TRANSIT COOPERATIVE RESEARCH PROGRAM

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TCRP Report 47

A Handbook for Measuring Customer Satisfaction and Service Quality

Transportation Research Board

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Report 47

A Handbook for Measuring Customer Satisfaction and Service Quality

MORPACE INTERNATIONAL, INC.
Farmington Hills, MI

in association with

CAMBRIDGE SYSTEMATICS, INC.
Cambridge, MA

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TRANSIT COOPERATIVE RESEARCH PROGRAM

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

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

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

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

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

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

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

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

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

To save time and money in disseminating the research findings, the report is essentially the original text as submitted by the research agency. This report has not been edited by TRB.

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FOREWORD

By Staff
Transportation Research Board

This handbook focuses on how to measure customer satisfaction and how to develop transit agency performance measures. It will be of interest to transit managers, market research and customer service personnel, transit planners, and others who need to know about measuring customer satisfaction and developing transit agency performance measures. The handbook provides methods on how to identify, implement, and evaluate customer satisfaction and customer-defined quality service.

Transit agencies are concerned with delivering quality service to customers, which is often defined by on-time performance, comfort, safety, and convenience. Transit agencies continually strive to define quality service, yet a problem exists—definitions of such service often evolve from management's perceptions of what constitutes quality. These management definitions may vary significantly from what current and potential customers perceive to be quality service.

Consumer definitions of quality service could prove helpful to the transit industry. Under TCRP Project B-11, *Customer-Defined Transit Service Quality*, research was undertaken by MORPACE International, Inc., to develop a methodology to assist transit agencies in identifying, implementing, and evaluating customer-defined service quality and in defining performance indicators that include customer-defined quality service measures for fixed-route transit. This research includes rural, suburban, and urban markets.

To achieve the project objective of producing a handbook, the researchers conducted a review of current literature related to customer-defined transit service quality measures, customer satisfaction measurement techniques within transit and other industries, and transit performance measures and indicators. Next, the research team developed a comprehensive list of service-quality measures from the customer's perspective, ensuring that each measure was specific and clearly defined. A survey was administered to customers to arrive at a ranking of service-quality measures, in order of their impact on overall customer satisfaction. The survey instrument was developed and refined based on the results of pretests. Alternative methods for ranking servicequality measures were explored and evaluated, and a new approach was introduced. Finally, the list of service-quality measures was compared with the list of agency performance indicators, and the performance measures were revised to reflect customerdefined service. Using the research findings from the field test, the methodology was refined and a preliminary method for assessing transit operations was developed. Methods for benchmarking and tracking information are also identified.

CONTENTS

A Handbook for Measuring Customer Satisfaction and Service Quality

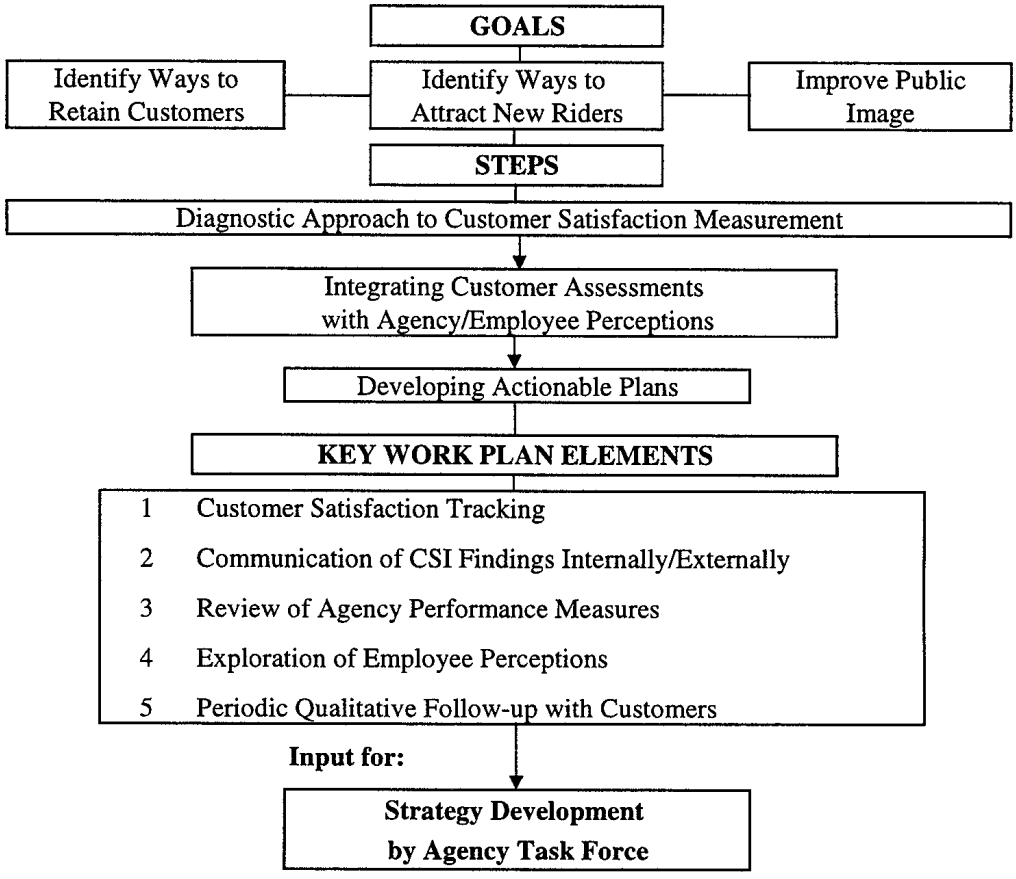
CHAPTER 1. INTRODUCTION

1A. The Goals of Customer Satisfaction and Service Quality Measurement

For transit agencies, as in other service industries, increases in customer satisfaction translate into retained markets, increased use of the system, newly attracted customers, and a more positive public image. To accomplish these ends, public transit needs reliable and efficient methods for identifying the determinants of service quality from the customers' perspective.

The primary focus of this handbook is how to measure customer satisfaction and how to develop transit agency performance measures in response to research findings. These are key elements of an ongoing customer satisfaction monitoring process. However, before proceeding with these tasks, it is helpful to consider the framework implied when customer feedback becomes the driver of agency service improvement actions. Chart 1.1 below sets forth the goals, steps, and key work plan elements of a successful customer satisfaction management plan.

Chart 1.1
Overall Customer Satisfaction Management Plan



The results of a customer satisfaction measurement program cannot be expected to drive transit agency service improvement plans unless the findings correlate with agency-based performance measures, i.e. that data which the agency collects on a regular basis to document service performance. Customer perspectives must also be validated or understood by frontline transit agency employees if corrective action plans are to translate into successful implementation.

Hence, the customers' perspective, as measured, must be effectively communicated to agency personnel. This communication should facilitate management's use of customer feedback in determining which service improvements require immediate attention, which require further monitoring, and which indicate a need for educating customers about service parameters. For while customers must always be first, customers may not always be right. A fully diagnostic approach to customer satisfaction measurement is essential, rather than reliance on ratings and ranking of service attributes alone.

Customer satisfaction indices, or CSIs, are determined from benchmark and tracking customer surveys. These indices rely on measuring the impact of customers' ratings of individual service attributes on overall satisfaction with service.

Several quantitative survey analysis techniques for this measurement are in use within transit and other service industries. These include quadrant and gap analysis, factor analysis and multiple regression analysis, and scattergrams. Of these, only factor and regression analysis can provide quantitative benchmarks for continuous tracking, but problems are inherent. These include the need for large sample sizes, the complications of explaining variability and weights, and reduction of potentially rich individual service attribute findings into results for aggregated dimensions — with less relevancy for specific transit improvements and performance measures.

This handbook proposes a new, simpler "impact score" or problems encountered approach. This approach determines the relative impact of service attributes on overall satisfaction, when a recent problem with the attribute is reported. Since the primary way transit agencies can improve customers' overall satisfaction with service is to reduce customers' problematic experiences, the goal is to identify those attributes which have the greatest negative impact on overall satisfaction and the greatest number of customers encountering a problem. These "driver attributes" can be identified and prioritized in a threestep process. Large sample and subsample sizes, and multivariate analysis techniques, are not required.

Another advantage of the impact score approach is that while more demanding telephone benchmark surveys are recommended to establish baselines, periodic (annual or biannual) updates and tracking of impact scores can be accomplished via on-board rider surveys only. These tracking updates can focus on problem occurrence and those measures of service quality found in the baseline survey to have the greatest impact on overall satisfaction.

For those transit agencies currently conducting customer satisfaction research using other methods, adding the impact score approach will require only the following minor addition to the questionnaire. After asking customers for their satisfaction rating on each individual service attribute (a series of questions almost always included), the follow-up question, "Have you experienced a problem with this service attribute within the last 30 days?" *(1: "Yes", 2: "No")* will be asked.

Unquestionably, all customer satisfaction analytical methods can be used in combination to fully explore underlying relationships in customer perceptions, with the overall, diagnostic goal of determining what elements of service need improvement. In combination with other approaches, or alone, impact scores provide a straightforward method with results that are easy to explain, do not require large sample sizes, and that streamline procedures for measuring — and improving — customer satisfaction over time.

The TCRP B-11 project comparatively field-tested the impact score and other customer satisfaction measurement approaches at three transit agency sites:

- an urban rail system, the Chicago Transit Authority (CTA) Red Line and CTA Blue Line in Chicago, Illinois,
- a suburban bus system, Sun Tran in Albuquerque, New Mexico, and
- a small city bus system, Greater Lynchburg Transit Company (GLTC) in Lynchburg, Virginia.

1B. How to Use This Handbook

This handbook is organized for the "new ideas" and "comprehensive" customer satisfaction measurement reader.

If you are interested in:

1.	How to Measure and Compute Impact Scores	→	GO TO CHAPTERS 5 AND 6
2.	Benefits, Requirements, and a Brief History of Customer Satisfaction Measurement	→	GO TO CHAPTER 2 AND APPENDIX A
3.	Identifying the Determinants of Service Quality from a Qualitative Perspective	→	GO TO CHAPTER 3 AND APPENDICES B AND C
	Example List of Transit Service Quality Measures	→	Page 13
4.	A Review of Quantitative Customer Satisfaction Measurement Techniques	→	GO TO CHAPTERS 4 AND 8
5.	Customer Satisfaction Research Design and Data Collection Methods	→	GO TO CHAPTER 7 AND APPENDICES D, E, AND F
	Customer Satisfaction Benchmark Survey Instrument	→	APPENDIX F
6.	The Development of Agency Performance Measures	→	GO TO CHAPTERS 9, 10, AND 11 AND APPENDIX G

1C. Key Words

Customer satisfaction measurement or indexing, or customer-defined service quality — determining the relevant impact of customers' ratings of individual service attributes on overall satisfaction with service.

Impact score or things gone wrong approach — a new approach to customer satisfaction measurement used extensively within automotive research and described herein.

Drivers of overall satisfaction — those service attributes with the greatest impact on overall satisfaction with service.

Attribute impact scores — scores that indicate the relevant position of a service attribute in terms of its impact on overall customer satisfaction and rate of customer reported problem occurrence.

Problem occurrence — the percent of customers experiencing a problem with a service attribute within the past 30 days.

CHAPTER 2. GOALS FOR TRANSIT INDUSTRY SERVICE QUALITY MEASUREMENT

2A. Benefits and Requirements of Service Quality Measurement for Transit

Although empirical evidence is limited, increases in customer satisfaction are generally believed to:

- shift the demand curve upward and/or make the slope of the curve steeper (i.e., lower price elasticity, higher margins)
- reduce marketing costs (customer acquisition requires more effort)
- reduce customer turnover
- lower employee turnover (satisfied customers affect the satisfaction of front-line personnel)
- enhance reputation and public image (positive customer word-of-mouth)
- reduce failure costs (handling customer complaints).[1]

For transit agencies, an increase in customer satisfaction translates into retained riders, increased use of the system, newly attracted customers, and an improved public image.

The requirements for a transit industry service quality measurement process are:

- to derive the determinants of service quality from the customers;
- to benefit from best practices established for service quality measurement within other industries;
- to take into account the complexities and unique aspects of public transit service;
- to consider the differences inherent in urban, suburban, and rural systems – including modal differences; and
- to develop methods that are reasonably easy to describe and to implement so that cost and time allocations are efficient.

Within the transit industry, only limited survey based customer satisfaction indexing research has been conducted. The 1993 IDEA study[2], based on small sample sizes within three urban transit systems, the 1995 Northwest Research Chicago Transit Authority Customer Satisfaction Report[3], and customer satisfaction studies conducted by BART in San Francisco[4], TRI-MET in Portland, Oregon, and MARTA in Atlanta are notable among the studies that have been published.

2B. Brief History of Customer Satisfaction Measurement

Appendix A provides a thorough literature review summary as to historical and methodological perspectives of customer satisfaction research.

Consumer behavior as a distinct discipline dates only from the mid 1960s. Interest in understanding and tracking specific consumer problems grew dramatically in the late 1970s under the broad label of consumer satisfaction/dissatisfaction (CS/D) research. Its growth coincided with a growing interest on the part of government regulators and consumer advocates in making policy formulation more rational and systematic. The earliest comprehensive CS/D studies were, in fact, motivated by the policy planning needs of a public regulatory agency, the Federal Trade Commission (Technical Advisory Research Program 1979), and a private non-profit sector organization, Ralph Nader's Center for Study of Responsive Law. Most CS/D research from 1975 to 1985 was conducted within product and goods industries. Only after 1980 were initial concepts and models developed to measure consumer satisfaction/dissatisfaction within service industries.

Since 1985, two different patterns have emerged. First, there has been a considerable drop in CS/D research from a public policy perspective. At the same time, however, there has been substantial growth in interest in the topic of consumer satisfaction research in the private sector. This has been driven primarily by the growth of the service sector of the economy where managers have realized that tracking satisfaction is crucial to success when intangibles such as personal attention and atmospheres are the "product". A number of private sector satisfaction tracking services have emerged. Many of these services have made extensive use of earlier methodological developments in social policy research.

Most of the early studies were based on survey data. An alternative approach was complaints data, data on the extent to which consumers voluntarily speak up about their dissatisfactions. Such data have the advantage of not requiring field surveys; however, they are typically biased in two important ways. First, some types of problems in some types of industries are more likely to be voiced than others, and some problems are less serious than others, and/or less costly than others. Monopolies, such as some transit systems, are often relatively "immune" to complaining except from a small elite. Finally, not all consumers complain. These problems have led researchers in recent years to fall back on the more costly, but more objective, survey research methods.

Initial survey research studies on CS/D sought to calibrate the amount and types of dissatisfaction in the marketplace as a basis for policy planning. This body of research was largely descriptive. Wide variation was found across purchase categories. These studies differ widely in the basic measure of dissatisfaction they used. Some focused on more or less objective measures of "problems", others on subjective feelings of "dissatisfaction." Some counted any negative experience whatsoever, some only "serious" dissatisfactions, and some only the most recent problem. Also, there was the issue of opportunity for problems. Definitional problems persist today.

2C. Defining Service Quality Measurement

Customer satisfaction research literature traditionally agrees that service quality is a measure of how well the service level delivered matches customer expectations. Delivering quality service means conforming to customer expectations on a consistent basis.[5] However, clearly, the fact that expectations are confirmed is not always sufficient for satisfaction.

Generally, a set of discrepancies or gaps exists regarding organizational perceptions of service quality and the tasks associated with service delivery to consumers. These gaps can be major hurdles to attempting to deliver a service that consumers would perceive as being high quality. Chart 2.1 on the following page shows the five gap areas identified.

These are:

GAP 1: Consumer expectation — management perception gap

These are discrepancies between executive perceptions and consumer expectations. Transit agency executives may not always understand what features connote high quality to consumers in advance, what features a service must have in order to meet consumer needs, and what levels of performance on those features are needed to deliver high quality service.

GAP 2: Management perception — service quality specifications

There may be constraints (resources, or market conditions) which prevent management from delivering what the consumer expects, or there may be an absence of total management commitment to service quality.

GAP 3: Service quality specifications — service delivery gap

There may be difficulty in standardizing employee performance even when guidelines exist for performing services well and treating consumers correctly.

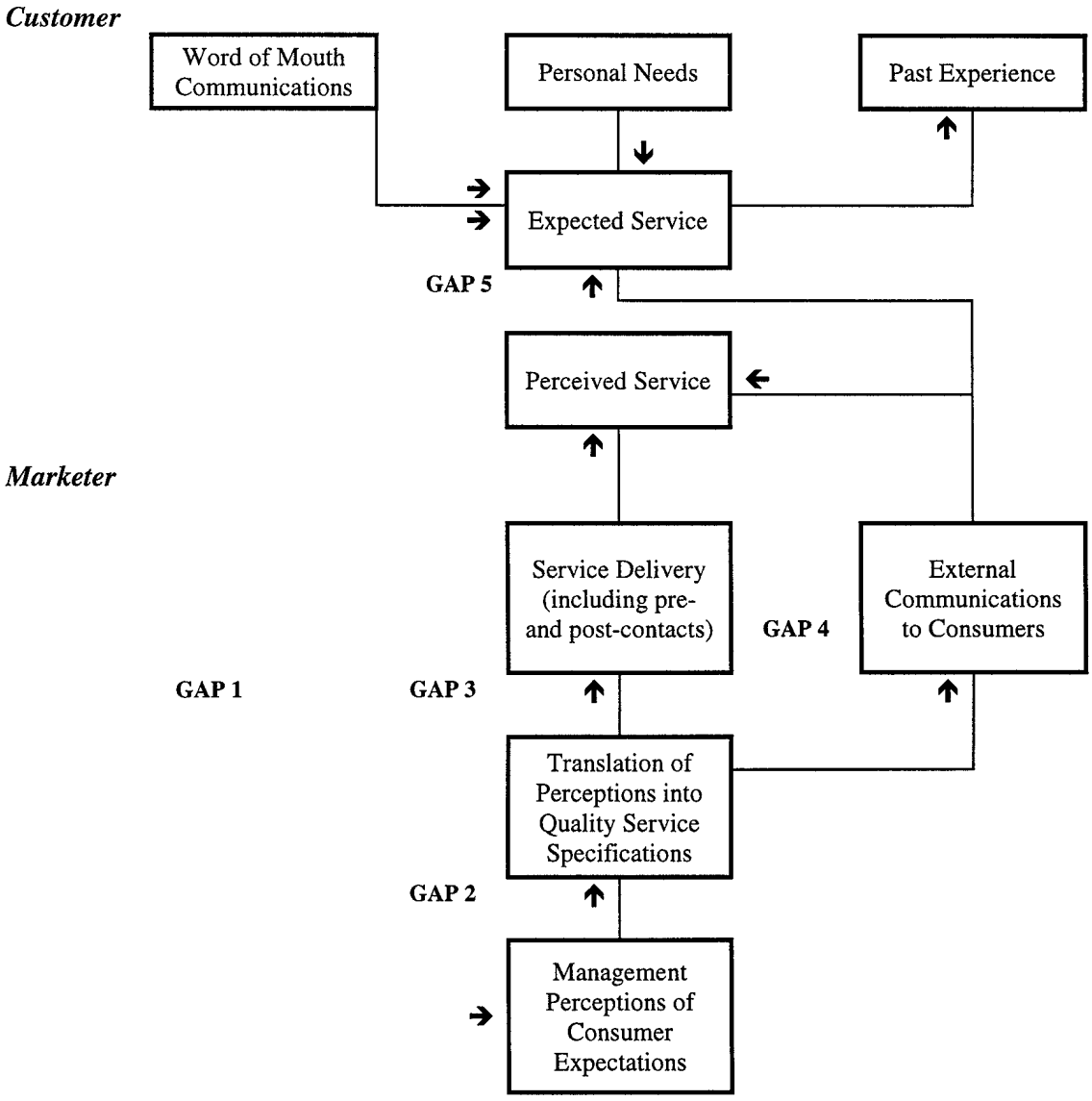
GAP 4: Service delivery — external communications gap

Media advertising and other communications by an agency can affect consumer expectations. Promising more than can be delivered will raise initial expectations but lower perceptions of quality when the promises are not fulfilled. Also, transit agencies can neglect to inform consumers of special efforts to assure quality that are not visible to consumers, thereby affecting consumer perceptions of the delivered service.

GAP 5: Expected service — perceived service gap

This is how consumers perceive the actual service performance in the context of what they expected. The quality that a consumer perceives in a service is a function of the magnitude and direction of the gap between expected service and perceived service.

Chart 2.1
Service Quality Model



Service quality, as perceived by a consumer, depends on the size and direction of GAP 5 which, in turn, depends on the nature of the gaps associated with the design, marketing, and delivery of services. That is, the magnitude and direction of each gap will have an impact on service quality.

ENDNOTES

[1] Fornell, Claes, "*A National Customer Satisfaction Barometer: The Swedish Experience"*, Journal of Marketing, January 1992, Volume 56, Number 1, pp. 6-21.

[2] IDEA Program Final Report, Customer Satisfaction for the Mass Transit Industry, Contract: TRANSIT-1, Transportation Research Board, prepared by: Tri-County Metropolitan Transportation District of Oregon, August, 1995.

[3] Customer Satisfaction Survey of Chicago Transit Authority Riders, Northwest Research Group, Inc., December, 1995.

[4] Passenger Environment Survey Report, BART Customer and Performance Research, January - March 1997.

[5] Lewis, Robert C. and Bernard H. Booms (1983), "The Marketing Aspects of Service Quality" in *Emerging Perspectives on Services Marketing*, L. Berry, G. Shostack, and G. Upah, eds., Chicago: American Marketing, pp. 99-107.

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CHAPTER 3. IDENTIFYING DETERMINANTS OF SERVICE QUALITY

Exploratory investigation suggests that, within most service industries, consumers use basically similar criteria in evaluating service quality.[6] These criteria seem to fall into 10 key categories labeled "service quality determinants". These determinants are listed below. Overlap among the 10 determinants may exist.

Determinants of Service Quality

1	RELIABILITY involves consistency of performance and dependability.
2	RESPONSIVENESS concerns the willingness or readiness of employees to provide service. It also involves timeliness of service.
3	COMPETENCE means possession of the required skills and knowledge to perform the service.
4	ACCESS involves approachability and ease of contact.
5	COURTESY involves politeness, respect, consideration, and friendliness of contact personnel.
6	COMMUNICATION means keeping customers informed in language they can understand and listening to them. It may mean that the company has to adjust its language for different consumers — increasing the level of sophistication with a well-educated customer and speaking simply and plainly with a novice.
7	CREDIBILITY involves trustworthiness, believability, and honesty. It involves having the customer's best interests at heart.
8	SECURITY is the freedom from danger, risk, or doubt.
9	UNDERSTANDING/KNOWING THE CUSTOMER involves making the effort to understand the customer's needs.
10	TANGIBLES includes the physical environment and representations of the service.

Research in other service industries indicates consumers "group" a wide array of attributes of service under one of the 10 dimensions noted when judging service quality. However, this research is preliminary and also suggests that it is advisable to determine, within the industry of study, whether identifiable service quality segments exist — and whether, and in what ways, consumer expectations differ across industry segments. Investigating how transit customers aggregate attributes of service into collapsed quality dimensions is important to understanding how customer satisfaction should be measured within an industry.

Regardless of what eventual quantitative analytical approaches are used, the process must begin with acquiring a list of service attributes *from the customers*, through an exhaustive "listening to the voice of the customer" process. This qualitative research is usually conducted through a series of focus groups. Customers are requested to describe the ideal service or product in all of its feature details. Then customers are asked to list their basic service or product requirements, starting with primary requirements and continuing through the secondary and tertiary components of each of these requirements. The moderator proceeds until the group has exhausted all the possible attributes of service quality they would consider.

This process is repeated at multiple geographic and customer segment sites and the results are combined and itemized into a full and complete attribute listing. The wording of the attributes is refined for clarity and linkage with expected results. For example, "frequent service so that wait times are short". (Or if further quantification is desirable: "frequent service so that wait times do not exceed 15 minutes".) This process usually results in a listing of 40 to 55 defined attributes of transit service that can be rated by customers (see Table 3.1, as an example).

A prototype moderator's guide for focus group sessions conducted to extract and prioritize customer service quality requirements can be found in Appendix B. Appendix C contains a more detailed description of the qualitative focus group explorations conducted as a part of the field test for this study, at each of the three demonstration transit agency sites. The same format was used at each site and for each transit mode. Recruitment of customers for the focus group sessions was accomplished through distribution and collection of an on-board, or at-station, questionnaire to passengers. Basic demographic and trip pattern data were requested, in addition to telephone numbers for the recruitment process.

Once the customer-defined service quality attribute list is developed for a locality, exhaustive qualitative research with customers does not need to be repeated for several years (every four to seven years is usually recommended). An open-ended question on the quantitative survey format which asks respondents to name the one change they would make to improve service, or to name any additional attributes or factors that have not been mentioned that affect their ratings of service quality, is usually sufficient to update service quality attribute listings for subsequent tracking research.

Table 3.1
Example List of Transit Service Quality Measures

1	Absence of graffiti
2	Absence of offensive odors
3	Accessibility of trains/buses to handicapped
4	Availability of handrails or grab bars on trains/buses
5	Availability of monthly discount passes
6	Availability of schedule information by phone/mail
7	Availability of schedules/maps at stations/stops
8	Availability of seats on train/bus
9	Availability of shelter and benches at stations/stops
10	Cleanliness of interior, seats, windows
11	Cleanliness of stations/stops
12	Cleanliness of train/bus exterior
13	Clear and timely announcements of stops
14	Comfort of seats on train/bus
15	Connecting bus service to stations/main bus stops
16	Cost effectiveness, affordability, and value
17	Cost of making transfers
18	Displaying of customer service/complaint number
19	Ease of opening doors when getting on/off train/bus
20	Ease of paying fare, purchasing tokens
21	Explanations and announcement of delays
22	Fairness/consistency of fare structure
23	Freedom from nuisance behaviors of other riders
24	Frequency of delays for repairs/emergencies
25	Frequency of service on Saturdays and Sundays
26	Frequent service so that wait times are short
27	Friendly, courteous, quick service from personnel
28	Having station/stop near destination
29	Having station/stop near my home
30	Hours of service during weekdays
31	Number of transfer points outside downtown
32	Physical condition of stations/stops
33	Physical condition of vehicles and infrastructure
34	Posted minutes to next train/bus at stations/stops
35	Quietness of the vehicles and system
36	Reliable trains/buses that come on schedule
37	Route/direction information visible on trains/buses
38	Safe and competent drivers/conductors
39	Safety from crime at stations/stops
40	Safety from crime on trains/buses
41	Short wait time for transfers
42	Signs/information in Spanish as well as English
43	Smoothness of ride and stops
44	Station/stop names visible from train/bus
45	Temperature on train/bus — not hot/cold
46	The train/bus traveling at a safe speed
47	Trains/buses that are not overcrowded
48	Transit personnel who know system

ENDNOTES

[6] A. Parasuraman, Valerie A. Zeithaml, and Leonard L. Berry, Journal of Marketing, Fall 1985, Vol. 49, Number 4, pp. 41-50.

CHAPTER 4. QUANTITATIVE ANALYTICAL TECHNIQUES

4A. Overview

In a typical quantitative customer satisfaction study, respondents evaluate overall satisfaction, then rate each individual service attribute that customers have defined. A key question for researchers is which attributes are the drivers of overall satisfaction (since not all attributes have equal impact)? When there are 40 to 50 attributes that can impact customer satisfaction, and transit agency resources are limited, how can it be determined which limited number of attributes should be targeted for problem occurrence reduction, in order to produce the greatest possible increase in overall customer satisfaction with transit service?

Researchers have suggested many procedures for dealing with this problem. Several are considered by Green and Tull (1975)[7] and reviewed in *The Maritz Marketing Research Report* (1993).[8] Work continues in this area; no true "answer" for all applications has emerged. However, *derived importance measures* are usually preferred over *stated importance measures.*

Stated importance measures ask respondents to explicitly state their perception of the importance of each attribute, usually using a 10-point scale. The results of this method can be straightforwardly interpreted; however, results can be few, if any, statistical differences among attributes, so the aim of the method — to prioritize attributes — is thwarted. For example, if 600 customers are asked to rate the transit service on 46 attributes, each on a scale of one to ten, the mean ratings for 8 to 10 of the attributes may range from 7.3 to 7.5, making the differences among their means statistically insignificant, using a *t-test of significance.* This makes quadrant analysis unreliable since differentiations among attributes by their mean importance or mean satisfaction ratings may not be statistically significant, at least without very large sample sizes. The statistical significance challenge is compounded when the results of a new tracking survey are compared with benchmark results. Additionally, the approach does not take into account, or provide a reliable means, for measuring the relative impact of service attributes on overall satisfaction.

Derived importance methods rely on the statistical association between individual ratings (predictors) and an overall satisfaction rating. The importance of an attribute is statistically determined from this relationship. These measures can be generally described as follows:

1. *Bivariate (Pearson) Correlation:*
   This measure separately tests the strength of the relationship of each independent variable (attribute) with the dependent variable (overall satisfaction). It has the advantages of familiarity and relative simplicity. However, joint effects with other attributes go undiscovered, and often many attributes are similarly correlated with overall satisfaction.

2. *Multiple Regression Analysis:*
   This approach allows the inclusion of additional independent variables (attributes) when testing the relationship with the dependent variable (overall satisfaction). However, an important consideration is that it is common in customer satisfaction research for attributes to be correlated — sometimes highly — with each other. This multicolinearity makes it difficult to measure the separate effects of the individual attributes on overall satisfaction using the multiple regression approach.

3. *Factor Analysis:*
   Factor analysis is a statistical technique that is used for many purposes including:

   - revealing patterns of intercorrelationships among variables, and

   - reducing a large number of variables to a smaller number of statistically independent variables (dimensions) that are each linearly related to the original variables.

4. *Combining Factor Analysis and Multiple Regression Analysis*
   When multicolinearity is encountered in multiple regression modeling, factor analysis can be used to first transform the independent variables to a smaller set of dimensions or artificial variables that are uncorrelated among themselves. Then multiple regression modeling is performed to predict the relative impact of the newly constructed dimensions on the dependent variable (overall satisfaction).

To date, factor analysis combined with multiple regression analysis has been the most prevalent analytical technique applied in customer satisfaction research within the transit industry.

4B. Problems with the Factor Analysis Approach

The *first* inherent problem is that a lot of the richness of the data is lost through factor analysis. Individual attributes that, in isolation, have a high impact on overall satisfaction may not get targeted because the factor analysis placed them within a dimension that did not prove crucial. For example, the attribute of "freedom from the nuisance behaviors of others" may, in isolation, be highly correlated with overall satisfaction. However, as a result of the factor analysis, this attribute can get placed within the dimension of "travel environment" or "appearance", a newly constructed dimension which is not found to have a strong impact on overall satisfaction.

The *second* is that factor analysis and multiple regression modeling, since they are highly complex, are not easy to describe to transit managers and operations personnel. Empirical data indicates that its use in other service industries limits "buy-in" by the very personnel who most need to be committed to the translation of customer expectations into agency performance measures.

The *third* and an important consideration is that it is not a good idea to build complex models if the data sets or subsample sets are small and the list of independent variables (attributes) you want to measure is extensive. Large sample sizes are required. This is particularly problematic for the transit industry where measures are needed for subsample groups such as by transit mode, transit dependent rider versus non-transit dependent rider, secure customer versus vulnerable or at-risk customer, or by geographic region of a city, or city vs. suburbs.

As a general rule, the minimum is to have at least five times as many observations as there are variables to be analyzed, and the more acceptable range would be a ten-to-one ratio. Some researchers even propose a minimum of 20 cases for each variable. (If 40 service attributes are being measured, the sample size or sampling strata should be a minimum of 800). "One must remember that with 30 variables, for example, there are 435 correlations in the factor analysis. At a .05 significance level, perhaps even 20 of those correlations would be deemed significant and appear in the factor analysis just by chance. The researcher should always try to obtain the highest cases-per-variable ratio to minimize the chances of "overfitting" the data,.. deriving factors that are sample specific with little generizability."[9]

The *fourth* consideration is a cautionary one that, while more sophisticated and elegant analytical methods have an appeal, it is risky to proceed when simpler and less demanding approaches will work as well.

The results of the Northwest Research 1995 report for the "Customer Satisfaction Survey of Chicago Transit Authority Riders" indicate that problems of multicolinearity may exist with the factor analysis approach to customer satisfaction measurement within the transit industry.[10] (MORPACE International, Inc. does not have the primary factor analysis data results for the previous "IDEA Project" conducted by J. D. Powers in 1993; however, the sample sizes for this pilot study were so small that a serious question arises about the validity of the factor analysis results.)

The 1995 CTA Customer Satisfaction Report gives the correlation data results for the dimensions of both bus travel and rail travel (sample sizes less than 600 each). The report acknowledges that: "It should be noted that in some cases, variables (attributes) are highly correlated with dimensions that are different than might be expected — for example, smoothness of ride correlates with driver attributes rather than with comfort of the ride as might be expected. This would suggest that riders think about attributes and combine attributes for evaluations in a way that is different from the traditional performance indicators used by transit (and, we would note, different from the way in which attributes are traditionally assembled by customers in other industries)."

In Chapter 8 of this report, we provide the results of our factor/regression analysis based on field test results. The usefulness and reliability of results will be compared with those provided by our proposed impact score approach.

4C. Uses of Quadrant Analysis

Quadrant analyses of customer satisfaction measures are often used to provide an underlying understanding of ratings. Thus, for example, "strengths" are shown in one quadrant of the graphs as those attributes that are above the median in customer importance and also above the median in customer satisfaction. (Sometimes, as in a Gap Analysis, importances are derived by a bivariate correlation of attribute satisfaction with overall satisfaction). Likewise, the "weaknesses" or "opportunity" quadrant contains those attributes above the median in importance, but below the median in satisfaction. Those attributes below the median in importance, but above the median in satisfaction can be labeled the "maintenance of effort" quadrant; while the last "non-critical" quadrant contains those attributes low in importance on which satisfaction is also judged to be low.

The disadvantages of this approach are that the divisions by quadrant are somewhat arbitrary and the magnitude of the differences between attribute ratings is not usually taken into account. This approach, while giving a general overview of the relationship between attribute importance and satisfaction ratings, does not provide a stable quantitative measure of the impact of attributes on overall customer satisfaction. There are no established numbers for each attribute that provide the benchmarks against which future similarly collected customer satisfaction attribute measures can be tested — for statistically significant changes in customer perception.

4D. Regional and Industry Response Bias

Customer measurements are often contaminated by a culture-induced scale bias that may invalidate crossnational or regional comparisons. The bias reveals itself as a tendency for some customers to give consistently higher or lower ratings of performance (even when actual performance levels are identical and expectations are controlled). For example, people from the New England region of the U.S. exhibit a temperament and follow norms quite unlike those found in Texas ... they are clearly working from different frames of reference which can color their evaluations.

The following discussion of this problem is excerpted from a 1996 copyright article by Symmetrics Marketing Corporation, entitled "Measuring Cross-National and Within-Country Response Bias Using the International Scale Bias Index (ISBI)".

> "While methods exist for estimating scale bias, all require that additional information be obtained from customers. Some of these methods are rather elaborate and tedious (e.g., conjoint-based) and/or are difficult to explain to customers (e.g., magnitude estimation). A *(proprietary)* technique developed by Symmetrics (Crosby, 1994; Crosby, 1992) makes it possible to reliably estimate the magnitude of the scale bias by asking customers additional questions that are a part of the International Scale Bias Index (ISBI). The index is formed averaging the ratings of composite items. The items are statements of performance categorized into six life domains: suppliers, sports, arts, education, science, and services. Differences between regions/countries in their mean index scores are mainly reflective of culture induced scale bias, i.e., a generalized tendency to be a harder or easier grader of performance. The index scores can be used to make adjustments in the customer measurements from each region/country in order to facilitate "apples-to-apples" comparisons."

Current methods for correcting cross-regional bias in customer satisfaction measures are proprietary and costly to incorporate. We point out their existence as a caution against comparing transit service quality measures across regions and transit agencies.

An additional concern is the comparison of transit customer measures with those measures found within other industries. In Sweden, the Customer Satisfaction Barometer (CSB) for more than 30 industries and more than 100 corporations found that CSB scores are significantly higher for products than for services, and that service monopolies score lower than competitive services (Fornell, 1993). Staple foods and automobiles score at the top of the CSB; the police force and television broadcasting are at the bottom (transportation services were not measured as a part of the Sweden CSB).

Thus, given present research methods, it is not advisable to set expected "target zones" for customer satisfaction within transit, or to compare these measures directly by region, or with measures derived for other industries. The best use of quantitative service quality measures is as internal benchmarks for an agency against which future progress can be measured. Additionally, the research must determine which measures, if targeted, will yield the greatest increase in overall customer satisfaction with service.

4E. Customer Loyalty and Establishing Customer Satisfaction Indices

Most major conceptual and measurement models of customer satisfaction explicitly include elements related to customer value and customer loyalty. Satisfaction is a necessary, but not a sufficient, condition of customer loyalty (D. Randall Brandt, 1996).[11] Customer loyalty is not repeat users or transit dependent riders. Many repeat customers may be choosing transit because of necessity, convenience, or habit. For these customers, if an alternative becomes available, they may quickly switch to that service or mode. Instead, customer loyalty is reflected by a combination of attitudes and behaviors. It usually is driven by customer satisfaction, yet also involves a commitment on the part of the customer to make a sustained investment in an ongoing relationship with transit service. Attitudes and behaviors that go with customer loyalty include:

- an intention to use transit service again
- a willingness (often an eagerness) to recommend transit service to friends, associates, and other persons

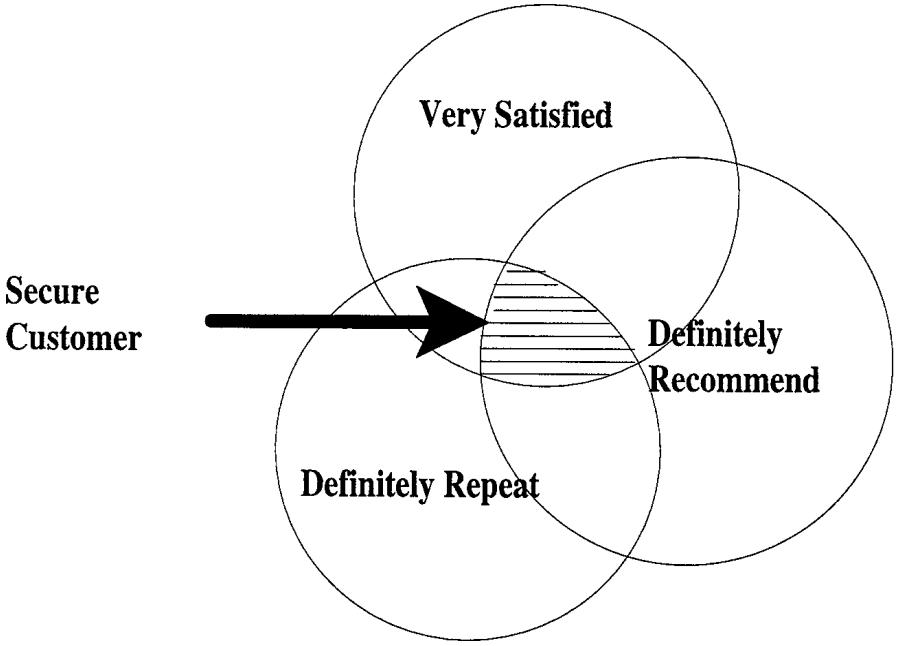
- commitment to, and even identification with, transit service
- disinterest in and/or a general resistance to alternative means of transportation, when these are available.

One measure of customer loyalty is the Secure Customer Index (D. Randall Brandt, 1996). A secure customer is one who says that he or she is:

- very satisfied with the service
- definitely will continue to use the service in the future
- definitely would recommend the service to others

The definition is illustrated in the diagram below:

Chart 4.1
Secure Customer Index



Responses to the three items — overall satisfaction, likelihood to continue using the service, and likelihood to recommend — can be combined to create multiple classifications or segments based on the degree of customer security. For example:

Secure Customers	=	% very satisfied/definitely would repeat/definitely would recommend
Favorable Customers	=	% giving at least "second best" response on all three measures of satisfaction and loyalty
Vulnerable Customers	=	% somewhat satisfied/might or might not repeat/might or might not recommend
At Risk Customers	=	% somewhat satisfied or dissatisfied/probably or definitely would not repeat/probably or definitely would not recommend

The capacity to establish linkages between customer satisfaction, customer loyalty, and business results should be part of the architecture of any organization's customer satisfaction measurement process.

4F. Market Segmentation of Customer Satisfaction Findings

An important advantage of the impact score approach, as will be illustrated in Chapter 8, is that once segments such as secure and vulnerable customers are identified, impact benchmark and tracking scores can be easily computed, ordered, and compared by customer loyalty segments.

Modest sample sizes will allow the full impact score analysis to be performed by transit mode segment, as well as by transit dependent status and such segments as commuters versus non-commuters, and frequency of use categories.

Chapter 5, which follows, presents a thorough explanation of the Impact Score Approach.

4G. Linking Customer Satisfaction to Performance Measures

The process of linking goals to performance through measuring Customer Satisfaction (CS) is exploratory and preliminary for even the most forward-thinking companies. First, companies must formalize and quantify the relationship between CS and firm or agency performance. By determining how CS improves performance or what specific CS components correlate with different improvements, corporations can focus on only the most effective endeavors, allowing them to become more efficient in implementation.

Delivering CS is at an early evolutionary state in most U.S. firms. Most firms are not focused on satisfying customers, even though research now correlates CS with improved performance. A firm's CS implementation process must reflect the needs of individual customer segments, and the overall program must be flexible enough to allow each business unit to develop measures and processes that fit its management needs.

Properly implemented and managed, the performance measures process ensures that customer input drives an organization's efforts to improve and innovate, and that the impact of these efforts can be assessed. The key question is how does the "voice of the customer" data compare with the "voice of the process" data? Customer expectations must be translated to, and linked with, performance measures for the agency.

The whole relationship of transit agency performance measures to customer-defined measures is the topic of Chapters 9, 10, and 11 of this report.

ENDNOTES

[7] Green, Paul E. and Tull, Donald S., Research for Marketing Decisions; 3rd edition; Prentice-Hall, Inc. 1975 (Englewood Cliffs, New Jersey), pp. 478-484.

[8] *Maritz Marketing Report*, 1993.

[9] Hair, Anderson, Tatham, Black, Multivariate Data Analysis, pp.373-374, Prentice Hall, New Jersey.

[10] Customer Satisfaction Survey of Chicago Transit Authority Riders, Northwest Research Group, Inc., December, 1995.

[11] "Customer Satisfaction Indexing" D. Randall Brandt, Conference Paper, American Marketing Association, 1996.

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CHAPTER 5. IMPACT SCORE TECHNIQUE: AN EXPLANATION OF THE METHOD

To address the impasse that often occurs in customer satisfaction measurement within the transit industry, MORPACE International, Inc. has developed a non-proprietary method for deriving customer satisfaction measures. The approach has an implicit logic that is easily understood and applied. Variations of this method have been used by MORPACE in major customer satisfaction studies within the automotive and health care industries.[12] Within the automotive industry this approach is known as the "Things Gone Wrong" approach.

The Impact Score approach determines the relative impact of attributes on overall satisfaction, by measuring customers' relative decreases in overall satisfaction, when a recent problem with an attribute is reported. This makes sense because, within the delivery of quality service framework, the primary way transit agencies can improve customers' overall satisfaction with service is to reduce customers' problematic experience with those attributes which have the greatest negative impact on overall satisfaction. These driver attributes can be identified and prioritized in a three-step process.

