service juxtaposed against conventional service provision. In sum, subscription service riders utilize the bus system more heavily than do patrons on conventional routes also riding the bus for work purposes. However, maximum allowable fare increases were much greater for conventional bus riders. Passengers on conventional routes evidence a much greater dependency on this mode than do subscription riders, which aids in explaining the fare increases tolerated by this segment.

The satisfaction levels with both forms of transit service were not significantly different, nor were maximum acceptable increases in time spent on the bus. These latter factors point to fairly equivalent demand criteria for both rider groupings. In that subscription service is a more appropriate program for workers having a common destination, the lack of significant differences in the elasticity of demand by the subscription and conventional route patrons points to the effectiveness of both forms of service provision. The market for subscription service among current conventional route patrons is low. That subscription service would have to be provided on essentially a demand-responsive basis for the large majority of patrons is evident, since these riders do not have common work destinations. Only 24 percent were willing to pay for such a service at $1.50 for a one-way trip and five percent at $2.50 per one-way work trip.

Other systems considering similar subscription service provision should assess the demand for patrons to travel to common destinations on a consistent basis. The length of the subscription service's mini-route coverage was a maximum of two miles with a low residential density. Subscription service oriented at other large industrial complexes should include at least 80 workers per mini-route who reside in a route catchment area of similar size and density levels to the residential sector described.

APPLICATION OF QUASI-EXPERIMENTAL APPROACHES: THE CASES OF WACO AND BEAUMONT

Two evaluative designs suitable to examine a project's impact based on pretests and posttests are (a) the before-after study and (b) the nonequivalent control group design. Both approaches are quasi-experimental and make use of data primarily at two time periods.

The data utilized for these last two evaluative studies were obtained from household surveys. A random selection process, similar to the Bureau of the Census' periodic sample surveys, was undertaken in August, 1976 and August, 1978. For a more complete explanation of sampling methodology and representativeness of household respondents, see Identification of Market Segments: An Analysis of Transit Needs and Service Requirements, Research Report 1052-1, which is the first report emanating from the joint SDHPT-TTI study. A subset of households from the original 1976 surveys in Waco and in Beaumont were revisited in 1978 to obtain information regarding changes in patronage, as well as in evaluation and knowledge of the local transit system.

Before-After Study: Effectiveness of Waco's Promotional Strategies

In attempting to implement a before-after comparison, a necessary first step is to clarify the goals that the program is attempting to achieve. In this case, transit promotional strategies undertaken in Waco were instituted to: (1) increase ridership; (2) introduce new services available, primarily the monthly pass; and (3) improve attitudes toward the system and awareness of bus services for Waco residents.

Given a clear picture of the goals of promotional campaigns, the next step is to derive operational indicators, or measurable dimensions, of the aforementioned objectives. Further, these indicators must be designed so as to be measured before and after implementation of the promotional efforts. When both measurements are taken, which in this instance was supplied by a representative sample of residents, a simple comparison of the data is then made.

Promotions in Waco consisted of radio and television advertisements, supplemented by new route and schedule maps (also printed as posters for business establishments). The impact of these promotional activities was tested primarily through a re-survey of 58 adult respondents, by examination of:

- Changes in Patronage
- Changes in Knowledge/Awareness Levels
- Changes in Evaluation of Transit System

Changes in Patronage. Trends in ridership between August, 1976 and August, 1978 exhibited several pronounced fluctuations, with other alterations in service (other than promotions) explaining several of these ridership changes. Overall, ridership in the 24 month period dropped from 57,219 for July, 1976 to 46,825 for July, 1978.

Relative to the survey data, regular patronage in August, 1976 among respondents was 7.4 percent, falling to 3.7 percent in 1978 (see Table 9). Sixty-three percent evidenced no alterations in bus usage shown by the shaded diagonal portion of Table 9, whereas 27 percent, those above the diagonal, are patronizing buses less. Ten percent show heavier dependency on the system. It should be noted that a small portion of those sampled did give the system trial usage in the two-year period. When questioned as to rides per month, buses had furnished 1 or 2 rides for 5.1 percent of the respondents, whereas 6.8 described use of the bus for 3 to 13 trips per month. In actuality, then, 12 percent of the sample depended on the system within the last month prior to the posttest.

Changes in Knowledge/Awareness Levels. In an effort to assess levels of awareness of local transit operations in 1976 and 1978, respondents were asked to provide the name of the bus system. In 1976, 90 percent of the sample correctly identified the Waco Transit System, whereas interviews with these same respondents in 1978 revealed 98 percent accuracy of responses. While the 8 percent improvement implies an increased awareness of the system, it is difficult to isolate out the interest in the bus system that may have been affected by the prior survey. Eleven percent were able to provide the name of the bus system in 1978 who could not recall the name in 1976; conversely 2 percent in 1978 could not recall the title who had knowledge of the system's name in 1976 (see Table 10).