> ***Step One*** is to determine which attributes have the most impact on *overall* customer satisfaction. For each attribute, the sample is divided into those respondents who have had a recent problem with the attribute and those respondents who have not recently experienced a problem with the attribute. (Those who have not experienced the attribute within the past 30 days are grouped with those who have, but have not had a problem.) The mean overall satisfaction ratings of the two groups are compared. The difference between the two mean overall satisfaction ratings is called the "gap score". Gap scores are computed and the attributes are then ordered by the size of their gap scores. A *t-test* can be used to determine where statistical significance lies among gap scores.
>
> The magnitude of an attribute's gap score should not change significantly over time. The relationship between a service quality attribute and overall satisfaction with transit service can be assumed to be structural. That is, once it is determined that an attribute is a driver of customer satisfaction it will probably remain so, unless significant societal changes occur, i.e., graffiti comes to be viewed as an art form.
>
> ***Step Two*** lists the attribute problem incidence rate for each attribute in a column next to its gap score. (The percent of customers who experienced a problem with the service attribute within the past 30 days). It will be important to take into account the rate at which a problem with an attribute occurs within the customer base. It may be that a particular attribute has a large gap score (and thereby a significant impact on overall satisfaction), but the percent of customers reporting a problem with the attribute is relatively small. In this case, it probably is not worth a transit agency's time and expense to attempt to further lower the problem occurrence rate for the attribute. On the other hand, if an attribute's gap score (impact on overall satisfaction) is moderately low, while the rate at which customers experience a problem with the attribute is high, the effect of the attribute on overall satisfaction is magnified and will require attention. Whether future increases or decreases in problem incidence rates are statistically significant can be validated by statistical tests (e.g., *chi-square test, z-test of proportions,* etc.).

Step Three creates a composite index by multiplying the attribute's overall satisfaction gap score by the attribute's problem incidence rate. The result is an attribute "impact score". The attributes are then placed in descending order of their impact scores. The top attributes are the drivers of customer satisfaction.

To summarize, impact scores are computed as shown in the following example:

Table 5.1
Impact Score Approach

	A Had Problem*: Mean Overall Satisfaction Rating	B No Problem*: Mean Overall Satisfaction Rating	C (B-A=C) Gap Score	D Reported Problem Occurrence Rate**		E (CxD=E) Impact Score
Attribute 1	6.5	8.5	2.0	0.548	=	1.0960
Attribute 2	6.3	8.2	1.9	0.442	=	0.8398
Attribute 3	5.3	8.1	2.8	0.173	=	0.4844

* within the past 30 days
** percent of customers experiencing a problem with the service attribute within the past 30 days

The impact score data analysis can be implemented using just a spreadsheet program. The spreadsheet can be structured so that the relevant inputs reside in one worksheet, the data analysis is conducted in a second worksheet, and the results summarized in a third worksheet. Inputs from the survey can be fed into simple formulas to determine mean ratings by group, gap values, percentages of respondents who had a problem with transit service, impact scores and *t-tests* to determine the statistical significance of identified differences. If this data analysis system is constructed in the benchmark year, transit agencies can input their own tracking data (from on-board surveys) during subsequent years.

This analytical approach is easy to describe to transit managers, the logic is implicit, and the method can be implemented without using advanced statistical analysis techniques, and with smaller sample and subsample sizes. The impact scores serve as statistically valid benchmarks for future customer satisfaction monitoring.

The appropriateness of the formula of multiplying the gap score by the problem incidence rate can be validated through a quadrant analysis of gap scores against problem incidence rates. What is the relative impact score of an attribute with a high gap score but a low incidence rate, or a low gap score but high incidence rate? Does the impact score prioritizing make sense when compared within a quadrant analysis? If not, weighting schemes for problem incidence rates can be considered.

ENDNOTES

[12] Proprietary studies conducted by MORPACE International, Inc. for Ford Motor Company and Aetna Health Plans during the 1990s.

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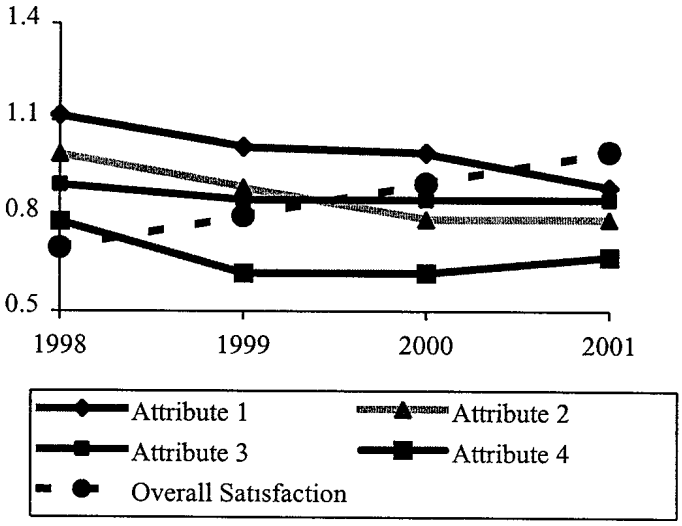
CHAPTER 6. IMPACT SCORES AS TRACKING MEASURES

As previously indicated, gap scores will not change significantly over time. It is problem occurrence rates that can fluctuate and which can be reduced by transit agency actions. Future increases or decreases in problem occurrence rates can be measured and validated with a *t-test or chi-square* test.

This makes it possible to limit tracking surveys to a re-measure of overall satisfaction and problem occurrence rates for each service attribute. With these data, impact scores can be recomputed and updated. Beyond the benchmark survey, short-form questionnaires can be administered on-board, greatly reducing continuing research costs for an ongoing customer satisfaction measurement program. The end result is service quality attribute tracking from the customer's perspective, as shown in Chart 6.1. This tracking information is crucial for developing appropriate, and sufficiently targeted, transit agency performance measures. It also provides a means for evaluating the specific impacts of planned agency actions over time.

Chart 6.1
Example
Overall Satisfaction and Attribute Impact Score Tracking



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CHAPTER 7. QUANTITATIVE RESEARCH DESIGN

7A. Overview

There are two primary requisites of any market research process:

1. As we have discussed, the analytical plan must be sufficiently powerful to produce results that are both useful and statistically valid and, concomitantly,

2. Sampling plans and data collection procedures must assure the reliability of the input data.

The 1996 two-part *Travel Survey Manual* prepared by Cambridge Systematics, Inc. (with Barton Aschman Associates) for the U.S. Department of Transportation and the U.S. Environmental Protection Agency is a primary source and reference document for research methods as they apply to transit customer surveys.

In relation to prerequisite #1 above, as we have explained, both quadrant analysis and factor analysis combined with multiple regression analysis, can be unreliable in producing results that are sufficient foundations for transit agency actions. Depending on final collected sample sizes, these approaches can also end up being statistically unreliable for transit subgroup markets. Other industries such as automotive, health care, and financial services have learned from hard experience that these multivariate analysis approaches are often best used as added value analytical explorations, which may add benefit to predictable findings.

Prerequisite #2 stipulates that, for the analytical results to be both useful and valid, the data on which it is based must have been collected in a way that minimizes both sampling errors and non-sampling errors and biases. (For a full discussion of these issues the reader is referred to Section 5.0 of the above referenced *Travel Survey Manual.*) Essentially, increasing sample size is the primary means of reducing sampling error; while non-sampling error is reduced by ensuring that the sample collected is fully representative of the population of transit riders.

A major problem for most initial Customer Satisfaction/Service Quality Benchmark Surveys (and our impact score approach is no exception) is that they must almost always be conducted by phone, due to the length of the questionnaire required to measure all possible attributes. There are some exceptions to this, such as BART and other commuter rail lines, where time on the service is adequate to allow customers to fill out a questionnaire of modest length. However, as previously noted, since the gap scores (the measure of relationship between each attribute and overall satisfaction) do not change much over time, it is possible to limit customer satisfaction tracking surveys to a re-measure of overall satisfaction and the percent of customers experiencing a problem with each attribute — plus relevant transit use and demographic questions. With these data, impact scores can be recomputed and updated. Future increases or decreases in problem occurrence rates can be validated by a *chi-square* test.

For tracking surveys it is also appropriate to consider paring the original list of attributes being tested to those which received the top 10 to 15 impact scores in the Benchmark Survey. This reduction in length makes it feasible to administer the tracking questionnaire via a representative on-board or an at-station survey, thus greatly reducing future research costs.

The second difficulty with data collection methods for the Benchmark Survey is that it is almost always inefficient, and sometimes inappropriate, to conduct this survey using a random-digit-dial (RDD) household telephone sample, because of the low incidence rate of transit riders within most populations. The market research industry rule of thumb is that RDD sampling methodology is not cost effective for customer surveys if the incidence rate of customers falls below 15%. Additionally, there is some evidence (BART and CTA survey experience) that when RDD survey methodologies are used to capture transit riders, infrequent riders are over sampled. Therefore, an alternative step is required to compile a representative sampling frame of transit customer telephone numbers. This can be accomplished through on-board or at-station surveys.

A detailed sampling plan for the on-board or at-station surveys must be developed by mode, route, travel days, and time of day. Sampling plans will differ widely by site and, again the *Travel Survey Manual* (Section 8.0) is the best reference for designs. The specific sampling plans for the on-board or at-station surveys at the three transit agency sites for this project are detailed in Appendix D. Contact points with riders varied.

7B. Questionnaire Development

Questionnaires distributed must be serially numbered and tracked to verify route/station and time of day of distribution. Surveyors keep written records of the numbers of the questionnaires distributed on or during their assigned trip or time period, so that segment response rates can be tabulated and the data weighted according to agency provided ridership counts by mode, routes, and time of day.

The Sampling Frame Collection Instrument is a short-form questionnaire suitable for obtaining rider transit usage and demographic information, essential as a baseline for measuring the validity of Benchmark Survey phone respondents. A sample on-board or at-station questionnaire is included as Appendix E. Survey items, at a minimum, should include:

a. frequency of use
b. transit dependency status trip purpose
c. transfer patterns
d. zip code
e. age
f. employment status
g. income
h. ethnic group
i. sex
j. overall satisfaction with service
k. respondent's phone number

7C. Response Rates and Sampling Error Estimates

Respondents are asked to provide their home or work telephone number so that the follow-up Benchmark Survey can be completed by phone at their convenience. To encourage the provision and legibility of valid telephone numbers, prizes of $100 each can be offered through a lottery of those who complete and return the on-board or at-station questionnaire — with a valid phone number.

For the TCRP B-11 project field test, a total of 10,000 questionnaires were distributed on CTA, 5,000 on the Red Line and 5,000 on the Blue Line; 2,720 questionnaires were distributed on Sun Tran in Albuquerque, and 821 on GLTC in Lynchburg, Virginia. An at-station survey response rate of 46.3% was accomplished for CTA Rail (29.5% with valid phone numbers); the response rate for Sun Tran was

48.6% (43.2% with valid phone numbers); and for GLTC 33.6% (27.4% with valid phone numbers). When the demographics and transit usage patterns of those riders who provided numbers were compared with those riders who did not provide numbers, no statistically significant differences were found.

Some weights were required to assure results from the on-board and at-station surveys were representative by lines and stations for CTA, by routes for Sun Tran, and by time of day at each of the three transit sites (See Appendix D).

For completion of the Benchmark Survey phone interviews at each site, quotas were established by line, station or route, and time of day, as required to assure fully representative samples. Additionally, phone completes were monitored for frequency of transit use, income, and age to assure representativeness with on-board/at-station survey sample rider characteristics.

Within the field test time and budget available, a total of 974 phone interviews were completed — 300 with customers of the CTA Red Line, 302 with customers of the CTA Blue Line, 303 with customers of Sun Tran, and 69 with GLTC customers. Results for the CTA Blue Line, Red Line, and Sun Tran have a sampling margin of error of ± 4.7% at the 90% confidence level. At the 90% confidence level, weighted results for combined CTA rail have a sampling error margin of ± 3.3%, while results for GLTC have a sampling margin of error of 9.9%. Weighting factors for CTA and Sun Tran data can be found in Appendix D to this report. Throughout this report, findings cited take into account the possible calculated sampling error for each transit sample.

7D. Customer Satisfaction Benchmark Survey Instrument

An example benchmark questionnaire survey instrument is provided in Appendix F. This interviewing format averages 20 minutes in length.

The Benchmark Survey Instrument contains the following key elements, each of which is measured on a 10-point scale. Those attributes tested are the 46-48 composite elements developed as a result of the qualitative research at each of the three demonstration sites (See Table 3.1).

Benchmark Questionnaire

- overall satisfaction with the service or product (Q61)
- the importance of each service attribute (Q13-Q60)* **
- satisfaction with each attribute (Q62-Q109)**
- whether the customer experienced a problem with each attribute within the past 30 days ("yes", "no") (Q110A-JJ)**
- customer loyalty segment questions (Q129 and Q130)
- open-ended exploration of the one service improvement customers would like to see (Q131)

- transit use and demographic segment questions:

    a. frequency of use (Q1)
    b. transit dependency status (Q2-Q3, Q133)
    c. tenure of transit use (Q4)
    d. trip purpose (Q5-6)
    e. transfer patterns (Q7-Q9)
    f. transit access mode (Q10-Q11)
    g. fare method (Q12)
    h. zip code (QB)
    i. length of residency (Q132)
    j. age (Q134)
    k. employment status (Q135)
    l. income (Q136-Q138)
    m. ethnic group (Q139)
    n. sex (Q140)

Notes:

* *Importance measures are not necessary for factor analysis, multiple regression analysis, or impact scores and it is recommended, in the interest of brevity, that this series of questions be eliminated. For quadrant analysis, importance measures can be derived. An index of importance can be derived by correlating each of the attributes with overall satisfaction. The median of the correlation coefficients can be determined, and each of the correlations can be expressed as a percentage of this median value.*

** *A split sample can be used to test some attributes for importance, satisfaction, and problem occurrence. The purpose of the split sample is to shorten the length of the survey. For example, at each of the TCRP B-11 sites, all respondents were asked to rate the same 30 attributes, then one-third of respondents were asked to complete ratings for an additional 6 attributes, while another one-third were asked to rate a different 6 attributes, and the last one-third of respondents were asked to rate the final 6 attributes. Thus, in total, 48 attributes were tested, but each respondent was asked to rate only 36. Differences in sample sizes must be taken into account when determining statistically significant differences among ratings for impact scores; and factor analysis is unreliable unless all respondents are asked about all attributes.*

For all analyses of results presented in Chapter 8, two of the attributes tested are not included. These are "having a (station) (bus stop) near my home" and "having a (station) (bus stop) near my workplace or destination". These two attributes generally are considered most important to transit customers, are essential to overall satisfaction with service, and have very low rates of reported problem occurrence, primarily because if the convenience of station or stop location is not present, the customer does not use transit.

A trade-off choice series of possible safety improvements at transit stations or stops, or on trains and buses, is included in the Benchmark Survey as an optional investigation (Q111-Q128).

CHAPTER 8. AN ILLUSTRATION OF COMPARATIVE QUANTITATIVE RESULTS — USING ALTERNATIVE ANALYTICAL TECHNIQUES

Based on TCRP B-11 Field Test Results

CTA — CHICAGO, ILLINOIS RED LINE SERVICE:

8A. CTA Red Line - Computation of Impact Scores

For each transit site, impact scores are calculated from the survey data results, and are as displayed as shown in Tables 8.1 and 8.2 (CTA Red Line), Tables 8.5 and 8.6 (CTA Blue Line), Tables 8.9 and 8.10 (Combined CTA Rail) Tables 8.15 and 8.16 (Sun Tran, Albuquerque), and Tables 8.22 and 8.23 (GLTC, Lynchburg, VA). First, data for whether or not a customer has experienced a problem with each attribute is cross-tabulated with mean overall satisfaction. Thus, for example as shown in Table 8.1, the mean overall satisfaction of those CTA Red Line customers (sample size=300) who have experienced a problem with "trains being overcrowded" within the last 30 days is 6.102; while the mean overall satisfaction of those customers who have not experienced a problem with trains being overcrowded is 7.278. The gap score is the difference between the two means (1.176). The percent of Red Line customers who have experienced a problem with trains being overcrowded within the last 30 days, is 75.3%, as shown in Table 8.2. To combine the effects of these two results we multiply the gap score (1.18) by the problem occurrence rate (.753) to arrive at an overall impact score of 0.886 for the attribute.

Impact scores for each attribute are then placed in descending order (Table 8.1), and the results are a display of the most problematic service attributes, from top to bottom. The logical assumption is that reducing the percent of customers who have a negative experience with the impact or driver attributes will have the greatest possible upward effect on overall satisfaction with the transit system.

However, Table 8.2 shows a more complete picture from the data. The darkly shaded cells show the attributes that are above the median rank for each category. The ranking columns (with ranks of 1 to 10 for importance, 1 to 8 for satisfaction, 1 to 12 for problem occurrence, and 1 to 7 for the overall satisfaction gap value) show the statistically significant placement of each attribute for the measure indicated. These statistical rankings are based on the appropriate *t-test, chi-square test, or z-test for proportions.* Incorporating this information, we can say that the service attribute of "trains being overcrowded" is of only medium importance to customers (4^{th} in ranking), while satisfaction with the attribute is very low (8th). This disparity is reflected in the impact score calculation for the overall satisfaction gap value (1.176 or 1.2). This value ranks the attribute as only 3^{rd} in its impact on overall satisfaction with service. However, the attribute's reported problem occurrence rate (73.5% of customers) ranks it 1^{st} in this category. On the impact score placement scale, taking into account both the overall satisfaction gap value and rank and the problem occurrence value and rank, this attribute ranks first — as the attribute whose improvement would have the greatest positive impact on overall satisfaction with CTA Red Line service.

The top target area attributes for the CTA Red Line as determined by the impact score approach are as shown below:

CTA Red Line Service
Target Attributes
(N=300)

	Attribute
1	Trains that are not overcrowded
2	Reliable trains that come on schedule
3	Cost effectiveness, affordability, and value
4	Explanations and announcement of delays
5	Frequent service so that wait times are short
6	Cleanliness of the train interior
7	Temperature on the train
8	Absence of offensive odors
9	Freedom from the nuisance behaviors of others
10	Smoothness of the ride and stops
11	Availability of seats on the train

8B. CTA Red Line — Comparison with Quadrant Analysis

As shown in Tables 8.1 and 8.2, when impact score results for the CTA Red Line are compared with Quadrant Analysis results as shown in Chart 8.3, some significant differences appear. The Quadrant Analysis is based upon mean stated attribute rating for importance and satisfaction. An alternative Gap Analysis would derive importance ratings from correlations of attribute satisfaction ratings with overall satisfaction ratings, as described in section 7D.

For the quadrant analysis, it should first be noted that (given the sample size of 300), if the appropriate tests of statistical significance are applied (at the 90% confidence level), many of the service attributes have the exact same positioning on the quadrant analysis chart. Thus, the service attributes of explanations of delays and cleanliness of interiors share the same positioning (1). The positioning is a rank of "3" in importance and a rank of "6" in satisfaction. Likewise, the attributes of physical condition of stations and fairness/consistency of fare share the same positioning on a quadrant analysis chart as indicated (2). These attributes are both ranked "4" in importance and "5" in satisfaction. Ordering service attributes by their quadrant analysis placement becomes a function of statistical significance, influenced highly by completed sample sizes.

Moreover, as previously discussed, importance ratings for attributes, gap analysis of the relationship between attribute satisfaction ratings and overall satisfaction, and gap values as computed for impact scores are likely to remain constant over time. The order of importance of attributes alone, or as calculated by relationship with overall satisfaction, is a structural one not likely to change much when remeasured in future years. Thus, tracking of customer satisfaction, using quadrant analysis or gap analysis, depends mostly on changes in stated satisfaction ratings for attributes, and the differences in these ratings over time is likely to be statistically insignificant for many attributes — particularly if satisfaction with service is generally high.

Differences in Impact Score and Quadrant Analysis results are identified as follows:

In Target Area by Impact Scores, but not by Quadrant Analysis

Cost Efficiently, Value and *Smoothness of Ride* — The quadrant analysis does not take into account this attribute's high impact on overall satisfaction; any significant rise in problem occurrence for this attribute could have a large impact on overall satisfaction.

Availability of Seats — The quadrant analysis does not take into account the high reported problem occurrence, while the attribute has a moderate impact on overall satisfaction.

In Target Area by Quadrant Analysis, but not by Impact Scores

Frequency of Delays and *Fairness/Consistency of Fare* — The quadrant analysis does not take into account lower rankings in reported problem occurrence.

Physical Condition of Station — The quadrant analysis does not take into account the attribute's low impact on overall satisfaction.

8C. CTA Red Line - Translation of Impact Scores to a Report Card

Once impact scores are placed in descending order, statistically significant differences in ranking can be calculated using standard tests for statistical significance (Table 8.2). The table can then be simply divided by quadrants (adhering to statistically significant breaks in ranking) to assign report card grades to each individual service attribute.

For the benchmark survey, the top quadrant of impact scores will always be a "D" grade level, the bottom quadrant an "A", and the mean impact score for all 46 attributes will always be a B- to C+. However, in future years, benchmark impact scores can be used to designate absolute ranges for grade levels. (See Table 8.1) For CTA Red Line tracking surveys, a "D" can be assigned to all impact scores above 0.586, a "C" to all impact scores within the range of 0.315 to 0.586, a "B" to impact scores between 0.129 and 0.314, and an "A" to impact scores below 0.129. The overall tracking grade for the Line can be the average of the tracking survey impact scores.

It should be kept in mind that, due to regional bias as discussed in section 4D, comparisons in absolute impact score values among transit agency sites are not valid. Only the order of attributes by impact scores should be related. The purpose of the impact score analysis is to identify ways to improve an agency's customer satisfaction and to measure this progress against the agency's own previous data.

Report card grades for attributes can be presented to customers (with a tracking graph as shown in Chart 6.1), as part of tracking surveys. Research in other industries has shown that customers are more likely to participate in customer satisfaction surveys when they are presented with the results of the benchmark and tracking surveys.

	Table 8.1 **Computation of Impact Scores - Red Line** *(N=300)*	**Mean Overall Sat. w/ Problem**	**Mean Overall Sat. w/o Problem**	**Gap Value**	**Percent Who Had Problem**	**Impact Score**	**Report Card**
1	Trains that are not overcrowded	6.10177	7.27778	1.176	0.753	0.886	**D**
2	Reliable trains that come on schedule	5.62092	7.26207	1.641	0.510	0.837	**D**
3	Cost effectiveness, affordability, and value	4.30000	7.00000	2.700	0.291	0.786	**D**
4	Explanations and announcement of delays	5.61224	7.14765	1.535	0.490	0.752	**D**
5	Frequent service so that wait times are short	5.57746	7.13376	1.556	0.474	0.738	**D**
6	Cleanliness of the train interior	5.72611	7.12587	1.400	0.523	0.733	**D**
7	Temperature on the train	5.48062	7.10119	1.621	0.430	0.697	**D**
8	Absence of offensive odors	5.88824	7.07087	1.183	0.567	0.670	**D**
9	Freedom from the nuisance behaviors of others	5.91908	7.03937	1.120	0.577	0.646	**D**
10	Smoothness of the ride and stops	5.54264	7.03509	1.492	0.430	0.642	**D**
11	Availability of seats on the train	6.00000	7.02609	1.026	0.617	0.633	**D**
12	Transit personnel who know the system	4.33333	6.84211	2.509	0.240	0.602	**C**
13	Fairness/consistency of fare structure	4.50000	6.88000	2.380	0.251	0.597	**C**
14	Frequency of delays for repairs/emergencies	5.38636	6.69643	1.310	0.440	0.576	**C**
15	Clear and timely announcements of stops	5.35294	6.93878	1.586	0.340	0.539	**C**
16	Comfort of seats on the train	4.19048	6.69136	2.501	0.206	0.515	**C**
17	Short wait time for transfers	5.30000	7.00552	1.706	0.300	0.512	**C**
18	Friendly, courteous, and quick service	5.03704	6.90654	1.870	0.270	0.505	**C**
19	Ease of paying fare, purchasing tokens	5.72650	6.90588	1.179	0.390	0.460	**C**
20	Cleanliness of stations	5.70339	6.84066	1.137	0.393	0.447	**C**
21	Posted minutes to next train at stations	5.25610	6.85354	1.597	0.273	0.437	**C**
22	Hours of service during weekdays	4.89552	6.83621	1.941	0.223	0.433	**C**
23	Cost of making transfers	4.00000	6.77027	2.770	0.129	0.357	**C**
24	Physical condition of stations	6.01471	6.70732	0.693	0.453	0.314	**B**
25	Displaying of customer service number	5.08929	6.61611	1.527	0.187	0.285	**B**
26	Connecting bus service to stations	5.63014	6.71345	1.083	0.243	0.264	**B**
27	Availability of shelter and benches	5.71429	6.64977	0.935	0.257	0.240	**B**
28	Availability of monthly/discount passes	4.83333	6.38235	1.549	0.150	0.232	**B**
29	Ease of opening doors of train	5.37037	6.61728	1.247	0.180	0.224	**B**
30	Safe and competent conductors	4.89744	6.60385	1.706	0.130	0.222	**B**
31	Availability of schedules/maps at stations	5.49123	6.65297	1.162	0.190	0.221	**B**
32	Cleanliness of the train exterior	5.00000	6.60078	1.601	0.120	0.192	**B**
33	Station names visible from train	5.25000	6.51852	1.269	0.129	0.164	**B**
34	Quietness of the vehicles and system	6.04167	6.50725	0.466	0.258	0.120	**A**
35	Route/direction visible on trains	5.64103	6.50769	0.867	0.130	0.113	**A**
36	Accessibility to those with a disability	5.51724	6.65534	1.138	0.097	0.110	**A**
37	Safety from crime on trains	5.46667	6.50000	1.033	0.100	0.103	**A**
38	Absence of graffiti	6.08333	6.48571	0.402	0.255	0.103	**A**
39	Frequency of service on Saturdays and Sundays	6.31169	6.63804	0.326	0.257	0.084	**A**
40	Number of transfer points outside downtown	6.00000	6.66667	0.667	0.089	0.059	**A**
41	Safety from crime at stations	5.70833	6.43590	0.728	0.080	0.058	**A**
42	Availability of information by phone and mail	5.50000	6.62500	1.125	0.043	0.048	**A**
43	Availability of handrails or grab bars	6.65217	6.61039	-0.042	0.230	-0.010	**A**
44	Physical condition of vehicles and infrastructure	6.50000	6.37349	-0.127	0.108	-0.014	**A**
45	Provision of signs and information in Spanish	7.33333	6.65476	-0.679	0.034	-0.023	**A**
46	Train traveling at a safe speed	6.92857	6.55682	-0.372	0.137	-0.051	**A**

Table 8.2
Summary of Rankings and Scores - CTA Red Line

	Attribute (N=300) Median Importance Rank=4 Low Satisfaction >4 Median Problem Experience Rank=8 (25%) Median Overall Satisfaction Gap Value Rank=3	Impor-tance Ranking	Satis-faction Ranking	Percent Who Experienced Problem		Overall Satisfaction Gap		Impact Score	Report Card
				%	Rank	V	Rank		
1	Trains that are not overcrowded	4	8	75.3	1	1.2	3	0.886	(1) D
2	Reliable trains that come on schedule	1	5	51.0	4	1.6	2	0.837	(2) D
3	Cost effectiveness, affordability, and value	2	4	29.1	8	2.7	1	0.786	*(3) D
4	Explanations and announcements of delays	3	6	49.0	4	1.5	3	0.752	(3) D
5	Frequent service so that wait times are short	2	5	47.4	4	1.6	2	0.738	(4) D
6	Cleanliness of the train interior	3	6	52.3	3	1.4	3	0.733	(4) D
7	Temperature on the train	3	5	43.0	5	1.6	2	0.697	(4) D
8	Absence of offensive odors	3	7	56.7	3	1.2	3	0.670	(5) D
9	Freedom from nuisance behaviors of others	4	7	57.7	2	1.1	4	0.646	(5) D
10	Smoothness of ride and stops	6	5	43.0	5	1.5	3	0.642	(5) D
11	Availability of seats on the train	6	7	61.7	2	1.0	4	0.633	(5) D
12	Transit personnel who know the system	5	4	24.0	8	2.5	1	0.602	*(6) C
13	Fairness/consistency of fare structure	4	5	25.1	8	2.4	1	0.597	*(6) C
14	Frequency of delays for repairs/emergencies	3	5	44.0	5	1.3	3	0.576	*(6) C
15	Clear and timely announcements of stops	6	4	34.0	7	1.6	2	0.539	(6) C
16	Comfort of seats on the train	7	4	20.6	9	2.5	1	0.515	*(7) C
17	Short wait time for transfers	4	4	30.0	7	1.7	2	0.512	(7) C
18	Friendly, courteous, and quick service	4	4	27.0	8	1.9	2	0.505	(7) C
19	Ease of paying fare, purchasing tokens	5	4	39.0	6	1.2	3	0.460	(8) C
20	Cleanliness of stations	5	5	39.3	6	1.1	4	0.447	(8) C
21	Posted minutes to next train at stations	7	5	27.3	8	1.6	2	0.437	(8) C
22	Hours of service during weekdays	3	2	22.3	8	1.9	2	0.433	(8) C
23	Cost of making transfers	7	3	12.9	10	2.8	1	0.357	*(9) C
24	Physical condition of stations	4	5	45.3	5	0.7	5	0.314	(9) C
25	Displaying of customer service number	8	6	18.7	9	1.5	3	0.285	(9) C
26	Connecting bus service to stations	7	4	24.3	8	1.1	4	0.264	(10) B
27	Availability of shelter and benches	7	5	25.7	8	0.9	4	0.240	(11) B
28	Availability of monthly/discount passes	7	3	15.0	9	1.5	3	0.232	*(11) B
29	Ease of opening doors of train	6	2	18.0	9	1.2	3	0.224	(11) B
30	Safe and competent conductors	2	2	13.0	10	1.7	2	0.222	(11) B
31	Availability of schedules/maps at stations	8	5	19.0	9	1.2	3	0.221	(11) B
32	Cleanliness of the train exterior	9	4	12.0	10	1.6	2	0.192	(12) B
33	Station names visible from train	4	2	12.9	10	1.3	3	0.164	*(12) B
34	Quietness of the vehicles and system	7	5	25.8	8	0.5	5	0.120	*(13) A
35	Route/direction information visible on train	5	2	13.0	10	0.9	4	0.113	(13) A
36	Accessibility to those with a disability	6	5	9.7	11	1.1	4	0.110	(13) A
37	Safety from crime on trains	1	3	10.0	10	1.0	4	0.103	(13) A
38	Absence of graffiti	6	5	25.5	8	0.4	5	0.103	*(13) A
39	Frequency of service on Saturdays and Sundays	8	5	25.7	8	0.3	6	0.084	(13) A
40	Number of transfer points outside downtown	8	3	8.9	11	0.7	5	0.059	*(14) A
41	Safety from crime at stations	1	3	8.0	11	0.7	5	0.058	(14) A
42	Availability of information by phone and mail	7	3	4.3	12	1.1	4	0.048	*(15) A
43	Availability of handrails or grab bars	5	3	23.0	8	0.0	6	-0.010	*(16) A
44	Physical condition of vehicles and infrastructure	3	3	10.8	10	-0.1	7	-0.014	*(16) A
45	Provision of signs and information in Spanish	10	3	3.4	12	-0.7	7	-0.023	*(16) A
46	Train traveling at a safe speed	3	1	13.7	10	-0.4	7	-0.051	*(17) A

( ) Numbers indicate statistically significant rank at the 90% confidence interval level **Split sample size=100* *Shaded cells are above median*

Chart 8.3
Quadrant Analysis of Performance *(Satisfaction)* vs. Importance for CTA Red Line Service

The intersection of the axis is the median rank value on importance (from left to right) and satisfaction (from bottom to top)

(N=300)

NOTE: Please refer to the numbered list of attributes in Table 8.1 and 8.2 for descriptions of the attributes shown as numbers in the above chart.

The "target area" consists of the attributes that riders consider very important, but are rated low on satisfaction. The following attributes fell into the "target area" for the CTA Red Line:

- Trains that are not overcrowded
- Reliable trains that come on schedule
- Explanations and announcements of delays
- Frequent service so that wait times are short
- Cleanliness of the train interior
- Temperature on the train
- Fairness/consistency of fare structure
- Frequency of delays for repairs/emergencies
- Cleanliness of stations
- Physical condition of stations

8D. CTA Red Line — Comparison with Factor Analysis

A factor analysis was performed on the 30 attributes not included in split sampling (all respondents were asked to rate each of these questions). It should be noted, utilizing the impact score approach, only one attribute that appears in the target area was a part of split sampling treatment: "cost effectiveness, affordability, and value". However, five of split sample attributes placed within the second tier for impact score rankings. Split sampling of 18 attributes (including "having a station near my home" and "having a station near my destination") was used in the TCRP B-11 project to reduce the length of the phone interview. Each respondent was asked to rate the same 30 attributes, the remaining 18 attributes where rated by only a third of the sample (100 respondents for the Red Line), with each third being asked to rate a different 6 attributes.

Split sampling cannot be effectively used when factor analysis is employed. For factor analysis to be reliable without very large sample sizes, all respondents must be asked all questions. Therefore, this factor analysis comparison is based on comparison analysis of the 30 attributes asked of all CTA Red Line customers.

The correlation results for the factor solution are displayed in Table 8.4. Four dimensions were found which are labeled: "trip performance", "personal security", "customer service", and "comfort".

The communality correlations for the attributes within each dimension are as shown for each attribute.

Table 8.4
Factor Dimensions for CTA Red Line Service

1 Trip Performance		2 Personal Security		3 Customer Service		4 Comfort	
Frequent Service	0.7318*	Safety on Trains	0.7445*	Service # Display	0.6166*	Not crowded	0.7164*
Reliable, On-Time	0.7147*	Safety at Stations	0.7123*	Maps at Stations	0.6079*	Seat Availability	0.6261*
Wait for Transfers	0.6884*	Absence of Odors	0.6765*	Posted Schedule	0.5457*	Train Temperature	0.5684
Hours of Service	0.6453*	Clean Interiors	0.6637*	Shelters/Benches	0.5588	Ride Smoothness	0.5092
Friendly Service	0.6030*	Free of Nuisances	0.5822*	Disability Access	0.5003		
Delay Explanations	0.5913*	Clean Stations	0.5623*				
Route Info. on Rail	0.5795*	Clean Exteriors	0.4532*				
Safe Conductors	0.5444*	Stations Condition	0.4993				
Connecting Buses	0.5223*	Ease Paying Fare	0.3342				
Announcement Clarity	0.5217*						
Opening Doors	0.5195*						
Frequency Sat/Sun.	0.4223						

** values greater than 0.5 significance (N=300)*

None of the intercorrelations among attributes is above the 0.8 level that would be considered highly correlated. All except one correlation are within the medium range of 0.4 to 0.8. The factor analysis does little to help us differentiate among the many "trip performance" attributes as to what should be targeted for agency action. It is clear Red Line customers equate cleanliness of the trains and stations with a sense of personal security and safety; however, the travel environment attributes important to Red Line customers were more specifically identified by the impact score analysis. Shelters and benches could be as easily correlated with the "comfort" dimension as with "customer service".

When multiple regression analysis is performed to identify the dimensions' order in terms of the strength of their relationship with overall satisfaction with Red Line service, the order is as follows:

1. Trip performance
2. Comfort
3. Customer service
4. Personal security

By contrast the impact score analysis found the target area attributes for Red Line Service to be a combination of specific attributes within the trip performance, comfort, and personal security dimensions. "Not overcrowded", "temperature on trains", smoothness of ride", "absence of odors", and "clean train interiors" all have higher correlations with (or impacts on) overall satisfaction than "route/direction information on trains", "connecting bus service", or "frequency of service on Saturdays/Sundays" — all attributes placed within the first ordered dimension. A factor analysis alone would be unlikely to target important and specific trip environment characteristics which cross factor defined dimension boundaries.

CTA BLUE LINE SERVICE

8E. CTA Blue Line - Computation of Impact Scores

The top target area attributes for the CTA Blue Line as determined by the impact score approach are as shown below:

CTA Blue Line Service
Target Attributes
(N=302)

	Attribute
1	Reliable trains that come on schedule
2	Frequent service so that wait times are short
3	Availability of seats on the train
4	Trains that are not overcrowded
5	Frequency of delays for repairs/emergencies
6	Cost effectiveness, affordability, and value
7	Explanations and announcement of delays
8	Friendly, courteous, and quick service
9	Smoothness of the ride and stops
10	Ease of paying fare, purchasing tokens
11	Clear and timely announcement of stops
12	Fairness/consistency of fare structure

Thus, for Blue Line service, customer-defined requirements are more travel performance oriented than for Red Line service in Chicago. Also, the physical condition of vehicles and infrastructure is more likely to have an impact on overall satisfaction for Blue Line riders. Red Line service customers are more concerned with such travel environment elements as:

- Cleanliness of the train interior
- Temperature on the train
- Absence of offensive odors
- Freedom from the nuisance behaviors of others

The attributes above have slightly lower reported problem occurrence rates on the Blue Line, and also have less impact on Blue Line customers' overall satisfaction.

8F. CTA Blue Line — Comparison with Quadrant Analysis

When impact score results for the CTA Blue Line, as shown in Table 8.5 and Table 8.6, are compared with Quadrant Analysis results as shown in Chart 8.7, significant differences appear.

Differences in Impact Score and Quadrant Analysis results are identified as follows:

In Target Area by Impact Scores, but not by Quadrant Analysis

Cost Efficiency, Value and *Friendly Service* — The quadrant analysis does not take into account this attribute's high impact on overall satisfaction; any significant rise in problem occurrence for this attribute could have a large impact on overall satisfaction.

Availability of Seats — The quadrant analysis does not take into account the high reported problem occurrence, while the attribute has a moderate impact on overall satisfaction.

Ease of Paying Fare and *Clear and Timely Announcements* — The quadrant analysis does not take into account both the moderately high reported problem occurrence and moderate impact on overall satisfaction displayed by these two attributes.

In Target Area by Quadrant Analysis, but not by Impact Scores

Cleanliness of Stations — The quadrant analysis does not consider the modest problem occurrence reported and the attribute's modest impact on overall satisfaction.

Absence of Offensive Odors, Cleanliness of Interiors, Freedom from Nuisance Behaviors of Others — The quadrant analysis does not take into account that these attributes lower impact on overall satisfaction for Blue Line customers.

8G. CTA Blue Line - Translation of Impact Scores to a Report Card

Once impact scores are placed in descending order, statistically significant differences in ranking can be calculated using standard tests for statistical significance (Table 8.6). The table can then be simply divided by quadrants (adhering to statistically significant breaks in ranking) to assign report card grades to each individual service attribute.

For future CTA Blue Line tracking surveys, a grade level "D" can be assigned to all attributes with impact scores above 0.350, a "C" can be assigned to all impact scores within the range of 0.249 to 0.350, a "B" to impact scores between 0.122 to 0.248, and an "A" to impact scores below 0.121.

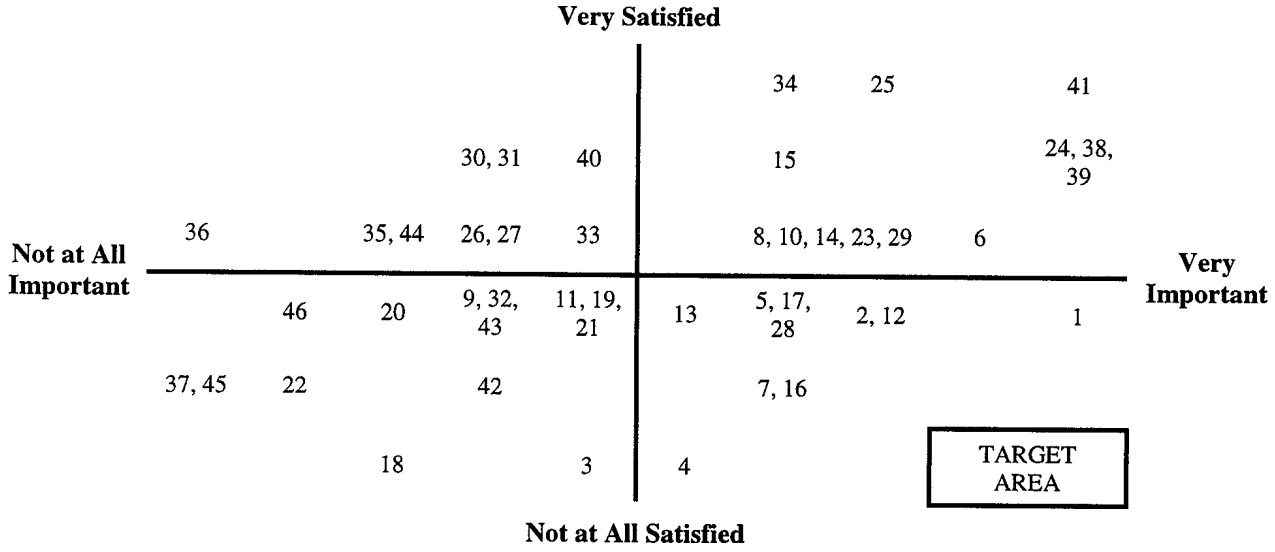
	Table 8.5 Computation of Impact Scores – Blue Line *(N=302)* Attribute	Mean Overall Sat. w/ Problem	Mean Overall Sat. w/o Problem	Gap Value	Percent Who Had Problem	Impact Score	Report Card
1	Reliable trains that come on schedule	6.16779	7.93377	1.766	0.494	0.872	D
2	Frequent service so that wait times are short	6.11679	7.85277	1.736	0.454	0.788	D
3	Availability of seats on the train	6.48824	7.77273	1.284	0.563	0.723	D
4	Trains that are not overcrowded	6.71066	7.77670	1.066	0.652	0.695	D
5	Frequency of delays for repairs/emergencies	6.30952	7.76786	1.458	0.429	0.626	D
6	Cost effectiveness, affordability, and value	4.68421	7.72840	3.044	0.190	0.578	D
7	Explanations and announcement of delays	6.48630	7.60131	1.115	0.483	0.539	D
8	Friendly, courteous, and quick service	5.56164	7.52444	1.963	0.242	0.475	D
9	Smoothness of the ride and stops	6.38136	7.46995	1.089	0.391	0.426	D
10	Ease of paying fare, purchasing tokens	6.20618	7.46392	1.258	0.321	0.404	D
11	Clear and timely announcements of stops	6.22680	7.46078	1.234	0.321	0.396	D
12	Fairness/consistency of fare structure	5.55556	7.53165	1.976	0.186	0.368	D
13	Cleanliness of stations	6.21348	7.39906	1.186	0.295	0.350	C
14	Temperature on the train	6.50442	7.37566	0.871	0.374	0.326	C
15	Transit personnel who know the system	4.11111	7.48235	3.371	0.096	0.324	C
16	Absence of offensive odors	6.67153	7.36585	0.694	0.454	0.315	C
17	Cleanliness of the train interior	6.67164	7.35119	0.680	0.444	0.302	C
18	Displaying of customer service number	5.92063	7.32850	1.408	0.209	0.294	C
19	Short wait time for transfers	6.45161	7.40237	0.951	0.308	0.293	C
20	Posted minutes to next train at stations	6.01563	7.39352	1.378	0.212	0.292	C
21	Physical condition of stations	6.55455	7.32461	0.770	0.364	0.280	C
22	Quietness of the vehicles and system	6.43243	7.10938	0.677	0.366	0.248	B
23	Physical condition of vehicles and infrastructure	5.42857	7.14118	1.713	0.141	0.241	B
24	Safe and competent conductors	5.57143	7.30469	1.733	0.139	0.241	B
25	Hours of service during weekdays	5.85106	7.27381	1.423	0.156	0.222	B
26	Connecting bus service to stations	6.15254	7.23881	1.086	0.195	0.212	B
27	Comfort of seats on the train	5.92857	7.34884	1.420	0.140	0.199	B
28	Freedom from the nuisance behaviors of others	6.72477	7.22917	0.504	0.361	0.182	B
29	Availability of handrails or grab bars	6.45000	7.27500	0.825	0.200	0.165	B
30	Number of transfer points outside downtown	5.14286	7.10390	1.961	0.083	0.163	B
31	Route/direction visible on trains	5.13043	7.21455	2.084	0.076	0.158	B
32	Availability of shelter and benches	6.52174	7.20601	0.684	0.228	0.156	B
33	Availability of monthly/discount passes	6.50000	7.29730	0.797	0.140	0.112	A
34	Station names visible from train	5.16667	7.00000	1.833	0.059	0.108	A
35	Availability of schedules/maps at stations	6.45238	7.19919	0.747	0.139	0.104	A
36	Cleanliness of the train exterior	6.33333	7.17121	0.838	0.109	0.091	A
37	Frequency of service on Saturdays and Sundays	6.70455	7.17089	0.466	0.146	0.068	A
38	Safety from crime on trains	6.20000	7.10676	0.907	0.066	0.060	A
39	Safety from crime at stations	6.18750	7.09790	0.910	0.053	0.048	A
40	Ease of opening doors of train	6.90698	7.11200	0.205	0.142	0.029	A
41	Train traveling at a safe speed	6.90909	7.13483	0.226	0.110	0.025	A
42	Accessibility to those with a disability	6.92000	7.05310	0.133	0.083	0.011	A
43	Absence of graffiti	6.88462	6.89474	0.010	0.255	0.003	A
44	Availability of information by phone and mail	7.33333	7.15476	-0.179	0.067	-0.012	A
45	Provision of signs and information in Spanish	7.60000	7.07143	-0.529	0.056	-0.030	A
46	Cost of making transfers	7.22222	6.83117	-0.391	0.105	-0.041	A

Table 8.6
Summary of Rankings and Scores - CTA Blue Line

	Table 8.6 Summary of Rankings and Scores - CTA Blue Line								
	Median Importance Rank=4 Low Satisfaction >3 *(N=302)* Median Problem Experience Rank=8 (19%) **Attribute** Median Overall Satisfaction Gap Value Rank=4	**Importance Ranking**	**Satisfaction Ranking**	**Percent Who Experienced Problem**		**Overall Satisfaction Gap**		**Impact Score**	**Report Card**
				%	**Rank**	**V**	**Rank**		
1	Reliable trains that come on schedule	1	4	49.4	3	1.8	3	0.872	(1) D
2	Frequent service so that wait times are short	3	4	45.4	3	1.7	3	0.788	(1) D
3	Availability of seats on the train	6	6	56.3	2	1.3	4	0.723	(2) D
4	Trains that are not overcrowded	5	6	65.2	1	1.1	5	0.695	(2) D
5	Frequency of delays for repairs/emergencies	4	4	42.9	4	1.5	4	0.626	*(3) D
6	Cost effectiveness, affordability, and value	2	3	19.0	8	3.0	1	0.578	*(3) D
7	Explanations and announcement of delays	4	5	48.3	3	1.1	5	0.539	(4) D
8	Friendly, courteous, and quick service	4	3	24.2	7	2.0	2	0.475	(5) D
9	Smoothness of the ride and stops	7	4	39.1	5	1.1	5	0.426	(6) D
10	Ease of paying fare, purchasing tokens	4	3	32.1	6	1.3	4	0.404	(6) D
11	Clear and timely announcements of stops	6	4	32.1	6	1.2	4	0.396	(6) D
12	Fairness/consistency of fare structure	3	4	18.6	8	2.0	2	0.368	*(6) D
13	Cleanliness of stations	5	4	29.5	6	1.2	4	0.350	(7) C
14	Temperature on the train	4	3	37.4	5	0.9	5	0.326	(7) C
15	Transit personnel who know the system	4	2	9.6	10	3.4	1	0.324	*(7) C
16	Absence of offensive odors	4	5	45.4	3	0.7	6	0.315	(7) C
17	Cleanliness of the train interior	4	4	44.4	4	0.7	6	0.302	(8) C
18	Displaying of customer service number	8	6	20.9	7	1.4	4	0.294	(8) C
19	Short wait time for transfers	6	4	30.8	6	1.0	5	0.293	(8) C
20	Posted minutes to next train at stations	8	4	21.2	7	1.4	4	0.292	(8) C
21	Physical condition of stations	6	4	36.4	5	0.8	5	0.280	(8) C
22	Quietness of the vehicles and system	9	5	36.6	5	0.7	6	0.248	*(9) B
23	Physical condition of vehicles and infrastructure	4	3	14.1	9	1.7	3	0.241	*(9) B
24	Safe and competent conductors	1	2	13.9	9	1.7	3	0.241	(9) B
25	Hours of service during weekdays	3	1	15.6	9	1.4	4	0.222	(9) B
26	Connecting bus service to stations	7	3	19.5	8	1.1	5	0.212	(9) B
27	Comfort of seats on the train	7	3	14.0	9	1.4	4	0.199	*(10) B
28	Freedom from the nuisance behaviors of others	4	4	36.1	5	0.5	6	0.182	(10) B
29	Availability of handrails or grab bars	4	3	20.0	7	0.8	5	0.165	*(10) B
30	Number of transfer points outside downtown	7	2	8.3	10	2.0	2	0.163	*(10) B
31	Route/direction visible on trains	7	2	7.6	10	2.1	2	0.158	(10) B
32	Availability of shelter and benches	7	4	22.8	7	0.7	6	0.156	(10) B
33	Availability of monthly/discount passes	6	3	14.0	9	0.8	5	0.112	*(11) A
34	Station names visible from train	4	1	5.9	10	1.8	3	0.108	*(11) A
35	Availability of schedules/maps at stations	8	3	13.9	9	0.7	6	0.104	(11) A
36	Cleanliness of the train exterior	10	3	10.9	10	0.8	5	0.091	(11) A
37	Frequency of service on Saturdays and Sundays	10	5	14.6	9	0.5	6	0.068	(12) A
38	Safety from crime on trains	1	2	6.6	10	0.9	5	0.060	(12) A
39	Safety from crime at stations	1	2	5.3	11	0.9	5	0.048	(12) A
40	Ease of opening doors of train	6	2	14.2	9	0.2	7	0.029	(13) A
41	Train traveling at a safe speed	1	1	11.0	10	0.2	7	0.025	*(13) A
42	Accessibility of trains to those with a disability	7	5	8.3	10	0.1	7	0.011	(14) A
43	Absence of graffiti	7	4	25.5	7	0.0	8	0.003	*(14) A
44	Availability of information by phone and mail	8	3	6.7	10	-0.2	8	-0.012	*(15) A
45	Provision of signs and information in Spanish	10	5	5.6	11	-0.5	8	-0.030	*(16) A
46	Cost of making transfers	9	4	10.5	10	-0.4	8	-0.041	*(16) A

*( ) Numbers indicate statistically significant rank at the 90% confidence interval level *Split sample size=100 Shaded cells are above median*

Chart 8.7
Quadrant Analysis of Performance *(Satisfaction)* vs. Importance for CTA Blue Line Service



The intersection of the axis is the median rank value on importance (from left to right) and satisfaction (from bottom to top)

(N=302)

NOTE: Please refer to the numbered list of attributes in Table 8.5 and 8.6 for descriptions of the attributes shown as numbers in the above chart.

The "target area" consists of the attributes that riders consider very important, but are rated low on satisfaction. The following attributes fell into the "target area" for the CTA Blue Line:

- Reliable trains that come on schedule
- Frequent service so that wait times are short
- Frequency of delays for repairs/emergencies
- Explanations and announcement of delays
- Fairness/consistency of fare structure
- Cleanliness of stations
- Absence of offensive odors
- Cleanliness of the train interior
- Freedom from the nuisance behaviors of others

8H. CTA Blue Line — Comparison with Factor Analysis

A factor analysis was performed for the 30 attributes not included in split sampling (all respondents were asked to rate each of these questions). The CTA Blue Line correlation results for the factor solution are displayed in Table 8.8 below. Five dimensions were found which are labeled: "personal security", "trip performance", "communications", "customer/agency interaction", and "transfer service".

The communality correlations for the attributes within each dimension are as shown for each attribute.

Table 8.8
Factor Dimensions for CTA Blue Line Service

1 Personal Security		2 Trip Performance		3 Communications		4 Customer/Agency Interactions	
Safety at Stations	0.7181*	Reliable, On-Time	0.7096*	Route Info. on Rail	0.6074*	Safe Conductors	0.6582*
Safety on Trains	0.6601*	Frequent Service	0.7193*	Posted Schedule	0.5329*	Friendly Service	0.6215*
Absence of Odors	0,6424*	Seat Availability	0.6744*	Maps at Stations	0.5127*	Ride Smoothness	0.5858*
Clean Interiors	0.6042*	Not crowded	0.6558*	Service # Display	0.4747*	Hours of Service	0.5330
Clean Stations	0.5900*	Ease Paying Fare	0.5642*	Frequency Sat/Sun	0.6213	Delay Explanations	0.4670
Free of Nuisances	0.5533*	Train Temperature	0.5328	Announcement Clarity	0.6170	Opening Doors	0.3878
Stations Condition	0.5368			Disability Access	0.4587	**5 Transfer Services**	
Shelters/Benches	0.4577			Clean Exterior	0.6189	Connecting Buses	0.5860*
						Wait for Transfers	0.5735*

** values greater than 0.5 significance (N=302)*

None of the intercorrelations among attributes is above the 0.8 level that would be considered highly correlated. All except one correlation are within the medium range of 0.4 to 0.8.

The factor analysis for Blue Line service attributes is less differentiated than for the Red Line. Multicolinearity among attributes is extensive. The factor analysis obtained significant values for only two-thirds of the 30 attributes tested. For example, the temperature on the train is closely correlated with the dimension of trip performance but also with perceptions of customer/agency interactions.

On the basis of multiple regression analysis using the dimensions as the independent variables, the order of the dimensions in terms of their affect on overall satisfaction is as follows:

1. Trip performance
2. Customer/agency interactions
3. Communications
4. Transfer service
5. Personal security

Three of the attributes identified by the impact score approach as within the top tier for target issues are not within the top factor analysis dimension — because they were not highly correlated with other trip performance attributes. These attributes are: explanations/announcements of delays, friendly/courteous/ quick personnel, and smoothness of the ride and stop. All of these attributes are placed by the factor analysis in a secondary dimension tier that we have labeled "customer/agency interactions".

COMBINED CTA RAIL

8I. Combined CTA Rail - Computation of Impact Scores

The top target attributes for combined CTA rail customers, determined from weighted data as defined in Appendix D, and determined by the impact score approach are as shown below:

Combined CTA Rail
Target Attributes
(N=602)

	Attribute
1	Trains that are not overcrowded
2	Reliable trains that come on schedule
3	Frequent service so that wait times are short
4	Cost effectiveness, affordability, and value
5	Availability of seats on the train
6	Explanations and announcement of delays
7	Frequency of delays for repairs/emergencies
8	Cleanliness of the train interior
9	Temperature on the train
10	Smoothness of the ride and stops
11	Absence of offensive odors

The target issues or attributes are a combination of travel performance and travel environment issues. As previously noted, Blue Line customers are more concerned with the former. (See Tables 8.9 and 8.10 for impact scores).

It should also be noted that for the top attribute of concern, "trains that are not overcrowded", almost three-fourths (72%) of CTA customers report that they have had a problem with this within the last 30 days. Also, satisfaction with this attribute was the lowest for all attributes. However, perhaps due to the fact that such a high percentage of customers experience this problem, negative experience does not show a high impact on overall satisfaction, and the attribute ranks only in the median range for importance. Thus, while this attribute should be tracked, it is possible that reducing the percent of customers experiencing a problem with overcrowding will not have a significant effect on improving overall satisfaction.

The impact score analysis shows both Red Line and Blue Line customers to be price sensitive. The "cost and value" attribute should also be carefully tracked. Experiencing problems with this attribute has a significant impact on overall satisfaction with service; a rise in the percent of customers reporting a problem with cost or value could significantly lower overall customer satisfaction levels.

Almost half of CTA customers report experiencing a problem with four travel environment issues:

- Cleanliness of the train interior
- Temperature on the train
- Smoothness of the ride and stops
- Absence of offensive odors

The first two have significant effects on overall customer satisfaction with service; the latter two, smoothness of the ride and stops and absence of offensive odors, have an impact on overall satisfaction that is just below the median for all attributes.

Frequency of service on Saturdays and Sundays, accessibility of trains to those with a disability, and absence of graffiti have high dissatisfaction ratings; however, these attributes are shown by the impact score approach to have low or moderate problem occurrence rates and affects on overall satisfaction.

CTA generally gets high marks on:

- Number of transfer points
- Safety from crime on trains and at stations
- Physical condition of vehicles and infrastructure
- Availability of information by phone and mail
- Traveling at a safe speed

8J. Combined CTA Rail — Comparison with Quadrant Analysis

When impact score results for the combined CTA Rail customers are compared with Quadrant Analysis results as shown in Chart 8.11, significant differences appear.

The quadrant analysis does not take into account the relatively low problem incidence rate for "fairness and consistency of fares" and "cost effectiveness, affordability, and value", coupled with the very high affect of "cost and value" on overall satisfaction. The quadrant analysis includes "fairness and consistency of fares" in the target issues but excludes "cost and value".

The quadrant analysis includes "freedom from the nuisance behaviors of others"; however, this attribute is reported as a problem by only 26% of customers and has an impact on overall satisfaction that is below the median for all attributes. Conversely, "availability of seating, "trains that are not overcrowded", and "smoothness of ride" are excluded from the target area in a quadrant analysis, ignoring their high reported problem incidence rates, coupled with moderate to high impacts on overall satisfaction.

Due to weighting complications and the unreliability of factor solutions for the CTA Blue Line (extensive multicolinearity among attributes), the factor analysis for combined CTA Rail customer ratings did not yield meaningful or reliable results.

	Table 8.9 Computation of Impact Scores – Comb. CTA *(N=602)* Attribute	Mean Overall Sat. w/ Problem	Mean Overall Sat. w/o Problem	Gap Value	Percent Who Had Problem	Impact Score	Report Card
1	Trains that are not overcrowded	6.29363	7.49242	1.199	0.718	0.861	D
2	Reliable trains that come on schedule	5.80658	7.50032	1.694	0.504	0.854	D
3	Frequent service so that wait times are short	5.75943	7.38828	1.629	0.467	0.761	D
4	Cost effectiveness, affordability, and value	4.39626	7.26903	2.873	0.257	0.738	D
5	Availability of seats on the train	6.15946	7.30777	1.148	0.598	0.687	D
6	Explanations and announcement of delays	5.91285	7.30710	1.394	0.488	0.680	D
7	Frequency of delays for repairs/emergencies	5.69564	7.06657	1.371	0.436	0.598	D
8	Cleanliness of the train interior	6.01977	7.21211	1.192	0.496	0.591	D
9	Temperature on the train	5.80431	7.20345	1.399	0.411	0.575	D
10	Smoothness of the ride and stops	5.81572	7.19205	1.376	0.416	0.573	D
11	Absence of offensive odors	6.12198	7.19043	1.068	0.527	0.563	D
12	Fairness/consistency of fare structure	4.78248	7.11284	2.330	0.233	0.543	C
13	Transit personnel who know the system	4.29662	7.07976	2.783	0.192	0.534	C
14	Freedom from the nuisance behaviors of others	6.12014	7.12360	1.003	0.502	0.504	C
15	Friendly, courteous, and quick service	5.20614	7.12706	1.921	0.260	0.499	C
16	Clear and timely announcements of stops	5.64498	7.12386	1.479	0.333	0.492	C
17	Ease of paying fare, purchasing tokens	5.87251	7.11565	1.243	0.366	0.455	C
18	Cleanliness of stations	5.84863	7.05388	1.205	0.359	0.433	C
19	Comfort of seats on the train	4.64287	6.92748	2.285	0.183	0.418	C
20	Short wait time for transfers	5.79642	7.13653	1.340	0.303	0.406	C
21	Posted minutes to next train at station	5.47769	7.05084	1.573	0.252	0.396	C
22	Hours of service during weekdays	5.15371	6.99567	1.842	0.200	0.368	C
23	Physical condition of stations	6.17621	6.94231	0.766	0.422	0.323	C
24	Displaying of customer service number	5.39901	6.85914	1.460	0.194	0.283	B
25	Connecting bus service to station	5.78635	6.91459	1.128	0.227	0.256	B
26	Safe and competent conductors	5.14170	6.84351	1.702	0.133	0.226	B
27	Cost of making transfers	4.97181	6.79186	1.820	0.121	0.220	B
28	Availability of shelter and benches	5.97356	6.85097	0.877	0.247	0.217	B
29	Availability of monthly/discount passes	5.40911	6.71615	1.307	0.146	0.191	B
30	Availability of schedules/maps at stations	5.76036	6.85627	1.096	0.172	0.188	B
31	Ease of opening doors of train	5.82508	6.79138	0.966	0.167	0.161	B
32	Cleanliness of the train exterior	5.43475	6.79734	1.363	0.116	0.158	B
33	Station names visible from train	5.23260	6.70261	1.470	0.104	0.153	B
34	Quietness of the vehicles and system	6.21698	6.70514	0.488	0.298	0.145	B
35	Route/direction visible on trains	5.51982	6.76093	1.241	0.111	0.138	B
36	Number of transfer points outside downtown	5.70389	6.82442	1.121	0.087	0.097	A
37	Safety from crime on trains	5.65754	6.71720	1.060	0.088	0.093	A
38	Frequency of service on Saturdays and Sundays	6.40272	6.81838	0.416	0.218	0.091	A
39	Accessibility to those with a disability	5.95590	6.80120	0.845	0.092	0.078	A
40	Physical condition of vehicles and infrastructure	6.04472	6.64285	0.598	0.120	0.072	A
41	Absence of graffiti	6.37482	6.63472	0.260	0.255	0.066	A
42	Safety from crime at stations	5.82205	6.67161	0.850	0.071	0.060	A
43	Availability of handrails or grab bars	6.58857	6.84577	0.257	0.220	0.057	A
44	Availability of information by phone and mail	6.31010	6.80248	0.492	0.051	0.025	A
45	Train traveling at a safe speed	6.92286	6.75798	-0.165	0.128	-0.021	A
46	Provision of signs and information in Spanish	7.45813	6.79871	-0.659	0.042	-0.028	A

Table 8.10
Summary of Rankings and Scores - Combined CTA Rail

	Attribute	Median Importance Rank=6 Median Importance Rank=6 (N=602) Median Problem Experience Rank=9 (23%) Median Overall Satisfaction Gap Value Rank =6	Importance Ranking	Satisfaction Ranking	Percent Who Experienced Problem		Overall Satisfaction Gap		Impact Score	Report Card
					%	Rank	V	Rank		
1	Trains that are not overcrowded		6	11	71.8	1	0.9	8	0.861	(1) D
2	Reliable trains that come on schedule		1	7	50.4	3	1.7	4	0.854	(1) D
3	Frequent service so that wait times are short		3	7	46.7	4	1.6	4	0.761	(2) D
4	Cost effectiveness, affordability, and value		3	5	25.7	9	2.3	2	0.738	*(3) D
5	Availability of seats on the train		7	10	59.8	2	1.2	6	0.687	(3) D
6	Explanations and announcement of delays		4	8	48.8	4	1.4	5	0.680	(4) D
7	Frequency of delays for repairs/emergencies		5	7	43.6	5	2.8	1	0.598	*(5) D
8	Cleanliness of the train interior		4	8	49.6	3	1.2	6	0.591	(5) D
9	Temperature on the train		5	6	41.1	5	1.4	5	0.575	(5) D
10	Smoothness of the ride and stops		7	7	41.6	5	0.8	8	0.573	(5) D
11	Absence of offensive odors		4	9	52.7	3	1.1	7	0.563	(5) D
12	Fairness/consistency of fare structure		5	6	23.3	9	1.4	5	0.543	*(6) C
13	Transit personnel who know the system		6	4	19.2	11	1.3	6	0.534	*(6) C
14	Freedom from the nuisance behaviors of others		5	8	50.2	3	1.0	7	0.504	(6) C
15	Friendly, courteous, and quick service		5	5	26.0	8	1.9	3	0.499	(6) C
16	Clear and timely announcements of stops		7	6	33.3	7	1.5	5	0.492	(6) C
17	Ease of paying fare, purchasing tokens		6	6	36.6	6	1.2	6	0.455	(7) C
18	Cleanliness of stations		6	7	35.9	6	1.2	6	0.433	(7) C
19	Comfort of seats on the train		8	5	18.3	11	1.5	5	0.418	*(8) C
20	Short wait time for transfers		6	6	30.3	7	1.3	6	0.406	(8) C
21	Posted minutes to next train at station		8	7	25.2	9	1.6	4	0.396	(9) C
22	Hours of service during weekdays		4	2	20.0	10	1.8	3	0.368	(9) C
23	Physical condition of stations		6	7	42.2	5	-0.7	12	0.323	(10) C
24	Displaying of customer service number		9	9	19.4	11	1.5	5	0.283	(11) B
25	Connecting bus service to station		8	5	22.7	10	1.1	7	0.256	(11) B
26	Safe and competent conductors		2	3	13.3	13	1.7	4	0.226	(12) B
27	Cost of making transfers		9	5	12.1	13	0.4	10	0.220	*(12) B
28	Availability of shelter and benches		8	6	24.7	9	1.4	5	0.217	(12) B
29	Availability of monthly/discount passes		8	5	14.6	12	2.3	2	0.191	*(13) B
30	Availability of schedules/maps at stations		9	6	17.2	11	1.1	7	0.188	(13) B
31	Ease of opening doors of train		7	2	16.7	12	1.0	7	0.161	(14) B
32	Cleanliness of the train exterior		10	5	11.6	13	1.4	5	0.158	(14) B
33	Station names visible from train		5	2	10.4	14	0.5	9	0.153	*(14) B
34	Quietness of the vehicles and system		8	7	29.8	8	1.1	7	0.145	*(14) B
35	Route/direction visible on trains		7	2	11.1	13	1.2	6	0.138	(14) B
36	Number of transfer points outside downtown		9	4	8.7	14	1.8	3	0.097	*(15) A
37	Safety from crime on trains		1	4	8.8	14	1.1	7	0.093	(15) A
38	Frequency of service on Saturdays and Sundays		10	8	21.8	10	1.1	7	0.091	(15) A
39	Accessibility to those with a disability		8	7	9.2	14	0.8	8	0.078	(15) A
40	Physical condition of vehicles and infrastructure		4	4	12.0	13	0.6	9	0.072	*(16) A
41	Absence of graffiti		8	6	25.5	9	0.3	10	0.066	*(16) A
42	Safety from crime at stations		1	4	7.1	14	0.8	8	0.060	(16) A
43	Availability of handrails or grab bars		6	4	22.0	10	0.5	9	0.057	*(16) A
44	Availability of information by phone and mail		8	4	5.1	15	-0.2	11	0.025	*(17) A
45	Train traveling at a safe speed		3	1	12.8	13	2.9	1	-0.021	*(18) A
46	Provision of signs and information in Spanish		10	5	4.2	15	0.3	10	-0.028	*(18) A

( ) Numbers indicate statistically significant rank at the 90% confidence interval level **Split sample size=100* *Shaded cells are above median*

Chart 8.11
Quadrant Analysis of Performance *(Satisfaction)* vs. Importance for Combined CTA Rail Service

The intersection of the axis is the median rank value on importance (from left to right) and satisfaction (from bottom to top)

(N=602)

NOTE: Please refer to the numbered list of attributes in Tables 8.9 and 8.10 for descriptions of the attributes shown as numbers in the above chart.

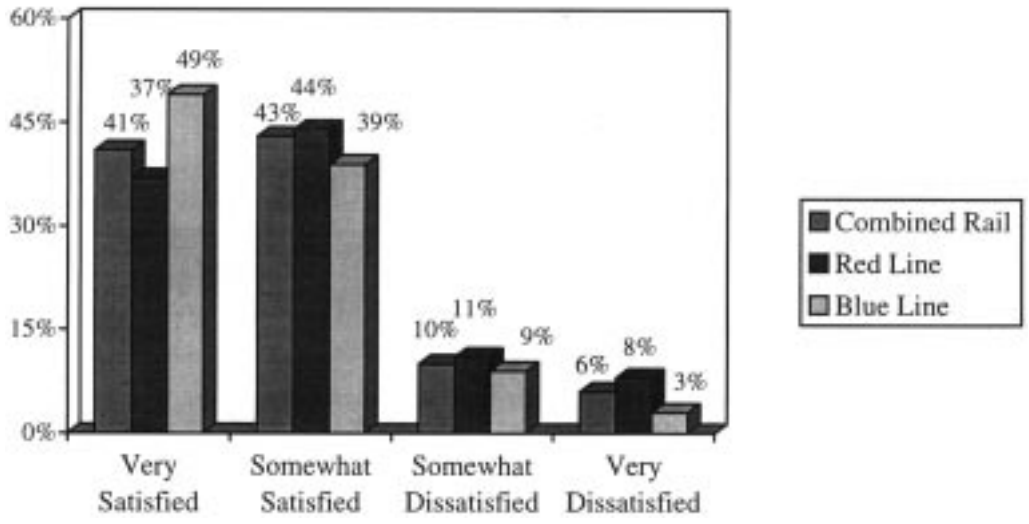
The "target area" consists of the attributes that riders consider very important, but are rated low on satisfaction. The following attributes fell into the "target area" for combined CTA Rail:

- Reliable trains that come on schedule
- Frequent service so that wait times are short
- Explanations and announcement of delays
- Frequency of delays for repairs/emergencies
- Cleanliness of the train interior
- Temperature on the train
- Absence of offensive odors
- Fairness/consistency of fare structure
- Freedom from the nuisance behaviors of others

8K. Market Segmentation of CTA Rail Customer Satisfaction Findings

The overall satisfaction ratings of CTA customers are shown in Chart 8.12 below. Overall, for combined rail customers 41% report being very satisfied with CTA service, and 43% are somewhat satisfied. Only 6% report being very dissatisfied and 10% somewhat dissatisfied. Blue Line customers are slightly more satisfied than are Red Line customers.

Chart 8.12
CTA Customer Overall Satisfaction with Service



As discussed in Chapter 4, customer loyalty is as important as customer satisfaction. It is important to determine, on the basis of key responses, which customers are secure in their use of public transit, which are favorable towards it, which are vulnerable to no longer using transit, and which are at risk of shifting to other forms of transportation.

A secure customer is one who says that he or she is:

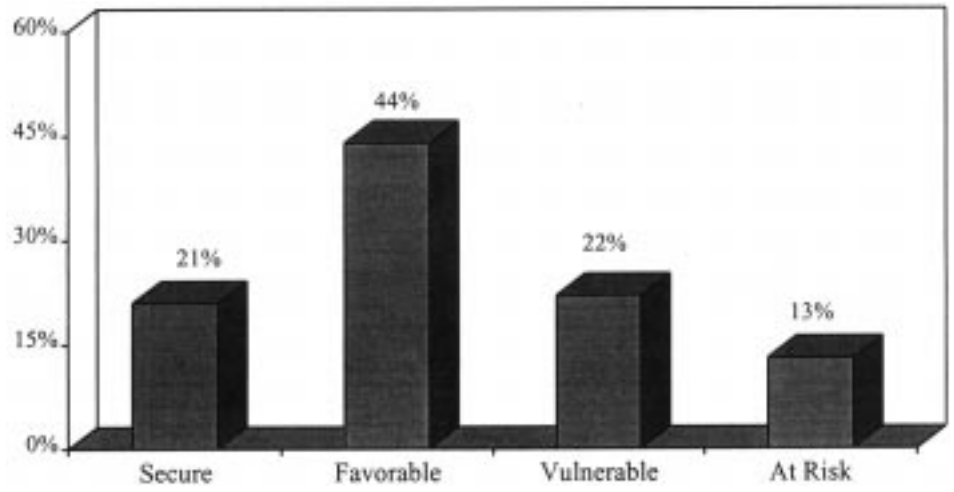
- very satisfied with the service
- definitely will continue to use the service in the future
- definitely would recommend the service to others

A vulnerable customers is one who says he or she is:

- somewhat satisfied or dissatisfied
- might or might not use the service in the future
- might or might not recommend the service to others

Among CTA Rail customers, 21% can be classified as secure customers, 44% as favorable, 22% as vulnerable customers, and 13% at risk of becoming non-customers (See Chart 8.13 below.)

Chart 8.13
Customer Loyalty Segments Among Combined CTA Rail Customers



Customer loyalty indices for public transportation are complicated by the issue of transit dependent customers. While only 22% of secure customers say they use transit because they do not have a car available or because they do not drive, 41% of combined vulnerable and at risk customers are in the transit dependent category. Those who prefer to take the train whether than driving are more likely to be committed to CTA use than those who use public transit because they must.

Vulnerable and at risk customers are more likely to take a bus to the station where they board and are more likely to make transfers. There are no statistically significant differences between secure and vulnerable/at risk customers by income, age, employment, or trip purpose. By gender, 58% of secure customers are female as compared with 69% of vulnerable/at risk customers.

Twenty-three percent of vulnerable/at risk customers are either somewhat or very dissatisfied with CTA service; 24% say they probably or definitely will not continue to use public transit in the future if another means of transportation becomes available to them. Nineteen percent say they would probably or definitely not recommend use of CTA to a family member, friend, or co-worker.

Also important to market segmentation analysis is the ability to look at the ordering of service attributes by different segments of the market since we know not all customers are affected the same by all service quality elements. One of the greatest advantages of the impact score approach is that impact scores can be easily calculated and ordered by market segment, as for example, by secure and vulnerable/at risk customers as shown for combined CTA Rail in Table 8.14. As shown in Chart 8.13, secure customers represent 21% of the market while vulnerable/at risk customers account for 35% of the combined CTA Rail market.

"Cleanliness of the train interiors, seats, and windows" and "cleanliness of station stops" are significantly more important to secure customers, while "cost effectiveness, affordability, and value" is significantly less important. "Short wait time for transfers" is significantly more important to vulnerable/at risk customers. Less important to these customers are environmental factors, including: "absence of offensive odors", "cleanliness of train interiors", and "freedom from the nuisance behaviors of others" — all attributes within the top ten in importance to secure customers.

Such segmentation of impact scores can be easily calculated for other market segments such as transit-dependent vs. non-transit dependent riders, or by geographic area, trip purpose, or primary destination.

	Table 8.14 **Computation of Impact Scores - Combined CTA Rail Customer Loyalty Segments** **Attribute** *(N=602)*	**Mean Overall Sat. w/ Problem**	**Mean Overall Sat. w/o Problem**	**Gap Value**	**Percent Who Had Problem**	**Impact Score**	**Rank**
	Secure Customers						
1	Trains that are not overcrowded	7.36235	8.13308	0.771	0.686	0.529	1
2	Reliable trains that come on schedule	7.07696	7.99432	0.917	0.427	0.392	2
3	Frequent service so that wait times are short	7.03512	7.96817	0.933	0.392	0.366	2
4	**Cleanliness of the train interior**	**7.16515**	**7.96710**	**0.802**	**0.454**	**0.364**	**2 +**
5	Availability of seats on the train	7.32644	7.94828	0.622	0.555	0.345	3
6	Smoothness of the ride and stops	7.05570	7.91527	0.860	0.366	0.315	4
7	Frequency of delays for repairs/emergencies	7.06786	7.89124	0.823	0.379	0.312	4
8	Explanations and announcement of delays	7.21379	7.89039	0.677	0.416	0.281	4
9	Freedom from the nuisance behaviors of others	7.26699	7.88058	0.614	0.453	0.278	4
10	Absence of offensive odors	7.30930	7.88659	0.577	0.478	0.276	4
11	**Cleanliness of stations**	**6.99347**	**7.86992**	**0.876**	**0.304**	**0.266**	**4 +**
12	Temperature on the train	7.14546	7.85302	0.708	0.353	0.250	5
13	Friendly, courteous, and quick service	6.68744	7.78390	1.096	0.175	0.192	5
14	Clear and timely announcements of stops	7.08625	7.79377	0.708	0.262	0.185	6
15	**Cost effectiveness, affordability, and value**	**6.38235**	**7.78757**	**1.405**	**0.129**	**0.181**	**6 -**
16	Ease of paying fare, purchasing tokens	7.19884	7.78630	0.587	0.307	0.180	6
17	Short wait time for transfers	7.19579	7.77486	0.579	0.287	0.166	6
18	Fairness/consistency of fare structure	6.72123	7.82275	1.102	0.138	0.152	6
19	**Transit personnel who know the system**	**6.16158**	**7.78456**	**1.623**	**0.093**	**0.151**	**6**
20	**Comfort of seats on the train**	**6.61636**	**7.72501**	**1.109**	**0.111**	**0.123**	**7**
	Vulnerable Customers						
1	Cost effectiveness, affordability, and value	3.62760	5.81638	2.189	0.504	1.103	1
2	Reliable trains that come on schedule	4.44817	6.04795	1.600	0.671	1.073	1
3	Availability of seats on the train	4.49564	5.87758	1.382	0.679	0.938	2
4	Frequency of delays for repairs/emergencies	3.97006	5.48472	1.515	0.588	0.891	3
5	Trains that are not overcrowded	4.73048	5.83770	1.107	0.797	0.882	3
6	**Short wait time for transfers**	**3.91538**	**5.81547**	**1.900**	**0.447**	**0.849**	**4 +**
7	Frequent service so that wait times are short	4.44978	5.77330	1.324	0.630	0.834	4
8	Transit personnel who know the system	3.40172	5.53745	2.136	0.370	0.790	5
9	Fairness/consistency of fare structure	3.70728	5.50804	1.801	0.419	0.755	6
10	Explanations and announcement of delays	4.49426	5.65520	1.161	0.638	0.741	6
11	Smoothness of the ride and stops	4.36636	5.56162	1.195	0.521	0.623	7
12	Comfort of seats on the train	3.41746	5.26958	1.852	0.324	0.600	7
13	Temperature on the train	4.35080	5.50986	1.159	0.514	0.596	7
14	Clear and timely announcements of stops	4.31140	5.51090	1.200	0.480	0.576	7
15	Friendly, courteous, and quick service	4.24527	5.51283	1.268	0.454	0.575	7
16	**Absence of offensive odors**	**4.62531**	**5.48172**	**0.856**	**0.654**	**0.560**	**8 -**
17	Ease of paying fare, purchasing tokens	4.54374	5.54626	1.003	0.551	0.552	8
18	**Cleanliness of the train interior**	**4.56273**	**5.41501**	**0.852**	**0.558**	**0.476**	**9 -**
19	**Freedom from the nuisance behaviors of others**	**4.71521**	**5.25303**	**0.538**	**0.584**	**0.314**	**10 -**
20	**Cleanliness of stations**	**4.67618**	**5.17164**	**0.495**	**0.469**	**0.232**	**11 -**

SUN TRAN — ALBUQUERQUE, NEW MEXICO

8L. Sun Tran - Computation of Impact Scores

The top target attributes for Sun Tran customers determined from weighted data as defined in Appendix D and determined by the impact score approach are as shown below:

Sun Tran
Target Attributes
(N=303)

	Attribute
1	Frequency of service on Saturdays/Sundays
2	Hours of service during weekdays
3	Frequent service so that wait times are short
4	Reliable buses that come on schedule
5	Short wait time for transfers
6	Connecting bus service
7	Freedom from the nuisance behaviors of others
8	Availability of shelter and benches
9	Posted minutes to next bus

The target issues or attributes for Sun Tran are, first, travel performance attributes, followed by travel environment issues (See Tables 8.15 and 8.16 for impact scores).

Over half of Sun Tran customers say they had a problem over the past 30 days with the frequency of service on Saturdays and Sundays, and 45% report a problem with the hours of transit service during the week. Limited transit service has the greatest impact on overall customer satisfaction.

Sun Tran customers are less price sensitive than CTA customers, with none of the cost or value attributes placing within the top quadrant of concern.

Cleanliness of bus stops has a high dissatisfaction rank and a high problem occurrence rank (36%), but a low impact on overall satisfaction with transit service. This seems to indicate that customers do not hold the transit agency as directly responsible for this attribute as for others.

Sun Tran gets high marks on:

- Costs of making transfers
- Stop names visible from bus
- Safety from crime on the buses
- Accessibility of the buses to the handicapped
- Comfort of seats on the bus

8M. Sun Tran — Comparison with Quadrant Analysis

When impact score results for Sun Tran customers are compared with quadrant analysis results as shown in Chart 8.17, significant differences appear.

The quadrant analysis does not take into account the relatively low problem incidence rate for "availability of information by phone or mail". The quadrant analysis includes this attribute within the target issues; the impact score approach does not.

The quadrant analysis excludes "reliable buses that come on schedule", "freedom from the nuisance behaviors of others", "posted minutes to the next bus", and "connecting bus service" from the target area; the impact analysis includes these attributes within the target issues. The first three all have high problem incidence rates which are not taken into account by the quadrant analysis, while "connecting bus service", which has a relatively low problem occurrence rate, has a very high impact on overall satisfaction.

8N. Sun Tran - Translation of Impact Scores to a Report Card

Once impact scores are placed in descending order, statistically significant differences in ranking can be calculated using standard tests for statistical significance (Table 8.16). The table can then be simply divided by quadrants (adhering to statistically significant breaks in ranking) to assign report card grades to each individual service attribute.

For future Sun Tran tracking surveys, based on this benchmark survey, a grade level "D" can be assigned to all attributes with impact scores above 0.269, a "C" can be assigned to all impact scores within the range of 0.147 to 0.269, a "B" to impact scores between 0.079 to 0.146, and an "A" to impact scores below 0.079.

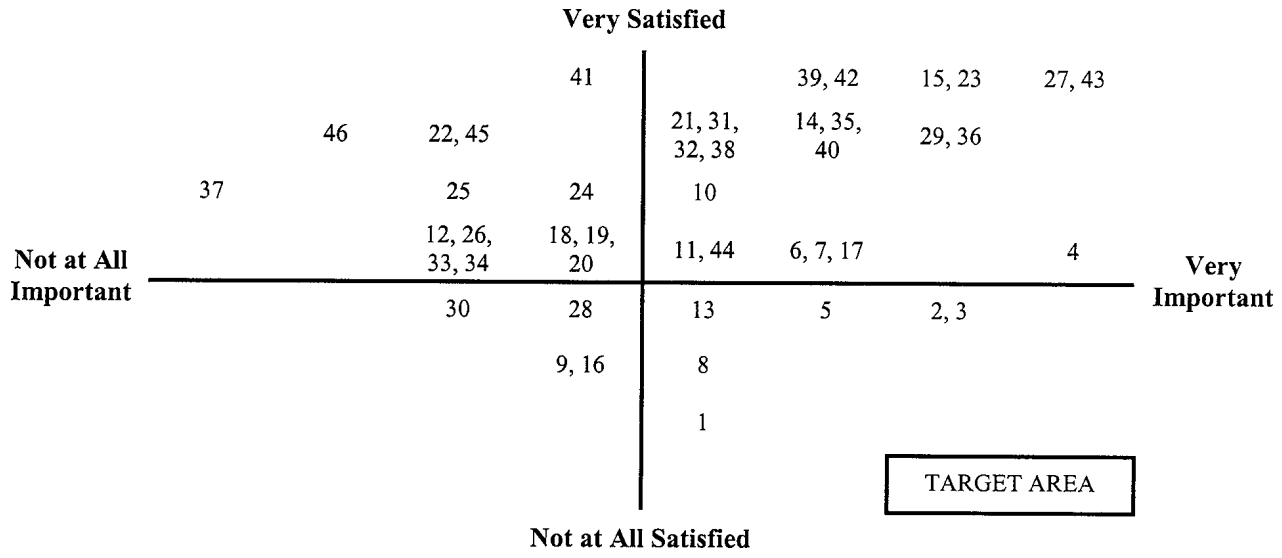
	Table 8.15 Computation of Impact Scores – Sun Tran *(N=303)* Attribute	Mean Overall Sat. w/ Problem	Mean Overall Sat. w/o Problem	Gap Value	Percent Who Had Problem	Impact Score	Report Card
1	Frequency of service on Saturdays and Sundays	6.71165	8.20391	1.492	0.575	0.858	D
2	Hours of service during weekdays	6.34320	8.10990	1.767	0.454	0.802	D
3	Frequent service so that wait times are short	6.34535	8.00453	1.659	0.424	0.703	D
4	Reliable buses that come on schedule	6.64539	7.98533	1.340	0.499	0.669	D
5	Short wait time for transfers	6.19392	7.88153	1.688	0.325	0.548	D
6	Connecting bus service	5.70243	7.81161	2.109	0.220	0.464	D
7	Freedom from the nuisance behaviors of others	6.56610	7.74306	1.177	0.363	0.427	D
8	Availability of shelter and benches	6.79795	7.72839	0.930	0.444	0.413	D
9	Posted minutes to next bus	6.53567	7.63188	1.096	0.286	0.314	D
10	Availability of seats on the bus	6.80008	7.57949	0.779	0.341	0.266	C
11	Absence of offensive odors	6.74047	7.58236	0.842	0.314	0.264	C
12	Physical condition of bus stops	6.62695	7.58742	0.960	0.265	0.255	C
13	Availability of information by phone and mail	4.68292	7.47849	2.796	0.091	0.254	C
14	Friendly, courteous, and quick service	6.41042	7.57092	1.161	0.213	0.247	C
15	Bus traveling at a safe speed	5.64977	7.49433	1.845	0.133	0.245	C
16	Availability of schedules/maps at stops	6.55621	7.50766	0.951	0.247	0.235	C
17	Cleanliness of the bus interior	6.62293	7.54500	0.922	0.251	0.231	C
18	Number of transfer points outside downtown	5.97704	7.32556	1.349	0.170	0.229	C
19	Routes/direction visible on buses	6.37641	7.53746	1.161	0.194	0.225	C
20	Buses that are not overcrowded	6.96623	7.53271	0.566	0.379	0.215	C
21	Frequency of delays for repairs/emergencies	6.72991	7.68394	0.954	0.222	0.212	C
22	Clear and timely announcements of stops	6.44527	7.53746	1.092	0.188	0.205	C
23	Cost effectiveness, affordability, and value	5.28781	7.68313	2.395	0.084	0.201	C
24	Smoothness of the ride and stops	6.83845	7.51191	0.673	0.291	0.196	C
25	Absence of graffiti	6.45057	7.41708	0.967	0.202	0.195	C
26	Ease of paying the fare	6.36349	7.45764	1.094	0.178	0.195	C
27	Safe and competent drivers	6.60627	7.50051	0.894	0.206	0.184	C
28	Explanations and announcement of delays	6.81129	7.48603	0.675	0.246	0.166	C
29	Availability of monthly/discount passes	6.73780	7.63960	0.902	0.165	0.149	C
30	Displaying of customer service number	6.50774	7.42109	0.913	0.160	0.146	B
31	Temperature on the bus	6.53278	7.45634	0.924	0.145	0.134	B
32	Physical condition of vehicles and infrastructure	5.55634	7.35358	1.797	0.074	0.133	B
33	Cleanliness of bus stops	7.02619	7.45588	0.430	0.307	0.132	B
34	Provision of signs and information in Spanish	4.67949	7.30646	2.627	0.040	0.105	B
35	Transit personnel who know the system	6.35187	7.61934	1.267	0.082	0.104	B
36	Safety from crime at bus stops	6.54418	7.42549	0.881	0.116	0.102	B
37	Cleanliness of the bus exterior	6.40449	7.40713	1.003	0.099	0.099	B
38	Ease of opening doors of the bus	6.88809	7.41428	0.526	0.186	0.098	B
39	Availability of handrails or grab bars	5.60407	7.31775	1.714	0.053	0.091	B
40	Fairness/consistency of fare structure	5.85207	7.62219	1.770	0.051	0.090	B
41	Cost of making transfers	5.63149	7.19186	1.560	0.050	0.078	A
42	Stop names visible from bus	6.71187	7.28215	0.570	0.108	0.062	A
43	Safety from crime on buses	6.48161	7.40716	0.926	0.064	0.059	A
44	Accessibility to those with a disability	6.80382	7.28734	0.484	0.088	0.043	A
45	Comfort of seats on the bus	7.45973	7.49189	0.032	0.129	0.004	A
46	Quietness of the vehicles	7.25733	7.21912	-0.038	0.082	-0.003	A

Table 8.16
Summary of Rankings and Scores - Sun Tran

	Attribute (N=303)	Median Importance Rank=4; Low Satisfaction >3; Median Problem Experience Rank=7 (18%); Median Overall Satisfaction Gap Value Rank=4	Importance Ranking	Satisfaction Ranking	Percent Who Experienced Problem %	Percent Who Experienced Problem Rank	Overall Satisfaction Gap V	Overall Satisfaction Gap Rank	Impact Score	Report Card
1	Frequency of service on Saturdays and Sundays		4	7	57.5	1	1.5	3	0.858	(1) D
2	Hours of service during weekdays		2	5	45.4	2	1.8	2	0.802	(2) D
3	Frequent service so that wait times are short		2	5	42.4	3	1.7	3	0.703	(3) D
4	Reliable buses that come on schedule		1	4	49.9	2	1.3	4	0.669	(3) D
5	Short wait time for transfers		3	5	32.5	5	1.7	3	0.548	(4) D
6	Connecting bus service		3	4	22.0	7	2.1	2	0.464	(5) D
7	Freedom from the nuisance behaviors of others		3	4	36.3	4	1.2	4	0.427	(5) D
8	Availability of shelter and benches		4	6	44.4	3	0.9	5	0.413	(6) D
9	Posted minutes to next bus		5	6	28.6	5	1.1	4	0.314	(7) D
10	Availability of seats on the bus		4	3	34.1	4	0.8	5	0.266	(8) C
11	Absence of offensive odors		4	4	31.4	5	0.8	5	0.264	(8) C
12	Physical condition of bus stops		6	4	26.5	6	1.0	4	0.255	(8) C
13	Availability of information by phone and mail		4	5	9.1	9	2.8	1	0.254	*(8) C
14	Friendly, courteous, and quick service		3	2	21.3	7	1.2	4	0.247	(8) C
15	Bus traveling at a safe speed		2	1	13.3	9	1.8	2	0.245	*(8) C
16	Availability of schedules/maps at stops		5	6	24.7	6	1.0	4	0.235	(8) C
17	Cleanliness of the bus interior		3	4	25.1	6	0.9	5	0.231	(8) C
18	Number of transfer points outside downtown		5	4	17.0	8	1.3	4	0.229	*(8) C
19	Routes/direction visible on buses		5	4	19.4	7	1.2	4	0.225	(8) C
20	Buses that are not overcrowded		5	4	37.9	4	0.6	5	0.215	(9) C
21	Frequency of delays for repairs/emergencies		4	2	22.2	7	1.0	4	0.212	*(9) C
22	Clear and timely announcements of stops		6	2	18.8	7	1.1	4	0.205	(9) C
23	Cost effectiveness, affordability, and value		2	1	8.4	10	2.4	1	0.201	*(9) C
24	Smoothness of the ride and stops		5	3	29.1	5	0.7	5	0.196	(9) C
25	Absence of graffiti		6	3	20.2	7	1.0	4	0.195	*(9) C
26	Ease of paying the fare		6	4	17.8	7	1.1	4	0.195	(9) C
27	Safe and competent drivers		1	1	20.6	7	0.9	5	0.184	(9) C
28	Explanations and announcement of delays		5	5	24.6	6	0.7	5	0.166	(9) C
29	Availability of monthly/discount passes		2	2	16.5	8	0.9	5	0.149	*(9) C
30	Displaying of customer service number		6	5	16.0	8	0.9	5	0.146	(10) B
31	Temperature on the bus		4	2	14.5	8	0.9	5	0.134	(10) B
32	Physical condition of vehicles and infrastructure		4	2	7.4	10	1.8	2	0.133	*(10) B
33	Cleanliness of bus stops		6	4	30.7	5	0.4	6	0.132	(10) B
34	Provision of signs and information in Spanish		6	4	4.0	11	2.6	1	0.105	*(11) B
35	Transit personnel who know the system		3	2	8.2	10	1.3	4	0.104	*(11) B
36	Safety from crime at bus stops		2	2	11.6	9	0.9	5	0.102	(11) B
37	Cleanliness of the bus exterior		8	3	9.9	9	1.0	4	0.099	(11) B
38	Ease of opening doors of the bus		4	2	18.6	7	0.5	6	0.098	(11) B
39	Availability of handrails or grab bars		3	1	5.3	10	1.7	3	0.091	*(11) B
40	Fairness/consistency of fare structure		4	2	5.1	10	1.8	2	0.090	*(11) B
41	Cost of making transfers		6	1	5.0	10	1.6	3	0.078	*(12) A
42	Stop names visible from bus		3	1	10.8	9	0.6	5	0.062	*(12) A
43	Safety from crime on buses		1	1	6.4	10	0.9	5	0.059	(12) A
44	Accessibility to those with a disability		4	4	8.8	9	0.5	6	0.043	(12) A
45	Comfort of seats on the bus		6	2	12.9	9	0.0	7	0.004	*(13) A
46	Quietness of the vehicles		7	2	8.2	10	0.0	7	-0.003	*(13) A

( ) Numbers indicate statistically significant rank at the 90% confidence interval level **Split sample size=100* *Shaded cells are above median*

Chart 8.17
Quadrant Analysis of Performance *(Satisfaction)* vs. Importance for Sun Tran Service



The intersection of the axis is the median rank value on importance (from left to right) and satisfaction (from bottom to top)

(N=303)

NOTE: Please refer to the numbered list of attributes in Tables 8.15 and 8.16 for descriptions of the attributes shown as numbers in the above chart.