Other questions asked only in 1978 differentiated respondents by awareness levels (as shown in Table 10):

- 63.5 percent correctly identified colors on bus exteriors;

Table 9. Use of Waco Transit System (in percentages)

1978	1976			
	Never Used	Used in Past	Use Sometimes	Use Regularly
Never Used	15	8	4	2
Used in Past	0	39	9	4
Use Sometimes	4	4	7	0
Use Regularly	0	2	0	2

$\chi^2 = 0.001$

Table 10. Alterations in Knowledge of Bus System and Current Knowledge Levels

I. Name of Bus System:

1976 —— 90% Correct
1978 —— 98% Correct

2% —— In 1978 Unable to Recall Title Who Had Knowledge of Name in 1976

11% —— In 1978 Able to Provide Title Who Had Previously Been Unable to Recall Name in 1976

II. Color of Buses:

63.5% —— Correct (At Least Two Colors)
23.0% —— Partial (Only One Color)
13.5% —— Incorrect or Not Sure

III. Possession of Route Map:

17% —— Had Route Map
83% —— No Map Available

IV. Awareness of Monthly Passes:

26% —— Aware of Passes
3% —— Not Sure
71% —— Unaware of Passes

V. Cost of Monthly Passes:

3.5% —— Correct Response
96.5% —— Incorrect or Not Sure

- 17.0 percent had possession of a route map;
- 26.0 percent were aware of monthly passes; and
- 3.5 percent correctly identified the price of a monthly pass.

Especially interesting is the proportion who had route maps in their households, when compared with percent of residents riding local buses on either an occasional or regular basis.

As the primary purpose of the follow-up survey in Waco was to assess alterations in transit use and awareness precipitated by promotional activities, three items dealing with the impacts of advertisements were subject to comparison over the two-year period, as shown in Table 11. Respondents were asked "Are you aware of any promotional activities by the Waco Transit System to encourage the use of their buses?" In 1976, only 16 percent responded postively whereas, in 1978, 23 percent suggested that they were aware of such advertisements (see Table 11). Of these promotions, 12 percent recalled specific television advertisements and 5 percent noted radio promotions.[4]

Comparison of the second promotional item over the twenty-four month period depicted 25 percent in 1976 responding positively to the question "Do you think that advertising the bus system would encourage you to ride buses more often?" Nevertheless, in 1978 only 16 percent responded affirmatively to this item, and 52 percent were less supportive of promotional activities in 1978 than in 1976 (see Table 11).

A possible explanation for this decreased interest in promotional activities lies in the anticipated costs of such campaigns, with residents increasingly

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[4] Of those viewing television ads, all respondents evaluated them positively. However, for the radio promotions, 3.4 percent had a favorable impression while 1.7 percent negatively evaluated them. In a similar on-board survey undertaken in January, 1978, 16 percent of the riders had viewed television ads, with 11 percent suggesting that, overall, these were "good" promotions. Of the 22 percent of the riders hearing radio ads, only 12 percent had a favorable reaction.

Table 11. Alterations in Awareness of Waco Transit System's Promotional Efforts

I. "Are You Aware of Any Promotional Activities by Waco Transit System?"

16% —— (1976) Responded Positively
23% —— (1978) Responded Positively

70% —— Evidenced No Change in Awareness
20% —— Responded Positively in 1978 Who Were Not Aware of Any Promotional Activities in 1976
10% ____ Had Knowledge of Promotions in 1976, But no Awareness in 1978

II. Awareness of Media Promotions

12% —— (1978) Viewed Television Advertisements
5% —— (1978) Heard Radio Advertisements

III. "Would Advertising the System Encourage You to Ride Buses More Often?"

25% —— (1976) Responded Positively
16% —— (1978) Responded Positively

28% —— No Change in Response
20% —— More Supportive of Bus Promotions in 1978 Than in 1976
52% —— Less Supportive of Bus Promotions in 1978 Than in 1976

opposed to any publicly funded programs, especially those of a seemingly superfluous nature to respondents. A fuller appraisal of the indirect effects of attitudes regarding funding of transit services will be presented in the next section of this chapter.

For both 1976 and 1978 surveys, an item on information provision was included, as depicted in Table 12. In 1976, route schedules and maps were predominant modes of information dissemination recommended by Waco residents. In 1978, telephone information services, followed by map and schedule information, were the most frequently suggested informational tools. Possibly, greater awareness of the convenience factors associated with telephone information services were evident in the altered recommendations provided by respondents.[5]

Changes in Evaluation of the Waco Transit System. Recent concern for increased restraints on government spending appear to have been diffused into the transit arena. Table 12 points to changes in attitudes toward optimum funding arrangements for further transit services. The first two columns of Table 13 depict the percent of respondents suggesting that each of five possible funding sources was either "Very Satisfactory" or " Satisfactory" in 1976 and in 1978. The last three columns emphasize alterations in opinion by percentages. Consistently for the four funding sources which have potential for subsidizing transit (with local taxes and the state general revenue fund already fulfilling this function), residents were less amenable to these sources of support for the system in 1978 than in 1976. Respondents suggesting that property taxes were a satisfactory means of support dropped from 26 percent to 8 percent. State taxes as a funding base did not change appreciably,

[5]As shown in the January, 1978 on-board survey, riders continue to favor the adequate provision of simple route schedules and maps as the most crucial means of disseminating transit-related information.

Table 12. Responses to "How Might Information Best Be Provided to Make Bus Riding Easier for You?" (in percentages)

	Signs	Maps	Booths	Schedules	Phone Service	Other
1976	23.5	50.0	35.3	70.6	14.7	Place Information at Bus Stops
1978	20.6	38.2	14.7	23.5	50.0	Send in Mail, Place in Newspaper

possibly because respondents consider themselves more removed from this source, thereby less personally affected. The use of gasoline taxes as a means of transit funding also had dropped only 5 percentage points. While not considered a favorable source by the vast majority, this source has some support, primarily because of the perceived energy situation.