The "target area" consists of the attributes that riders consider very important, but are rated low on satisfaction. The following attributes fell into the "target area" for Sun Tran:

- Frequency of service on Saturdays and Sundays
- Hours of service during weekdays
- Frequent service so that wait times are short
- Short wait time for transfers
- Availability of shelter and benches
- Availability of information by phone and mail

8O. Sun Tran — Comparison with Factor Analysis

A factor analysis was performed on the 30 attributes not included in split sampling (all respondents were asked to rate each of these questions). The Sun Tran correlation results for the factor solution are displayed in Table 8.18 below. Five dimensions were found which are labeled: "trip performance", "personal security", "bus environment", "communications", and "seating comfort".

The communality correlations for the attributes within each dimension are as shown for each attribute.

Table 8.18
Factor Dimensions for Sun Tran Service

1 Trip Performance		2 Personal Security		3 Bus Environment		4 Communications	
Frequent Service	0.7424*	Stops Condition	0.7129*	Opening Doors	0.5275*	Maps at Stops	0.6766*
Wait for Transfers	0.5739*	Clean Stops	0.5554*	Ride Smoothness	0.5612*	Posted Schedule	0.5966*
Hours of Service	0,5348*	Absence of Odors	0.5702*	Clean Exteriors	0.5007*	Route Info. on Bus	0.5332*
Reliable, On-Time	0.5641*	Free of Nuisances	0.5962*	Safe Drivers	0.5455*	Delay Explanations	0.5945*
Connecting Service	0.6841*	Safety at Stops	0.6224*	Disability Access	0.5475*	Ease Paying Fare	0.4560*
Frequency Sat/Sun	0.4679*	Clean Interiors	0.5554*	Bus Temperature	0.3603*	Service # Display	0.4994*
		Shelters/Benches	0.5139*	Friendly Service	0.5842*	**5 Seating Comfort**	
		Safety on Bus	0.6224			Announcement Clarity	0.5299
						Not crowded	0.7211*
						Seat Availability	0.6615*

** values greater than 0.5 significance (N=303)*

None of the intercorrelations among attributes is above the 0.8 level that would be considered highly correlated. All except one correlation are within the medium range of 0.4 to 0.8.

A complete review of bivariate correlation results for all 30 attributes shows that multicolinearity among attributes is extensive, even though most communality estimates for the dimension placements are significant. For example, cleanliness of the interior of the bus is related to the dimension of personal security at a significant level, but it is also highly related with attributes within the bus environment dimension such as temperature on the bus and ease of opening doors.

Sun Tran customers clearly equate bus stop condition, and cleanliness of stops and bus interiors, with attributes of personal safety.

On the basis of multiple regression analysis using the dimensions as the independent variables, the order of the dimensions in terms of their affect on overall satisfaction is as follows:

1. Trip performance
2. Communications
3. Personal security
4. Seating comfort
5. Bus environment

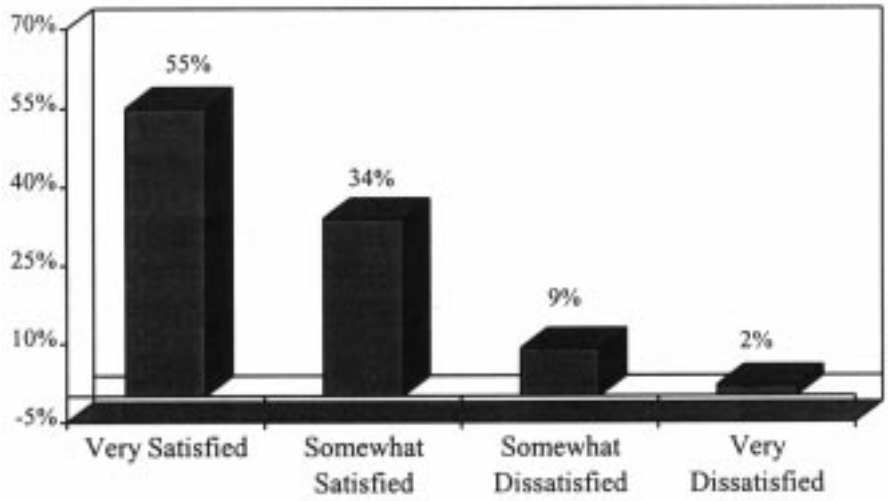
However, the differentiation in effect on overall satisfaction among the dimensions of personal security, seating comfort, and bus environment are only slight.

Two of the attributes identified by the impact score approach as within the top tier for target issues are not within the top factor analysis dimension — because they were not highly correlated with other trip performance attributes. These attributes are: freedom from the nuisance behaviors of others and posted minutes until the next bus. Freedom from nuisance behaviors is located within the third (or bottom) tier dimension(s) by the factor analysis approach, while posted minutes until the next bus is within the second tier dimension of communications. Both of these attributes have high rates of reported problems encountered.

8P. Market Segmentation of Sun Tran Satisfaction Findings

The overall satisfaction ratings of Sun Tran customers are shown in Chart 8.19. Overall, 55% report being very satisfied with Sun Tran service, and 34% are somewhat satisfied. Only 2% report being very dissatisfied and 9% somewhat dissatisfied.

Chart 8.19
Sun Tran Customer Overall Satisfaction with Service



As discussed in Chapter 4, customer loyalty is as important as customer satisfaction. It is important to determine, on the basis of key responses, which customers are secure in their use of public transit, which are favorable towards it, which are vulnerable to no longer using transit, and which are at risk of shifting to other forms of transportation.

A secure customer is one who says that he or she is:

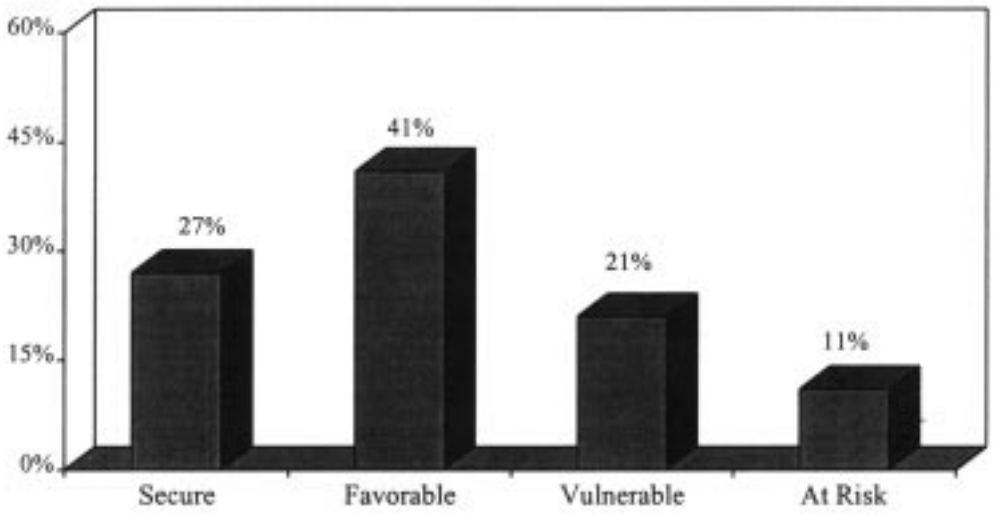
- very satisfied with the service
- definitely will continue to use the service in the future
- definitely would recommend the service to others

A vulnerable customers is one who says he or she is:

- somewhat satisfied or dissatisfied
- might or might not use the service in the future
- might or might not recommend the service to others

Among Sun Tran customers, 27% can be classified as secure customers, 41% as favorable, 21% as vulnerable customers, and 11% at risk of becoming non-customers (See Chart 8.20).

Chart 8.20
Customer Loyalty Segments Among Sun Tran Customers



Customer loyalty indices for public transportation are complicated by the issue of transit dependent customers. In Albuquerque, only 41% of secure customers say they use transit because they do not have a car available or because they do not drive, while 80% of combined vulnerable and at risk customers are in the transit dependent category. Again, as in Chicago, those who prefer to take transit rather than driving are more likely to be committed to Sun Tran use than those who use public transit because they must.

Vulnerable and at risk Sun Tran customers are not more likely to make transfers than secure customers, but they are more likely to report longer wait times between transfers (28 vs. 18 minutes) than secure customers. Vulnerable and at risk Sun Tran customers, on average, have lived within the Albuquerque area for a shorter period of time (11 years vs. 22 years), but are only slightly younger than secure customers (35 vs. 45 years old on average). There are no statistically significant differences between secure and vulnerable/at risk customers by income, employment, trip purpose, or gender. Vulnerable and at risk customers are more likely to be Caucasian and are less likely to be Hispanic.

Thirteen percent of vulnerable/at risk customers are either somewhat or very dissatisfied with Sun Tran service; 16% say they probably or definitely will not continue to use public transit in the future if another means of transportation becomes available to them. Sixteen percent say they would probably or definitely not recommend use of Sun Tran to a family member, friend, or co-worker.

Most important to market segmentation analysis is the ability to look at the ordering of service attributes by different segments of the market since we know not all customers are affected the same by all service quality elements. One of the greatest advantages of the impact score approach is that impact scores can be easily calculated and ordered by market segment, as for example, by secure and vulnerable/at risk customers as shown for Sun Tran in Table 8.21. As shown in Chart 8.20, secure customers represent 27% of the market while vulnerable/at risk customers account for 32% of the Sun Tran market.

"Availability of shelters and benches at stops", "availability of seats on the bus", and "bus traveling at a safe speed" are more important as target issues to secure customers. "The number of transfer points available outside downtown" is more important to vulnerable and at risk customers, while the "availability of seats on the bus" is less important.

Such segmentation of impact scores can be easily calculated for other market segments such as transit-dependent vs. non-transit dependent riders, or by geographic area, trip purpose, or primary destination.

	Table 8.21 **Computation of Impact Scores – Sun Tran** **Customer Loyalty Segments** **Attribute** *(N=303)*	**Mean Overall Sat. w/ Problem**	**Mean Overall Sat. w/o Problem**	**Gap Value**	**Percent Who Had Problem**	**Impact Score**	**Rank**
	Secure Customers						
1	Hours of service during weekdays	7.48515	8.69633	1.211	0.424	0.514	1
2	Frequency of service on Saturdays and Sundays	7.87545	8.54752	0.672	0.615	0.413	2
3	Reliable buses that come on schedule	7.74876	8.58853	0.840	0.463	0.389	2
4	Short wait time for transfers	7.41874	8.57841	1.160	0.314	0.364	2
5	**Availability of shelter and benches**	**7.81956**	**8.55689**	**0.737**	**0.492**	**0.363**	**2 +**
6	**Availability of seats on the bus**	**7.50899**	**8.52467**	**1.016**	**0.318**	**0.323**	**2 +**
7	Connecting bus service	7.13994	8.47067	1.331	0.209	0.278	3
8	**Bus traveling at a safe speed**	**6.41917**	**8.43711**	**2.018**	**0.136**	**0.274**	**3 +**
9	Frequent service so that wait times are short	7.79445	8.45495	0.661	0.402	0.266	3
10	Freedom from the nuisance behaviors of others	7.78429	8.42057	0.636	0.347	0.221	3
11	Absence of offensive odors	7.71150	8.40818	0.697	0.299	0.208	3
12	Physical condition of bus stops	7.72142	8.40671	0.685	0.290	0.199	3
13	Availability of schedules/maps at stops	7.69634	8.29292	0.597	0.214	0.128	4
14	Cleanliness of the bus interior	7.94489	8.29553	0.351	0.272	0.095	4
15	Posted minutes to next bus	7.90426	8.23418	0.330	0.260	0.086	4
16	Availability of information by phone and mail	6.67154	8.15822	1.487	0.043	0.064	5
17	Number of transfer points outside downtown	7.57362	7.91412	0.341	0.171	0.058	5
18	Friendly, courteous, and quick service	8.15105	8.20729	0.056	0.129	0.007	6
	Vulnerable Customers						
1	Hours of service during weekdays	5.04121	7.07280	2.032	0.599	1.217	1
2	Frequency of service on Saturdays and Sundays	5.25395	6.85313	1.599	0.759	1.214	1
3	Frequent service so that wait times are short	4.89393	7.06618	2.172	0.557	1.210	1
4	Short wait time for transfers	4.61565	6.60199	1.986	0.420	0.834	2
5	Reliable buses that come on schedule	5.27080	6.60779	1.337	0.562	0.751	3
6	Connecting bus service	4.30330	6.47534	2.172	0.341	0.741	3
7	Availability of shelter and benches	4.79507	6.56279	1.768	0.395	0.698	3
8	Freedom from the nuisance behaviors of others	4.99120	6.47308	1.482	0.418	0.619	4
9	**Number of transfer points outside downtown**	**4.13709**	**6.08379**	**1.947**	**0.263**	**0.512**	**5 +**
10	Posted minutes to next bus	4.97654	6.33321	1.357	0.332	0.450	5
11	Physical condition of bus stops	4.88861	6.30198	1.413	0.315	0.445	5
12	Availability of information by phone and mail	4.21425	6.22139	2.007	0.184	0.369	6
13	Cleanliness of the bus interior	4.98172	6.19680	1.215	0.280	0.340	6
14	Absence of offensive odors	5.35840	6.15209	0.794	0.389	0.309	6
15	Bus traveling at a safe speed	4.34202	6.17452	1.833	0.167	0.306	6
16	Availability of schedules/maps at stops	5.15169	6.06183	0.910	0.305	0.278	7
17	**Availability of seats on the bus**	**5.50022**	**6.09005**	**0.590**	**0.396**	**0.234**	**7 -**
18	Friendly, courteous, and quick service	5.65749	5.96620	0.309	0.326	0.101	8

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8Q. GLTC - Computation of Impact Scores

The top target attributes for GLTC customers, determined from weighted data as defined in Appendix D, and determined by the impact score approach are as shown below:

GLTC
Target Attributes
(N=69)

	Attribute
1	Freedom from the nuisance behaviors of others
2	Reliable buses that come on schedule
3	Buses that are not overcrowded
4	Cleanliness of bus stops
5	Availability of seats on the bus
6	Smoothness of the ride and stops
7	Absence of offensive odors
8	Cleanliness of the bus interior
9	Explanations and announcement of delays
10	Frequent service so that wait times are short

The target issues or attributes for GLTC are primarily environment of service issues (See Tables 8.22 and 8.23 for impact scores).

Almost half of GLTC customers say they had a problem over the past 30 days with the frequency of service on Saturdays and Sundays; however, this attribute has a very weak impact on overall satisfaction with service. Almost one-third of customers report a problem with "freedom from the nuisance behaviors of others" and "cleanliness of bus stops"; however, the latter also does not have a large impact on overall satisfaction with transit service.

GLTC customers are less price sensitive than CTA customers, with none of the cost or value attributes placing within the top quadrant of concern.

Trains that are not overcrowded and availability of seats have a very high impact on the overall satisfaction of GLTC customers, but reported rates of problems encountered with these two attributes were relatively low and perhaps limited to certain routes, at certain hours.

GLTC gets high marks on:

- Costs of making transfers
- Physical condition of vehicles

8R. GLTC - Translation of Impact Scores to a Report Card

Once impact scores are placed in descending order, statistically significant differences in ranking can be calculated using standard tests for statistical significance (Table 8.23). The table can then be simply divided by quadrants (adhering to statistically significant breaks in ranking) to assign report card grades to each individual service attribute.

For future GLTC tracking surveys, based on this benchmark survey, a grade level "D" can be assigned to all attributes with impact scores above 0.214, a "C" can be assigned to all impact scores within the range of 0.057 to 0.214, a "B" to impact scores between 0.010 to 0.056, and an "A" to impact scores below 0.010.

	Table 8.22 Computation of Impact Scores - GLTC *(N=69)* Attribute	Mean Overall Sat. w/ Problem	Mean Overall Sat. w/o Problem	Gap Value	Percent Who Had Problem	Impact Score	Report Card
1	Freedom from the nuisance behaviors of others	7.90909	9.21739	1.308	0.319	0.417	D
2	Reliable buses that come on schedule	7.55556	9.13725	1.582	0.261	0.413	D
3	Buses that are not overcrowded	7.40000	9.18868	1.789	0.217	0.389	D
4	Cleanliness of bus stops	8.00000	9.06383	1.064	0.319	0.339	D
5	Availability of seats on the bus	7.38462	9.03571	1.651	0.188	0.310	D
6	Smoothness of the ride and stops	7.00000	9.01695	2.017	0.145	0.292	D
7	Absence of offensive odors	7.94444	9.00000	1.056	0.261	0.275	D
8	Cleanliness of the bus interior	7.27273	9.00000	1.727	0.159	0.275	D
9	Explanations and announcement of delays	7.53846	8.98182	1.443	0.188	0.272	D
10	Frequent service so that wait times are short	7.71429	8.98182	1.268	0.203	0.257	D
11	Availability of shelter and benches	8.20000	8.93878	0.739	0.290	0.214	C
12	Ease of opening doors of the bus	7.25000	8.91803	1.668	0.116	0.193	C
13	Connecting bus service	7.55556	8.88136	1.326	0.130	0.173	C
14	Displaying of customer service number	7.00000	8.86885	1.869	0.087	0.163	C
15	Safety from crime at bus stops	7.42857	8.85250	1.424	0.101	0.144	C
16	Physical condition of bus stops	8.14286	8.84906	0.706	0.203	0.143	C
17	Ease of paying the fare	7.77778	8.86000	1.082	0.130	0.141	C
18	Availability of monthly/discount passes	8.35600	9.00000	0.644	0.217	0.140	C
19	Frequency of delays for repairs/emergencies	8.00000	8.78947	0.789	0.174	0.137	C
20	Cleanliness of the bus exterior	6.75000	8.84615	2.096	0.058	0.122	C
21	Temperature on the bus	8.09091	8.84483	0.754	0.159	0.120	C
22	Short wait time for transfers	8.23077	8.78846	0.558	0.188	0.105	C
23	Friendly, courteous, and quick service	8.20000	8.81356	0.614	0.145	0.089	B
24	Posted minutes to next bus	7.80000	8.75410	0.954	0.072	0.069	B
25	Number of transfer points outside downtown	8.16667	8.40000	0.233	0.286	0.067	B
26	Safety from crime on buses	6.50000	8.79104	2.291	0.029	0.066	B
27	Clear and timely announcements of stops	8.00000	8.78125	0.781	0.072	0.056	B
28	Bus traveling at a safe speed	8.00000	9.19048	1.190	0.045	0.054	B
29	Availability of information by phone and mail	8.50000	9.05000	0.550	0.091	0.050	B
30	Transit personnel who know the system	8.49762	9.04762	0.550	0.087	0.048	B
31	Accessibility to those with a disability	7.66667	8.79365	1.127	0.043	0.048	B
32	Hours of service during weekdays	8.00000	8.76923	0.769	0.058	0.045	B
33	Safe and competent drivers	8.00000	8.76923	0.769	0.058	0.045	B
34	Comfort of seats on the bus	8.00000	8.86364	0.864	0.043	0.037	B
35	Fairness/consistency of fare structure	8.00000	8.68182	0.682	0.043	0.029	A
36	Quietness of the vehicles	8.00000	8.68182	0.682	0.043	0.029	A
37	Absence of graffiti	8.00000	8.69565	0.696	0.042	0.029	A
38	Frequency of service on Saturdays and Sundays	8.68750	8.75000	0.063	0.464	0.029	A
39	Stop names visible from bus	8.00000	8.56522	0.565	0.042	0.024	A
40	Cost effectiveness, affordability, and value	8.50000	8.66667	0.167	0.087	0.015	A
41	Route/direction visible on buses	8.50000	8.75385	0.254	0.029	0.007	A
42	Availability of schedules/maps at stops	8.66667	8.73016	0.063	0.087	0.006	A
43	Availability of handrails or grab bars	N/A	9.00000	N/A	0.000	0.000	A
44	Provision of signs and information in Spanish	N/A	8.84211	N/A	0.000	0.000	A
45	Physical condition of vehicles and infrastructure	N/A	8.54167	N/A	0.000	0.000	A
46	Cost of making transfers	N/A	8.47610	N/A	0.000	0.000	A

Table 8.23
Summary of Rankings and Scores - GLTC

	Attribute (N=69) Median Importance Rank=2; Low Satisfaction >2; Median Problem Experience Rank=3 (15%); Median Overall Satisfaction Gap Value Rank=2	Importance Ranking	Satisfaction Ranking	Percent Who Experienced Problem %	Percent Who Experienced Problem Rank	Overall Satisfaction Gap Value V	Overall Satisfaction Gap Value Rank	Impact Score	Report Card
1	Freedom from the nuisance behaviors of others	2	3	31.9	2	1.3	2	0.417	(1) D
2	Reliable buses that come on schedule	2	2	26.1	2	1.6	2	0.413	(1) D
3	Buses that are not overcrowded	3	3	21.7	3	1.8	1	0.389	(1) D
4	Cleanliness of bus stops	3	3	31.9	2	1.1	3	0.339	(1) D
5	Availability of seats on the bus	2	2	18.8	3	1.7	2	0.310	(2) D
6	Smoothness of the ride and stops	3	2	14.5	3	2.0	1	0.292	(2) D
7	Absence of offensive odors	3	3	26.1	2	1.1	3	0.275	(2) D
8	Cleanliness of the bus interior	2	2	15.9	3	1.7	2	0.275	(2) D
9	Explanations and announcement of delays	2	3	18.8	3	1.4	2	0.272	(2) D
10	Frequent service so that wait times are short	2	2	20.3	3	1.3	2	0.257	(2) D
11	Availability of shelter and benches	2	3	29.0	2	0.7	3	0.214	(3) C
12	Ease of opening doors of bus	2	2	11.6	4	1.7	2	0.194	(3) C
13	Connecting bus service	2	2	13.0	4	1.3	2	0.173	(3) C
14	Displaying of a customer service phone number	3	3	8.7	4	1.9	1	0.163	(3) C
15	Safety from crime at bus stops	2	2	10.1	4	1.4	2	0.145	(3) C
16	Physical condition of bus stops	3	3	20.3	3	0.7	3	0.143	(3) C
17	Ease with which I can pay the fare	3	3	13.0	4	1.1	3	0.141	(3) C
18	Availability of monthly/discount passes	2	3	21.7	3	0.6	3	0.140	*(3) C
19	Frequency of delays for emergencies	3	3	17.4	3	0.8	3	0.137	*(3) C
20	Cleanliness of the bus exterior	3	2	5.8	5	2.1	1	0.122	(4) C
21	Temperature on the bus	2	2	15.9	3	0.8	3	0.120	(4) C
22	Short wait time for transfers	3	2	18.8	3	0.6	3	0.105	(4) C
23	Friendly, courteous, and quick service	2	2	14.5	3	0.6	3	0.089	(4) C
24	Posted minutes to next bus	3	2	7.2	4	1.0	3	0.069	(4) C
25	Number of transfer points outside downtown	3	4	28.6	2	0.2	4	0.067	*(4) C
26	Safety from crime on buses	1	2	2.9	5	2.3	1	0.066	(4) C
27	Clear and timely announcements of stops	3	2	7.2	4	0.8	3	0.056	(5) B
28	Bus traveling at a safe speed	1	1	4.5	5	1.2	3	0.054	*(5) B
29	Availability of information by phone and mail	2	3	9.1	4	0.6	4	0.050	(5) B
30	Transit personnel who know the system	2	2	8.7	4	0.6	4	0.048	*(5) B
31	Accessibility of buses for handicapped	2	2	4.3	5	1.1	3	0.048	(5) B
32	Hours of service during weekdays	2	2	5.8	5	0.8	3	0.045	(5) B
33	Safe and competent drivers	1	1	5.8	5	0.8	3	0.045	(5) B
34	Comfort of seats on the bus	3	1	4.3	5	0.9	3	0.037	*(5) B
35	Fairness and consistency of fare structures	3	2	4.3	5	0.7	3	0.029	*(5) B
36	Quietness of the vehicles	7	2	4.3	5	0.7	3	0.029	*(5) B
37	Absence of graffiti	4	2	4.2	5	0.7	3	0.029	*(5) B
38	Frequency of service on Saturdays and Sundays	3	4	46.4	1	0.1	4	0.029	(5) B
39	Stop names visible from bus	2	1	4.2	5	0.6	4	0.024	*(5) B
40	Cost effectiveness, affordability, and value	2	1	8.7	4	0.2	4	0.015	*(5) B
41	Route/direction information visible on buses	2	2	2.9	5	0.3	4	0.007	*(6) A
42	Availability of schedules/maps at stops	3	3	8.7	4	0.1	4	0.006	(6) A
43	Availability of handrails or grab bars	1	1	0.0	6	N/A	5	0.000	*(6) A
44	Provision of signs and information in Spanish	4	4	0.0	6	N/A	5	0.000	*(6) A
45	Physical condition of vehicles	3	2	0.0	6	N/A	5	0.000	*(6) A
46	Cost of making transfers	4	1	0.0	6	N/A	5	0.000	*(6) A

( ) Numbers indicate statistically significant rank at the 90% confidence interval level **Split sample size=100* *Shaded cells are above media*

CHAPTER 9. AGENCY REVIEW OF CUSTOMER SATISFACTION SURVEY FINDINGS

Following the preparation of the draft project report outlined in Chapter 8, the results of the customer satisfaction surveys were shared with the three transit agencies used as field test sites. Following the distribution of these findings, interviews[13] were conducted with senior staff of each agency to discuss the agency's reactions to the findings, the degree to which they concurred with the results, and how this process could be utilized in ongoing efforts on the part of the agency to both improve customer satisfaction and system performance. An important objective of this overall effort is to identify ways in which the results from the surveys can be utilized by transit agencies in their marketing and service improvement programs. Obtaining agency feedback on the specific survey results was considered an important means of determining how the results could thus be applied.

9A. General Reactions to Results

Each of the three agencies was in general agreement with the survey findings relevant to their service. The Assistant Director of Sun Tran said that the findings were remarkably consistent with the agency's perceptions of service needs and performance issues. She also felt that the results helped verify the agency's overall concerns about service delivery and also said the findings were consistent with what the agency has been hearing at public meetings when service issues are discussed. The Assistant Director indicated that the predominant concerns identified through the survey were related to level of service issues such as off-peak scheduling, frequency of service, and route coverage and added that Sun Tran has been experiencing financial shortfalls which have resulted in reductions of weekend, midday, and early a.m./late p.m. service in order to concentrate service during peak periods. This has led to exactly the kinds of concerns identified in the survey.

The Market Research Director for the CTA was also generally in agreement with the findings of the CTA surveys. He felt that the ratings, implied importance of service dimensions, and the "gap" concept made sense and that the findings were generally consistent with previous surveys undertaken by the CTA. The ratings also agreed with his own perceptions of CTA service. He noted however, that the list of attributes was quite extensive and, as a result, some of the attributes of this survey (e.g. odors, temperature) have not been addressed in previous CTA surveys. He indicated that there were no major surprises relative to CTA's findings, based on the CTA's ongoing, wide-ranging market research program. The CTA conducts a total of about 15 surveys per year, which involve a mix of telephone and intercept surveys. Intercept surveys include on-board surveys, surveys at rail platforms, and surveys at bus stops. The targets of the surveys range from rider surveys to more focused surveys of employees and students using the system. CTA staff have been collecting attitudinal data and monitoring riders' perceptions for a few years and are particularly interested in knowing what their customers want and how their perceptions change over time. In conjunction with these efforts, they are trying to understand how they can best "advertise" improvements in service to ensure that they are actually perceived by CTA customers.

The General Manager of the GLTC had some reservations about the findings of the survey and, in certain instances, felt that the results may be biased against certain isolated problems which are route- or schedule-specific. However he also noted that previous customer surveys conducted by the agency had identified similar customer's satisfaction issues as those identified in the current survey.

9B. Usefulness of Survey Procedures and Application of Findings

It was the general consensus of the participating transit agencies that the survey approach produced useful results which could be beneficial in identifying customer needs and service improvement priorities. Agencies felt that the process was practical for application, that the cost of implementation was reasonable, and that the results are understandable and useful.

The Assistant Director of Sun Tran indicated that the City of Albuquerque conducts an annual citizens' survey relevant to all services provided by the City. This survey always includes questions relevant to transit service, although they are usually very basic such as "Do you use public transit?" and "How often?" This year, due to activities related to the promotion of RTA formation, there were additional qualitative questions such as "Is transit service convenient for you?" However, more specificity is necessary to provide Sun Tran with usable information to evaluate customer needs and concerns. Therefore, the customer satisfaction survey was very useful for Sun Tran. A particularly important aspect was the way of using the survey to report not only the incidence and frequency of service-related problems but also riders' strength of sentiment. It was indicated that this kind of survey could be used to verify to the Division Managers that what they are doing to improve service matters to their customers. Once improvements are implemented, repeat surveys should be conducted to identify the next set of service improvement objectives. In terms of frequency, repeating the survey every two to three years was considered appropriate. It was also mentioned that the videotapes of the focus group sessions have been beneficial and that the tapes were shown to Division Managers to demonstrate that "the people who are complaining about service problems are not kooks; they are just like us."

The General Manager of GLTC concurred that the survey is understandable, and easily doable, a feature which is essential if tight-budget transit authorities are going to carry it out. He indicated that he intends to use the procedure in the future. However, he does not think that they will be able to carry out focus groups as part of the procedure. In terms of the ultimate benefits that might result from the procedure, it would be the agency's objectives to address the problems identified through the survey to improve customer satisfaction with transit services. He indicated that this would hopefully result in fewer complaints about service. He noted however that he did not think that improvements would result in increases in the number of passengers or the number of trips taken on the transit system because most of their riders are transit dependent. Instead, he hoped that by addressing these issues that the transit service would gain a more positive public image.

9C. Reactions to Findings Relevant to Specific Attributes

As part of the phone interviews, the transit agency representatives were asked to provide their reactions to the 10 most important service attributes identified in their respective customer surveys. These attribute-specific questions were intended to determine the basis for each specific customer satisfaction issue, discuss whether the agency is currently doing anything to monitor this attribute or similar performance characteristics, and identify how such data, as an agency monitored performance measure, might be systematically collected as an agency monitored performance measure. This information provides examples of how agencies might respond to customer concerns which are both operational or qualitative in nature.

1. Sun Tran

1.1 Frequency of service on Saturdays/Sundays

This is a complaint which Sun Tran receives frequently and is considered a function of recent financial constraints which have caused service reductions during off-peak periods and weekends. The Albuquerque City Council has recently funded a feasibility study to examine expanded weekend transit services, despite overall cutbacks in the city budget. (Although Albuquerque has a booming local economy, tax receipts have not grown as projected, resulting in an overcommitment of the city's tax revenues and cutbacks in city services).

This attribute can be readily monitored through a review of the current operating schedule. Progress in addressing customer satisfaction can be monitored by documenting enhancements to the weekend service schedule. Overall responsibility for making service changes is with Sun Tran's Service Development Division, although all division managers are briefed with respect to service changes.

1.2 Hours of service during weekdays

This attribute is closely linked with the preceding attribute of frequency of service. Again, this concern is a reflection of Sun Tran's financial condition, forcing an emphasis on the higher demand peak period service. Most Sun Tran routes terminate at the end of the peak (many have their last run at 4:45 p.m., most by 6:00 p.m.) This has presented a particular problem for workers in the convenience industry whose hours extend beyond the normal workday schedule. This, in turn, has affected employment decisions as a result of mobility limitations for the transit dependent population. Sun Tran has been told by some employers that they are unable to fill entry-level positions for early morning operations. This information has filtered back to Sun Tran as a result of their Welfare-to-Work efforts and TDM activities with local employers. Sun Tran recently conducted a phone survey of 40 employers and 450 welfare-to-work recipients and homeless shelter residents to better understand welfare-to-work issues. Results of the customer satisfaction survey corroborated the findings of the welfare-to-work survey.

As for the preceding attribute, this attribute can be readily monitored through a review of the current operating schedule. Progress in addressing customer satisfaction can be monitored by documenting enhancements to the weekday schedule. This is also the responsibility of the Service Development Division.

1.3. Frequent service so that wait times are short

Consistent with the factors contributing to the attributes related to service frequency, budgetary problems have led to reductions in service, particularly during the midday period. These reductions began in July 1995 when the system was redesigned from one which emphasized service between primary activity centers to a grid system. This contributed to improved transfer opportunities and coverage over a broader area. However, it also resulted in curtailment of services to outlying areas. This attribute may have been cited as a problem by customers who had previously used routes that had higher frequencies prior to July 1995 which were then cut back.

As for the preceding attributes, this attribute can be readily monitored through a review of the current operating schedule. Progress in addressing customer satisfaction can be monitored by documenting enhancements to the weekday schedule. This is also the responsibility of the Service Development Division.

1.4 Reliable buses that come on schedule

Schedule reliability has emerged relatively recently as a concern which Sun Tran had not previously made an effort to monitor. However, it is being cited more frequently as a concern in public meetings. Sun Tran has since made an effort to monitor schedule reliability through their on-going performance monitoring program. Initially this began with the monitoring of on-board announcement by drivers of upcoming stops.

Currently Sun Tran personnel ride on the buses and make an assessment of service reliability on a quarterly basis. The criteria applied for "on-time" performance is zero minutes for buses arriving early and no more than five minutes for buses arriving late; otherwise, the trip is considered to be off schedule. The findings from this review are presented and discussed at the Division Managers' meetings.

1.5 Short wait time for transfers

Transfers were examined at the time of the route restructuring in June 1995. To a large extent, the length of wait time is a function of the frequency of service, although basic service coordination is also a factor. As discussed in the preceding sections, service frequency had been affected by the agency's budgetary problems.

It is primarily the responsibility of drivers to notify the Service Development Manager if there is a problem in the coordination of services leading to excessive wait times for transfers.

1.6 Connecting bus service

It was unclear to Sun Tran what this attribute was indicating. It is likely that it was addressing the same issues as described in section 1.5 above. However, it may also be an indication that service is not available to certain desired destinations. In this case, the particular attribute was ambiguous. Sun Tran commented in this regard that a number of the attributes could be interpreted in various ways and that more information is needed for certain attributes to fully understand what the customer is saying.

1.7 Freedom from the nuisance behavior of others

Sun Tran was not surprised to see this attribute identified. A large percentage of their system riders use the Central Avenue (Route 66) bus and it travels through some "problem" neighborhoods, as described by Sun Tran. There may be potential social conflicts between some riders and individuals who board in these neighborhoods. It was also mentioned that Sun Tran does not have many school age riders, thereby minimizing the likelihood that this attribute was generated by friction between students and elderly riders. Sun Tran has begun using uniformed security personnel in the past year as a result of an assault which occurred following the de-boarding of two Sun Tran riders. However, Sun Tran does not feel that there was a general perception that transit was unsafe in Albuquerque.

1.8 Availability of shelter and benches

Sun Tran provides shelters at a number of high traffic locations throughout the system and is trying to install more through a cooperative program with the City Council and local businesses which would finance the structure and then post advertising on the shelter. Bus benches have been installed in the past year at all Sun Tran stops with the exception of locations where the terrain is prohibitive. The Service Development Division is responsible for installation and monitoring of bus stop amenities.

1.9 Posted minutes to next bus

This attribute is assumed to refer to the posting of schedules at bus stops, as opposed to some sort of real-time bus arrival information system (which would be impractical given the extent of Sun Tran's services). Originally Sun Tran only posted schedules at their downtown stop locations. However they have gotten requests from customers to expand this posting. As a result, there is now a policy to post schedules at all bus stops. This program is underway, although it is currently only 10% complete.

The Service Development Division is responsible for the posting of schedules at bus stops.

1.10 Availability of seats on the bus

Sun Tran is aware of crowding problems on the Central Avenue buses which occur throughout the day and on their express routes during peak periods. During peak periods the Central Avenue buses are filled to capacity and, as a result, additional buses have been added.

Crowding is not normally monitored by Sun Tran.

2. Chicago Transit Authority

2.1 Trains that are not overcrowded

Crowding is not considered to be a systemic problem but it is related to frequency of service and varies by route and time of day. It turns out that in some cases (e.g., Red line, one of the two lines surveyed) even during off-peak hours there is relative crowding because the headway gets reduced by about 50%.

Such decisions reflect a demand/load factor-driven approach. There are also instances especially throughout the bus system where service is offered very infrequently (up to 30 minutes headway) as a result of a policy decision to offer service on underutilized routes.

2.2 Reliable trains that come on schedule

Among CTA customers there is the perception that there are delays and service unreliability. Although CTA collects on-time performance (OTP) data, it is not easy to decipher what exactly the customer experiences. Data is collected by supervisors at selected stations, including the terminals and three or four intermediate stops. A train is counted as being late if it arrives more than five minutes late. As a result of this methodology, CTA statistics show an OTP higher than 95%. There are two categories with trains six to nine minutes late and trains arriving nine or more minutes behind schedule.

2.3 Frequent service so that wait times are short

As indicated in section 2.1 above, frequency of service varies by route and time of day. According to the CTA, frequent rail service is available at a system wide level 24 hours a day. Frequency drops by about half during off-peak. On the Red line, frequencies vary between 10 and 15 minutes and on the Blue line between 6 and 10 minutes.

2.4 Cost effectiveness, affordability, and value

It is assumed that this measure is primarily a function of fare policy. Currently, a one-way fare is $1.50 and the cost of a one-way fare with a rail/bus or bus/bus transfer is $1.80; the transfer is valid for two hours. There are some stations with free transfer (e.g., Howard station for rail/rail transfer to Evanston). Tokens are available in currency exchanges in batches of 10 tokens priced at $15 (no discount). There is also the option of a monthly pass with unlimited usage priced at $88. Finally, there is also a "value stored" card option where riders can store up to $100 against future ticket usage. If more than $13.50 is added to the card, riders are credited $1.50, effectively a discount of 10% for the $15 increment.

2.5 Availability of seats on train

This is assumed to be directly correlated with the attribute "Trains that are not overcrowded", which is discussed under section 2.1.

2.6 Explanations and announcement of delays

The CTA indicated that communicating with the riders has been an ongoing problem.

2.7 Frequency of delays for repairs/emergencies

Performance data indicate that Blue and Red lines have a worse record compared to the other CTA lines. Therefore, riders' perception seems to be consistent with the performance measure of "Mean Mileage between Reported Defects" and the measure of "Average Reported Defects by Car". Both performance indicators are also consistent with the age of the rolling stock. Orange and Brown lines with newest equipment show the best record in both of these measures.

2.8 Cleanliness of interior

The measures that CTA collects relevant to this attribute are clearly "supply driven" such as measures of the number of times that buses and rail cars get washed.

A report submitted by the Manager, Quality Improvement, Rail, entitled "Inspection of Cleanliness of Rail Cars" is sent to General Manager, Rail Engineering and Technical Services. The report classifies rail cars according to level of cleanliness (clean, semi-clean, dirty) before they are released for morning service.

According to a March 1996 report, from a total of 410 cars inspected 96% of rail cars entering service were clean with the remaining 4% characterized as semi-clean ("cars were swept but had papers/debris laying around"). According to an April 1996 report, of the 60 inspected cars that should have received a "mini wash", 90% were found clean while of the 60 inspected cars that should have received a full wash only 69% were classified as clean.

This indicates a great deal of variability relative to cleanliness. Furthermore, it was noted that this is only a measure of car cleanliness before they enter service.

2.9 Temperature on train

The CTA suggested that this might relate to potential problems mainly with air conditioning malfunctioning during the summer months especially on overcrowded trains.

2.10 Smoothness of ride and stops

This perception is a function of the alignment but, as is the case with service breakdowns, it also reflects the state of the infrastructure and the age and condition of the rolling stock. The Blue and Red lines have both aging rolling stock and, in sections of their route system, the infrastructure is also a candidate for updating.

3. Greater Lynchburg Transportation Commission

3.1 Freedom from the nuisance behaviors of others

GLTC thinks this attribute is primarily based on age differences among the population served. There can be conflicts between noisy teenagers and elderly passengers. The elderly passengers often do not feel comfortable when the noisy teenagers are present. GLTC logs complaints on a daily basis and looks at the frequency of complaints, and when possible, the time of day of complaints to determine if there are any trends. Complaints first go to the Front Office (by phone, mail, and sometimes they hear from city council members). If complaints have to do with passenger behavior, the complaint is referred to the Transportation Department. If the complaint has to do with cleanliness, the Maintenance Department is notified. If there is a decline in complaints about other passengers' poor behavior, GLTC would consider this progress or improvement. They would address an increase in such complaints in a number of ways:

- Supervisors would start riding buses on specific routes with increased complaints,
- The transit agency would notify local police of a growing incidence of complaints,
- In extreme cases, specific people would be banned from buses,
- Bus operators would be offered assistance and training in how to deal with unruly passengers, and
- Video technology could be installed; however, this presents an expensive option and would be used to record, but not necessarily reduce, nuisance behavior.

3.2 Reliable buses that come on schedule

This attribute was considered to be a function of a variety of causes, such as bus engines running hot; passengers having trouble reading the schedule; and people waiting at stops that are between two timepoints. GLTC operations reports show a 10% missed connection rate for timed connections. Some people say that "I was standing at a bus stop, and the bus just passed me by."

GLTC conducts hourly schedule checks which are the responsibility of the Transportation Department, specifically the transportation supervisors. Sixty to seventy percent of trips are monitored at connection points, while other missed connections are reported by the drivers. The overall number of missed connections is reported daily to the general manager. These data do not indicate a pattern of missed connections so far. Additional monitoring could be conducted utilizing GIS, a GPS tracking system, or more staff to monitor. Ideally, this information should be collected daily and reported monthly. However, these capabilities would cost money that the agency is not likely to get.

3.3 Buses that are not overcrowded

GLTC monitors bus crowding through customer complaints and random observations by supervisors. Occasionally ride checks are conducted, but not often enough to capture trends in crowding. They also do driver audits about every two years. GLTC hires outside firms to carry out these audits without the driver's knowledge to check how individual drivers are performing - not necessarily to monitor crowding. GLTC also collects Section 15 type data every five years. GLTC staff routinely look at ridechecks. Based on system averages, GLTC data do not indicate a widespread crowding problem.

Currently, GLTC does not consider it a significant problem. However, if GLTC determines that overcrowding becomes a significant problem, it is conceivable that more focused ridechecks could be conducted and drivers could report their loads to try to determine where and when overcrowding occurs.

3.4 Cleanliness of bus stops and shelters

The maintenance department is responsible for the cleanliness of the stops, shelters and buses. The issue of trash at the bus stops may be more a result of city policy than the transit agency's efforts to keep stops clean. A few years ago the city started charging $0.90 per bag of garbage when picked up at residential properties. Residents must buy stickers that are then put on their garbage bags. Household garbage is deposited in the receptacles at bus stops (where there is no charge for depositing garbage) by individuals who do not want to pay this fee. This has contributed to more litter and debris at bus stops, creating a significant burden for GLTC.

3.5 Availability of seats on the bus

This is viewed as the same attribute as "Buses that are not overcrowded", which was discussed under section 3.3.

3.6 Smoothness of the ride and stops

GLTC monitors ride quality through supervisor observations and driver audits by monitoring bus speeds with radar guns and through customer complaints. GLTC believes operator training could be improved to encourage drivers to drive with more care. GLTC does not think that smoothness of ride is a function of the age or condition of their fleet. The fleet is relatively young, with the oldest buses built in 1990. It was noted that Lynchburg's nickname is Hill City because of its many hills, possibly contributing to the perceived lack of smooth riding.

3.7 Absence of offensive odors

GLTC thinks that riders' identification of offensive odors as a problem may be related to a small number of riders who do not bathe regularly. If it is a reoccurring problem, they may confront the person and help them find resources for better hygiene. Otherwise, it is not considered a significant or measurable problem.

3.8 Cleanliness of the bus interior

This attribute was not commented on by GLTC although it may correlate with "Cleanliness of bus stops and shelters", discussed under section 3.4.

3.9 Explanations and announcement of delays

GLTC agrees that passengers deserve an explanation of delays when they are happening. However, there is uncertainty regarding how this attribute could be monitored, other than asking drivers to report whether they made delay announcements or not, and recording the number of complaints that are registered about a specific delay. GLTC felt driver and supervisor training could be improved related to explaining delays to passengers.

3.10 Frequent service so that wait times are short

This attribute was not commented on by GLTC.

ENDNOTES

[13] Phone interviews were conducted with Mike Carroll, General Manager of the Greater Lynchburg Transportation Commission on February 24, 1998, with Dawn Matson, Assistant Director of Sun Tran (Albuquerque, NM) on February 26, 1998, and with Darwin Stuart, Market Research Director, Chicago Transit Authority, on March 5, 1998.

CHAPTER 10. CONVERTING SERVICE QUALITY RESEARCH FINDINGS INTO TRANSIT AGENCY PERFORMANCE MEASURES

10A. Introduction

The assessment of the determinants of transit service quality has so far focused on the analysis of the survey that measures transit users' attitudes towards service and derives the implied priorities for transit service improvements. This analysis has provided useful insights into the factors that make up transit rider satisfaction which influence mode choice behavior and consequently the observed transit ridership.

The interpretation of the survey results by managerial staff in each of the three transit agencies further underscores the importance and usefulness of developing and maintaining a market research program that focuses on customer satisfaction. The robustness and resonance of the survey findings with management's opinions about the service offered bring to focus the steps that are required to take action to improve service.

In this chapter we build upon the existing analysis framework by structuring the discussion of performance measurement from a transit agency's management perspective. Instead of focusing on the quality of service perceived and expected by the customer, we shift to ways of measuring the quality of service actually offered by the transit agency. The ability to accurately measure performance allows the agency both to evaluate its service and to define realistic and measurable goals for service improvements.

We first discuss the importance of linking transit riders' perspectives to objective disaggregate measures of transit performance. The different types of analyses that can be conducted are discussed along with the desired elements of an ongoing data collection plan that focuses on the greatest possible level of detail.

The performance measures are then identified in a manner that is consistent with customers' experience by breaking down a transit trip to its individual components and by defining customer expectations of service. Each of the 46 transit service attributes that were evaluated in the survey is related to the different components of the transit trip to identify service attributes that share common characteristics.

The 10 most important aspects of service that have been identified through the survey analysis for each transit agency are then tabulated to identify service attributes that are common to rail and bus transit systems in each of the three cities. For each of those service attributes we define customers' expectations and discuss a range of mostly simple performance measures that can be used to measure the ability of the transit agency to offer service that meets these expectations.

10B. A Transit Agency's Perspective to Transit Performance Measurement

The consumer-oriented approach to transportation service planning is rooted in the assumption that the observed transit ridership and transit market share are the result of the mode choices made by each individual commuter. The analysis framework presented in Figure G.1 of Appendix G highlights the importance of transit level of service, individual traveler characteristics, and communication and marketing channels on the formation of travelers' perceptions and consequently on their likelihood of riding transit.

The analysis of the transit rider survey has provided a way of evaluating the link between riders' perceptions and their overall satisfaction with transit service. A better understanding of transit customers' needs and wants would allow the transit agency to identify the strengths and weaknesses of transit service against competing modes and the differences in service for individual routes within the transit system.

Examples of successful customer-driven approaches to the design and marketing of transit service quality are documented in a recent study of four European transit systems.[14] The common theme among these case studies is the intent to demonstrate the transit agency's commitment to service quality and its sensitivity to customer input by promising a standard of service. This allows customers to evaluate the ability of the transit agency to provide the level of service to which it was committed.

Among the service improvements that were considered and implemented in the transit systems under study were the provision of more frequent service, the improvement of reliability, purchase of new equipment, improved customer relations, electronic payment facilities, and more convenient connections. A similar review of 40 transit systems in the United States[15] identified increases in transit ridership that system managers attributed to level of service adjustments, pricing changes, marketing and information initiatives, enhancement of service coordination, and market segmentation.

Therefore, the next important step in the process from a transit agency perspective is to develop a strategy of service improvements that is responsive to its customers' expressed needs and wants. In particular, a transit agency needs to define the type and level of service improvements that need to be implemented to address weaknesses in service for those service attributes considered most important by its customers.

The collection of data reflecting riders' perceptions of transit service along with an ongoing program of transit performance data collection at the transit line and route level by different times of day and days of the week can be used by a transit agency to:

- identify existing weaknesses of transit service as reflected in the responses provided by transit riders and in the performance measures being monitored;

- set priorities for service improvements by focusing on the aspects of transit service that need to be addressed first and by identifying the service routes and segments of the market that will be affected the most;

- design and implement the identified improvements in transit service; and

- design an information dissemination program that will properly communicate the improvements to the riding public.

A recent Transit Cooperative Research Program study[16] approaches the subject of quality of transit service by adopting a total quality management (TQM) framework for public transportation. To meet the objectives of increased productivity, reduced costs, and higher ridership through improved rider satisfaction the study focuses on controllable factors that influence public transit performance. Recognizing the human service character of public transit, the study focuses on "putting customers first" by responding to customer expectations and by translating market research into actionable procedures.

An important consideration in the outlined approach is the ability to "manage by fact" and establish a range of measures that can be used to monitor and evaluate performance. Among the criteria for developing these performance measures that are included in the report are the:

- validity of data that are sampled by credible unbiased methods;
- completeness of data that cover a broad spectrum of aspects of service;
- policy sensitivity of data that can be used to support managerial decisions;
- timeliness of data that can be processed, analyzed and interpreted on time;
- transparency of the data collection process;
- inexpensive data that may already be collected for another purpose; and
- ability to interpret data by developing measures that are easy to understand, compare, and communicate to management and the public.

The ability to make the linkage between riders' statements and measures of transit performance is therefore instrumental in providing transit management with the means of evaluating alternative service improvements aimed at enhancing rider satisfaction and transit ridership. Such an evaluation can be supported by an ongoing data collection effort that captures differences by transit route, time of day, and day of the week and focuses on a comprehensive list of transit performance indicators. As a result, the ongoing analysis of the transit performance measures can be used to:

- provide transit management with a systemwide overview of transit operations for different transit modes;
- evaluate transit performance on a route-specific level of detail by focusing on individual segments of the transit network;
- monitor changes in transit service over time to identify deteriorating conditions or to highlight improvements in service in response to service intervention;
- identify the variation in transit level of transit service by collecting data specific to a service area, time of day, or day of the week for the service attributes of interest; and
- guide the development of marketing and communication strategies to inform transit customers and potential customers of the desirable service features.

10C. Overview of Transit Performance Measures

The collection of transit performance data to support the monitoring, evaluation, and the implementation of improvements in service presents a challenge to transit agencies. Although transit agencies might be interested in collecting a wide array of information, the cost of collecting and analyzing a large amount of transit performance and service quality data presents a constraint to transit agencies.

As a result, the data collection and analysis activities should be concentrated on those aspects of transit service that are both crucial to their operations and that more accurately reflect the needs and wants of customers and potential customers. The objective is to match the most important perceptions to specific aspects of transit service and to identify one or more corresponding service performance indicators. These measures will differ by transit agency given the different priorities expressed by riders, the differences in the nature of services offered, and the feasibility and cost of collecting the relevant data.

Travelers' need to travel reflects their need to participate in an activity that is located elsewhere. In this context, travelers' choices of residential location, workplace, time-of-day of travel, and transportation mode reflect their desire to minimize the disutility of travel. In the case of transit riders, the disutility of travel encompasses the whole travel experience from the planning of a transit trip at their point of origin through the walk egress portion of the trip to get to their final destination. To better understand and measure the service that a transit rider receives, the total travel experience has been broken into the trip components and service dimensions shown in Table 10.1.

Table 10.1
Correspondence Between Trip Components and Dimensions of Service

Trip Components	Service Dimensions
Trip planning	Passenger information
Cost of transit	Fare level and type
Walk to transit stop	Accessibility
Wait at transit stop	Station environment Passenger information Service delivery Security
Travel by transit	Vehicle environment Passenger information Service delivery Security
Transfer to transit	Station environment Passenger information Service delivery Security
Walk to destination	Accessibility

Prior to their trip, transit riders may need to seek information about the most convenient route, departure time, transfers, and fare to get to his or her destination. Sources for such information include printed transit route maps and schedules, information provided over the phone by individuals at a passenger information center, and electronic versions of schedule and fare information. Although such information is seldom needed for routine trips, it can be of great value to infrequent transit users and non-users who are unfamiliar with the system.

The level of transit fares is another aspect of transit service that contributes to the disutility of travel and affects riders' perceptions of transit's attractiveness. Although transit fares are often lower than the corresponding operating, maintenance, and parking costs of private modes, fare levels can have an adverse impact on the price-sensitive frequent traveler segment of the travel market. The availability of different types of fares, such as monthly passes, ten-ride discount tickets, and electronic fare media with value storage capabilities, and fare restrictions increase travelers' flexibility to choose an optimal payment strategy that fits their own travel patterns.

The travel components of a transit trip include:

- the access to the transit station/bus stop,
- the time spent waiting for transit service,
- the in-vehicle experience of riding transit,
- potential transfer(s) to different transit services, and
- the egress to the final destination.

The access and egress walk components of the trip are only in part linked to the everyday operations of a transit system. Although the number, location, and spacing of stations and stops and the adjacent land-use development may affect transit service considerably, they are primarily linked to the original design of the service. On the other hand, riders' perceptions of the accessibility of rail stations and bus stops can be positively influenced by interventions such as kiss-and-ride facilities, availability of long-term station parking, sidewalk maintenance, availability of well-lit access paths, and maintenance programs for stairs, escalators, and elevators leading to platforms.

The time waiting at the station or stop, the in-vehicle component of the trip, and the transfer to another transit route are all characterized by:

- traditional measures of transit service such as wait time, travel time, and service reliability;
- the station/stop and vehicle environments that the transit riders experience; and
- the availability and quality of information available to riders at rail stations, bus stops, and en route.

Table 10.2 provides a link between the components of a transit trip, the dimensions of transit service, and the 46 attributes of service that were used in the transit rider survey. These linkages illustrate both the depth of the rider survey and the potential range of corresponding measures of performance. The list of candidate performance measures can be extended even further considering that a variety of measures can be defined for attributes like service reliability depending on the nature of service. A range of surrogate measures may be needed to properly reflect riders' feelings of security at stations, stops, and on-board transit vehicles.

Table 10.2
Ratings of Service By Trip Component and Service Dimension

Trip Components	Service Dimensions	Ratings	Potential Measures
Trip planning	Passenger information	Availability of information by phone and mail	Response time for providing requested information. Accuracy of information provided.
Cost of transit	Fare level and type	Availability of monthly/discount passes	Available fare types.
		Fairness and consistency of fare structures	Relative cost per mile for different traveler segments.
		Cost effectiveness, affordability, and value	Cost per one-way trip.
		Cost of making transfers	Cost of transfers.
		Ease of paying the fare	Available fare types. Fare restrictions (exact fare only, surcharges, etc.).
Walk to transit stop	Accessibility	Accessibility to those with a disability	Percent of elevators in working condition.
Wait at transit stop	Service delivery	Frequent service so wait times are short	Wait time.
		Hours of service during weekdays	Hours of weekday service.
		Frequency of service on weekends	Weekend wait times. Hours of weekend service.
		Reliable trains/buses that come on schedule	Schedule adherence measures.
	Passenger information	Availability of schedules/maps at stations/stops	Availability.
		Display of customer service number	Availability.
		Transit personnel who know the system	Percent of correct answers to questions.
		Provision of signs and information in Spanish	Availability.
		Explanations and announcement of delays	Audibility of public address system.
		Posted minutes to next train/bus	Availability, accuracy of information.
	Station environment	Availability of shelters and benches	Availability.
		Physical condition of stations/stops	Quality of lighting, seating, telephones.
		Cleanliness of stations/bus stops	Presence and amount of trash.
		Absence of graffiti	Presence and amount of graffiti.
		Absence of offensive odors	Presence of such odors.
	Security	Safety from crime at stations/stops	Presence of police, transit staff, emergency phones, etc.
		Freedom from the nuisance behavior of others	"Quality-of-life" and system rules violations.
Travel by transit	Vehicle environment	Absence of graffiti	Presence and amount of graffiti.
		Absence of offensive odors	Presence of such odors.
		Availability of handrails or grab bars	Availability. Percent of passengers with access to them.
		Availability of seats on the train/bus	Number of seats. Number of unused seats.
		Cleanliness of the train/bus exterior	Presence and amount of graffiti and dirt.
		Cleanliness of the train/bus interior	Presence and amount of trash.
		Comfort of seats on the train/bus	Material and condition of seats.

Table 10.2
Ratings of Service By Trip Component and Service Dimension
(continued)

Trip Components	Service Dimensions	Ratings	Potential Measures
Travel by transit *(continued)*	Vehicle environment *(continued)*	Ease of opening doors of train/bus	Need for special efforts to get through vehicle's doors.
		Temperature on the train/bus	Temperature range within the vehicle.
		Quietness of the vehicles	Noise level without riders.
		Smoothness of the ride and stops	Acceleration/deceleration profile of vehicles. Driver training record.
		Physical condition of vehicles and infrastructure	Maintenance profile of vehicle. Breakdowns.
	Passenger information	Clear and timely announcement of stops	Audibility of public address systems. Presence of announcements.
		Route/direction visible on trains/buses	Availability, accuracy of maps, destination indicators.
		Friendly, courteous, and quick service	Demeanor of transit personnel.
		Transit personnel who know the system	Percent of correct answers to questions.
		Explanations and announcement of delays	Presence of announcements.
		Station/stop names visible from train/bus	Number and spacing of signs, lighting.
	Service delivery	Frequency of delays for breakdowns/emergencies	Mean distance between failures.
		Trains/buses that are not overcrowded	Load factors.
	Security	Freedom from the nuisance behavior of others	"Quality-of-life" and system rules violations.
		Safe and competent drivers/conductors	Driver training and accident records.
		Train/bus traveling at safe speed	Vehicle travel speeds.
Transfer to transit	Accessibility	Connecting bus service	Availability/frequency of connecting services.
		Short wait time for transfers	Transfer times.
		Accessibility to those with a disability	Percent of elevators in working condition. Presence and quality of curb cuts, ramps, tactile surfaces.
Walk to destination	Accessibility	Accessibility to those with a disability	Presence and quality of curb cuts, ramps, tactile surfaces.

In the remainder of this chapter, we focus on the 10 most important determinants of service for each of the transit systems under study. Table 10.3 summarizes the findings and highlights the similarities and differences across the three systems and the two CTA lines that were examined.

The two service attributes that emerged as the most important across all routes sampled were the frequency and reliability of transit service, both of which reflect important policy-sensitive aspects of transit service design. The third service attribute that was mentioned by riders in all three transit systems but only in one of the CTA lines was the freedom from the nuisance behaviors of others, an important but subtle and difficult to quantify service dimension. The remaining "top ten" service attributes were split between those that were perceived as important by riders in Chicago and Lynchburg and those that were mentioned by riders of the Sun Tran service who mostly focused on frequency-related issues.

In sections 10D to 10M, we focus the discussion on the individual service dimensions and the corresponding measures.

10D. Frequency of Transit Service

Based on the customer satisfaction surveys, frequency of transit service is among the most important elements of transit service. Frequency was at the top of riders' lists for each of the three agencies where transit riders were surveyed.

Frequency has two interpretations for transit riders. First, it refers to the hours of operation of transit services. Many routes and services are available only during weekday peak periods, and sometimes riders need to make trips served by the routes and services on weekends and on off-peak times of weekdays. Limitations in transit service hours obviously affect travelers who need to travel during the hours or days when there is no service. In addition, some potential transit riders choose not to use transit services because the particular services are unavailable for their anticipated return trips or because they cannot be certain about the time of their return trips and need to be certain that they do not get stranded.

Limitations in transit services and routes are almost always necessary for reasons of cost-effectiveness. The low ridership levels that would be generated on many routes simply cannot justify the cost of providing services at these times. However, from the customers' point of view, having service at all hours and on all days is desirable. A straightforward customer-oriented measure of this aspect of service frequency is the hours per day and days per week that transit service is available for each route.

The second interpretation that customers have of service frequency is how often buses and trains come when the route is being operated. This can be measured most directly by the wait time that customers experience. When service headways (the time between successive trains or buses) are relatively short, wait time can be assumed to be one-half the headway. As headways get longer and people begin to arrive for specific scheduled trains or buses, wait times level out. However, the general inconvenience of having only a few buses or trains from which to choose continues to increase as headways are increased. Since headways and wait times usually vary by time of day and between weekdays and weekends, measuring them for customers' actual time of travel is likely to greatly improve the relationship between customer ratings and the service measures. Therefore, bus and train headways can be used as straightforward measures of service convenience reflecting the frequency of service by route, time of day, and day of the week.

Table 10.3
Similarities and Differences Across Transit Systems

	CTA Overall	CTA Red Line	CTA Blue Line	GLTC	Sun Tran
Frequent service so that wait times are short	x	x	x	x	x
Reliable trains/buses that come on schedule	x	x	x	x	x
Explanations and announcement of delays	x	x	x	x	
Trains/buses that are not overcrowded	x	x	x	x	
Freedom from the nuisance behaviors of others		x		x	x
Smoothness of the ride and stops	x	x	x	x	
Cost effectiveness, affordability, and value	x	x	x	x	
Availability of seats on the train/bus	x		x	x	
Frequency of delays for repairs/emergencies	x		x		x
Cleanliness of the train/bus interior	x	x		x	
Temperature on the train/bus	x	x			
Absence of offensive odors		x			
Friendly, courteous, and quick service			x		
Ease of paying the fare			x		
Frequency of service on weekends					x
Hours of service during weekdays					x
Short wait time for transfers					x
Connecting bus service					x
Availability of shelters and benches					x
Posted minutes to next train/bus					x
Cleanliness of stations/bus stops				x	

In addition, customers making trips that require one or more transfers are likely to view the frequency of the second and subsequent routes or services as especially important because those frequencies will dictate the amount of time that the customers can expect to spend making transfers. Transfer time is usually considered to be particularly onerous by transit riders. For this reason, it is recommended that measures of the time spent transferring are developed at least for the most important origin-destination pairs in the area served by transit.

The frequency of service is the primary determinant of actual customer wait times and one of the most important determinants of their level of satisfaction with transit service delivery. Closely related to service frequency (in customers' minds) is service reliability — the ability to stay on the expected schedules. The next section discusses this aspect of service.

10E. Reliability of Transit Service

The large number of transit agencies reporting measures of service reliability reflects the importance of providing reliable and predictable service both from a transit operations and a transit rider's perspective. Furthermore, the variety of definitions of on-time reliability reflects the different perspectives of transit agencies in measuring this service attribute (Appendix G).

It is highly advantageous both to operators and customers to maintain consistent and predictable service on transit routes and lines. For operators, a lack of regularity and uniformity leads to the inefficient use of resources (with some vehicles overloaded while others are underutilized), increased costs, and lower systemwide productivity. Two-thirds of transit operators view maintaining reliability as very important element of transit service delivery.[17] For customers, non-uniform and inconsistent service increases the level of uncertainty and uneasiness they feel at stops and stations, exacerbates crowding on vehicles and at station and stop waiting areas, and makes transfers more difficult and time-consuming.

The reliability of transit service is most often measured by on-time performance, which reflects how closely the delivery of transit service matches the published schedule. Specific measures of on-time performance include:

- percent of trains or buses reaching pre-specified points on time in different time periods, where on time is defined as arriving in a pre-specified time window;
- variance in travel times between two points;
- average minutes of bus or train delay measured at specific locations; and
- regularity of service (schedule adherence) at specific locations.

There are certain dimensions to on-time performance that make its measurement complicated. The objective of a transit rider is to arrive at his/her destination on-time, regardless of any en-route schedule variations. It is possible for trains or buses to be badly off schedule, and still get a passenger to the destination at the desired time. At the same time, transit riders are interested in minimizing the time spent waiting for vehicles since it is a component of travel time that is perceived as more onerous than invehicle travel time. It is also possible for the on-time performance measures to poorly conform to riders' experiences in this regard.

In analyzing on-time performance measures, it is often difficult to compare different types of services and different types of routes. Most on-time performance measures will have disparate ranges for different transit modes because the modes are affected by different exogenous factors. For instance, it is quite difficult to meaningfully compare the on-time performance of a commuter rail line with that of an urban bus because the bus is more vulnerable to weather problems and highway incidents. Riders recognize the inherent reliability differences, and usually customer satisfaction levels will be based on different levels of expectation.

Even within mode comparisons are difficult. To facilitate the assessment of on-time performance a distinction needs to be made between frequent transit service that is offered in small regular intervals and infrequent service that is provided according to a published schedule. In addition, the length of the route is likely to skew on-time performance results.

Because of these difficulties in comparing on-time performance for different services, it is also difficult to develop meaningful systemwide on-time performance measures. The most effective measures are obtained for specific services or small groups of services. They are best analyzed through comparisons over time as opposed to comparisons with each other.

There are also a number of operations measures that can be used as a surrogate measure for transit reliability. These measures are supply-driven and reflect the ability of the transit agency to provide the required amount of service rather than the quality of service. These measures could be used as surrogate indicators in cases where there is no option for additional data collection and analysis and include:

- the frequency of service breakdowns which is usually expressed as the average number of miles between breakdowns including a vehicle failure, road call, or service interruption, and

- vehicle availability which measures the number of vehicles that are available for service suggesting that the likelihood that service will be delivered as scheduled decreases with fewer available vehicles.

10F. Explanations and Announcement of Delays

For transit riders, one of the most difficult aspects of delays in service is the associated uncertainty about what has happened and how long they will need to wait for a train or bus. Riders are much more accommodating of delays when they are provided with information regarding the reasons for the delay and the likely length of the delay. The information allows riders to better plan ahead, and at a broader level, it helps to make riders feel like the transit system recognizes that the delays are a problem and that the transit workers are actively working on the problems.

A number of transit systems try to provide delay information to riders through on-board and station public address systems. In addition, some agencies have experimented with providing electronic map information on-board vehicles, at stations, and at bus stops. Automated Vehicle Location (AVL) systems allow operators to post real-time or close-to-real-time information for passengers.

In Europe, many transit agencies pride themselves on passenger amenities, especially the provision of customer information.[18] In London, where uncertainty about delays is among the most common sources of rider dissatisfaction, arrival time and destination information is beaconed to transit stops. In Stuttgart, the transit agency makes use of their AVL-based transit fleet management system to provide traveler information at terminal kiosks and through an in vehicle route guidance system.[19]

In addition to the more high-tech communications devices, transit agencies also provide likely-delay information to passengers through newsletters, flyers, and telephone customer service representatives.

A number of measures can be used to gauge how well delay information is being disseminated to riders, including:

- availability of on-board and station public address systems;

- availability of other electronic real-time displays;

- frequency and clarity of announcements and messages;

- percentage of significant delays for which correct information was provided to passengers on-board affected vehicles;

- percentage of significant delays for which correct information was provided to passengers waiting at affected stations or bus stops; and

- percentage of foreseeable delays (construction, maintenance, weather-related) of which customers are made aware.

Transit agencies also commonly measure the quality of their customer communications that are not directly related to delays. Some agencies reported measures that are aimed at quantifying each of the different communication efforts that transit agencies carry out. Examples of such measures include the percentage of calls by the public answered within 90 seconds; the number of service requests received by the public; and the number of calls received asking for transit-related information.

The number of complaints expressed by transit passengers is used by some agencies as a surrogate of service performance and is often reported on a monthly basis. This measure presents an effort by the transit agencies to be responsive to their clients' needs and wants. Agencies collect and analyze complaints by type (e.g. facilities, operators) and by mode and normalize the frequency of complaints by dividing by the number of transit riders or the number of transit service miles provided.

10G. Crowding On-board Trains and Buses

A common complaint about public transit systems in large cities is that trains and buses are often too crowded. Generally, the most common reasons that vehicles get overcrowded is that there is a service frequency or reliability problem, so the fact that crowding is of importance to survey respondents reinforces the importance of measuring frequency and reliability.

The crowding on-board trains and buses is an easily quantifiable measure through the calculation of various load factors. The load factors reflect the discrepancy between the available transit capacity and the corresponding transit ridership. Load factors can be expressed as the number of passengers on a vehicle divided by the vehicle's design capacity, the number of passengers divided by the crush capacity of the vehicle, or the number of passengers on a vehicle divided by the number of available seats. Passenger loading estimates are best obtained through direct observation of vehicles passing prespecified points (usually the maximum loading points).

10H. Behavior of Other Riders

Security concerns are an important element of customer satisfaction. In the surveys, these concerns manifested themselves as concerns about the behavior of other riders. If transit customers perceive that the nuisance behavior of other riders is tolerated, then their level of concern about their personal security will increase. Where there is a high level of so-called "quality-of-life" crimes and rules violations, there is more of a feeling that there is no one in charge of the system.

One way to measure the level of nuisance behavior is to track police arrest and citation records. The weakness of this approach is that it is confounded by changes in the level of effort by police to enforce system rules and by the general presence of police within the system. The presence of police officers within the system will tend to shift crimes and incidents to different places in the system, so measured improvements may not accurately reflect riders' experiences.

Some transit agencies have tried to obtain measurements on the amount of nuisance behavior by discretely sending observers into the system to collect information on fare evasion and other minor crimes and rules violations. OC Transpo in Ottawa has developed Transecure, a neighborhood watch program within its system to allow police to locate and respond to bad behavior or suspicious activities. Information from such a program is likely to be better than arrest or citation data because those observing the bad behavior will not be recognized as police. If a system is able to spend enough resources to obtain a statistically significant sample of time periods and locations, then changes over time can be monitored and compared to survey results.

10I. Smoothness of the Ride

The smoothness of the ride and the stops is an indicator of rider comfort that is not easily quantified. Smoothness can be measured on a subjective basis by having transit staff ride transit vehicles that are in operation and to rate the ride quality. Alternatively, scientific instruments could be used to measure the forces being experienced by riders as the vehicles traverse their routes.

These measures are more difficult to use and interpret than other measures discussed in this chapter. A number of factors contribute to the relative smoothness of the transit ride, including:

- the condition of the railroad track or the roadway;
- the operating condition of the rail or bus vehicles;
- the speed of the bus and the composition of the roadway traffic; and
- the experience of the rail and bus operator.

Riders' dissatisfaction about the smoothness of the trip can be caused by problems related to any or all of these factors. Therefore, developing direct measures to quantify smoothness will not necessarily help a transit operator determine whether or how to make improvements to the system to improve customer satisfaction. Given this problem, it is probably unlikely that smoothness measures would be helpful to transit operators unless they were specifically designed to isolate the different factors that go into ride smoothness.

10J. Cost Effectiveness, Affordability, and Value

The cost of travel by transit is almost always subsidized by local, state and/or national governments in an effort to promote transit use, alleviate roadway congestion, and improve the mobility of the transit-dependent segments of the population. However, in almost all cases the users are required to pay fares to use transit systems. Fare levels affect customer satisfaction and ridership.

For any given customer, the measure that is directly related to the questions of cost effectiveness, affordability, and value is the cost per transit ride. Because most systems offer some type of discounted multi-ticket fare as an option to a one-way ticket, the cost per ride may be different depending on the ticket type that individuals use. If monthly passes or another type of unlimited ride ticket types are available, the cost per ride will also vary based on the amount of system usage.

In most cases, the average cost per ride that individuals pay will vary by traveler market segment because ticket type choice will vary by market segment. Developing separate measures for different traveler market segments may be the best way to relate customer satisfaction with transit fare levels.

10K. Availability of Seats

Availability of seats is a special case of crowding on transit vehicles that is discussed above under section 10G. One can measure the ratio of the number of people on a vehicle to the number of seats on a vehicle to quantify the availability of seats.

10L. Frequency of Delays due to Repairs/Emergencies

The paramount importance of delays and reliability to transit passengers was discussed above under section 10E. However, the analysis of the survey results suggests that riders do not consider all delays equally. Delays that are due to breakdowns or accidents are particularly irksome to transit riders because they are to some extent preventable. Weather-related delays, while certainly viewed negatively, have a lesser impact than delays due to bus or train mechanical problems.

Transit agencies commonly quantify the reliability of transit vehicles with the measures mean distance between failures (MDBF) or average failures per vehicle. Operations staff use these measures to detect problems with vehicles of one type or another, so separate values are calculated for each vehicle type in the system. The primary advantage of these measures is that most agencies collect this information on a continuing basis anyway, so no additional data collection is necessary.

The primary disadvantage of these measures is that they are not collected for the purpose of measuring the quality of customer service delivery. To relate the measure to particular riders' customer satisfaction, it is sometimes necessary to obtain detailed information about the vehicle types being used on specific routes and to calculate route-specific or service type-specific weighted averages of the mean distance between failures. In addition, the type and circumstances of failures will have a large impact on customers' perceptions and this information is not necessarily captured by the maintenance measures. It would probably be quite useful to categorize the specific problems causing the breakdowns, whether or not passengers were able to be rerouted once a vehicle broke down, and the response time to address the incident.

The frequency of transit-related accidents was another category of measures cited by many agencies. Some of the agencies normalize the number of accidents per miles of service while other agencies break out accidents by type including passenger accidents, employee accidents, preventable accidents, vehicle accidents, etc. Measures of accident incidence are usually reported on a monthly and a mode-specific basis.

10M. Passenger Environment On-board Vehicles and at Stations/Stops

The general environment through which passengers travel on transit has a great deal to do with their level of satisfaction. However, it is difficult to develop a consistent and objective approach to measuring the quality of the passenger environment.

Some agencies employ professionals whose responsibilities include monitoring the system from the customer's point-of-view. These individuals are trained to consistently rate stations and vehicles according to specific objective measures or on qualitative pre-set scales. This information is then

aggregated and tracked over time to measure how the passenger environment changes. The information is shared with the operations managers who are responsible for the specific elements being evaluated, so that they are able to evaluate the quality of their departments' service delivery.

New York City Transit uses its passenger environment survey to obtain data on a wide range of subway categories[20], including:

Station

- lighting at different locations within stations;
- public address system clarity;
- condition of escalators and elevators;
- presence and readability of system maps in the stations;
- amount of litter on the platforms and track bed;
- amount of stains and spills on the platforms;
- amount of graffiti in the station;
- quality of the station signage;
- condition of public phones;
- condition of turnstiles, gates, token vending machines;
- courtesy and appearance of token booth personnel;
- availability of maps and system information in the station.

Subway Cars

- exterior graffiti;
- condition of doors;
- lighting;
- air conditioning, fans, car temperature;
- clarity of station stop and safety announcements;
- amount of litter, spills, and stains in the car and;
- presence of graffitied, scratched, and cracked windows;
- appearance of guards.

Bay Area Rapid Transit (BART) performs a similar quarterly review of its facilities.[21] The BART survey includes 31 specific measures that are organized around organizational areas of responsibility. The BART measures include:

Facilities Management

- Station Patio Cleanliness
- Parking Lot Cleanliness
- Landscape Appearance

Station Operations

- Station Cleanliness
- Station Graffiti
- Restroom Cleanliness
- Advertisements in Stations
- Brochures in Kiosks

Station Agents

- Agent Available or Sign in Place
- Agent in Uniform
- Agent wearing Name Badge

BART Police

- BART Police Personnel in Stations
- BART Police Personnel in Parking Lots/Garages
- BART Police Personnel on Trains

Public Address Announcements

- P.A. Arrival Announcements
- P.A. Transfer Announcements
- P.A. Destination Announcements

Rolling Stock

- Train Exterior Graffiti
- Train Doors Operative
- Train Interior Graffiti
- Train Interior Cleanliness
- Train Window Etching
- Temperature on Trains
- Advertisements on Trains

Elevator/Escalator Availability

- Station Elevator Availability
- Escalator Availability - Street
- Escalator Availability - Platform

Automatic Fare Collection Availability

- Fare Gate Availability
- Ticket vending Machine Availability

On-Time Performance

- Train on Time
- Customer on Time

A number of the passenger environment measures are subjective and qualitative. The careful training of observers and tests to ensure that ratings are being made consistently are essential for the data collection effort to be effective. However, despite the difficulty in establishing and monitoring the data collection effort, passenger environment surveys are probably the best way for transit agencies to understand their systems from customers' perspectives.

ENDNOTES

[14] European Conference of Ministers of Transport, Round Table 92: *Marketing and Service Quality in Public Transport,* Organization for Economic Cooperation, Paris, France, 1993.

[15] Transit Cooperative Research Program, Research Results Digest, Number 4, *Transit Ridership Initiative*, Transportation Research Board, National Research Council, Washington D.C., February 1995.

[16] Transit Cooperative Research Program, Research Results Digest, Number 3, *Total Quality Management in Public Transportation*, Transportation Research Board, National Research Council, Washington D.C., October 1994.

[17] National Cooperative Transit Research & Development Program, Synthesis 15, *Supervision Strategies for Improved Reliability of Bus Routes*, Transportation Research Board, National Research Council, Washington D.C., September 1991.

[18] Transit Cooperative Research Program, Research Results Digest, Number 22, *International Transit Studies Program - Report on 1996 Missions*, Transportation Research Board, National Research Council, Washington D.C., October 1997.

[19] Transit Cooperative Research Program, Research Results Digest, Number 20, *International Transit Studies Program - Report on the First Three Missions*, Transportation Research Board, National Research Council, Washington D.C., May 1997.

[20] Charles River Associates Incorporated, *Metropolitan Transportation Authority Comprehensive Line Improvement Study*, March 1994.

[21] Aaron Weinstein and Rhonda Albom, *Securing Objective and Reliable Data on the Quality of the Passenger Environment — The Redesign of BART's Passenger Environment Measurement System,* presented at the 77th Annual Meeting of the Transportation Research Board (January 1998).

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CHAPTER 11. AN OVERVIEW OF DATA COLLECTION AND ANALYSIS METHODS

In this chapter we outline the broadly defined desirable features of a data collection and analysis plan. The differences in the level of service offered and the nature of the markets served by each transit system do not allow the development of a unique set of specific data collection and analysis procedures. Furthermore, the identification of a different set of priorities for service improvements by riders of different transit systems further stresses the need for a customized approach to data collection and analysis.

The broadly defined principles guiding the data collection and analysis approach are presented in two sections. We first outline the elements of a data collection plan that minimizes biases and aggregation errors, provides data that are internally consistent and relevant from a passenger perspective, and accounts for the statistical significance of the collected data at a reasonable cost. We conclude our discussion by outlining different ways of analyzing the collected transit performance data and summarizing the results.

11A. Principles of Data Collection

In order to gauge the quality of customer service by measuring specific service attributes, it is essential that the transit agency consider the quality of the data that are being collected and the appropriateness of the chosen data collection method(s). As noted in the previous chapter, data on different service measures can be obtained by a variety of manual and automatic methods.

The manual methods include observation of service attributes by field inspectors, by field worker data collection staff, and by "mystery riders," transit agency staff or contractors who ride the system as customers would without letting transit workers know who they are or where they will be. In many cases, inspectors assemble the data that would be used in evaluating service attributes for their own purposes, thus the added cost of using this information for customer service evaluation is low. Special data collection procedures by transit staff and mystery riders can be used to obtain the other service measures.

Some transit service measures can be recorded automatically. For instance, systems that use buses equipped with AVL systems can automatically collect data on vehicle headway, on-time performance, and ridership allowing us to calculate a multitude of performance measures discussed in this report. Furthermore, the implementation of an AVL system allows the development of passenger information systems that can be used to provide estimated time of arrival to waiting passengers, display vehicles on an electronic map at a bus stop or rail station, and provide en route information to transit passengers.

A review of the current status of AVL bus transit systems in the U.S. along with a detailed technical review of different AVL architectures and technologies is presented in a recent TCRP report.[22] The advantage of such a data collection mechanism is that a variety of accurate performance data can be automatically collected at the route level by time of day and day of the week. At the same time, the challenge with these data is the ability to properly sample, organize, and analyze the information that is gathered in order to obtain the meaningful measures that are being sought.

Planners need to be aware that there are several potential problems with any given measure that can reduce its usefulness in analyzing service delivery. Among the potential problems are:

- bias;
- aggregation error;
- inconsistency;
- irrelevancy form the passenger perspective;
- insignificance; and
- cost to assemble and analyze data.

These issues are discussed below.

Bias. In this context, bias refers to a set of systematic errors that tend to overstate or understate the performance of the system for a specific measure. Performance measures should be as free from bias as possible. Examples of biased measures include data from a non-representative sample of routes or services and data assembled with methods that cause the observed situation to be different than that experienced by riders. If an agency were to assess the reliability of its bus system by measuring on-time performance only on routes of one type, say routes that serve major downtown stops, erroneous conclusions about the system as a whole are likely. Similarly, if an agency were to evaluate aspects of customer service by having uniformed inspectors observe transit employees' interactions with customers, then it is likely the results of such an evaluation would not reflect conditions when inspectors were not present.

Aggregation Error. If service measures are collected at too gross a level, important nuances of customer service delivery will be lost. For instance, if on-time performance was calculated on a systemwide basis and was used to gauge customer satisfaction with on-time reliability, it is possible that the measure is masking significant differences between different routes and lines. If a small number of routes have significantly poorer performance than the system as a whole, their effect on the objective service measures will understate the negative effect that they have on customer satisfaction.

Inconsistency. Because the most effective way to analyze service measures is to analyze changes over time and differences between different routes and services, the measures of service delivery and the scales used to record them should be consistent over time, from location to location, and from one evaluator to another. This is particularly important for the more subjective measures such as cleanliness. If inspectors or members of the field staff are employed to rate stations or vehicles on cleanliness, each one of them should have consistent ratings. In addition, the ratings should not vary with time. This is sometimes difficult because changes in the level-of-acceptability of certain conditions are likely to occur over time, particularly if a system invests in improvements in the specific aspect of service under study.