In assessing fare increases as an optimum approach for continuing service, it appears that the greatest change has occurred in attitudes. Again, respondents perceive the other four options as less appropriate over the two year period, while there has been a 26 percent increase in those professing that an increase in transit fares would be the most satisfactory funding source for the transit system.

The fact that these individuals are less "public regarding" also is evidenced in their shrinking support for disadvantaged population segments. Seventy-six percent in 1976 favored setting aside city tax money for special transportation for older persons; in 1978 only 60 percent were favorable to this proposition. Likewise 78 percent in 1976 supported city tax dollars to be used for special transportation for the handicapped; in 1978 only 56 percent were amenable to the proposal.

Waco residents increasingly place constraints on what they perceive to be altruistic funding programs, with the impact of Proposition 13 felt at the local level in regard to transit provision. However, evaluations of the bus system per se are generally more positive and more supportive than previously. Three items asked in 1976 and in 1978 were compared in Table 14. The first item, presenting a positive trade-off for transit in lieu of more freeways, shows a gain in transit support. The second item, indicating that public transportation has no future in Waco, has lost support in the twenty-four month time lapse. Finally, the proportion suggesting they would never travel by city bus, no matter what improvements were made, has also decreased. Thus,

Table 13. Changes in Attitudes Toward Funding Sources for Transit
(in percentages)

	Percent Favoring Funding Source For Transit		Percent Change in Attitudes		
	1976	1978	Views Unchanged	More Favorable	Less Favorable
I. Property Taxes	26 ↔	8	48	19	33
II. Local Taxes	24 ↔	22	40	22	38
III. State Taxes	19 ↔	16	33	30	37
IV. Gasoline Taxes	15 ↔	10	31	31	38
V. Increase Transit Fares	32 ↔	58	26	48	26

Table 14. Changes in Evaluation of Local Bus System
(in percentages)

	Percent Agreement		Percent Change in Attitudes		
	1976	1978	Views Unchanged	More Favorable to Transit in 2 Yrs.	Less Favorable to Transit In 2 Yrs.
I. There Needs to be Greater Emphasis on Improving Bus Service and Less on Building Freeways	45 ↔	49	33	42	25
II. There Is Really No Future for Public Transportation	24 ↔	21	33	29	38
III. I Will Never Travel by City Bus No Matter How Much the Service Is Improved	14 ↔	11	28	31	41

responses to all three items show augmented support for the local bus system. In sum, the respondents indicate a more positive evaluation of the system, but have less of a "public regarding" attitude toward transit funding, i.e. they are less willing to monetarily support a public transit facility. The effects of this two-pronged evaluation are felt in the area of transit marketing, where more residents have knowledge of the system and a more favorable attitude toward the system because of promotional efforts and service development, but are inclined to place financial constraints on any further marketing efforts or other service improvements.

Nonequivalent Control Group Design: Impact of Route Alterations in Beaumont

For the evaluative effort undertaken in Waco a before-after study furnished the assessment framework. Measurements were made before and after the Waco marketing program was implemented. However, there was no procedure to control for extraneous effects, such as an increased interest in the system precipitated by events independent of the promotional efforts.

In Beaumont, a more complex design was used to evaluate route changes -- the nonequivalent control group study -- diagrammed earlier as:

	Before	Change to System	After
Experimental Portion ⟶	0_1	X	0_2
Control Portion ⟶	0_3		0_4

The phrase "nonequivalent control group" refers to the fact that the control route was not necessarily selected by a random process. Likewise, the choice of which route to alter was not a random decision, but based on prior passenger counts. Thus, the design is considered quasi-experimental in nature.

The basic design was altered to obtain measurements regarding three routes, one of which had undergone major alterations in two years, the second having minor changes, and the third evidencing no change whatsoever. Therefore the design is repeated in actual form as:

	Before	Change to System	After
Route 1: Major Alteration	0_1	X_a	0_2
Route 2: Minor Alteration	0_3	X_b	0_4
Route 3: No Alteration (Control)	0_5		0_6

$$d_1 = 0_2 - 0_1$$
$$d_2 = 0_4 - 0_3$$
$$d_3 = 0_6 - 0_5$$

The test of program or project impact is indicated by the differences observed among d_1, d_2, and d_3. The logic of this design is sound, assuming that other features of these routes, besides the alterations per se, do not impinge on the findings. Ideally, the three routes would be matched along criteria such as socioeconomic characteristics of the three service or catchment areas, ridership levels, peak and off-peak ridership, headways, and other salient characteristics. Because of the small number of routes in Beaumont currently, i.e. five, there were differences along the major criteria. Most prominent of these differences was observed between Route 1, primarily an upper socioeconomic area, and Routes 2 and 3, with lower socioeconomic residents. These latter two routes are similar in terms of ridership characteristics and levels of use.[6] Additionally, as with the Waco study, it is

[6] Route 1 was the College-Calder route, Route 2 the Crockett-Laurel route, and Route 3 the Pine-Buford route.

possible that respondents surveyed at two time periods may be "sensitized" by the first survey and not react to service alterations in the same manner as the general public. Hopefully, the use of a control group -- those respondents on Route 3 -- overcomes this difficulty.