When agencies employ staff to make subjective measurements of service measures, the following steps should be taken whenever possible:

- develop objective measures whenever possible (e.g., use a thermometer to measure the temperature on vehicles, rather than a field worker rating of temperature);

- train the field workers extensively, employing actual field evaluations, to ensure that different fieldworkers rate things consistently;

- test inter-rater variations in ratings to ensure that raters remain consistent (sometimes the best way to test this is to have raters have some overlapping responsibilities).

Irrelevancy to Customers. Often, it is possible to use already-collected measures of performance to evaluate service delivery to customers. Of course, whenever this is possible it is desirable from an efficiency point-of-view. However, because these data are collected for purposes other than the evaluation of customer service delivery, planners need to assess the relevancy of the measure to customers. For example, information on on-time performance is commonly collected at train and bus terminals. In many cases where ridership is highly directional or is skewed to be on only part of the route or line, on-time performance at a particular terminal point may be largely irrelevant to customers. If a morning peak train runs close to schedule going into the CBD but then is delayed after it has made it past the CBD, the delay is irrelevant to the large majority of riders. In this case, a better on-time performance measure would be one that was collected at a CBD station.

Insignificance. In order to draw valid conclusions from the assessment of service measures, an agency needs to ensure that enough data are sampled and assembled to make the conclusions statistically significant. An agency should first define finite elements of its system, such as stations, buses in a particular time period, or buses on a particular route. As a second step, statistical sampling methods should be applied to determine how many of the elements need to be studied or observed in order to make statistically valid conclusions. If information is assembled in an ad hoc way, it is possible that variations in service quality will never be accurately observed.

Cost to Assemble Data. Finally, as for any primary data collection effort, the costs of getting particular types of data need to be considered and traded-off with the benefits of the data that would be collected. In general, the errors introduced by the potential problems described above can be reduced somewhat through more and better data collection efforts that almost always increase the cost of data collection. Although it is difficult to determine the cost-effectiveness of data collection efforts, the agency should set as a priority maintaining data on the measures associated with the three or four of the most important aspects of service from the customer's point-of-view.

For those aspects of service that are perceived as less important, an agency should probably obtain data through less rigorous methods, perhaps using less accurate measures that are already collected or are easily collected. In developing cost estimates for service data collection, an agency should seriously consider the added benefits of maintaining the data assembly over time, rather than on a one-time basis. In addition, an agency should consider collecting detailed high-quality data for specific elements of the system, rather than the system as a whole.

11B. Approaches to the Analysis of Performance Data

The ultimate objective of the analysis of the transit performance measures is to facilitate a focused and accurate assessment of any existing weaknesses in service and the measures that need to be taken in response to these performance problems. To provide transit management with a means of identifying the strengths and weaknesses of transit service and supporting its evaluation the analysis should, as stated earlier:

- provide transit management with a systemwide overview of transit operations for different transit modes;

- evaluate transit performance on a route-specific level of detail by focusing on individual segments of the transit network;

- monitor changes in transit service over time to identify deteriorating conditions or to highlight improvements in service in response to service intervention;

- identify the variation in transit level of transit service by collecting data specific to a service area, time of day, or day of the week for the service attributes of interest; and

- guide the development of marketing and communication strategies to inform transit customers and potential customers of the desirable service features.

To provide transit management with these insights, we demonstrate four different broadly defined ways in which the collected transit performance data can be analyzed. We use as a hypothetical example a measure of bus on-time reliability as reflected in the percentage of buses arriving late at the central business district bus terminal. We have also assumed that comparable data on on-time performance are available for four different points in time between 1979 and 1997. The figures that are presented and discussed allow us to:

- measure bus performance at a systemwide level and compare it with differences in performance at the bus route level;

- identify trends in systemwide and route-specific levels of bus performance over time;

- assess differences in the perceptions of different market segments including bus riders and nonusers, frequent and infrequent transit riders, riders using different routes, and riders with different socioeconomic characteristics; and

- compare riders' perceptions to measures of transit service to identify whether the strengths and weaknesses perceived by riders actually reflect the level of transit service that is currently provided.

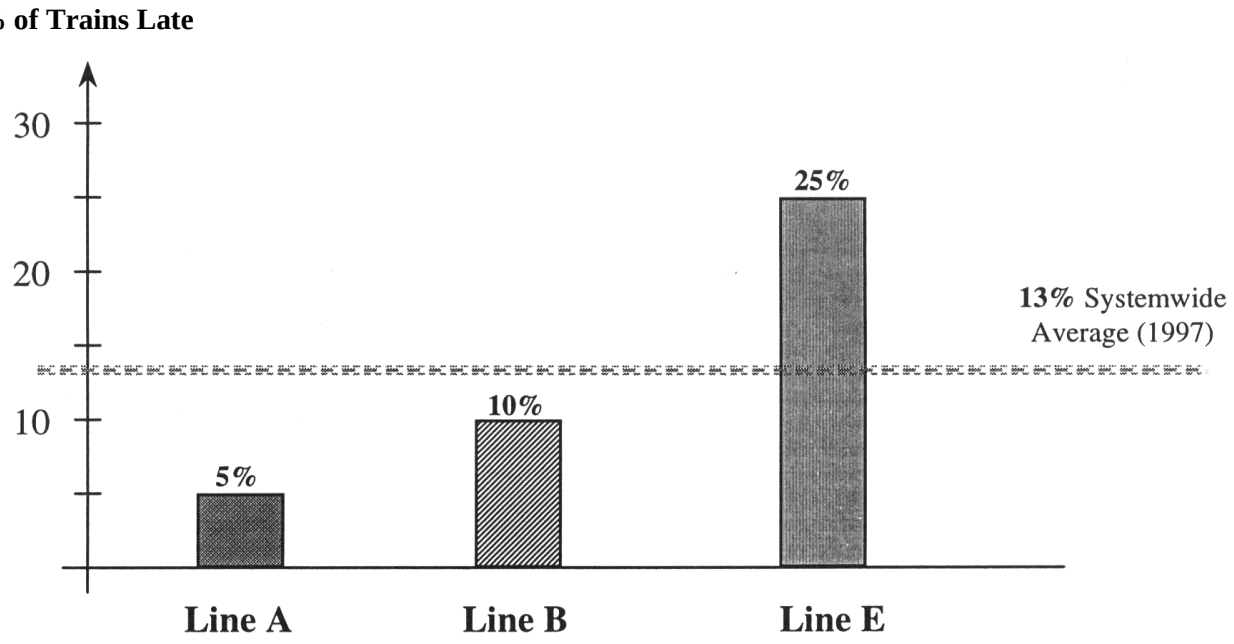
These layers of analysis correspond to an ever-increasing level of complexity. It is therefore not expected that all layers of analysis will be employed by each agency to study each of the important aspects of service. Furthermore, the more complex analyses presented below also require a wealth of data that may be maintained only for a few important measures of service.

I. Cross-Sectional Analysis of Transit Performance

The analysis of on-time transit reliability at a single point in time can provide a snapshot of transit performance both at a systemwide and at a transit route level. Although the systemwide measure can be a useful indicator of overall performance especially when monitored over time, it is also important to focus on the performance over sections of the transit system to identify potential differences by line.

Figure 11.1 presents a hypothetical example where the aggregation at the bus system level without any attention to the disaggregate route level of detail would mask important differences in performance by bus route. As shown in Figure 11.1, the overall on-time performance for the transit bus system is reflected on a satisfactory systemwide average of 87% of buses arriving within a specified time interval. However, a more detailed analysis of on-time performance at the route level suggests that there are considerable differences in route performance that would ordinarily be masked by focusing solely on the systemwide average measure.

Figure 11.1
Comparative Route Analysis



Therefore, on the basis of such a cross-sectional analysis of the bus system, the analysis would conclude that:

- the overall level of bus on-time performance is satisfactory, but
- there are important differences by route which suggest that:
  - route E experiences a significant amount of buses that are late and should be identified as a priority for service improvements;
  - route B operates at an acceptable better-than-average level but should be monitored to prevent any deterioration in service; and
  - route A should be used as a benchmark of on-time performance for the whole system.

II. Historical Analysis of Transit Performance

An additional layer of analysis can be provided by the study of systemwide and route specific on-time performance over time. Such an analysis can be used to identify trends of progress and deterioration in transit service that are not provided by the snapshot provided by the cross-sectional analysis.

A review of the hypothetical historical patterns of on-time performance for the same system shown in Figure 11.2 uncovers some important trends that could help explain the differences in on-time reliability across the system. In particular, it appears that the systemwide trend of deteriorating on-time

performance has been reversed in the past three years. However, there are some important underlying differences among the three routes suggesting that:

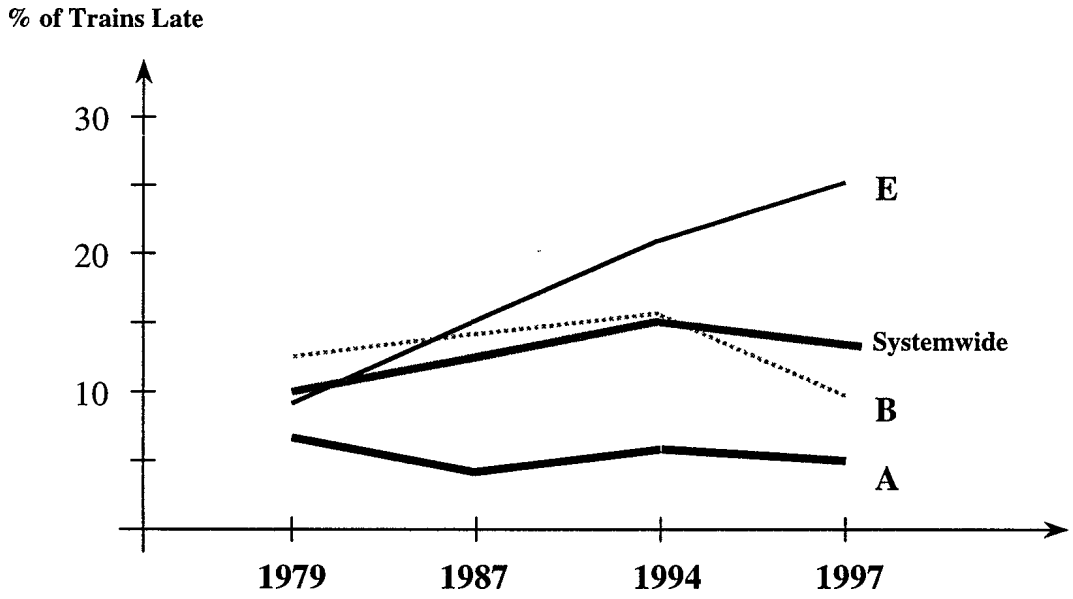
- the current poor on-time performance for route E is the result of an ongoing deterioration in transit level of service and reflects problems that date back more than a decade and that have gradually affected transit service;

- route B has enjoyed improved on-time reliability over the past three years reflecting the systemwide trend; and

- route A has maintained an excellent level of service over time.

Thus, despite the improvement in systemwide service performance the identified route-specific patterns of stability, progress, and deterioration in service performance over time can be used to support route-specific interventions.

Figure 11.2
Performance Monitoring Over Time



III. Riders' Attitudes and Transit Performance

The third layer of analysis that supplements the cross-sectional and historical analysis of transit performance data focuses on the joint analysis of transit riders' attitudes and transit performance. Two general types of analysis can be accommodated within this context. First, an analysis of the differences in attitudes across segments of the transit market can help identify opportunities for marketing to different groups of riders. Second, a comparison of attitudes and transit performance can help identify riders' misperceptions and identify opportunities for communicating service improvements to transit riders.

Figure 11.3 illustrates the differences in perceptions among users and nonusers as reflected on their ratings of five different aspects of transit service. A rating scale of 0 to 10 was used with higher values corresponding to more positive perceptions of transit service. As shown in Figure 11.3, current transit riders rate all aspects of transit service, with the exception of safety while using the system, higher than nonusers do. The pattern of differences in the respondents' ratings suggests that:

- the transit agency needs to allocate resources to enhance riders' perception of feeling safe and secure while riding the transit system;

- the perception of safety and security among nonusers does not appear to be the primary reason for not using the transit system;

- the gap between users' and nonusers' perceptions is greater for "frequency of transit service" and "transit on-time performance" which are perceived rather positively by current riders of the transit system; and

- there are considerable opportunities to improve nonusers' perceptions of transit service along most of the dimensions of transit service as part of an effort to increase transit ridership.

Although the example of such an analysis is presented at the systemwide level for transit riders and nonusers it can be further expanded along two additional dimensions. First, route-specific analyses can be conducted for routes and groups of routes that are of greatest interest to the transit authority. Second, comparisons of attitudes among market segments can be expanded to account for differences among frequent and infrequent riders, male and female riders, and riders with different degrees of captivity to transit. These analyses can provide insight into the appeal of different transit routes to distinct segments of the market.

Finally, it is possible that the availability of transit performance and survey data at similar points in time allow comparisons between riders' perceptions and transit performance measures. Such comparisons are again most meaningful if they can be repeated over time and across different routes of the system. The availability of such data supports a fourth layer of analysis that can be used to relate patterns of change in transit performance to changes in riders' perceptions.

The comparisons that can be made allow us to identify cases where service improvements have a positive impact on riders' perceptions and cases where despite improvements in transit service transit riders' perceptions continue to remain rather low.

Figure 11.3
Perceptions of Users and Nonusers for Route A

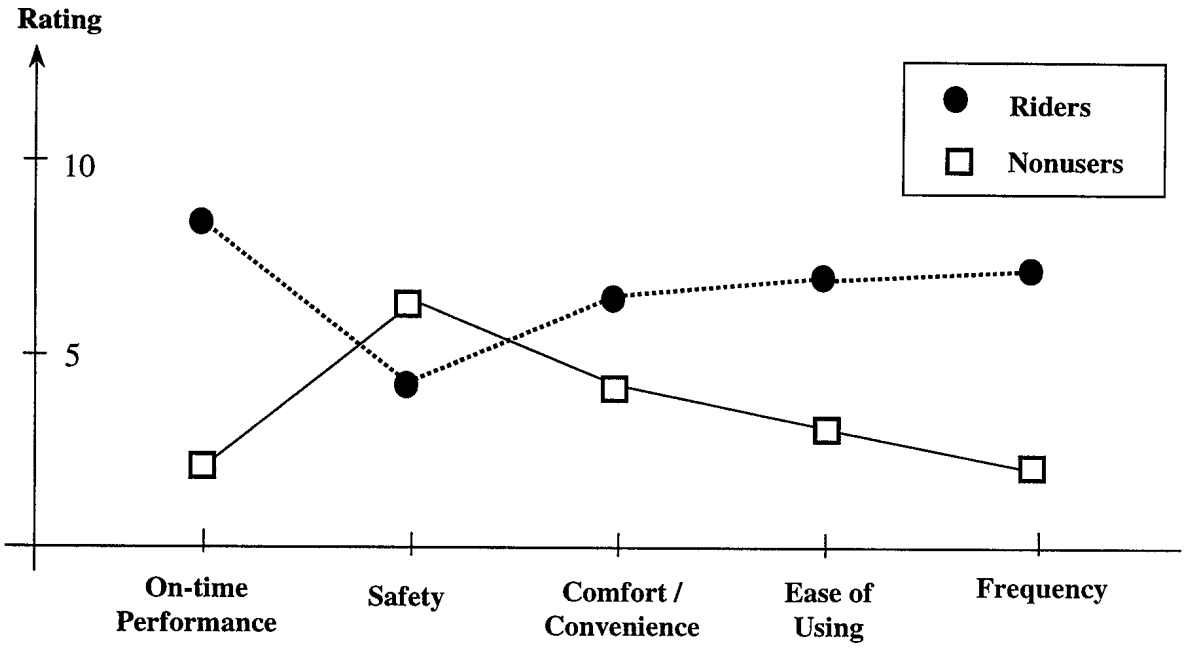


Figure 11.4 offers an example of comparisons that can be made using historical attitudinal data and corresponding performance data at the route level to identify the extent to which there is a correlation between traveler perceptions and transit performance.

The bar chart and the left hand axis illustrates the average ratings given by riders of routes A and E on a scale of 0 to 10 with higher values corresponding to more positive perceptions of service. The line graph and the right hand axis correspond to the on-time performance reflecting the percentage of buses arriving late for the A and B routes at the three study years.

The comparisons that can be made suggest that:

- riders' ratings for route E are consistently lower than those by riders of route A properly reflecting the historically better on-time performance of route A;

- route E riders' ratings of the transit service have dropped over time in a manner that is consistent with the deteriorating performance of route E;

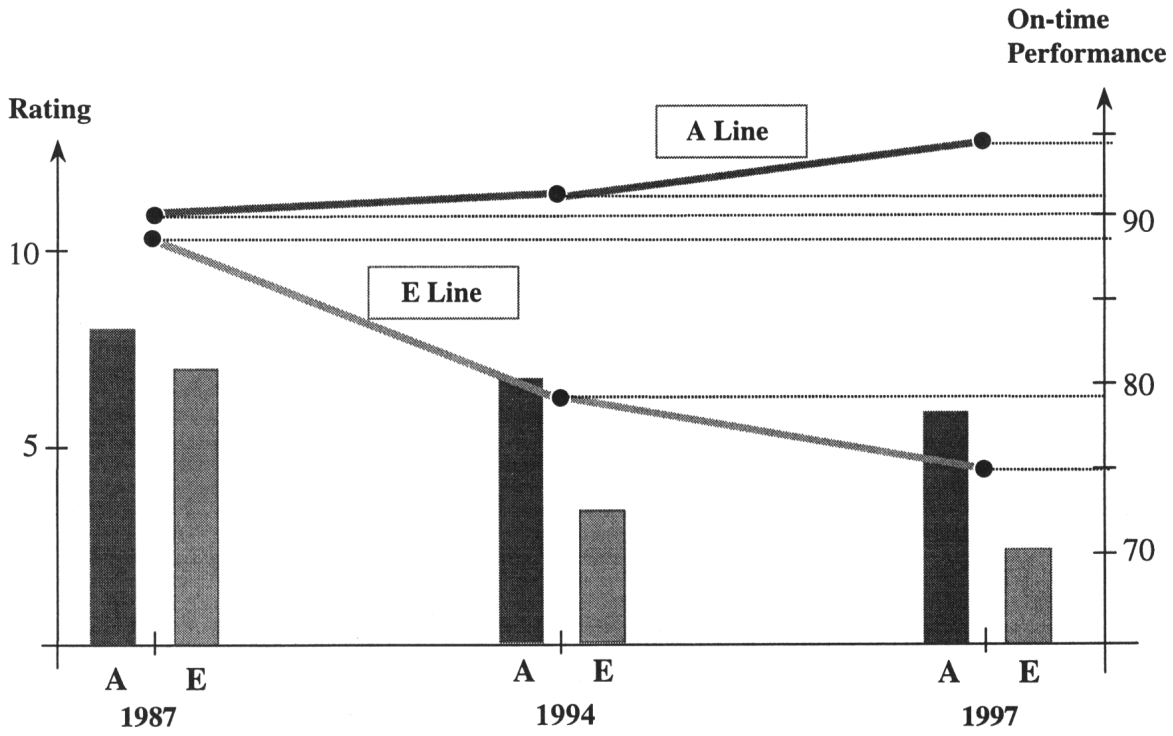
- the gap between the ratings for route A and E has widened over time again properly corresponding to the widening gap in the level of transit on-time performance offered by each route; and

- the drop over time in riders' ratings of route A is not consistent with the high level of on-time performance for route A.

These observations suggest that riders' evaluations are generally consistent with the level of service that is provided. The need to improve the on-time performance along route E is supported both by the existing low level of on-time reliability on that route as well as the low ratings provided by riders. It is expected that the implementation of such service improvements will enhance route E riders' perceptions and bring them closer to the ratings provided by riders on route A.

Finally, the apparent inconsistency between the historically high level of on-time reliability for route A and the steady or decreasing ratings by route A riders suggests that other aspects of the performance for this route need to be examined more closely. It is possible that due to deterioration in other service characteristics for route A, riders provide ratings for on-time reliability that are lower than expected. However, if there are no apparent weaknesses in other aspects of route A service, the implementation of a marketing campaign aimed at riders of route A may be considered to stress the existing high level of service.

Figure 11.4
Performance Measure versus Riders' Perceptions



ENDNOTES

[22] Transit Cooperative Research Program, Synthesis 24, *AVL Systems for Bus Transit*, Transportation Research Board, National Research Council, Washington D.C., 1997.

APPENDIX A

CUSTOMER SATISFACTION/DISSATISFACTION RESEARCH — AN HISTORICAL PERSPECTIVE

Consumer behavior as a distinct discipline dates only from the mid 1960s. Interest in understanding and tracking specific consumer problems grew dramatically in the late 1970s under the broad label of consumer satisfaction/dissatisfaction (CS/D) research. Its growth coincided with (and was abetted by) a growing interest on the part of both government regulators and leaders with the consumer movement in making the policy formulation process more rational and systematic. Critics of past consumer policy formulation had argued that it was too often influenced by chance events, letter-writing campaigns, media publicity, and partisan political agendas. The earliest comprehensive CS/D studies were, in fact, motivated by the policy planning needs of a public regulatory agency, the Federal Trade Commission (Technical Advisory Research Program (TARP) 1979), and a private non-profit sector organization, Ralph Nader's Center for Study of Responsive Law.

Pioneering studies by Handy and Pfaff in the mid 1970s developed raw and weighted indexes of consumer satisfaction with food products across seven broad food categories. After that point, research on the topic grew rapidly.

Since 1985, two different patterns have emerged. First, there has been a considerable drop in CS/D research from a public policy perspective. At the same time, however, there has been substantial growth in interest in the topic of consumer satisfaction research within the private sector. This has been driven primarily by the growth of the service sector of the economy where managers have realized that tracking satisfaction is crucial to success when intangibles such as personal attention and atmospheres are the "product." A number of private satisfaction tracking services have emerged. Many of these services have made extensive use of earlier methodological developments in social policy research.

Initial studies on CS/D sought to calibrate the amount and types of dissatisfaction in the marketplace as a basis for policy planning. This body of research was largely descriptive (TARP 1979). Wide variation was found across purchase categories. These studies differ widely in the basic measure of dissatisfaction they used. Some focused on more or less objective measures of "problems," others on subjective feelings of "dissatisfaction." Some counted any negative experience whatsoever, some only "serious" dissatisfactions, and some only the most recent problem. Also, there was the issue of opportunity for problems. Measures did not always control for frequency of purchase. Definitional problems persist today.

Most of the early studies were based on survey data. An alternate approach was complaints data, data on the extent to which consumers voluntarily speak up about their dissatisfactions. Such data have the advantage of not requiring field surveys; however, they are typically biased in two important ways. First, some types of problems in some types of industries are more likely to be voiced than others, and some problems are less serious than others, and or less costly than others. Monopolies are often relatively "immune" to complaining except from a small elite. Still other industries are more encouraging of complaints. Finally, not all consumers complain. These problems have led researchers in recent years to fall back on the more costly, but more objective, survey research methods.

Finally, most CS/D research from 1975 to 1985 was conducted within product and goods producing industries. Only after 1980 were initial concepts and models developed to measure consumer satisfaction/dissatisfaction within service industries.

LITERATURE SEARCH SUMMARY FOR SERVICE QUALITY AND CUSTOMER SATISFACTION MEASUREMENT — OUTSIDE TRANSIT INDUSTRY

***Conceptual Model of Service Quality and Its Implications for Future Research*, A. Parasuraman, Valerie A. Zeithaml, and Leonard L. Berry, Journal of Marketing, Fall 1985, Vol. 49, Number 4, pp. 41-50.**

Overview

The attainment of quality in products and services was a pivotal concern of the 1980s. While quality in tangible goods has been described and measured by marketers, quality in services is largely undefined and unresearched. The authors attempt to rectify this situation by reporting the insights obtained in an extensive exploratory investigation of quality in four service businesses and by developing a model of service quality. Propositions and recommendations to stimulate future research about service quality are offered.

Quality and measurement are not easily articulated by consumers (Takeuchi and Quelch 1983). Interpretation and measurement of quality also present problems for researchers. While the substance and determinants of quality may be undefined, its contribution to increasing market share and return on investment is unequivocal.

Existing Knowledge About Service Quality

Knowledge about goods quality is insufficient to understand service quality. Three well-documented characteristics of services — intangibility, heterogeneity, and inseparability — must be acknowledged. Because they are performances rather than objects, precise manufacturing specifications concerning uniform quality can rarely be set. Because of intangibility, the firm may find it difficult to understand how consumers perceive their services and evaluate service quality (Zeithaml 1981).

Second, services, especially those with high labor content, are heterogeneous: their performance often varies from producer to producer, from customer to customer, and from day to day. Consistency of behavior from service personnel (e.g., uniform quality) is difficult to ensure (Booms and Bitner 1981) because what the firm intends to deliver may be entirely different from what the customer receives.

Third, production and consumption of many services are inseparable (Carmen and Langeard 1980, Upah 1980). In labor intensive services, quality occurs during service delivery, usually in an interaction between the client and front-line personnel.

Service quality literature traditionally agrees that service quality is a measure of how well the service level delivered matches customer expectations. Delivering quality service means conforming to customer expectations on a consistent basis. (Lewis and Booms 1983)

Insights from Exploratory Qualitative Investigation

A set of discrepancies or gaps exists regarding executive perceptions of service quality and the tasks associated with service delivery to consumers. These gaps can be major hurdles to attempting to deliver a service which consumers would perceive as being high quality. Figure A.1 on the following page shows the five gap areas identified.

These are:

GAP 1: *Consumer expectation — management perception gap*
Discrepancies between executive perceptions and consumer expectations. Service firm executives may not always understand what features denote high quality to consumers in advance, what features a service must have in order to meet consumer needs, and what levels of performance on those features are needed to deliver high quality service.

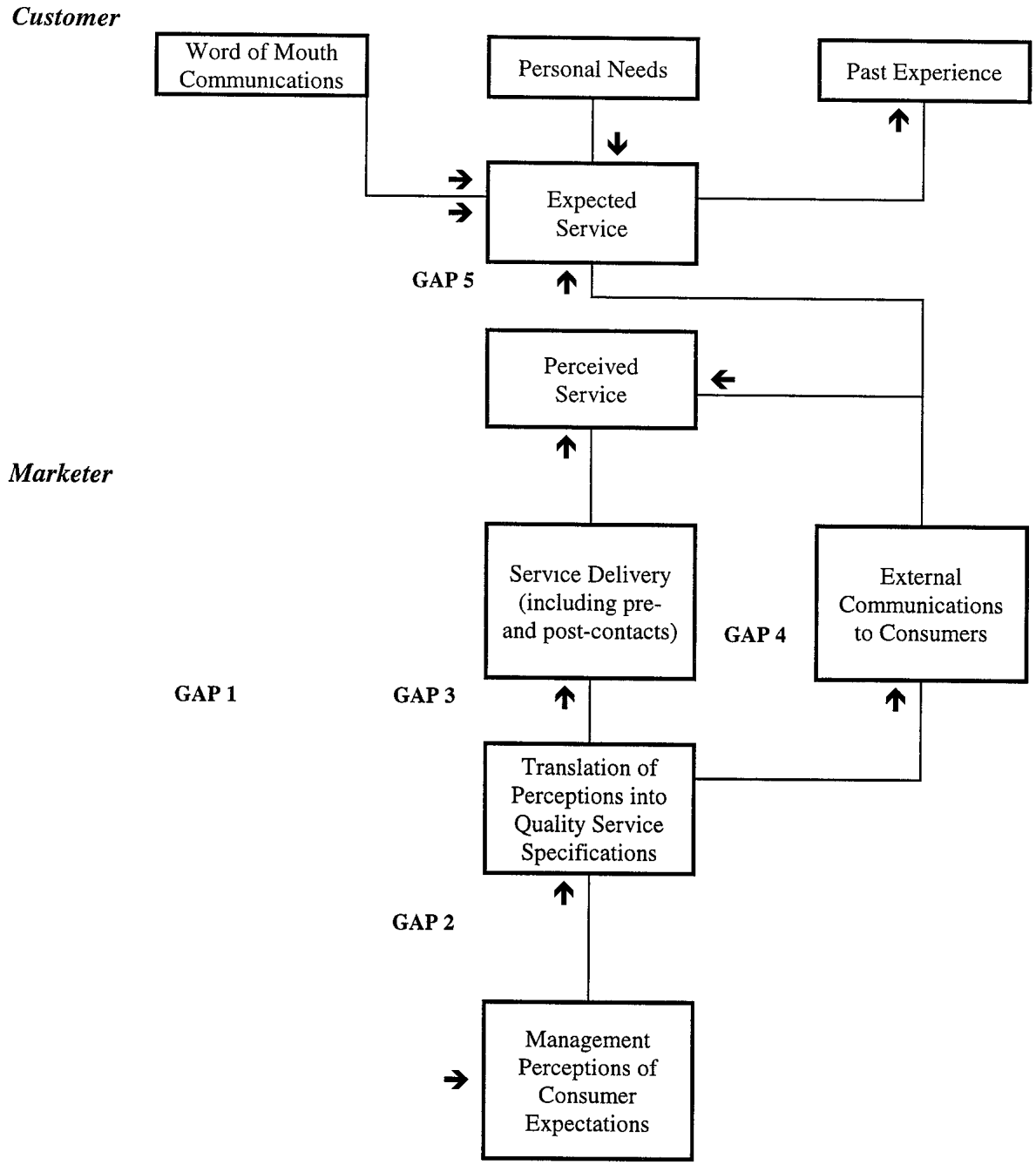
GAP 2: *Management perception — service quality specifications*
Constraints (resources, or market conditions) which prevent management from delivering what the consumer expects, or the absence of total management commitment to service quality.

GAP 3: *Service quality specifications — service delivery gap*
Difficulty in standardizing employee performance even when guidelines exist for performing services well and treating consumers correctly.

GAP 4: *Service delivery — external communications gap*
Media advertising and other communications by a firm can affect consumer expectations. Promising more than can be delivered will raise initial expectations but lower perceptions of quality when the promises are not fulfilled. Also firms can neglect to inform consumers of special efforts to ensure quality that are not visible to consumers thereby affecting consumer perceptions of the delivered service.

GAP 5: *Expected service — perceived service gap*
How consumers perceive the actual service performance in the context of what they expected. The quality that a consumer perceives in a service is a function of the magnitude and direction of the gap between expected service and perceived service.

Figure A.1
Service Quality Model



A Quality Service Model

The foundation of the model is the set of gaps shown in Figure A.1. Service quality as perceived by a consumer depends on the size and direction of GAP 5 that, in turn, depends on the nature of the gaps associated with the design, marketing, and delivery of services. The gaps on the marketer side of the equation can be favorable or unfavorable from a service quality perspective. That is, the magnitude and direction of each gap will have an impact on service quality.

The Perceived Service Quality Component

This exploratory investigation suggests that, regardless of the type of service, consumers used basically similar criteria in evaluating service quality. These criteria seem to fall into 10 key categories that are labeled "service quality determinants." These determinants are listed in Table A.2 below. Overlap among the 10 determinants may exist.

Table A.2
Determinants of Service Quality

1 RELIABILITY involves consistency of performance and dependability.

2 RESPONSIVENESS concerns the willingness or readiness of employees to provide service. It also involves timeliness of service.

3 COMPETENCE means possession of the required skills and knowledge to perform the service.

4 ACCESS involves approachability and ease of contact.

5 COURTESY involves politeness, respect, consideration, and friendliness of contact personnel.

6 COMMUNICATION means keeping customers informed in language they can understand and listening to them. It may mean that the company has to adjust its language for different consumers — increasing the level of sophistication with a welleducated customer and speaking simply and plainly with a novice.

7 CREDIBILITY involves trustworthiness, believability, and honesty. It involves having the customer's best interests at heart.

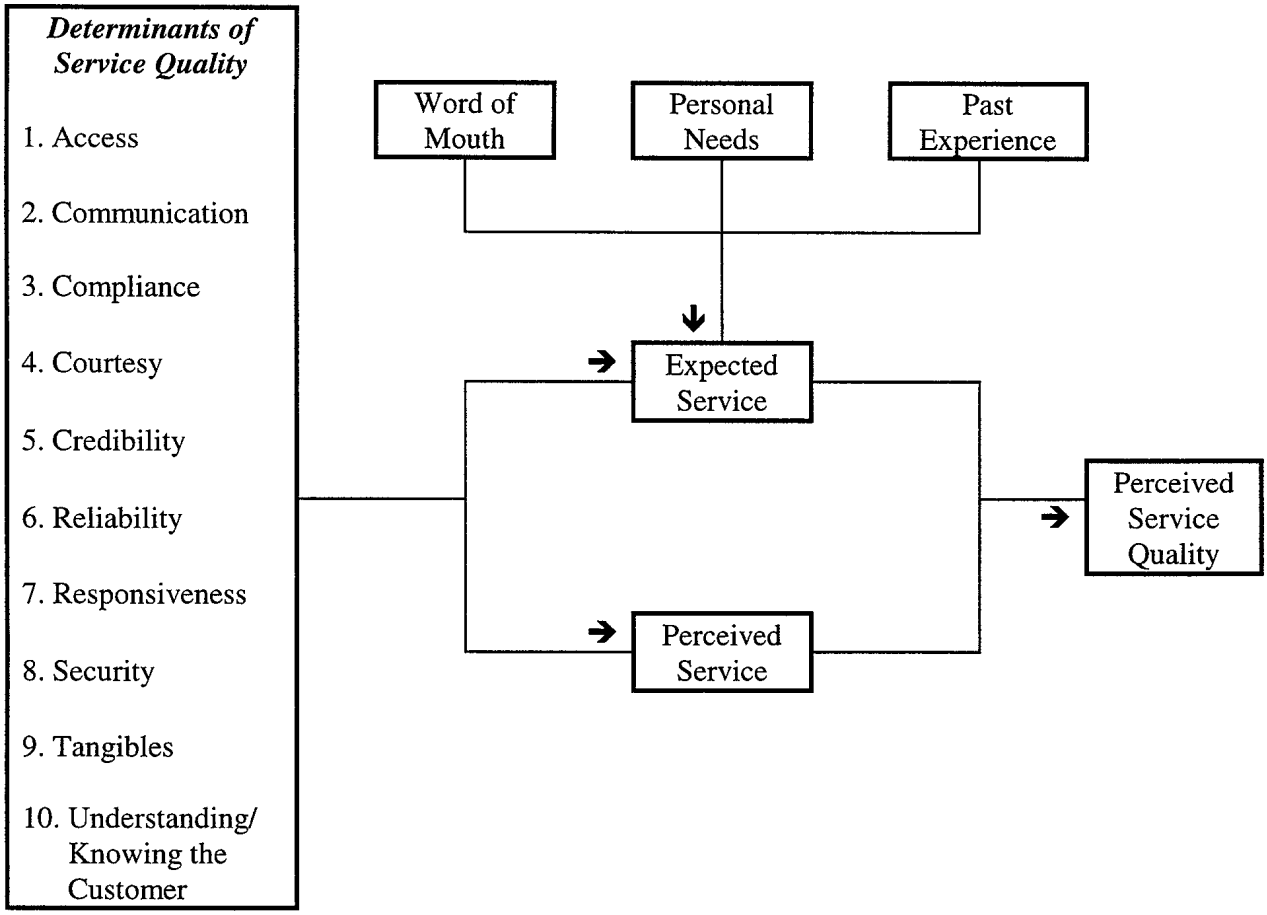
8 SECURITY is the freedom from danger, risk, or doubt.

9 UNDERSTANDING/KNOWING THE CUSTOMER involves making the effort to understand the customer's needs.

10 TANGIBLES includes the physical environment and representations of the service.

It is quite possible that the relative importance of the 10 determinants in molding consumer expectations (prior to service delivery) may differ from their relative importance vis-à-vis consumer perceptions of the delivered service. Figure A.3 on the following page indicates that perceived service quality is the results of the consumer's comparison of expected service with perceived service.

Figure A.3
Determinants of Perceived Service Quality



Two of the determinants which consumers appear to have difficulty evaluating are *competence* (the possession of the required skills and knowledge) and *security* (freedom from danger, risk, or doubt). Consumers are probably never really certain of these attributes, even after experiencing the service.

Perceived service quality is posited to exist along a continuum ranging from ideal quality to totally unacceptable quality, with some point along the continuum representing satisfactory quality. The position of a consumer's perception of service quality on the continuum depends on the nature of the discrepancy between the expected service (ES) and perceived service (PS). When ES > PS perceived quality is less than satisfactory; when ES = PS perceived quality is satisfactory; and when ES < PS, perceived quality is more than satisfactory and will tend toward ideal quality.

Although the preliminary research showed that consumers used similar criteria in judging service quality, the group participants differed on the relative importance of those criteria to them, and their expectations along the various quality dimensions. Research needs to determine whether identifiable service quality segments exist and whether and in what ways consumer expectations differ.

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***A National Customer Satisfaction Barometer: The Swedish Experience*, Claes Fornell, Journal of Marketing, January 1992, Volume 56, Number 1, pp. 6-21.**

Overview

Many individual companies and some industries monitor customer satisfaction on a continual basis, but Sweden is the first country to do so on a national level. The annual Customer Satisfaction Barometer (CSB) measures customer satisfaction in more than 30 industries and for more than 100 corporations. The new index is intended to be complementary to productivity measures. Whereas productivity basically reflects quantity of output, CSB measures quality of output (as experienced by the buyer). The author reports the results of a large-scale Swedish effort to measure quality of the total consumption process as customer satisfaction. Efforts to measure customer satisfaction on a nationwide basis are now underway in several other countries including the U.S., Japan, and Norway.

The U.S index is the result of a joint venture between the American Quality Foundation and the University of Michigan Business School. The significance of customer satisfaction and its place within the overall strategy of the firm are discussed.

Inherent Differences Among Industry and Firm Customer Satisfaction Levels

Substantial literature suggests that market share leads to profitability (see Buzzell and Gale 1987). Customer satisfaction also is believed to lead to profitability (Business International 1990). Traditionally, much more effort is devoted to the offense for customer acquisition then to the defense to protect the present customer base (Fornell and Wernerfelt 1987, 1988). However, in the face of slow growth, a good defense is critical. Defensive strategy involves reducing customer exit and switching. One way of accomplishing this objective is to have highly satisfied customers. While improving market share and improving customer satisfaction individually result in higher profitability, it is far from certain that market share and customer satisfaction themselves are positively correlated. If an industry or company enjoys high levels of customer satisfaction, decreases in market share (perhaps because of a rise in cost) are less likely to affect profitability. Decision making in this situation is a combination of price

and quality. However, it is more difficult for a firm with a large market share to also have a high average level of customer satisfaction, especially if customer needs or wants are heterogeneous.

The ideal point conceptualization as one aspect of customer satisfaction suggests a new hypothesis about market structure and customer satisfaction. The contention is that the monopoly will have a lower score on customer satisfaction indexes than other non-monopoly industries, if it faces a heterogeneous demand. Lower customer satisfaction in this case is partially a reflection of the difficulty in serving a heterogeneous market with a limited variety of service or product offerings. On the other hand, we would expect that industries characterized by a good fit between the levels of demand and supply heterogeneity (homogeneity) to have higher customer satisfaction ratings than those with a poor fit. Industries, including monopolies, that supply a high quality homogeneous product to a homogeneous market should have high satisfaction.

Also explored is the impact of customer satisfaction on repeat business and customer loyalty in different industries. Loyal customers are not necessarily satisfied customers, but satisfied customers tend to be loyal customers. Customer switching barriers comprise a host of factors that also bring about retention. Switching barriers make it more costly for the customer to switch to another supplier or mode. Transaction costs, learning costs, loyal customer discounts, customer habit, emotional cost, and cognitive effort, coupled with financial, social, and psychological risks on the part of the buyer, all add up to switching barriers. However, previously insulated organizations become vulnerable, for they are seldom well prepared and have not made the investments in quality and customer satisfaction necessary to prevent customer exit. Low barriers and weak customer satisfaction force the company to compete on price. With high satisfaction there is less price sensitivity.

Uses of the Sweden Customer Satisfaction Barometer (CSB)

To combine premises, the proposition that evolves from the ideal-point model and the switching-barrier effect suggests that customer satisfaction should be lower in industries where repeat buyers face high switching costs and where the industry offers a homogeneous product to a heterogeneous market. With this presumption in mind, the CSB in Sweden offers the following information:

- industry comparisons
- comparisons of individual firms with the industry average
- comparison over time
- predictions of long-term performance
- *Though empirical evidence is limited, increases in customer satisfaction are generally believed to: (1) shift the demand curve upward and/or make the slope of the curve steeper (i.e. lower price elasticity, higher margins), (2) reduce marketing costs (customer acquisition requires more effort, (3) reduce customer turnover, (4) lower employee turnovers (satisfied customers affect the satisfaction of front-line personnel), (5) enhance reputation (positive customer word of mouth), (6) reduce failure costs (handling customer complaints).*
- answers to specific management questions
  (Such as the effects of overall quality and price, the impact of customer expectations, the quality increase necessary to retain dissatisfied customers, price sensitivity, switching patterns, customer complaints, and effects of word of mouth.)

Highlights of CSB Measurement

The literature on customer satisfaction/dissatisfaction suggests that satisfaction is an overall postpurchase evaluation. There is no consensus on how to measure it. Hausknecht (1990) identifies more than 30 different measures that have been used in previous research. There are three different dimensions: (1) general satisfaction (as in the studies by Moore and Shuptrine 1984; Oliver and Bearden 1983; Oliver and Westbrook 1982; and Westbrook 1980), (2) confirmation of expectations (as in studies by Oliver 1977; Swan, Trawick, and Carroll 1981), and (3) the distance from the customer's hypothetical ideal product (Tse and Wilton 1988, and Sirgy 1984). Customer satisfaction for the CSB is defined as a function of these three indicators, thus the fallibility of measures is acknowledge and taken into account.

The traditional view of satisfaction/dissatisfaction as the discrepancy between perceived performance and expectation (P-E) is not dismissed *a priori* in CSB. However, CSB measurement allows for the possibility of dissatisfaction even when expectations are confirmed (a negative correlation). For example, if low quality is expected but the product is purchased nevertheless (because of supply restrictions or price), the expectations are confirmed. Clearly, the fact that expectations are confirmed is not sufficient for satisfaction.

Presumably, customers take both price and quality into account. To avoid compounding the two, for the CSB, each was measured in the light of the other — by price (given quality) and quality (given price).

For most industries surveyed, sample frames were drawn via random digit dialing with screening for customer status. In no cases were company customer lists used as sample frames. Hence data were costly but presumably more objective.

Almost all customer satisfaction research is hampered by highly skewed distributions for satisfaction. For example, in studies ranging from shoes to medical care, more than 80% of the customers were satisfied. Only in captive markets might repeat buyers be dissatisfied in general. Skewness is a problem, but it is a statistical one. Highly skewed variable distributions do not lend themselves to conventional tests of significance and, what is equally serious, lead to downward biases in correlation analysis, low reliability, and sometimes misleading arithmetic means. In CSB, the problem of skewness was handled by (1) extending the number of scale points (usually 5 or 7) to 10 to allow respondents to make finer discriminations, (2) using a multiple-indicator approach for greater accuracy, and (3) estimating via a version of partial least squares (PLS).

CSB Results

The results of the CSB fit the reasoning presented. Overall, CSB scores are significantly higher in industries where heterogeneity/homogeneity in demand is matched by the supply. Staple foods and automobiles score at the top of the CSB; the police force and television broadcasting are at the bottom. (Transportation services were not measured as a part of the Sweden CSB.) Overall, it is noteworthy that services score lower than products, both among monopolies and among competing firms.

The Effect on Customer Loyalty

Just as price elasticity varies among firms and industries, so does "customer satisfaction elasticity." It is very important to determine how sensitive the present customer base is to satisfaction. In view of the current business emphasis on quality, one may well get the impression that quality and customer satisfaction are equally important to all firms or industries. Customer satisfaction is more important (for

loyalty) in some industries than in others. Industries with low elasticities are those in which switching costs are high (police, postal services, etc.)

The most meaningful measurement of quality is how it affects customer satisfaction. Changes in satisfaction are predictors of future performance.

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***Expectations, Performance Evaluation, and Consumers' Perception of Quality*, R. Kenneth Teas, Journal of Marketing, October 1993, Volume 57, Number 4, pp. 18-34.**

Overview

The author examines conceptual and operational issues associated with the measurement framework defined as customer "perceptions-minus-expectations" (P-E) identified by Parasuraman, Zeithaml, and Berry (1985). The examination indicates that the P-E service gap premise is of questionable validity because of a number of conceptual problems involving the (1) conceptual definition of expectations, (2) theoretical justification of the expectations component of the P-E framework, and (3) measurement validity of the expectation (E) and revised expectation (E*) measures specified in the published service quality literature.

The P-E model and two alternative perceived quality modes that are designed to address the problems associated with the P-E model are empirically tested and the implications of the conceptual issues examined in the study and of the empirical findings are explored.

Definition Problems

Alternative definitions of expected or ideal service exist. Conceptualizing service expectation as ideal standards is a problem under each of the interpretations examined.

Classic attitudinal model point interpretation (Ginter 1974; Green and Srinivasan 1978). In these models, the ideal point is the perfect or utility maximizing level of the attribute. For example, if the attribute has a non-maximum ideal point, once the ideal point is reached "there are negative utility returns for further increases in the attribute" (Lillien, Kotler, and Moorthy 1992, p.9). Favorableness of an evaluation of an attitude object is positively related to the closeness of the object to the ideal object.

Feasible ideal point interpretation. A second interpretation of the service quality ideal standard is that it represents a feasible level of performance under ideal circumstances. However, the "feasible ideal point" conception of E is not compatible with the service quality P-E measurement specification, when finite classic ideal point attributes are involved.

Operational Definition Problems

Empirical research has identified important problems concerning the operationalization of the service expectation (E) concept. Respondents may assign unrealistically high ratings to the E response scales. Carmen (1990) questions the validity of expectation measures when consumers do not have "well-formed expectations." Research by Teas (1993) indicates that a considerable portion of the variance in responses to the E scale is because of variance in respondents' interpretations of the question being asked, rather than to variance in respondents' attitudes.

To correct respondents high ratings on E scales, Parasuraman, Berry, and Zeithaml (1990) proposed a revised expectation (E*) measure, based on ratings of the attribute's "essentialness" for excellent service. However, using the revised definition of expectation (E*), in conjunction with the P-E measurement specification, suggests that high performance on essential attributes (high E* scores) reflects lower quality than high performances on attributes that are less essential (low E* scores). This measurement result is illogical.

Results of Testing Alternative Perceived Quality Frameworks

The results suggest a considerable portion of the variance of service quality expectation measures may be because of respondents' misinterpretations of the question or the scales. The empirical testing also indicates that the inclusion of attribute weights in the P-E or other alternative frameworks does not improve the validity of the models. This result is similar to the findings of other research that indicates importance weights often do not increase, and may decrease, the predictive validity of multiattribute models (Bass and Wilkie 1973).

The conceptual and operational definition problems with the P-E "gap" framework and alternative tested models create ambiguity concerning the interpretation and theoretical justification of these perceived quality concepts.

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***Competing Based on the Customer's Hierarchy of Needs,* Doug Schaffer, National Productivity Review (Summer 1995) pp. 9-15.**

Even when companies improve their performance, they often have difficulty achieving real competitive advantage in the face of often astounding operational improvements, since most customers just do not seem very excited. This is largely because customers have been excluded from improvement efforts to date. For companies to better perform in ways that matter to their customers, they must know why customers buy from them in the first place. This represents a shifting hierarchy of needs that requires companies to improve their performance in ways that will make their customers sit up and take notice.

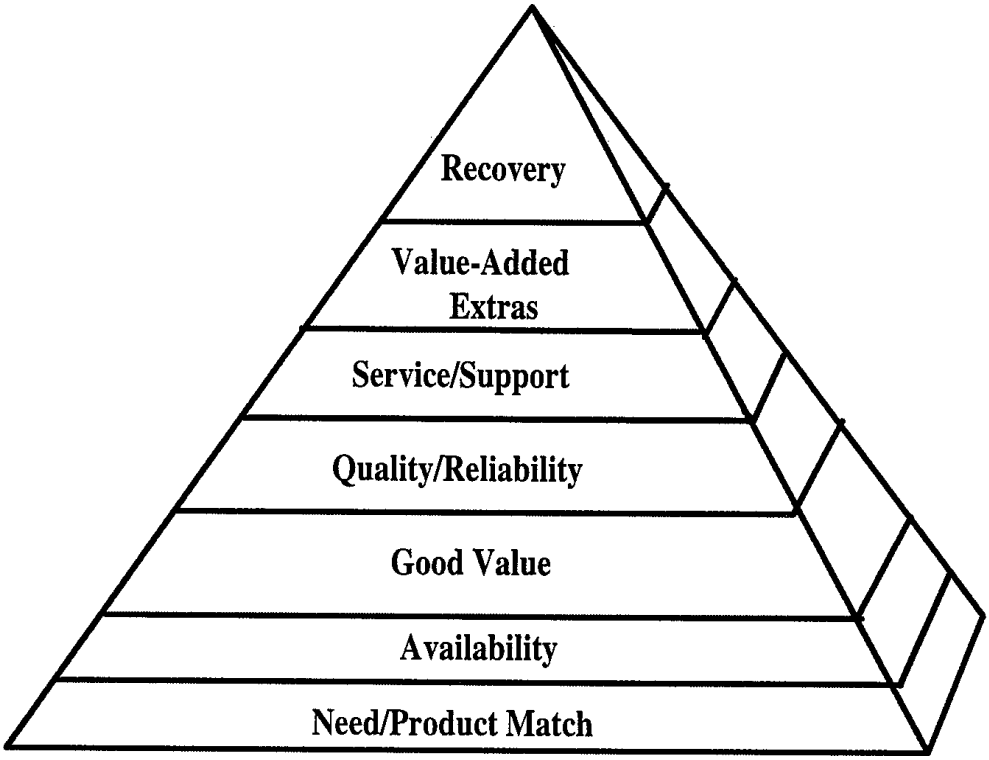
It is typical for companies to launch improvement programs in response to competitive pressures, then several years down the road report improvements that primarily affect internal operations. Published reports often list fewer engineering problems or defects, streamlined purchasing processes, lower

receivables, improved employee safety, etc. All are worthy goals and certainly contribute to a healthy balance sheet, but may be only of marginal interest to customers. Many programs to improve corporate performance are more effective in reducing costs and improving profitability than spurring growth and increasing market share.

Most companies have a rudimentary understanding of why customers buy their product or select their service. However, most would be hard-pressed to explain how much of a customer's decision is based on service characteristics, value, or reputation.

In his 1954 work, *Motivation and Personality,* Abraham Maslow proposed a theory of human motivation characterized by a hierarchy of needs. Inserting the needs of the customer into Maslow's model yields a model of customer motivation (Exhibit A.4).

Exhibit A.4
Hierarchy of Customer Needs



First on the list is how closely a product or service matches what the customer needs. The product must be available when the customer needs it. Customers expect a good value — the relationship of the cost to perceived benefit. Customers also expect quality and reliability. They never want to be stranded, inconvenienced, or endangered by products or services. (Customers employ a standard of zero tolerance.) Customers want to be treated well, never put down or demeaned. Customers also have come to expect an occasional value-added extra that makes it easier to do business with a company and improves the cost/benefit ratio. Finally, customers faced with a problem expect the supplier to recover, to fix the problem without harassing the customer.

Once customers have decided to purchase a product or service from a particular supplier, their overall satisfaction and willingness to do business with that supplier in the future rest with the supplier's ability to satisfy needs at the top of the hierarchy. Those who fail to manage the customer relationship at the top of the hierarchy loose customers despite the value, quality and availability of their products. Eventually, they create a reputation for themselves that waves off potential customers and erodes their sales base.

Any performance improvement effort should begin with an analysis of the company's performance against its customers' hierarchy of needs. Strengths and weaknesses should be identified and priorities set based on this analysis.

***Best Practice for Customer Satisfaction in Manufacturing Firms*, Griffin, Abbie, Greg Gleason, Rick Preiss, and Dave Shevenaugh, Sloan Management Review (Winter 1995)**

The most frequently measured Customer Satisfaction (CS) variables were expressed as numbers. Most companies use simple scales that assume satisfaction ranges linearly between 0 and 10 or 0 and 100. More elaborate measures of customer satisfaction that look at performance relative to expectations, or disconfirmation measures of satisfaction, are not frequently used. CS measures are often upwardly biased, not linear. Customers are the subset of the total population who are already somewhat satisfied with products and services, so the response population does not form a normal distribution about the midpoint, which is what most analytical procedures for linear scales assume. However, if you cut the scale off at 5 and consider only the responses above 5, the response distribution of the "average" firm might be much closer to a normal distribution about the new midpoint, 7.5 of 75 percent. This truncated scale would more closely conform to the standard statistical assumptions for linear interval scales.

The process of linking goals to performance through measuring CS is exploratory and preliminary at even the most forward-thinking companies. First, companies must formalize and quantify the relationship between CS and firm performance. By determining how CS improves performance or what specific CS components correlate with different improvements, corporations can focus on only the most effective endeavors, allowing them to become more efficient in implementation.

Delivering CS is at an early evolutionary state in most U.S. firms. Most firms are not focused on satisfying customers, even though research now correlates CS with improved performance. A firm's CS implementation process must reflect the needs of individual customer segments, and the overall program must be flexible enough to allow each business unit to develop measures and processes that fit its management needs.

***Avoid Top Box Problem by Using Another Box*, Dan Prince, President, Prince Marketing Research, Marketing News, June 1995, p. H-32.**

This article suggests an alternative to the "top box problem" when measuring customer satisfaction. This alternative uses a three-point scale. Respondents are asked to rate overall satisfaction, and satisfaction on individual attributes, as (1) much better than expected, (2) about as expected, and (3) worse than expected. If a customer chooses (1), it means they are expressing delight with the product or service, not just satisfaction. The research showed that if a customer is delighted, there is a 90% chance they will purchase the product or service again. If (2) is chosen, the customer is expressing satisfaction with a low product or brand loyalty. And finally, if (3) is chosen, the customer is dissatisfied with the product or service.

This alternative approach provides two benefits:

- it measures a customer's view against his or her expectation, and
- it gets rid of the top box problem of skewness — bias to the top of the scale.

Finally, using this alternative approach enables management to understand how well their product or service actually measures against their customers' expectations.

DEFINITIONS:

Top box problem:

> Most customers — if they are still your customer — will tend to give overall satisfaction scores that fall into one of the top boxes on your answer sheet, usually, "excellent" or "good" (7 to 10 on a 10-point scale).
>
> A second variation of the top box problem is that when respondents are asked, "How satisfied are you with X," followed with a request to rate X on a scale of importance, most customers will say each variable is either "very important" or "important."

***Rational and Adaptive Performance Expectation in A Customer Satisfaction Framework,* Johnson, Michael D., Eugene W. Anderson, and Claes Fornell, Journal of Consumer Research, Inc., Vol. 21, March 1995, pp. 595-707.**

There is an extensive and growing body of research on customer satisfaction that focuses primarily on disaggregate or individual-level satisfaction with particular goods or services. Relatively little attention has been paid to the determinants of market-level satisfaction, which is defined here as the aggregate satisfaction of those who purchase and consume a particular product offering (e.g., Ford Escort owners or Federal Express users). Studying customers in the aggregate is one way to establish empirical generalizations in the domain of satisfaction research.

The modeling of customer satisfaction depends critically on how satisfaction is conceptualized. Two general conceptualizations of satisfaction exist: transaction-specific satisfaction and cumulative satisfaction. Consumer researchers are often concerned with satisfaction as an individual, transaction-specific measure or evaluation of a particular product or service experience. Alternately, satisfaction is viewed as a cumulative, abstract construct that describes customers' total consumption experience with a product or service. This conceptualization of satisfaction is more consistent with existing views. Satisfaction is a customer's overall evaluation of his or her purchase and consumption experience to date. Measures of this satisfaction component can serve as a common denominator for describing differences across firms and industries, while transaction-specific evaluations provide information only about shortrun product or service encounters. Cumulative satisfaction is a fundamental indicator of a firm's (or market's) current and long-run performance.

To construct indices of customers' satisfaction at the market level for individuals who purchase and consume a particular product or service offerings, three measures are proposed: aggregate expectations, perceived performance, and satisfaction. Expectations are measured first by asking customers how well they expected the product or service to perform. Two measures are then collected to operationalize performance (perceived quality relative to price paid and a rating of how much the customer has paid

relative to how well the product or service has performed). Finally, three measures are used to operationalize satisfaction: overall satisfaction, confirmation of expectations, and distance from the customer's hypothetical ideal product or service in the industry. Three-stage (extrapolative, adaptive, and rational) least square estimates are used to determine market expectations and satisfaction. In every case, satisfaction is positively affected by both performance and expectations.

The results show that there is a significant carryover effect for customer satisfaction from period to period. That is, market satisfaction is a relatively stable, cumulative phenomenon that changes gradually over time.

Green, Paul E. and Tull, Donald S. Research for Marketing Decisions; 3rd edition; Prentice-Hall, Inc. 1975 (Englewood Cliffs, New Jersey), pp. 478-484.

In a typical customer satisfaction study, respondents evaluate overall satisfaction, followed by ratings on many individual attributes. A key question for researchers is which attributes are most important in determining overall satisfaction. Not all attributes have equal impact. A method of prioritizing is needed to allocate limited resources more efficiently.

Researchers have suggested many procedures for dealing with this problem. Several are considered by Green and Tull (1975), Hauser (1991), and *The Maritz Marketing Research Report* (1993). Work continues in this area; no true "answer" for all applications has emerged. However, derived importance measures are usually preferred over stated importance measures.

Stated importance measures ask respondents to explicitly state their perception of the importance of each attribute, usually using a 10-point scale. The results of this method can be straightforwardly interpreted; however, the results can be few, if any, statistical differences among attributes, so the aim of the method — to prioritize attributes — is thwarted. (How does a mean 7.8 rating differ specifically from a mean 7.5 rating?)

Derived importance methods rely on the statistical association between ratings (predictors) and an overall rating. The importance of an attribute is statistically determined from this relationship. Green and Tull consider four derived importance measures. If, in the very unlikely case that all attributes are uncorrelated with each other, all four yield identical measures of relative importance. Measures discussed by Green and Tull are:

- *Bivariate (Pearson) correlation:* This measure has the advantages of familiarity and simplicity. Unlike the other three, it's not affected by adding or deleting other attributes in a regression equation; however, joint effects with other attributes go undiscovered.

- *Standardized regression coefficient or beta weight:* Model misspecifications and the influence of other attributes in the regression model are particularly troublesome in this approach. This measure can be very unstable.

- *The product of the beta weight and the corresponding Pearson correlation:* This measure is a compromise between the two former measures.

- *The coefficient of part determination:* This model represents an incremental gain in predictive power but is adversely influenced by the inclusion or exclusion of particular attributes in the model.

All four measures exhibit limitations. However, an important consideration is that it is common in customer satisfaction research for attributes to be correlated — sometimes highly — with each other. This makes it difficult to measure the separate effects of the individual attributes on overall satisfaction. The latter three measures are all subject to instability when attributes are highly correlated. When interrelations exceed .5 — a fairly frequent occurrence for customer satisfaction data — the beta weights can shift dramatically.

Moreover, the latter three measures can also be affected by the addition or deletion of particular attributes to the regression model. The multiple regression model used for the latter three measures must have the correct functional form.

In the face of these problems, use of the first measure, simple bivariate correlation is recommended. However, considering each attribute in isolation is also unrealistic.

Green and Tull offer an alternative to combat multicolinearity; namely, to transform the original attributes into an uncorrelated set of new variables using the technique of principal component analysis. The principal components reveal the colinearity in the data while allowing analysis such as stepwise multiple regression to be performed without multicolinearity — and without deleting one of more of the highly correlated attributes.

This approach has the added advantage of using multivariate techniques that can be explained and described.

APPENDIX B

MODERATOR'S GUIDE

A. Introduction

This is a nationally based study to explore customer requirements for transit service. We want to know how riders view quality of service. What features of service are important? What are the most troublesome aspects of riding transit? How can a transit agency best improve its service? These are the kinds of questions we want to ask. We also want to know how you define quality service and get your reactions to various ideas about how a transit agency can monitor their quality of service. Let's start by having each of you introduce yourself.

1. Current transit usage, frequency of usage, trip purposes, how long have they been using transit, cars in the household, primary reasons for using transit over other modes of transportation.

B. Description of Ideal Transit Service

1. How would you define the 'ideal' transit service?

2. What would you change about your current transit service to make it closer to the 'ideal'?

3. How do you define low quality transit service?

C. Discussion of Basic Transit Requirements

1. What are the basic requirements for transit service?

2. How would you define the dimensions of service quality?

   — safety
   — comfort
   — ease of using the system
   — convenience
   — performance/reliability
   — facilities
   — value

D. Review of Specific Transportation Attributes

SAFETY

1. What does "safety" mean when using rail/bus?

2. Here are some features related to "safety" mentioned by others. How important is each in your decision to use transit?

   — Safety from crime while riding
   — Safety at stations/bus stops
   — Safety related to the behavior of other persons
   — Safety related to the rail/bus operation

3. Are there other aspects of "safety" we failed to discuss?

COMFORT

1. How do you define "comfort" when riding rail/bus?

2. Here are some features related to "comfort" mentioned by others. How important is each in your decision to use transit?

   — Availability of seating at the station/bus stop
   — Availability of seats on the train/bus
   — Smoothness of the train/bus ride
   — Comfort of the seats
   — Degree of crowding on the train/bus
   — Comfortable temperatures on the train/bus
   — Availability of handrails/grab bars

3. Are there other aspects of "comfort" we failed to discuss?

EASE OF USING THE SERVICE

1. How would you define an "easy" system to ride?

2. Here are some features related to "ease of using a service" mentioned by others. How important is each in your decision to use transit?

   — Knowing when trains/buses arrive and depart
   — Availability of information at a station (RAIL ONLY)
   — Availability of printed schedules
   — Ease of getting information by telephone

   — Courtesy/helpfulness of ticket agents (RAIL ONLY)
   — Ease of purchasing tickets/passes/tokens

   — Visibility of station names from on the train (RAIL ONLY)
   — Visibility of train/bus names/route numbers/colors from the outside

   — Ease of getting on/off train/bus
   — Ease of paying fare

   — Ease of making connections/transfers
   — Knowledgeable and courteous conductors/drivers on-board
   — Availability of information about delays from conductors/drivers
   — Clear/timely stop announcements

3. Are there other aspects of "ease of use" we failed to discuss?

CONVENIENCE

1. What does "convenience" mean when riding rail/bus?

2. Here are some features related to "convenience" mentioned by others. How important is each in your decision to use transit?

   — Availability of stations/bus stops close to home
   — Availability of stations/bus stops close to work
   — Availability of stations/bus stops close to shopping
   — Availability of parking at stations/bus stops

3. Are there other aspects of "convenience" we failed to discuss?

PERFORMANCE/RELIABILITY

1. What does "performance and reliability" have when riding rail/bus?

2. Here are some features related to "performance and reliability" mentioned by others. How important is each in your decision to use transit?

   — Frequency of service
   — Travel time by train/bus
   — On-time performance
   — Wait time when transferring

3. Are there other aspects of "performance and reliability" we failed to discuss?

CONDITION OF VEHICLES AND FACILITIES

1. How do you define vehicles and facilities in good condition?

2. Here are some features related to the condition of vehicles and facilities mentioned by others. How important is each in your decision to use transit?

   — Cleanliness of the train/bus interior
   — Trains/buses clean of graffiti
   — Stations/bus shelters clean of graffiti
   — Cleanliness of train stations/bus stops

3. Are there other aspects of the condition of vehicles and facilities we failed to discuss?

VALUE

1. How would you define "value" with respect to riding rail/bus?

2. Here are some features related to "value" mentioned by others. How important is each in your decision to use transit?

   — Cost of a one-way ride
   — Cost of a transfer
   — Availability of discounted fares, e.g., senior citizens, students
   — Availability of volume discounts, e.g., monthly passes
   — Cost of parking at stations/bus stops

3. Are there other aspects of "value" we failed to discuss?

E. Defining Service Quality

1. How should a transit agency measure/monitor its own quality?

2. What information should a transit agency collect and use to monitor its quality?

3. Reactions to _____ collecting the following quality measures.

   — percent of trips on-time
   — headway consistency
   — breakdowns
   — communication measures
   — number of accidents
   — vehicle availability

   If I told you that the _____ reports that 92% of all trips on the _____ line arrive within four minutes of their scheduled arrival time, what does that mean to you?

   What does it mean if I say that on average _____ buses break down every 3,500 miles?

4. Do these measures present an honest picture of the quality of service provided by _____?

5. How should a transit agency demonstrate that its customers come first?

F. Closing

1. What does quality of transit service mean to you as a rider?

BASIC DIMENSIONS

- ☐ safety
- ☐ comfort
- ☐ ease of using the system
- ☐ convenience
- ☐ performance/reliability
- ☐ facilities
- ☐ value

SAFETY

- ☐ Safety from crime while riding
- ☐ Safety at stations/bus stops
- ☐ Safety related to the behavior of other persons
- ☐ Safety related to the rail/bus operation

COMFORT

- ☐ Availability of seating at the station/bus stop
- ☐ Availability of seats on the train/bus
- ☐ Smoothness of the train/bus ride
- ☐ Comfort of the seats
- ☐ Degree of crowding on the train/bus
- ☐ Comfortable temperatures on the train/bus
- ☐ Availability of handrails/grab bars

CONVENIENCE

- ☐ Availability of stations/bus stops close to home
- ☐ Availability of stations/bus stops close to work/shopping
- ☐ Availability of parking at stations/bus stops

PERFORMANCE/RELIABILITY

- ☐ Frequency of service
- ☐ Travel time by train/bus
- ☐ On-time performance
- ☐ Wait time when transferring

EASE OF USING THE SERVICE

- ☐ Knowing when trains/buses arrive and depart
- ☐ Availability of information at a station
- ☐ Availability of printed schedules
- ☐ Ease of getting information by telephone

- ☐ Courtesy/helpfulness of ticket agents
- ☐ Ease of purchasing tickets/passes/tokens

- ☐ Visibility of station names from on the train
- ☐ Visibility of train/bus names/route numbers/colors from the outside

- ☐ Ease of getting on/off train/bus
- ☐ Ease of paying fare

- ☐ Ease of making connections/transfers
- ☐ Knowledgeable and courteous conductors/drivers on-board
- ☐ Availability of information about delays from conductors/drivers
- ☐ Clear/timely stop announcements

CONDITION OF VEHICLES AND FACILITIES

- ☐ Cleanliness of the train/bus interior
- ☐ Trains/buses clean of graffiti
- ☐ Stations/bus shelters clean of graffiti
- ☐ Cleanliness of train stations/bus stops

VALUE

- ☐ Cost of a one-way ride
- ☐ Cost of a transfer
- ☐ Availability of discounted fares, e.g., senior citizens, students
- ☐ Availability of volume discounts, e.g., monthly passes
- ☐ Cost of parking at stations/bus stops

APPENDIX C

DEVELOPMENT AND REFINING OF CUSTOMER MEASURES

Selection of Sites for Customer Focus Group Discussions

A matrix of demographic and transit system criteria was proposed as the basis for selecting urban, suburban, and rural transit agency sites for the preliminary research. The project panel and staff approved the Work Plan and preliminary research sites proposed. The panel approved the conduct of preliminary research with customers of the Chicago Transit Authority (urban area), SunTran of Albuquerque (suburban), and the Greater Lynchburg Transit Company (rural area).

Development of a Moderator's Guide for Discussions

The finalized moderator's guide, using the Quality Function Deployment (QFD) method of extracting and prioritizing customer quality requirements, was developed progressing from requirements of the ideal system back to basic system requirements and to those requirements that would enhance service. A copy of the moderator's guide is within Appendix B to this report. The same format was used at each site and for each transit mode.

Organization of the Sessions

Six focus groups (two at each of the three selected preliminary research sites) were organized. Transit agency cooperation was secured. In Chicago, the Blue Line from O'Hare Airport to downtown Chicago was selected as the target urban transit service. Two major inner city bus lines were the customer service target in Albuquerque, and a major county circular small bus service was targeted in Greater Lynchburg, Virginia.

The two Chicago sessions were successfully held June 19, 1996. Nine Blue Line customers attended each session. Several CTA senior management representatives attended, as well as a TCRP B-11 panel member. The two sessions in Albuquerque were conducted on June 27, 1996; and the two sessions in Greater Lynchburg were conducted on July 2, 1996. Nine to eleven transit customers attended each of the Albuquerque and Lynchburg sessions.

Recruitment of customers for the sessions was managed by MORPACE International, Inc. In Chicago, MORPACE distributed and collected an on-board questionnaire to passengers on the Blue Line. Demographic and basic trip pattern data were requested, and participants for the customer service quality discussion sessions were solicited. In Albuquerque and Lynchburg, staff of the transit agencies distributed and collected the on-board questionnaires. All collected transit rider questionnaires were returned to MORPACE headquarters and respondents were called to arrange and confirm their participation in sessions. A mix of customers by geographic location along the line, trip purpose, and frequency of use was obtained.

For consistency, the Principal Investigator, Dr. James Leiman, moderated each of the six focus group sessions.

The following Table C.1 presents a summary of the focus group discussions at all three sites. The topics in bold under the "factor" column are those presented to participants by the focus group moderator, Dr. James Leiman, of MORPACE International, Inc. Under each topic are the factors that were mentioned by participants (open-ended responses) as service factors for that topic or dimension. Going across, an "X" for the factor under one of the six focus group sessions indicates that this factor was mentioned by the participants at this site and session *(C=Chicago, A=Albuquerque, and L=Lynchburg).*

Table C.1
Customer Defined Service Quality Measures

	Focus Group Locations*					
FACTORS	**C1**	**C2**	**A1**	**A2**	**L1**	**L2**
Reasons for Using Transit						
goes where I want to go/cost - cheaper than driving	5	6	5	4	2	3
transit dependent	4	3	6	5	9	8
Ideal Transit System						
modern/comfortable seats	X	X		X	X	
reliable – comes on schedule	X	X	X		X	X
convenient to work and home	X		X		X	
low cost/value for cost	X	X	X		X	
free or employer subsidized		X				
electronic timetable on platform - minutes until next train	X	X				
let you know by PA about delays - explain		X				
frequent service - wait time not more than 10-15 minutes	X	X	X		X	X
fast speed	X					
lots of transfer points - not just downtown	X		X			
always get a seat, not over crowded	X	X	X			X
quiet	X				X	
shopping and services at stations/stops	X					
able to buy tokens at all stations	X					
clean	X				X	
no graffiti	X					
shelter from the elements/benches at stations/ key stops		X	X	X		
more security		X				
cut down on soliciting		X				
24-hour service		X	X	X		
extended hours before and after a.m. and p.m. peaks			X	X	X	
more frequent Saturday and Sunday service			X	X		
courteous and friendly personnel at booths, on train/bus	X				X	X
personnel knows system - can provide travel information	X					
can hear PA system - announcement of stations						
better bus access service to stations or main bus lines			X			
better transfers/connections - not more than 5 minute wait			X	X	X	X
Basic Requirements for a Transit System						
visible customer response service - evidence of response		X				
faster handling of emergencies, less delay time		X				
trains/buses do not breakdown	X		X	X		X
gets you where you want to go	X	X	X			
able to get me to my destination on time	X	X	X		X	X

	Focus Group Locations*					
FACTORS	**C1**	**C2**	**A1**	**A2**	**L1**	**L2**
convenient - close by stations/stops	X	X	X		X	
system extensive, coverage - access to key destinations	X	X	X		X	
frequent service - not more than 10 minute wait time	X	X	X			X
reliable - on time performance, keep to schedule	X	X	X	X	X	X
time schedules and maps available	X	X	X			
quality employees, friendly , courteous, quick	X	X	X	X	X	X
cost effective travel - value for cost, affordable	X	X	X	X	X	
reliable - few breakdowns	X		X		X	X
feels safe from crime, security presence	X	X				
rider safe from injury/accidents - safe driver/conductor	X		X	X	X	X
comfortable temperature - protected from heat and cold	X	X	X		X	
bus stops have visible signs			X	X		
turnstiles operate		X				
bilingual signs/information		X				
extended hours, 24-hour service		X	X	X		
service on Saturdays and Sundays			X			
protected from elements/benches at stations/key stops		X		X		
clean		X		X	X	
accessible for those with a disability		X			X	X
good connections/transfers - not more than 10 minute wait		X				
Safety						
personnel - physical presence - on platforms/stations	X	X				
security personnel on trains/bus		X				
emergency phones	X					
video monitors - stations and cars	X	X				
reliable service - few breakdowns	X	X			X	X
driver operates bus safely - general traffic safety			X		X	X
drug and alcohol screening		X				
infrastructure in up-to-date condition		X				
hand rails - something to hold onto	X					
safe opening/closing doors	X					X
cut down on panhandlers, intoxicated riders, noisy kids		X	X		X	
remove vagrants from bus stops/stations			X			X
lighting at stations/bus stops	X	X	X		X	X
alarm button on train for crime		X				
education/signs to warn where crime can occur		X				
let you know what is happening when train/bus stops	X					
announce stops well in advance	X					
First aid kits and fire extinguishers available				X		
radios for drivers/operators for emergencies					X	
Comfort						
having seat		X	X	X	X	X
temperature in heat and cold	X	X	X	X	X	
vibration	X					
degree of crowding, enough room around you	X	X	X		X	X
adequate leg room			X			
availability of handrails	X					
smoothness of ride	X					X
loudness of train/bus	X					
smoothness of stops and starts from stations/stops	X	X	X			
clean bus/train	X	X		X		X

	Focus Group Locations*					
FACTORS	**C1**	**C2**	**A1**	**A2**	**L1**	**L2**
clean stations/stops	X	X		X		
clean smell	X	X		X		
cushioned or more comfortable seats		X	X	X		X
seats riding forward		X				
comfortable/efficient speed		X			X	
sliding or convenient opening doors		X	X			
hand rails or grips	X	X				
seating in stations/ at stops		X				
noisy kids/passengers			X			
no smoking			X			
What Makes System Easy to Use						
convenience-goes where you need to go, stops nearby	X	X	X	X	X	
reliability - keeps schedule, schedule consistency	X		X	X	X	
frequency of service - wait time not more than 10 minutes	X	X	X	X		
routes and transfers are clear	X					
tokens sold at stations	X	X				
bus access to stations/stops	X				X	
know wait time - electronic countdown to next train	X					
map and schedule handouts available	X	X	X	X	X	X
posted maps of system displayed at stations/key stops	X				X	X
customer service/complaints phone number displayed	X					
courteous and friendly personnel		X		X	X	X
personnel able to provide travel information	X			X	X	
station names visible	X	X				
routes and direction information visible on trains/bus	X	X	X	X		
bus stops are clearly marked, good signage				X		X
good PA system, announcing of stations/stops	X	X				
cost is affordable		X				
fare structure is easy to understand		X				
posted schedules and frequency at stations/stops		X			X	
availability of travel and schedule information by phone		X		X	X	
able to get schedule and maps by mail			X			
bilingual signs and bilingual information available		X				
ease of making transfers/connections - low wait time		X	X	X		
train/bus doors should provide easy access		X	X			
published information on on-time performance posted		X				
extended hours service			X			X
weekend service			X	X		
shelters and benches at stations/transfer points			X			
fare box gives change			X	X		
monthly/discount passes easily available				X		
bike racks on buses				X		
Convenience						
runs frequently - low wait time	X	X	X			X
can get tokens easily	X					
turnstiles work	X					
stations/stops nearby, good coverage	X	X	X		X	X
stations/stops well lighted	X					
fast	X		X			
24-hour service		X	X			
weekend service				X		

	Focus Group Locations*					
FACTORS	**C1**	**C2**	**A1**	**A2**	**L1**	**L2**
less stress	X		X			
good transfers/connections - low wait time			X			
cost for value	X		X			
shelter from elements and benches at stations/stops					X	
restroom close to bus stops/stations					X	
Performance and Reliability						
schedule consistency - same amount of time for trip	X	X	X	X	X	X
friendly and courteous personnel	X	X				
trains/buses run smoothly	X					
operating safely - good drivers/operators	X				X	
clean trains/buses and stations/stops	X	X	X			X
10-20 min. wait times acceptable - worry about security	X	X		X		
provide information about frequency - posted	X					
low wait time for transfers - good connections	X			X		X
few breakdowns of bus/train			X		X	X
Condition of Facilities						
clean	X	X	X	X	X	X
no graffiti - if they have time to do all this, it's not safe	X	X	X	X		
escalators, clocks, turnstiles are operating	X	X				
seats clean and in good condition	X	X	X	X		
no smell	X	X				
no smoking	X					
train/bus doors work properly			X			
stations and platforms/stops well lighted	X		X			
bus stops/stations properly maintained					X	X
trains/buses in good condition - few breakdowns						X
windows operate and can be seen through						X
Value - Meaning						
costs less than driving and parking - but $1.50 is highest	X			X	X	X
costs for comfort and time length of trip		X				
cost is fair			X	X	X	
How Should Transit Agencies Measure Their Quality						
periodic customer surveys - problems encountered	X	X	X	X	X	X
transit personnel use system themselves - mystery riders	X	X	X		X	X
monitor time intervals between stations	X	X	X	X		X
ridership counts when changes are made	X	X		X	X	
number of accidents/breakdowns/injuries - average per mile	X	X	X			
inspect stations/stops - random evaluations	X		X			
number of crime reports	X					
percent of trips on time - 90% acceptable	X	X			X	
riders need to know what schedule is to verify	X					
headway consistency	X	X				
no longer than 15 minute waits	X	X				
number of vehicles available		X				
number of riders vs. seats - crowding measure	X	X				
whether I got to my destination on time	X	X				
employee satisfaction/evaluation of system		X	X		X	
customer evaluation of courteousness of personnel		X				X
monitor driving habits of drivers and their speed			X	X		
compare service factors with other similar cities			X			
percent of riders who are not transit-dependent					X	

	Focus Group Locations*					
FACTORS	**C1**	**C2**	**A1**	**A2**	**L1**	**L2**
Communication measures						
number of complaints and inquiries	X		X		X	X
customer service number needs to be well posted	X					
evidence that complaints are responded to		X				
quarterly newsletter with information/feedback to riders		X				
customer loyalty program/award		X				
community forums or public hearings			X	X		X
publish performance statistics/compare with other cities						

Summary of Individual Participant Evaluations of Service Quality Measures

Following the focus group discussions, participants filled out forms (see Appendix B) which asked them to first pick the top two to three factors in importance in each of seven overall dimensions of: safety, comfort, convenience, performance/reliability, ease of using the service, condition of vehicles and facilities, and value. Then participants were asked to circle the top three dimensions of the seven in terms of importance to quality. The following is a statistical summary of the results for rail service participants (in Chicago, Illinois), and combined bus passengers (in Lynchburg, Virginia and Albuquerque, New Mexico).

Rail Passengers

- The most important dimension is **safety (1).**
  - The most important safety factor is "safety while riding".

- The next most important dimensions are **performance/reliability (2)** and **ease of using the service (3).**
  - The most important performance/reliability factor is "frequency of service", followed closely by "on-time performance".
  - The most important ease of using service factor is "knowing when trains arrive and depart".

- **For comfort**, the most important factors for rail passengers are equally the "availability of seating" and "the degree of crowding".

- **For convenience**, the most important factor is "availability of station close to home".

- **For condition of vehicles and facilities**, the most important factor is "cleanliness of train interior".

- **Value** is judged equally as the "cost of a one-way ride" and "the cost of a transfer".

Disregarding ratings of overall dimensions, the most important factors for rail service quality are, in order:

	Factor	Dimension
1	safety while riding	Safety
1	availability of station close to home	Convenience
2	frequency of service	Performance/Reliability
3	safety at stations	Safety
3	availability of stations close to work	Convenience
3	cleanliness of train interior	Condition of Vehicles/Facilities

Thus, if only the top three of seven dimensions in quality are considered as important for rail service, top factors are left out. The importance of the factors: "availability of station close to home", "availability of stations close to work", and "cleanliness of train exterior" would be ignored (because they fall within the less important dimensions of Convenience and Condition of Vehicles/Facilities). In fact, these three factors, overall, are within the top six factors in importance to rail riders when considering service quality.

Bus Passengers

- The most important dimension is **convenience (1).**
  - The most important convenience factors are equally "availability of bus stops close to home and work".

- The next most important dimension is **safety (2).**
  - The most important safety factor is "safety related to bus operations".

- The next most important dimension is **performance/reliability (3).**
  - The most important performance/reliability factor is "frequency of service".

- For comfort, the most important factor for bus passengers is the "temperature on the bus".

- For condition of vehicles and facilities, the most important factor is "cleanliness of bus interior".

- Value is judged most often as the "availability of volume discounts, such as monthly passes".

Disregarding ratings of dimensions, the most important factors for bus service quality are, in order:

	Factor	Dimension
1	cleanliness of bus interior	Condition of Vehicles/Facilities
2	knowing when buses arrive and depart	Ease of Using the Service
3	comfortable temperatures on the bus	Comfort
3	knowledgeable and courteous drivers on-board	Ease of Using the Service
4	frequency of service	Performance/Reliability
4	availability of volume discounts, e.g., monthly passes	Value

Thus, if only the top three of seven dimensions in quality are considered as important for bus service, the importance of all of the top six factors in importance would be ignored, except "frequency of service". The other most important service factors would be ignored because they fall within the lesser important dimensions of Condition of Vehicles/Facilities, Ease of Using the Service, Comfort, and Value. In fact, these five other factors are within the top six factors in importance to bus riders when considering service quality.

Focus Group Conclusions

1. The focus group discussions demonstrate that customers of both rail and bus service place the same factor within different dimensions of service. There is no clear and final understanding, among riders, of exactly which factors are uniquely related to a particular dimension of service. For example, frequency of service was sometimes mentioned as a quality factor under the dimension of Safety as well as under the dimension of Performance/Reliability. (People feel safer when they have to spend less time on the rail platform or at a bus stop.) Participants easily interchanged factors falling under Ease of Using the Service and Convenience. Comfort of seats frequently meant cleanliness of seats, confusing factors under the dimensions of Comfort and Condition of Vehicles/Facilities; and a factor such as the absence of graffiti at stations can be related by customers to Safety, as well as Condition of Vehicles/Facilities.

2. Individual factors most frequently mentioned as important to transit service quality sometimes fell within dimensions not considered as most important.

These findings, though qualitative only, make clear that caution should be observed in reducing individual factors to "umbrella" dimensions of service quality for transit.

Refinement of Service Quality Measures

With the assistance of Cambridge Systematics, the Table C.1 listing of service quality attributes was reviewed to eliminate duplications and refine wording for clarity. The factors listed were reduced to the list of 48 attributes shown in Table C.2. These attributes were targeted for testing in the quantitative pretest.

Table C.2
Revised List of Transit Service Quality Measures

1	Absence of graffiti
2	Absence of offensive odors
3	Accessibility of trains/buses to handicapped
4	Availability of handrails or grab bars on trains/buses
5	Availability of monthly discount passes
6	Availability of schedule information by phone/mail
7	Availability of schedules/maps at stations/stops
8	Availability of seats on train/bus
9	Availability of shelter and benches at stations/stops
10	Cleanliness of interior, seats, windows
11	Cleanliness of stations/stops
12	Cleanliness of train/bus exterior
13	Clear and timely announcements of stops
14	Comfort of seats on train/bus
15	Connecting bus service to stations/main bus stops
16	Cost effectiveness, affordability, and value
17	Cost of making transfers
18	Displaying of customer service/complaint number
19	Ease of opening doors when getting on/off train/bus
20	Ease of paying fare, purchasing tokens
21	Explanations and announcements of delays
22	Fairness/consistency of fare structure
23	Freedom from nuisance behaviors of other riders
24	Frequency of delays for breakdowns/emergencies
25	Frequency of service on Saturdays/Sundays
26	Frequent service so that wait times are short
27	Friendly, courteous, quick service from personnel
28	Having station/stop near destination
29	Having station/stop near my home
30	Hours of service during weekdays
31	Number of transfer points outside downtown
32	Physical condition of stations/stops
33	Physical condition of vehicles and infrastructure
34	Posted minutes to next train/bus at stations/stops
35	Quietness of the vehicles and system
36	Reliable trains/buses that come on schedule
37	Route/direction information visible on trains/buses
38	Safe and competent drivers/conductors
39	Safety from crime at stations/stops
40	Safety from crime on trains/buses
41	Short wait time for transfers
42	Signs/information in Spanish as well as English
43	Smoothness of ride and stops
44	Station/stop names visible from train/bus
45	Temperature on train/bus—not hot/cold
46	The train/bus traveling at a safe speed
47	Trains/buses that are not overcrowded
48	Transit personnel know system/provide information

APPENDIX D

SAMPLING PLAN FOR THE TCRP B-11 PROJECT FIELD TEST

It is almost always too difficult to conduct the Customer Satisfaction Benchmark Survey using a randomdigit-dial (RDD) household telephone sample because of the low incidence rate of transit riders within most populations. The industry rule of thumb is that RDD sampling methodology is not cost effective for customer satisfaction surveys if the incidence rate of customers falls below 15%. Therefore, an alternative step is required to compile a representative sampling frame of transit customers' telephone numbers. This was accomplished for the field test at each site through on-board or at-station surveys that collected demographic information and respondents' telephone numbers.

First, data was gathered from the transit agencies regarding ridership counts by mode, routes, travel days, and time of day of travel. Based on these data, survey sampling plans were devised that assured distribution of questionnaires to a representative sample of each system's defined ridership. Questionnaires were serially numbered and tracked to verify route/station and time of day of distribution, and surveyors kept written records of the numbers of the questionnaires distributed on or during their assigned trip or time period — so that segment response rates could be tabulated.

Sampling plans differed widely by site; however, given the project budget, sampling frames at all three sites were limited to weekday travel (since the characteristics of weekend riders are different and would require separate sampling frames). Trips between the PM Peak Period and AM Peak Period ("Night Owl Service") were also eliminated from the sampling frame at all sites, and at CTA the sampling frame was limited to AM Peak service only. By routes, the sampling frame in Chicago was limited to riders on the Blue and Red light rail lines; in Albuquerque, to the five fixed route bus lines with more than an average of 1,000 daily passengers, and in Lynchburg, Virginia all 2,000 daily riders were included in the sampling frame, with routes undifferentiated. At all three sites, both direction trips and boarders were sampled in accordance to rider proportional representation.

The specific methods for distributing the sampling frame collection instruments varied by site since modes and contact points with riders also varied. The sampling plan at each site was as follows:

Chicago, Illinois — CTA

> CTA provided us with updated counts for the average weekday number of CTA boardings by station and by time of the day. A total of 5,000 sampling frame collection instruments were distributed on the Blue Line and 5,000 were distributed on the Red Line. This allowed for a 40% response rate of which at least half would contain valid telephone numbers (a resulting sampling frame for the telephone benchmark survey of 1,000 customers per line). Benchmark telephone interviews were then completed with 30% of the sample, or 300 interviews per line.
>
> To ensure the representativeness of sampling frames, a sampling plan for the at-station distribution of short-form questionnaires was devised as follows:
>
> First, the percent of questionnaires to be distributed at each station was apportioned by the percent of boardings at each station (during the designated survey hours on an average weekday — stations included both the Douglas and Congress splits of the Blue Line). Thus, if 20% of the Blue Line riders board at station #1, 1,000 questionnaires (20% of 5,000) were distributed at this station. To assure random distribution of the questionnaire during the entire AM Peak time period at this station, each time period was divided into time sectors of 20 minutes each, for example, 6:01 a.m. to 6:20 a.m. would be sector 1, 6:21 to 6:40 a.m. would be sector 2, 6:41

to7:00 a.m. would be sector 3, etc. Then since questionnaires are distributed in clusters of 100, by computer generated random number selection, ten time sectors were selected for distribution of the 1,000 questionnaires at station #1 during the AM Peak.