Originally 495 adult respondents had been surveyed in August, 1976. Of that number, approximately 59 residing within two blocks of one of the three study routes (either the original routes or the routes in their current form) were contacted in 1978.

In February, 1977 Route 1 was altered to include a parallel northern route, thus creating one line of travel where two had previously existed. Route 2 had minor alterations in the southern portion undertaken in 1977. These service changes were measures to increase operational efficiency of the system. The crucial question for the present analysis revolves around the effectiveness of these changes, in terms of ridership response, attitudes toward the system, and overall impact of the system changes to the public.

Changes in Ridership Levels. Patronage for Route 1 in July, 1978 was 10,849 compared to 9,183 for this route in July, 1976 and 2,079 for the original route subsumed in Route 1. Thus, in 1976 the two routes carried 11,101 passengers, and carried 1,666 less in 1978 for the combined routes. Because the discontinued route had low ridership levels, removal from the system was considered cost efficient. Route 2 showed a slight increase from 7,879 to 7,903 for the twenty-four month period and the control route, Route 3, indicated a rise from 6,789 to 7,319.

Likewise, examination of sample surveys taken in August, 1976 and August, 1978 shows declines in passenger counts for Routes 1 (plus the original additional route) and 2, while Route 3 evidences an increased ridership (as shown in Table 15. Using the nonequivalent control group design, survey

Table 15. Nonequivalent Control Group Design Applied to Measure Ridership Response to Route Alterations

(by percent of respondents riding in 1976 and 1978)

Route	Survey Years			
	1978		1976	
Rt. 1 (Major Alteration)	$(0_2$	—	$0_1)$	
	(.04	—	.13)	= -9 percent
Rt. 2 (Minor Alteration)	$(0_4$	—	$0_3)$	
	(.39	—	.53)	= -14 percent
Rt. 3 (No Alteration) — CONTROL —	$(0_6$	—	$0_5)$	
	(.64	—	.44)	= +20 percent

respondents along Route 1 indicated a lowered use, almost ten percent less than two years earlier. Route 2 respondents, where alterations had been minor, showed a 14 percent decline in ridership on either an occasional or regular basis. However, along the control route, Route 3, where the transit path had remained stable, ridership increased by 20 percent.

Other post hoc evaluations of the route changes pointed to Route 1 residents as patronizing the system less than other respondents, not only for the month prior to the 1978 survey but in the last two years as well (see Table 16). Route 1 collapsed two routes, so that, generally, residents are farther from the current transit route than from the two earlier fixed paths. It should be re-emphasized, however, that a majority of Route 1 residents have high family incomes, and are therefore not transit dependent. Only four percent along Route 1 suggested that the route alteration affected family members or friends, whereas 12 percent suggested that the change affected domestics who worked in their homes.

Fifty-eight percent of Route 1 informants purported to be aware of the route changes, while 39 percent on Route 2 stated a familiarity with the route alterations. Interestingly, 36 percent of those in the control group (Route 3) also reported knowledge of route changes near them, which was unlikely with the primary exception being the overlapping (or criss-crossing) of other routes in the central business district. Route 3 survey respondents historically have been more dependent on bus service, as noted by the 64 percent who have ridden the system within the past two years and the 6.7 average monthly trips per respondent. No respondents surveyed in the Route 3 sample stated they had been personally affected by the purported route alteration, which is consistent with the expected zero-sum impact from this control group in the study. Twelve percent adjacent to Route 2 and eight

Table 16. Perceived Impact of Route Changes by Respondents Over Two-Year Period

		Route 1	Route 2	Route 3
I.	Frequency of Monthly Use: Average Number of Bus Trips Per Respondent	0	2.3	6.7
II.	Bus Ridership in Two-Year Period (in percentages)	4	35	64
III.	Awareness of Route Change (in percentages)	58	39	36
IV.	Personally Affected by Route Change (in percentages)	8	12	0
V.	Awareness of Other Affected by Route Change (in percentages):	20	9	11
	(Family)	(4)	(0)	(0)
	(Neighbors)	(4)	(9)	(11)
	(Workers in Home-Private Household Workers)	(12)	(9)	(0)

percent in Route 1 sample reported some personal consequences of the route changes.

Changes in Awareness and Evaluation of the Transit System by Route. Forty-five percent of the Route 3 respondents had system maps and schedules whereas 13 percent on Route 2 and only 4 percent on Route 1 had possession of a route map. Similarly, Route 3 informants all correctly (or partially) identified Beaumont Municipal Transit's bus exterior colors, compared to 81 percent for Route 2 and 90 percent of Route 1 respondents.

Perhaps most important are the changes in evaluation of the bus system evidenced in the twenty-four months. The three evaluative items discussed for the Waco before-after study also were included in the Beaumont survey. As shown below, the same non-equivalent control design framework for analysis as was used to measure ridership changes on the three routes was applied to the evaluative items. Summarizing Table 17 results in regard to respondents change in <u>positive</u> evaluation of the system, Route 1 informants were consistently less favorable to the local transit operations on all three items, while Route 3 residents were consistently more favorable in the two-year period. Route 2 informants were unchanged between 1976-1978 on item II, but gave a slightly higher evaluation on the other two items. Although the sample is a small proportion of area residents adjacent to each route, it can nevertheless be hypothesized that the lowered evaluation along Route 1 (which subsumed two separate routes) was a result of the direct or indirect effects of this service alteration. The more positive opinions through time revealed by Route 3 respondents was also evidenced in Waco on the same items. Other factors, including the differences in socioeconomic characteristics of respondents may also aid in explaining the differences in evaluation among routes.

Table 17. Changes in Positive Evaluation of Local Bus System

(in percentages)

	Agree		Disagree	
	1976	1978	1976	1978
I. There Needs to Be Greater Emphasis on Improving Bus and Less on Building Freeways				
Route 1	41	18		
Route 2	50	58		
Route 3	50	100		
II. There Is Really No Future for Public Transportation				
Route 1			61	43
Route 2			46	46
Route 3			20	80
III. I Will Never Travel By City Buses No Matter How Much the Service is Improved				
Route 1			60	52
Route 2			64	73
Route 3			60	80

For item I:

Route 1 —— $d_1 = (0_2 - 0_1) = (18 - 41) = -23$ percent

Route 2 —— $d_2 = (0_4 - 0_3) = (58 - 50) = 8$ percent

Route 3 —— $d_3 = (0_6 - 0_5) = (100 - 50) = 50$ percent

For item II:

Route 1 —— $d_1 = (0_2 - 0_1) = (43 - 61) = -18$ percent

Route 2 —— $d_2 = (0_4 - 0_3) = (46 - 46) = 0$ percent

Route 3 —— $d_3 = (0_6 - 0_5) = (80 - 20) = 60$ percent

For item III:

Route 1 —— $d_1 = (0_2 - 0_1) = (52 - 60) = -8$ percent

Route 2 —— $d_2 = (0_4 - 0_3) = (73 - 64) = 9$ percent

Route 3 —— $d_3 = (0_6 - 0_5) = (80 - 60) = 20$ percent

The results point to the utility of evaluating the effectiveness of service alterations and improvements as well as to the cost efficiency of such programs or projects. The application of the nonequivalent control group design to the case of route reductions in Beaumont suggests that ridership response and evaluations of the bus system are visibly impacted by these service changes.

The use of evaluative designs and performance indicators assist in answering the question: "Did the service alteration or improvement make any difference?"

CHAPTER IV

SUMMARY AND CONCLUSIONS

The technical study on which this report is based, "Marketing Public and Mass Transportation in Texas," explores strategies for stimulating transit ridership. The intention of this final report is to furnish analytical procedures for appraising the effectiveness of planned and implemented service improvements. Measurement of effectiveness ideally includes an analysis of the extent to which local bus systems serve the public, especially in terms of prescribed goals that have been established for the transit systems. Tangible impacts of system alterations include:

- ridership response
- changes in awareness or knowledge of the transit system
- modified evaluations of the bus operations

Other approaches to analyzing transit performance, including UMTA's uniform system of accounts and records, have placed an emphasis on indicators of efficiency. Primary concern has revolved around the productivity of use of available labor and capital resources. Assessment of system effectiveness is not necessarily juxtaposed against analyses of cost efficiency. Given a fixed allotment of funding, trade-offs among desirable service improvements must be evaluated and optimum strategies employed for increasing system effectiveness. Further, many service alterations, such as improved labor-management relations, not only increase the efficiency of the system but also increase the effectiveness of bus drivers in their daily contacts with the public. On the other hand, reducing the number of routes in a city sector from two to one may be mandated on a cost/benefit basis but not improve the effectiveness of the system to the public being served.

There are two levels of appraisal -- one a systemwide level and the second directed toward specific aspects or portions of service provision. This report has focused on the latter problem area, in an effort to prescribe approaches for evaluating performance of services impacted by system alterations and improvements. However, the evaluative designs discussed also prove applicable for examining systemwide performance.

Approaches to performance measurement vary from rigorous designs requiring a large amount of manpower and financial resources to "bargain basement" designs dependent on available data and providing only rough estimates of service impact. Twelve evaluation designs have been described, all of which were used successfully in previous studies of public services:

I. Formative Evaluation Designs
   A. Plan Evaluation
   B. Phase Evaluation

II. Summative Evaluation Designs: Non-Experimental Procedures
   A. After-Only Design
   B. Comparative Design
   C. The Case Study
   D. Planned-Actual Performance Comparison
   E. Time-Trend Projection Comparison

III. Summative Evaluation Designs: Quasi-Experimental Procedures
   A. Before-After Design
   B. Time Series Design
   C. Nonequivalent Control Group Design
   D. Combination Time Series and Nonequivalent Control Group Design

IV. Summative Evaluation Designs: Experimental Procedures
   A. Controlled Experiment

While techniques vary for each design, all methods are aimed at ascertaining the benefits or negative consequences of service improvements and alterations. Examples of five evaluative designs were provided, based on either on-board surveys, household surveys, or other supplemental, secondary data. These procedures, services assessed, and study sites were:

Evaluation Design	Service Alteration/Improvement	Study Sites
I. Comparative Design	Crowding/Comfort Considerations —— Fare Structure Assessment	Waco, Beaumont, Fort Worth, and Houston
II. The Case Study	Transit Signage	Houston
III. After-Only Study	Subscription Service	Fort Worth
IV. Before-After Design	Promotional Strategies	Waco
V. Nonequivalent Control Group Design	Route Alterations	Beaumont

Each of the case examples represented an attempt to utilize an evaluation design for assessing an existing service alteration or service feature that would have saliency for many systems. In addition, the application of the designs to current situations points to the strengths and disadvantages of the designs and to their adaptability for on-going issues facing transit systems.

Before undertaking evaluative efforts of local service alterations, it may prove advantageous to consider four criteria for determining whether the service, program, or project should be selected for evaluation:

I. Can results of a service evaluation influence decisions regarding the program? Hatry, et al. note (1973: 110-111):

— Services for which a decision regarding continuation, modification, or termination need to be made are obvious candidates.

— Poor candidates are those where decision makers (city managers or transit management) have strong preconceptions of the value of the service or where there is considerable support by influential vested interest groups -- if these circumstances make it very unlikely that the program would be altered, regardless of evaluation findings.

— Can the evaluation be completed in time to be helpful to decision makers? Evaluations which are completed after transit planners and management become committed to a decision are essentially useless.

II. Can the evaluation be done?

— Is sufficient data obtainable on important effects of the program? Program evaluations can never resolve all questions, but before beginning an evaluation it should first be clear that it will be possible to gather meaningful data on significant aspects of the program. For example, long-run impacts of driver training programs or fare structure changes may not appear for several years. In most cases, transit systems are unable to wait this long. Nevertheless, it is often true that *intermediate* results can be made available and provide significant information for interim decisions.

— Can sufficient resources be obtained to meet the time schedule and technical requirements of the evaluation?

— Has the program been stable enough so that an evaluation will provide relevant information? If the program is constantly changing, or is about to change, in significant ways it is not a good candidate for evaluation.

III. Who will be responsible for the evaluation?

— Generally, transit system personnel or city representatives who have operated or instituted a program or service should not be responsible for a formal evaluation. Otherwise, the credibility of the evaluation may be jeopardized.

— Prime candidates for evaluations of improvements or alterations are units at a higher organizational level than those responsible for the service. Additionally, consultants and researchers are available for such a task.

— In all cases, those directly responsible for the service should participate in the evaluation -- outlining original service objectives, evaluation criteria, service aspects under consideration, expected data problems, etc.

IV. Is the service alteration significant enough to merit the evaluation effort?

— Services which involve a large amount of manpower and monetary resources or those who have potentially significant benefits or negative consequences to ridership, other things being equal, should be given higher evaluation priority. Also, the likely cost of the evaluation should be compared to the possible decreases in service cost or improved effectiveness that could result.

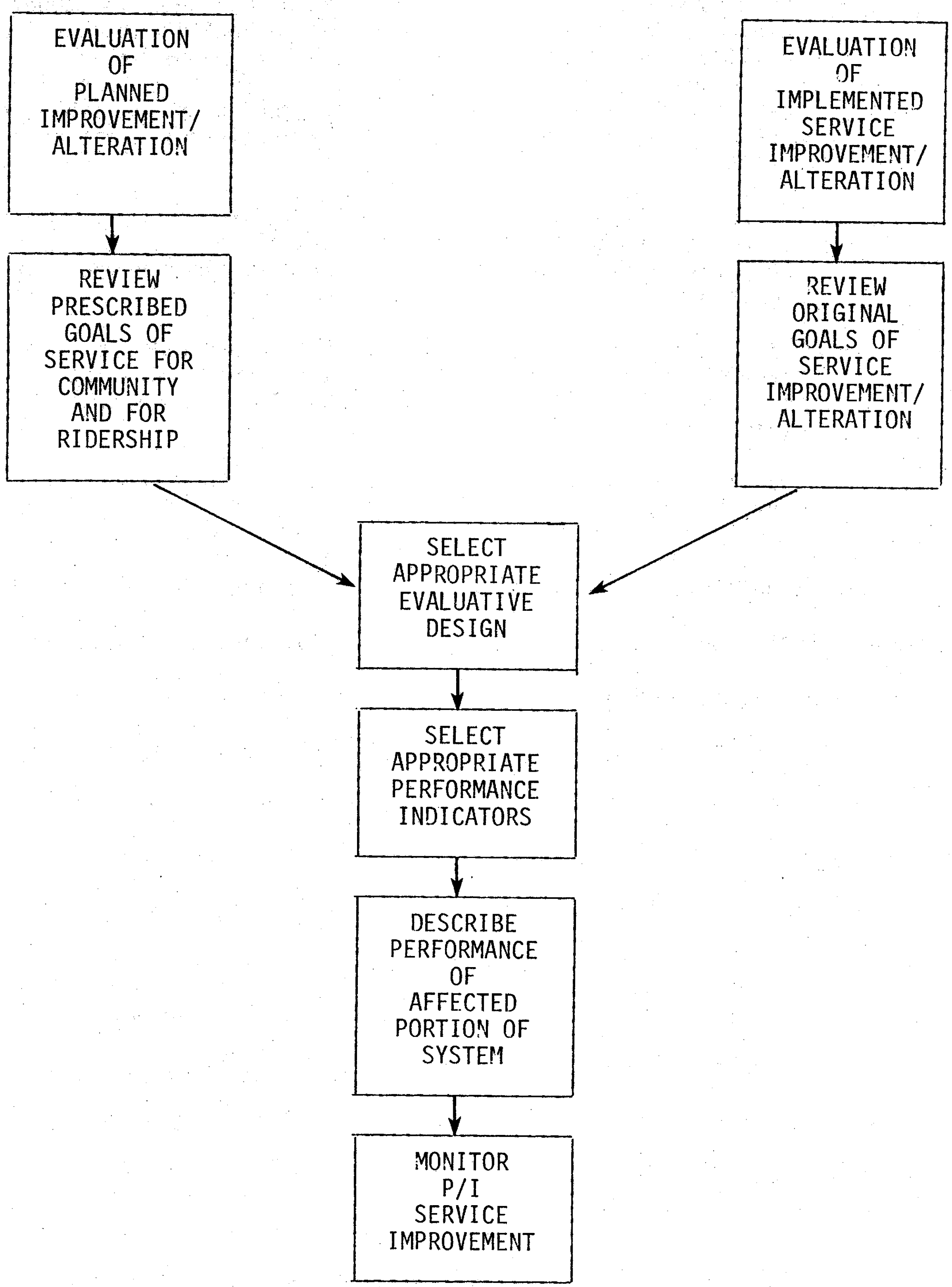
— Is the service suspected by either local executives or state/federal representatives of being marginal in benefits? If so, there may be opportunities for making major improvements or cost reductions.

— New programs whose benefits and costs are uncertain should be reviewed after operating long enough to demonstrate their effectiveness. Six months is normally a minimum time span for evaluating effects of service changes.

— Evaluation of services that are candidates for expansion can be particularly valuable.

Figure 5 points to a series of steps or phases involved in evaluative efforts. Whether the evaluation is focused upon already existing services or is a formal evaluation of a planned alteration, a review of objectives for the operation of the services is necessary. Selection of an appropriate evaluative design may be undertaken prior to delineation of performance indicators or simultaneously with the assignment of appropriate indicators. For example, choice of the design may be dependent on data availability or the feasibility of acquiring additional data. In appraising the effectiveness of a central terminal in the downtown area for transfers, passenger counts before and after the institution of the terminal provide a readily available indicator of service effectiveness, not only on a systemwide basis but also for specific routes and time periods. Thus, selection of an evaluative design could easily incorporate a longitudinal analysis, with a pretest and posttest evaluation framework. Nonetheless, determination of specific

Figure 5. Phases in Evaluation Effort Aimed at Assessment of System Alterations or Improvements



problems attached to the creation of a downtown terminal cannot be obtained from rider counts per se. For instance, lowered ridership because of a lack of shelters and benches at this central transfer point and specific route-to-route transfer problems cannot be obtained from passenger counts alone. In this respect, a more comprehensive and substantive set of performance indicators is required and should be anticipated at the outset of the evaluative effort.

A written description of the findings needs to be provided to ensure no misunderstanding over interpretation of results. Errors and poor methodology or inappropriate indicators might not be apparent and cannot be checked unless results are written. Further, transit management and city representatives should review the findings before they are disseminated (Hatry, 1973: 120-121):

> Their reactions and suggestions will often add to the overall perspective and occasionally they will detect major omissions in the evaluation that can either be corrected or considered in future decisions. Controversial interpretations by agency personnel should be expected, especially when the evaluation produces negative findings.

There is a feedback chain for the evaluation process, in that results of the assessment often have an impact on the services, either in augmenting and expanding the service or perhaps in discontinuing disadvantageous portions of the service.

The underlying purpose of this report has been to provide a framework for the utilization of performance measures to improve the efficacy of mass transportation. In determining the success of transit operations, it is necessary to examine the "output" of the system -- as measured in terms of public satisfaction and patronage. The evaluative approaches described in the report, if utilized conscientiously, make information available to transit representatives regarding the extent to which local objectives are being met. To evaluate transit service or service features, as the concept of "effectiveness" implies, the primary emphasis is on the value of particular service components. In this sense, evaluation of service effectiveness is an assessment of the degree to which a service alteration is meeting local objectives, the problems being encountered, the side effects it is creating, and the outcomes or benefits.

SELECTED REFERENCES

American Institutes for Research
1970 Evaluative Research: Strategies and Methods. Pittsburgh, Pa.

Bade, Nicholas
1977 "Marketing: Transit's Deliverance of Passing Fad?" Highway and Urban Mass Transportation (June): 4-7.

Bennett, Claude F.
1977 Analyzing Impacts of Extension Programs. Washington, D.C.: U.S. Department of Agriculture.

Bennett, Carl A. and Arthur A. Lymsdaine (eds.)
1975 Evaluation and Experiment: Some Critical Issues in Assessing Social Programs. New York: Academic Press.

Bernstein, Ilene N. (ed.)
1976 Validity Issues in Evaluation Research. Beverly Hills: Sage.

Bowman, Lewis, et al.
1972 "Self-Interest and Referendum Support: The Case of a Rapid Transit Vote in Atlanta." Pp. 119-136 in Harlan Hahn (ed.), People and Politics in Urban Society.

Caro, Francis G.
1977 Readings in Evaluation Research. New York: Russell Sage Foundation.

Epstein, Irwin, and Tony Tripodi
1977 Research Techniques for Programs Planning, Monitoring, and Evaluation. New York: Columbia University Press.

Franklin, Jack L. and Jean H. Thrasher
1976 An Introduction to Program Evaluation. New York: John Wiley.

Gabriel, Richard A.
1975 Program Evaluation: A Social Science Approach. New York: MSS Information Corporation.

Glass, Gene V.
1976 Evaluation Studies: Review Annual, Vol. 1. Beverly Hills, Ca: Sage Publications.

Goss, David N.
1978 "System Performance Indicators-The Need for Action is Now!" Paper presented at the Mid-Year Meeting of the American Public Transit Association, Houston, May.

Grizzle, Gloria
1973 Using Time Series Analysis to Evaluate the Impact of Team Policing. Institute of Government, University of North Carolina at Chapel Hill. Bulletin MCJPP-69.

Hatry, Harry P., Richard E. Winnie, Donald M. Fisk
1973 Practical Program Evaluation for State and Local Government Officials. Washington, D.C.: The Urban Institute.

Houghton, Tony
1974 "Some Theoretical Aspects of Evaluation and Their Application to Plan Making." Pp. 134-144 in Jean Perraton and Richard Baxter (eds.), Models, Evaluation and Information Systems for Planners, Lancaster, England: MTP Construction.

Kemp, John B.
1978 "Federal Regional Council and Uniform Reporting Project." Paper presented at the Third National Conference on Rural Public Transportation, Houghton, Michigan, June.

Kiresuk, Thomas J.
1968 "Goal Attainment Scaling at a County Mental Health Service." Evaluation, Special Monograph #1, pp. 12-18.

Kiresuk, Thomas J.
1968 "Goal Attainment Scaling: A General Method for Evaluating Comprehensive Community Mental Health Programs." Community Mental Health Journal, IV, pp. 443-453.

Lichfield, Nathaniel, Peter Kettle, Michael Whitbread
1975 Evaluation in the Planning Process. New York: Pergamon Press.

Mann, John
1972 "The Outcome of Evaluative Research." Pp. 267-282 in Carol H. Weiss (ed.) Evaluating Action Programs. Boston: Allyn and Bacon.

Moursund, Janet P.
1973 Evaluation: An Introduction to Research Design. Monterey, Ca.: Brooks/Cole.

Municipality of Metropolitan Seattle
1977 "Magic Carpet Evaluation Study." NTIS #PB 271-214.

Patton, Michael Quinn
1978 Utilization-Focused Evaluation. Beverly Hills: Sage.

Perraton, Jean
1974 "The Process of Evaluation." Pp. 117-133 in Jean Perraton and Richard Easter (eds.), Models, Evaluations and Information Systems For Planners. Lancaster, England: MTP Construction.

Rutman, Leonard (ed.)
1977 Evaluation Research Methods: A Basic Guide. Beverly Hills: Sage.

Seglin, Paul R.
1977 "Transit Performance." Paper presented at the First National Conference on Transit Performance, Norfolk, Va., September.

Smith, Robert L.
1978 "Introduction to the Workshop on Recordkeeping and Evaluation." Paper presented at the Third National Conference on Rural Public Transportation, Houghton, Mi., June.

Suchman, Edward A.
1976 Evaluative Research: Principles and Practice in Public Service and Social Action Programs. New York: Russell Sage Foundation.

Underwood, William C.
1978 "Performance Indicators - A Necessary Management Tool?" Paper presented at the Mid-Year Meeting of the American Public Transit Association, Houston, May.

U.S. Department of Transportation
1977 "Uniform System of Accounts and Records: Implementation." Federal Register, January 19, 1977, Part II.

The Urban Institute
1977 Low Fare and Fare-Free Transit: Some Recent Applications by U.S. Transit Systems (NTIS #PB 271-077).

Urban Mass Transportation Administration
1976 Increasing Transit Ridership: The Experience of Seven Cities. Washington, D.C.: Office of Policy and Programs Development (NTIS #PB 271-071).

Urban Mass Transportation Administration
1977 Proceedings of the First National Conference on Transit Performance. UMTA -DC-06-0184-77-1.

Walker, Kenneth R.
1978 "Improving Transit Usage in Small Urban Areas." Transit Journal 4 (Spring): 41-50.

Waller, John D., et al.
1976 Monitoring for Government Agencies. Washington, D.C.: The Urban Institute.

Weiss, Carol H.
1972 Evaluating Action Programs: Social Action and Evaluation. Boston: Allyn and Bacon.

Weiss, Carol H.
1972 Evaluation Research: Methods of Assessing Program Effectiveness. Englewood Cliffs, N.J.: Prentice-Hall.

Wholey, Joseph S., et al.
1977 Evaluation: When Is It Really Needed? Washington, D.C.: The Urban Institute.

Wilder, Gregory C.
1978 "Federal Initiatives: Reporting System and Common Approaches to Depreciation." Paper presented at the Third National Conference on Rural Public Transportation, Houghton, MI, June.

Winnie, Richard E. and Harry P. Hatry
1973 Measuring the Effectiveness of Local Government Services: Transportation. Washington, D.C.: The Urban Institute.

Yancey, Marcus
1978 "Performance Indicators: Viewpoint of the States." Paper presented at the Mid-Year Meeting of the American Public Transit Association, Houston, May.

———
1973 "Evaluation of Bus Transit Strategies." Highway Research Record No. 459. Washington, D.C.: Highway Research Board of the National Research Council.