Interviewers began distributing questionnaires to boarding passengers beginning at the start of the designated time sector. They continued to distribute questionnaires to all boarding passengers until they completed distribution of the 100 assigned serially numbered and recorded questionnaires. Interviewers kept count and recorded the number of refused questionnaires.

The number of interviewers assigned to distribute questionnaires at each station platform depended on the number of entrances to the Blue or Red Line platform and train during the time sector. Questionnaires were apportioned to interviewers in accordance with CTA's (management and ticket booth personnel) assessment of the proportion of boarding passengers from each entrance point. The goal was to ensure that each passenger boarding the Blue Line or Red Line, starting at the randomly selected time sector, received a questionnaire until all 100 questionnaires within the cluster had been distributed. Passengers were clearly instructed to fill out only one questionnaire during the two-day survey period.

Interviewers wore neon color baseball hats with the logo "Rider Survey" and had clearly signed collection bags (and pencils) to identify the survey as authorized by CTA. Passengers were encouraged to fill out the short-form, sampling frame collection questionnaire and return it before boarding the train, or to give the completed survey to a technician at the main exit stations.

As previously stated, the survey instrument announced that a lottery would be conducted among those completing the survey and providing a valid phone number for the follow-up Benchmark Survey. In Chicago, three $100 prizes were awarded to Blue Line respondents and three to Red Line respondents.

The goal was to collect a representative sample of 2,000 completed questionnaires from passengers on the Blue Line and 2,000 completed questionnaires from passengers on the Red Line; with at least half of these questionnaires providing valid telephone numbers. In fact, 2,333 completed questionnaires were collected from CTA Blue Line customers and 2,287 from CTA Red Line customers.

All questionnaires collected were keypunched. The transit usage and demographic characteristics of those providing valid telephone numbers were compared with those for the total on-board samples, to assure that the sampling frames for the Benchmark Survey would be representative. If there was any underrepresentation by station or demographic characteristic, additional calls could be made to that segment of the sampling frame when completing the telephone-based Benchmark Survey. Weights for the CTA on-board and telephone surveys are as shown in Table D.1.

Albuquerque, New Mexico — Sun Tran

It was determined that the sampling frame collection survey for Sun Tran would be conducted as an on-board survey on the five Sun Tran routes with an average of over 1,000 daily passengers. The survey was limited to the AM Peak and Midday time periods, since most PM trips are part of round-trip segments. A total of 2,720 short-form, sampling frame collection questionnaires were distributed over a four-day period. The goal was to distribute a questionnaire to every passenger on the five routes within the AM Peak and Midday periods. The routes and the number of questionnaires distributed are shown in Table D.2.

Questionnaires were distributed on a random sample of trips in both directions during the AM Peak and Midday time periods on the five routes. Survey technicians rode the buses for the full route, generally receiving round-trip assignments, and distributed and collected the surveys. They wore neon color baseball caps with the logo "Rider Survey" and had collection bags that clearly marked the survey as authorized by Sun Tran. Five $100 prizes were offered through lottery to those completing the survey and offering valid phone numbers. The goal was to obtain a minimum 40% response rate (1,088 completed questionnaires), half of which would have valid phone numbers. In fact, 1,321 completed on-board questionnaires were collected. Benchmark phone interviews were completed with 23% of this sampling frame (303 interviews).

Again, all questionnaires were keypunched and the transit usage and demographic characteristics of those providing phone numbers were compared with those for the total rider sample. Table D.2 shows the final weighting plan applied for the Sun Tran on-board and phone surveys.

Lynchburg, Virginia - Greater Lynchburg Transit Company

This small city bus system has an average of 2,000 daily passengers. Since this is a radial system, most passengers are collected and then come to a central destination or transfer point. Therefore, the only efficient method of survey instrument distribution and collection was to place survey technicians and collection boxes at the central destination transfer terminal.

The goal was to distribute a short-form, sampling frame questionnaire to all Greater Lynchburg Transit Company passengers. Again, five prizes of $100 each were awarded by lottery to encourage completion of the survey and provision of valid telephone numbers. Returns were expected to be received from a minimum of 60% of passengers (1,200), with two-thirds (800) providing telephone numbers. However, in actuality, only 1,170 questionnaires could be distributed, with 269 returned (response rate 23%). MORPACE International, Inc. was then able to complete phone interviews with 69 (26%) of these GLTC customers.

Completed interview sample sizes for the Benchmark Survey are sufficient for the analysis to be conducted. All results given in this report take into account completed sample sizes and are statistically significant at the 90% confidence level.

Total Sample Weights

Table D.3 documents how findings for "Total Transit", a combination of results from the three demonstration sites, were calculated using ridership counts from each sample strata consisting of the CTA Blue Line, CTA Red Line, Sun Tran system, and the Greater Lynchburg Transit Company.

Table D.1
Weights - CTA

Station Weights

	Rider Counts	% Riders	At Station Survey Have	% Have	Want	Weights	Phone Survey - No Weights Have	% Have
Blue Line	20,965	100%	2,333	100%	2,333		300	100.0%
Irving Park	2,822	12.5%	156	6.7%	291	1.865	37	12.3%
Cumberland	3,421	16.7%	369	15.8%	390	1.057	50	16.6%
Jefferson Park	5,887	24.9%	571	24.5%	581	1.018	75	25.0%
Belmont	3,414	16.7%	458	19.6%	390	0.852	50	16.7%
Logan Square	2,709	14.5%	277	11.9%	338	1.220	44	14.7%
Forest Park	2,712	14.7%	502	21.5%	343	0.683	44	14.7%
Red Line	39,555	100%	2,287	102.0%	2,287		300	100.0%
Howard	4,422	13.2%	212	9.3%	299	1.410	38	12.7%
Belmont	6,015	15.7%	428	18.7%	359	0.839	46	15.3%
Fullerton	5,037	15.1%	242	10.6%	345	1.426	44	14.7%
Addison	4,491	8.5%	318	13.9%	194	0.610	27	9.0%
79th Street	6,668	14.4%	521	22.8%	329	0.631	46	15.3%
95th Street	12,922	33.1%	566	24.7%	761	1.345	99	33.0%

Line Weights - For Both On-Board/At-Station Suvey and Phone Survey

	Rider Counts	% Riders	Have	Want	Weights
Blue Line	20,965	34.6%	2,333	1,617	0.693
Red Line	39,555	65.4%	2,287	3,003	1.313
Total CTA	60,520		4,620	4,620	

Table D.2
Weights — Sun Tran

Route Weights

	Rider Counts	% Riders	On-Board Survey - No Weights Have	% Have	Phone Survey - Weights Have	% Have	Want	Weights
Sun Tran	2,720	100.0%	1,321	100.0%	303	101.0%	303	
Route 4	353	13.0%	180	14.0%	46	15.0%	39	0.848
Route 5	544	20.0%	258	20.0%	67	22.0%	61	0.910
Route 8	435	16.0%	209	16.0%	45	15.0%	48	1.067
Route 11	490	18.0%	237	18.0%	71	23.0%	55	0.775
Route 66	898	33.0%	437	32.0%	74	25.0%	100	1.351

Table D.3
Total Sample Weights

	Rider Counts	% Riders	Have	Want	On-Board Weights	Have	Want	Phone Weights
Blue Line	20,965	33.0%	2,333	2,049	0.878	302	321	1.063
Red Line	39,555	61.0%	2,287	3,788	1.656	300	594	1.980
Sun Tran	2,720	4.0%	1,321	249	0.188	303	39	0.129
Lynchburg	1,170	2.0%	269	124	0.461	69	20	0.290
	64,410		6,210	6,210		974	974	

APPENDIX E

ARE YOU WILLING TO TAKE THE SUN TRAN SERVICE QUALITY PHONE SURVEY?

Sun Tran is conducting a service quality survey. This survey will require a ten-minute phone interview with passengers. THAT'S WHY WE NEED A PHONE NUMBER FROM YOU. Prizes of $100 each will be awarded to five passengers whose numbers are drawn. Please take a few minutes to fill out this questionnaire and return it immediately to a surveyor. Your participation is greatly appreciated!

1. What is your final destination?
   - ❒ your home
   - ❒ work
   - ❒ site related to work
   - ❒ school
   - ❒ shopping center or store
   - ❒ airport
   - ❒ another residence
   - ❒ other

A few questions about you....

2. What is your zip code at home?
   _ _ _ _ _
3. How old are you? ___ ___
4. Are you:
   ❒ Male ❒ Female
5. How many people are in your household? ___ ___
6. How many vehicles are available to your household?
   ❒ 0 ❒ 1
   ❒ 2 ❒ 3 or more
7. Was a vehicle available for this trip? ❒ Yes ❒ No
8. What was your combined household income in 1996?
   - ❒ Less than $30,000
   - ❒ $30,000 to $69,999
   - ❒ $70,000 or more
9. Are you:
   - ❒ White
   - ❒ Hispanic
   - ❒ African-American/Black
   - ❒ American Indian
   - ❒ Asian
   - ❒ Other

Please provide a phone number where you can be reached during the day or evenings and weekends. You will be asked to rate the bus service and report your service problem experiences.

Day-time Phone Number (on weekdays):

\- \-

(Area Code)

Evening or Weekend Phone Number:

\- \-

(Area Code)

_____

First Name *(Optional)*

Five $100 prizes will be awarded from a drawing among those providing phone numbers.

Phone numbers will be destroyed by the research firm following completion of the survey.

APPENDIX F

CUSTOMER-DEFINED TRANSIT SERVICE QUALITY MEASURES

INTRODUCTION:

Hello, my name is _____. I'm calling from the MORPACE International, Inc.. We are conducting a customer satisfaction survey for (CTA) (SunTran) (Greater Lynchburg Transit Company).

IF QA IS BLANK, GO TO QAAA:
QA. (IF SAMPLE CONTAINS FIRST NAME): May I please talk with _____?

GET PERSON TO PHONE AND CONTINUE:
You completed a short survey within the last few weeks while traveling (on the Blue Line) (on the Red Line) (on the bus):

(INTERVIEWER: VERIFY THAT RESPONDENT IS 16 OR OLDER. IF NOT, ASK FOR SOMEONE ELSE IN THE HOUSEHOLD 16 OR OLDER WHO HAS RIDDEN WITHIN THE PAST 30 DAYS.)

QAA. Was that you?

1 Yes (GO TO QB)
2 No

9 Don't Know/Refused

QAAA. For this survey, we would like to speak with someone in your household who is age 16 or older who has ridden (the Red Line) (the Blue Line) (public transit) within the past 30 days. Would that be you?

1 Yes
2 No **(ASK TO SPEAK TO SOMEONE ELSE WHO QUALIFIES—REREAD INTRODUCTION)**

QB. To verify that you live within our survey area, what is your zip code?

— — — — —

Q1. How many days did you ride (the CTA Blue Line) (the CTA Red Line) (public transit) within the past seven days?

_____
RECORD NUMBER AS 0 THROUGH 7

9 Don't know/Refused

Q2. Which of the following statements best describes why you ride this public transit? **(READ LIST)**

1 I ride because I can't or don't know how to drive
2 I ride because I don't have a car available
3 I prefer to take the (train) (bus)

9 Don't know/Refused

(IF Q2 = 3-9, ASK:)

Q3. Which of the following reasons best describes your reason for riding the (train) (bus)? **(READ LIST) (ALLOW ONE RESPONSE)**

1 Parking at my destination is too expensive
2 Riding the (train) (bus) is cheaper than driving
3 The (train) (bus) takes me straight to my destination
4 I ride to avoid traffic congestion
5 Other ***(Please describe)*** _____

Q4. To the nearest year, how long have you been riding (CTA) (Albuquerque public transit) (Lynchburg public transit)?

_____ **RECORD NUMBER OF YEARS**

Q5. Thinking about your typical trip — the one you make most often — what is the usual purpose of this trip? **(ALLOW ONE RESPONSE)**

1 To/from work
2 To/from school
3 To/from shopping
4 To/from recreation
5 To/from a friend or relatives home
6 To/from personal business
7 To/from a doctor's, medical, or dentist appointment
8 Other ***(Please specify)*** _____

9 Don't know/Refused/NA

Q6. What else do you use public transit for? **(ALLOW 8 RESPONSES)**

1 To/from work
2 To/from school
3 To/from shopping
4 To/from recreation
5 To/from a friend or relatives home
6 To/from personal business
7 To/from a doctor's, medical, or dentist appointment
8 Other ***(Please specify)*** _____

9 Don't know/Refused/NA

Q7. Does your typical trip involve transfers to another train or bus?

1 Yes
2 No

9 Don't know/Refused/NA

(IF Q7 = 1, ASK Q8 AND Q9)

Q8. How many transfers do you usually make one way?

1 2 3 4 5 6 7 8 9 10

Q9. Usually, how many minutes is your longest wait between transfers?
_____ RECORD NUMBER OF MINUTES

Q10. For this trip, how did you get to the first (train station) (bus stop)?
(READ LIST)

1 Walked
2 I was dropped off
3 Took a bus
4 Drove and parked
5 Other ***(Please specify)***_____

9 Don't know/Refused

Q11. How many minutes does it take you to get to the first (station) (bus stop) for this trip?

_____ RECORD NUMBER OF MINUTES

Q12. How do you usually pay your fare?
(DO NOT READ LIST)

1 Cash
2 Tokens
3 Monthly pass
4 Other ***(Please specify)***_____

9 Don't know/Refused

Q13 to
Q60. Now I'm going to read you a list of factors about public transportation. On a scale of 1 to 10, where 1 is very unimportant and 10 is very important, please tell me how important each of these factors are to you when using public transit.

01 Very unimportant
02
03
04
05
06
07
08
09
10 Very important

(ASK ALL:)

RANDOMIZE Q13-Q42

Q13. The accessibility of (trains) (buses) for the handicapped.
Q14. The cleanliness of the (train) (bus) exterior.
Q15. The cleanliness of (stations) (bus stops).
Q16. The cleanliness of the (train) (bus) interior including seats and windows.
Q17. Clear and timely announcements of stops.
Q18. Explanations and announcements of delays.
Q19. The absence of offensive odors (in stations and on train) (on buses).
Q20. The temperature on the (train) (bus)—protection from heat and cold.
Q21. Displaying of a customer service/complaint phone number.
Q22. The ease with which I can pay the fare such as (T-the ability to purchase tokens at stations) (B-fare boxes that give change).
Q23. The ease of opening doors when getting off and on the (train) (bus).
Q24. The hours of service during weekdays.
Q25. Freedom on the (train) (bus) from the nuisance behaviors of other riders (vendors, intoxicated riders, noisy kids).
Q26. Frequent service so that wait times for the next (train) (bus) are short.
Q27. Short wait time for transfers.
Q28. Connecting bus service (to stations) (main bus stops).
Q29. Posted information at (station) (stop) which provides the minutes to next (train) (bus).
Q30. Friendly, courteous, and quick service from (conductors and agents) (drivers).
Q31. Reliable (trains) (buses) that come on schedule.
Q32. Route and direction information that is visible on (trains) (buses).
Q33. Safe and competent (drivers) (conductors).
Q34. Safety from crime at (stations and on platforms) (at bus stops).
Q35. Safety from crime on (trains) (buses).
Q36. The frequency of service on Saturdays and Sundays.
Q37. The availability of schedules and maps at (stations) (stops).
Q38. The availability of seats on the (train) (bus).
Q39. (Trains) (Buses) that are not over crowded.
Q40. The availability of shelter and benches at (stations) (main bus stops).
Q41. The smoothness of the ride and stops.
Q42. The physical condition of (stations) (bus stops) (T-including turnstiles, clocks, and escalators).

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q43-Q48

Q43. Having a (station) (bus stop) near my home.
Q44. The provision of signs and information in Spanish as well as English.
Q45. The availability of handrails or grab bars on the (train) (bus).
Q46. The availability of travel and schedule information by phone and mail.
Q47. Having a (station) (bus stop) near my workplace or destination.
Q48. The (train) (bus) traveling at a safe speed.

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q49-Q54

Q49. The cost effectiveness, affordability, and value of my (train) (bus) trip.
Q50. The fairness and consistency of fare structures.
Q51. The frequency with which delays for breakdowns or emergencies occur.
Q52. Transit personnel who know the system and can provide travel information.
Q53. The availability of monthly/discount passes.
Q54. The comfort of seats on the (train) (bus).

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q55-Q60

Q55. (Station names that are visible from trains) (Clearly marked bus stops with visible signs).
Q56. The quietness of the vehicles (T-and system).
Q57. The number of transfer points available outside downtown.
Q58. The cost of making transfers.
Q59. The absence of graffiti at (stations) (stops) and on (trains) (buses).
Q60. The physical condition of vehicles (T-and the rail infrastructure).

Q61. Overall, on a scale of 1 to 10 where 1 is very dissatisfied and 10 is very satisfied, how satisfied are you with your (CTA train) (public transit) experience?

01 Very Dissatisfied
02
03
04
05
06
07
08
09
10 Very Satisfied

Q62 to
Q109. Now I need to know how satisfied you are with each of the components of public transportation service and your specific recent experience with each. First I will ask you to rate each factor on a scale of 1 to 10, where 1 is very dissatisfied and 10 is very satisfied. Then, if it applies, I will ask you if you have experienced a problem with this factor within the past month. The first factor is ...

01 Very Dissatisfied
02
03
04
05
06
07
08
09
10 Very Satisfied

(ASK ALL:) RANDOMIZE Q62-Q91

Q62. The accessibility of (trains) (buses) for the handicapped.
Q63. The cleanliness of the (train) (bus) exterior.
Q64. The cleanliness of (stations) (bus stops).
Q65. The cleanliness of the (train) (bus) interior including seats and windows.
Q66. Clear and timely announcements of stops.
Q67. Explanations and announcement of delays.
Q68. The absence of offensive odors (in stations and on train) (on buses).
Q69. The temperature on the (train) (bus)—protection from heat and cold.
Q70. Displaying of a customer service/complaint phone number.
Q71. The ease with which I can pay the fare such as (T-the ability to purchase tokens at stations) (B-fare boxes that give change).
Q72. The ease of opening doors when getting off and on the (train) (bus).
Q73. The hours of service during weekdays.
Q74. Freedom on the (train) (bus) from the nuisance behaviors of other riders (vendors, intoxicated riders, noisy kids).
Q75. Frequent service so that wait times for the next (train) (bus) are short.
Q76. Short wait time for transfers.
Q77. Connecting bus service (to stations) (main bus stops).
Q78. Posted information at (station) (stop) which provides the minutes to next (train) (bus).
Q79. Friendly, courteous, and quick service from (conductors and agents) (drivers).
Q80. Reliable (trains) (buses) that come on schedule.
Q81. Route and direction information which is visible on (trains) (buses).
Q82. Safe and competent (drivers) (conductors).
Q83. Safety from crime at (stations and on platforms) (at bus stops).
Q84. Safety from crime on (trains) (buses).
Q85. The frequency of service on Saturdays and Sundays.
Q86. The availability of schedules and maps at (stations) (stops).
Q87. The availability of seats on the (train) (bus).
Q88. (Trains) (Buses) that are not over crowded.
Q89. The availability of shelter and benches at (stations) (main bus stops).
Q90. The smoothness of the ride and stops.
Q91. The physical condition of (stations) (bus stops) (T-including turnstiles, clocks, and escalators).

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q92-Q97

Q92. Having a (station) (bus stop) near my home.
Q93. The provision of signs and information in Spanish as well as English.
Q94. The availability of handrails or grab bars on the (train) (bus).
Q95. The availability of travel and schedule information by phone and mail.
Q96. Having a (station) (bus stop) near my workplace or destination.
Q97. The (train) (bus) traveling at a safe speed.

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q98-Q103

Q98. The cost effectiveness, affordability, and value of my (train) (bus) trip.
Q99. The fairness and consistency of fare structures.
Q100. The frequency with which delays for breakdowns or emergencies occur.
Q101. Transit personnel who know the system and can provide travel information.
Q102. The availability of monthly/discount passes.
Q103. The comfort of seats on the (train) (bus).

(ASK 83 FROM EACH SAMPLE:) RANDOMIZE FOR Q104-Q109

Q104. (Station names which are visible from the train) (Clearly marked bus stops with visible signs).
Q105. The quietness of the vehicles (T-and system).
Q106. The number of transfer points available outside downtown.
Q107. The cost of making transfers.
Q108. The absence of graffiti at (stations) (stops) and on (trains) (buses).
Q109. The physical condition of vehicles (T-and the rail infrastructure).

(FOR Q62 TO Q91 AND Q93 TO Q95 AND Q97 TO Q109, ASK AFTER EACH QUESTION:)

Q110Ato

Q110JJ. Have you experienced a problem with this within the past month?

01 Yes
02 No

09 Don't know/Refused/NA

(ASK ALL:)

Q111. Have you experienced any situation that caused you to feel unsafe at a (train) (bus) (station) (stop) within the past month?

01 Yes
02 No

09 Don't know/Refused/NA

Q112. Have you experienced any situation that caused you to feel unsafe on a (train) (bus) within the past month?

01 Yes
02 No

09 Don't know/Refused/NA

Q113 to

Q122. Now I'm going to present you with a series of choices regarding safety improvements at (stations) (bus stops). For each choice I give you, please tell me which improvement you would prefer to see. Even if the choice is difficult, please try to decide which improvement is most important for increasing safety at the (stations) (bus stops).

RANDOMIZE Q113-Q122

Q113. 1 Better lighting at (stations) (bus stops), or
2 Video monitors (on the station platforms) (at bus stops)

Q114. 1 Better lighting at (stations) (bus stops), or
2 Better maintained/cleaner (stations) (stops)

Q115. 1 Better lighting at (stations) (bus stops), or
2 Knowing when the (train) (bus) will arrive

Q116. 1 Better lighting at (stations) (bus stops), or
2 Security personnel (on the station platforms) (at bus stops)

Q117. 1 Video monitors (on the station platforms) (at bus stops), or
2 Better maintained/cleaner (stations) (stops)

Q118. 1 Video monitors (on the station platforms) (at bus stops), or
2 Knowing when the (train) (bus) will arrive

Q119. 1 Video monitors (on the station platforms) (at bus stops), or
2 Security personnel (on the station platforms) (at bus stops)

Q120. 1 Better maintained/cleaner (stations) (stops), or
2 Knowing when the (train) (bus) will arrive

Q121. 1 Better maintained/cleaner (stations) (stops), or
2 Security personnel (on the station platforms) (at bus stops)

Q122. 1 Knowing when the (train) (bus) will arrive, or
2 Security personnel (on the station platforms) (at bus stops)

Q113 to
Q128. This time I will present a series of choices regarding safety improvements that could be made on the (trains) (buses). For each choice I give you, please tell me which improvement you would prefer to see. Please try to make a choice.

RANDOMIZE Q123-Q128

Q123. 1 Security personnel riding (trains) (buses), or
2 (Drivers) (Conductors) taking appropriate action to control the behavior of riders

Q124. 1 Security personnel riding (trains) (buses), or
2 Video monitors on the (trains) (buses)

Q125. 1 Security personnel riding (trains) (buses), or
2 (Drivers) (Conductors) being able to summon security assistance quickly

Q126. 1 (Drivers) (Conductors) taking appropriate action to control the behavior of riders, or
2 Video monitors on the (trains) (buses)

Q127. 1 (Drivers) (Conductors) taking appropriate action to control the behavior of riders, or
2 (Drivers) (Conductors) being able to summon security assistance quickly

Q128. 1 Video monitors on the (trains) (buses), or
2 (Drivers) (Conductors) being able to summon security assistance quickly

Q129. How likely are you to continue to use local public transportation in the future, even if another means of transportation is available? Would you say you definitely will, probably will, might or might not, probably will not, definitely will not?
(DO NOT READ LIST)

5 Definitely will
4 Probably will
3 Might or might not
2 Probably will not
1 Definitely will not

Q130. How likely would you be to recommend local public transportation to a family member, friend, or co-worker? Would you say you definitely would recommend it, probably would recommend it, might or might not recommend it, probably would not recommend it, definitely would not recommend it?
(DO NOT READ LIST)

5 Definitely would recommend it
4 Probably would recommend it
3 Might or might not recommend it
2 Probably would not recommend it
1 Definitely would not recommend it

9 Don't know/Refused

Q131. If you could make a recommendation to (CTA) (Albuquerque SunTran) (Lynchburg Transit), what one improvement would you most like to see?
(RECORD AS OPEN END)

_____

_____

Finally, just a few last questions for statistical purposes ...

Q132. How long have you lived in the (Chicago) (Albuquerque) (Lynchburg) area?

_____ **RECORD NUMBER OF YEARS**

(INTERVIEWER RECORD 96 IF RESPONDENT DOESN'T LIVE IN THE CHICAGO AREA.)

9 Don't know/Refused

Q133. How many vehicles in working condition do you have available for your use?

_____ **RECORD NUMBER OF VEHICLES**

9 Don't know/Refused

Q134. What is your approximate age? Would that be ...
(READ LIST)

1 16 to 17
2 18 to 19
3 20 to 29
4 30 to 39
5 40 to 49
6 50 to 59
7 60 to 69
8 70 or older

9 Don't know/Refused

Q135. Are you currently ...
(ALLOW 3 RESPONSES) (READ LIST)

01 Employed full-time
02 Employed part-time
03 Unemployed
04 Not employed outside the home
05 A student
07 Housewife
08 Retired

96 Other **(FIT INTO CATEGORY ABOVE)**

99 Don't know/Refused

Q136. Is your annual household income below or above $30,000 per year?

1 Below $30,000 per year
2 At or above $30,000 per year
DK PROBE FOR BEST ESTIMATE
9 Don't know/Refused

(IF Q136 = 1, ASK:)
Q137. Would that be ...
(READ LIST)

1 Less than $10,000 per year, or
2 $10,000 to less than $20,000,
3 $20,00 to less than $30,000?
DK PROBE FOR BEST ESTIMATE
9 Don't know/Refused

(IF Q136 = 2, ASK:)

Q138. Would that be ...
(READ LIST)

1 $30,000 to less than $40,000
2 $40,000 to less than $50,000
3 $50,000 to less than $60,000
4 $60,000 to less than $70,000
5 $70,000 to less than $80,000
6 $80,000 to less than $90,000
7 $90,000 to less than $100,000
8 $100,000 or more?
DK PROBE FOR BEST ESTIMATE
9 Don't know/Refused

Q139. Are you: (READ LIST)

1 Hispanic
2 Asian
3 African-American
4 Caucasian
5 Native American
7 Other ***(Please specify)***_____

Q140. For our records, I need to verify your telephone number. Is it ...

1 Yes
2 No

9 Refused

(IF Q140=2, ASK:)

Q141. What is your correct phone number?

(__ __ __) (__ __ __)—(__ __ __ __)

That completes our survey.
Thank you for your time and the useful information you have provided!

APPENDIX G

THE RELATIONSHIP OF PERFORMANCE MEASURES TO CUSTOMER-DEFINED SERVICE ATTRIBUTES

1. Introduction

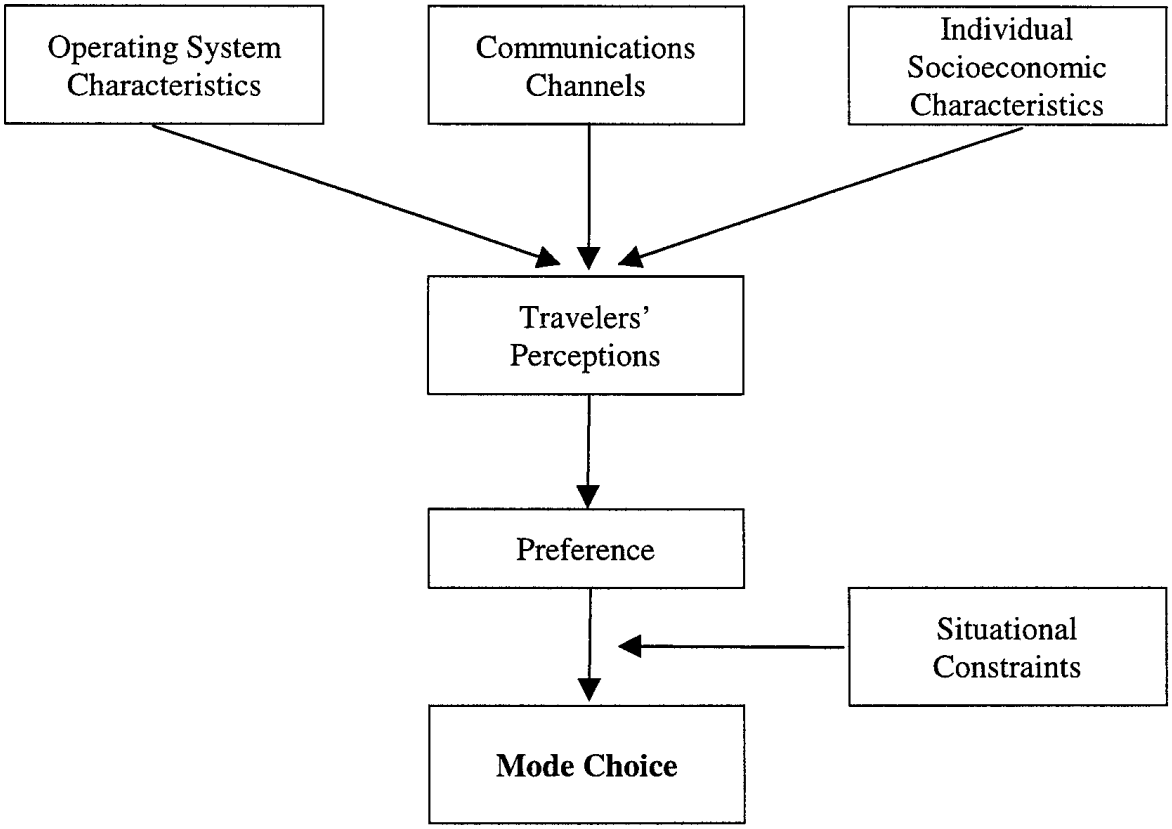
The objective of this literature review is to review and discuss the various transit performance indicators that are most commonly used by transit agencies as a means to monitor, as accurately as possible, the level of transit service offered. We present the measurement of transit performance by:

- discussing the importance of transit service characteristics as a determinant of traveler choice behavior and transit ridership;
- adopting a transit agency's perspective and summarizing the transit level of service measures as are traditionally collected by transit agencies in a few general dimensions;
- providing a detailed presentation of transit performance characteristics that are currently collected by each of the transit agencies that were contacted as part of this project; and
- discussing research that has been undertaken in the area of transit performance measurement and transit customer satisfaction.

2. A Transit Agency's Perspective

A consumer-oriented approach to transportation service planning is rooted in the assumption that the observed transit ridership and transit market share are the result of the mode choices made by each individual commuter. The framework presented in Figure G.1 of this appendix highlights the importance of transit level of service characteristics, individual characteristics, and communication and marketing channels on the formation of commuters' perceptions and preferences and consequently on their likelihood of riding transit.

Figure G.1
Factors Affecting Travelers' Mode Choice Decisions



Source: A.M. Tybout, J.R. Hauser, and F.S. Koppelman. Consumer Oriented Transportation Planning: An Integrated Methodology for Modeling Consumers' Perceptions, Preferences, and Behavior. *Advances in Consumer Research,* Vol. 5, October 1977.

It therefore becomes essential from a transit agency perspective to measure the level of transit service being offered in order to identify the potential transit strengths and weaknesses vis a vis competing modes. A better understanding of the relative strengths and weaknesses of transit service provides transit management with the means to evaluate alternative service improvements aimed at enhancing rider satisfaction and transit ridership. Therefore, the routine and ongoing collection of a comprehensive list of transit performance indicators can be used by transit agencies to:

- provide transit management with an overview of transit operations,
- evaluate transit performance on a system-wide, mode-specific, or route level of detail by monitoring changes in transit service over time,
- identify the strengths and weaknesses of transit service for particular attributes of service and the variation in service offered by different modes at different times of day and days of the week, and
- provide guidance in the development of marketing and communication strategies aimed at informing the customers and potential customers of the desirable features of transit service.

The collection of transit performance data to support the monitoring and evaluation of transit service presents a number of challenges to transit agencies. On one hand, transit agencies would ideally be interested in collecting information about every aspect of transit service that has an impact on transit operations including:

- the hours of operation,
- the frequency of transit service,
- station-to-station travel times,
- adherence to published schedules,
- the elapsed time between service breakdowns, and
- load factors by time of day and day of the week.

Furthermore, transit agencies would also be interested in collecting information and monitoring transit service by collecting information on performance measures which, although not directly related to transit performance, reflect the quality of transit service and affect transit riders' satisfaction including:

- the condition of rolling stock, train stations, and bus stops with respect to lighting conditions, cleanliness, and presence of graffiti,
- the operating condition of the turnstiles, elevators, or ticket booths, and
- the presence and/or the number of police officers on duty at a particular train station, at a bus terminal, or along a bus route.

On the other hand, the cost of collecting and analyzing such a wide array of transit performance and service quality data presents a constraint often faced by transit agencies. Furthermore, it may be difficult to quantitatively assess certain attributes of performance or service quality on an objective scale if the attribute is based on subjective perceptions. Station appearance or cleanliness would be examples of such attributes. As a result, transit agencies seek to concentrate their data collection and analysis activities towards those aspects of transit service that are both crucial to their operations and that more accurately reflect the needs and wants of their transit market.

The value of the collected transit performance data thus increases when the collected information covers the crucial aspects of transit service, it is measured properly to reflect the actual level of transit service offered, and it offers policy-sensitive information that allows transit management to evaluate alternative service improvements.

To facilitate this process, a survey of transit agencies was undertaken to identify the measures of transit performance currently collected and to evaluate the extent to which these measures are consumeroriented and whether they are sensitive to the needs and wants of individual transit riders. The transit agencies listed in Table G.2 of this appendix were selected to provide a geographically balanced sample of agencies of different sizes providing service in rural, suburban, and urban markets and whose operations cover different transit modes including bus, light rail, and heavy rail service.

Each of the 43 transit agencies is described in terms of:

- the geographic location of each agency which could be used to differentiate among transit agencies operating in the eastern, midwest, southern, and western areas of the U.S.;

- the transit modes that constitute the fleet of each transit agency including conventional diesel powered buses, electric trolleys and buses, light rail cars, subway cars, and commuter rail cars;

- the broadly defined characteristics of the service area served by each transit agency characterized as urban, suburban, or rural; and

- the size of each transit agency reflected both on the mix and the size of the agency's fleet as well as the number of transit agency employees.

Each of the agencies listed in Table G.2 was contacted about the types of performance and/or customer satisfaction measures they collect and analyze. In the following two sections we provide descriptions of the measures collected by those transit agencies that responded to our inquiries. Some of the agencies either reported collecting no performance or customer satisfaction measures, or did not respond due to staff or time constraints.

Table G.2
List of Transit Agencies Contacted as Part of the Research Study

Transit Agency	State	Area Type	Population	Buses	Electric Trolley Buses	Subway Rail Cars	Comm. Rail Cars	Locos	Light Rail Cars	Employees
Athens Transit System - The Bus	GA	Rural	97,697	23	0	0	0	0	0	42
Bi-State Development Agency	MO	Urban, Large	2,500,000	700	0	0	0	0	31	1,900
Central Ohio Transit Authority	OH	Urban, Medium	961,437	351	0	0	0	0	0	766
Chicago Transit Authority	IL	Urban, Large	4,000,000	2,172	0	1,216	0	0	0	13,000
Clinton (IA) Municipal Transit Administration	IA	Rural	29,300	9	0	0	0	0	0	17
Cobb Community Transit	GA	Urban, Small	450,000							
Dallas Area Rapid Transit	TX	Urban, Large	1,679,017	883						1,965
Greater Cleveland Regional Transit Authority	OH	Urban, Large	1,404,286	778	0	108	0	0	0	2,869
Greater Lynchburg Transit Company	VA	Rural	68,000	26	0	0	0	0	0	70
Jefferson Transit Authority	WA	Rural	21,000	14	0	0	0	0	0	24
Logan Transit District	UT	Rural	51,000	9	0	0	0	0	0	
Mass Transit Administration of Maryland	MD	Urban, Large	2,000,000	900	0	100	0	0	0	2,576
Massachusetts Bay Transportation Authority	MA	Urban, Large	2,594,590	1,037	0	416	331	52	197	
Memphis Area Transit Authority	TN	Urban, Medium	825,193	321	10	0	0	0	12	434
Metra (Metropolitan Rail)	IL	Urban, Large	7,100,000	0	0	0	894	135	0	
Metro Dade Transit Agency	FL	Urban, Large	1,861,000	545	0	136	0	0	12	2,342
Metropolitan Atlanta Rapid Transit Authority	GA	Urban, Large	1,225,000	699	0	240	0	0	0	3,444
Metropolitan Transit Authority of Harris County	TX	Urban, Large	271,200	1,163						3,240
Metropolitan Transit Commission	MN	Urban, Large	2,288,721	990						2,398
Metropolitan Transportation Authority/NYCTA	NY	Urban, Large	13,200,000	3,973	0	7,885				64,119
Miami Valley Regional Transit Authority	OH	Urban, Medium	567,735	230	36	0	0	0	0	663
Muskegon (Michigan) Area Transit System	MI	Rural	75,000	19	0	0	0	0	0	29
New Jersey Transit	NJ	Urban, Large	7,800,000	1,907	0	840	0	0	26	8,616
Niagara Frontier Transportation Authority	NY	Urban, Large	1,242,573	369	0	0	0	0	27	1,125

Table G.2
List of Transit Agencies Contacted as Part of the Research Study
(Continued)

Transit Agency	State	Area Type	Population	Buses	Electric Trolley Buses	Subway Rail Cars	Comm. Rail Cars	Locos	Light Rail Cars	Employees
Pace Suburban Bus Division of RTA	IL	Suburban	4,100,000	1,108	0	0	0	0	0	2,348
Pocatello Urban Transit	ID	Rural	55,000	19	0	0	0	0	0	
Port Authority of Allegheny County (PA Transit)	PA	Urban, Large	1,336,449	898					55	3,011
Regional Transit Authority	LA	Urban, Large	1,000,000							
Sacramento Regional Transit District	CA	Urban, Large	1,100,000	200	0	0	0	0	36	727
San Diego Metropolitan Transit Development	CA	Urban, Large	1,600,000						71	275
San Francisco Bay Area Rapid Transit District	CA	Urban, Large	2,736,400	0	0	590	0	0	0	2,639
Somerset (NJ) County Office of Transportation	NJ	Urban, Small	240,000	3	0	0	0	0	0	
Southeastern Penn Transportation Authority	PA	Urban, Large	3,700,000	1,442		353	346		247	9,923
Southern California Rapid Transit District	CA	Urban, Large	10,000,000	2,469	0	0	0	0	0	8,584
Suburban Mobility Authority for Regional Transit	MI	Suburban	3,687,300	357	0	0	0	0	0	846
Sun Tran (Tucson, AZ)	AZ	Urban, Medium	666,880	180	0	0	0	0	0	436
Sun Tran of Albuquerque	NM	Urban, Small	384,736	125	0	0	0	0	0	233
Topeka Metropolitan Transit Authority	KS	Urban, Small	119,883	38		0	0	0	0	65
Toronto Transit Commission	ONT	Urban, Large	2,100,000	1,677		622	0	0	248	10,242
Tri-County Commuter Rail Authority	FL	Urban, Large	4,000,000							
Tri-County Metropolitan Transportation District	OR	Urban, Large	1,200,000	569		0	0	0	26	1,802
Washington Metropolitan Area Transit Authority	DC	Urban, Large	2,500,000	1,507		674	0	0	0	8,369
Winston-Salem Transit Authority	NC	Urban, Small	254,880	58		0	0	0	0	130

3. An Overview of Transit Performance Measures

The performance measures collected by the transit agencies that were contacted can be summarized by up to eight broadly defined categories. These categories include both traditional categories of service performance that directly affect transit operations and measures that reflect a more qualitative approach to transit operations. The reported measures can be grouped under the following categories of measures related to:

- on-time performance and reliability,
- frequency of transit-related accidents,
- number of reported passenger complaints,
- frequency of transit service breakdowns,
- perceptions of rider safety,
- transit agency communication efforts,
- vehicle availability for service, and
- condition of rolling stock.

Measures that reflect **on-time performance** and reliability were the most often cited examples of transit performance measures reflecting how closely the delivery of transit services matches the published schedule. Agency policies usually state an allowable window of time (usually from three to five minutes after the scheduled arrival or departure time) during which a transit vehicle can arrive and still be considered on-time. Vehicles departing before their scheduled departure time are almost never considered on-time. This measure is usually expressed as a percent of scheduled trips that run on-time and is often broken out by mode with some agencies reporting peak and off-peak on-time performance separately. The number of agencies reporting measures of service reliability or schedule adherence illustrates the importance of providing reliable and predictable service both from an operations perspective and from the perspective of transit riders who are interested in arriving at their destination as scheduled.

The frequency of transit-related **accidents** was another category of measures cited by many agencies. Some of the agencies normalize the number of accidents per miles of service while other agencies break out accidents by type including passenger accidents, employee accidents, preventable accidents, vehicle accidents, etc. Measures of accident incidence are usually reported on a monthly and a mode-specific basis.

The **number of complaints** expressed by transit passengers is used by some agencies as a surrogate of service performance and is often reported on a monthly basis. This measure presents an effort by the transit agencies to be responsive to their clients' needs and wants. Agencies collect and analyze complaints by type (e.g. facilities, operators) and by mode and normalize the frequency of complaints by dividing by the number of transit riders or the number of transit service miles provided.

The frequency of **service breakdowns** is another traditional measure reflecting transit operations and is usually expressed as the average number of miles between breakdowns. Different agencies identify breakdowns as a vehicle failure, road call, or service interruption. This measure is usually mode-specific and is reported on a monthly basis.

A smaller number of agencies reported measures that are aimed at quantifying the various **communication efforts** that transit agencies carry out. Examples of such measures include the percentage of calls by the public answered within 90 seconds; the number of service requests received by the public; and the number of calls received asking for transit-related information.

A small number of agencies also reported measures that were related to passenger safety, the availability of vehicles in operation, and the condition of transit vehicles and stations. **Passenger safety** is measured either as the number of reported passenger injuries or incidents or as passengers' perceptions of how safe they felt while using the transit service. **Vehicle availability** is measured as the number of vehicles either available or not available for service. Vehicles are considered not available for service when they are not operable (e.g., they are in for maintenance). This measure can be used as an additional indicator of service performance because as the number of vehicles not available for service increases, the likelihood that service will not be delivered as scheduled increases as well. Finally, measures **reflecting vehicle and station condition** were based on subjective measure reported by inspectors. These measures reflected the cleanliness of vehicle interiors and stations, shelters, and bus stops, while in one case, the number of graffiti-free buses was also reported.

4. Inventory of Performance Measures by Transit Agency

In this section we present in greater detail the performance and customer satisfaction measures that are currently being collected by each of the transit agencies that were contacted and responded to our request. In our discussion of each agency's data collection efforts, we also make a preliminary effort to identify the offices within each agency that are responsible for the design and administration of the data collection effort, sources of the data and frequency of data collection, and the intended audience.

Albuquerque, NM: Sun Tran

Sun Tran currently collects data and prepares reports on mostly traditional performance measures such as the average number of riders per vehicle hour, total revenue hours, and average trip length. In addition, it also collects data on a few customer-focused measures such as the number of complaints and the number of riders with bikes using the available bus racks.

To supplement the Sun Tran data collection effort, the City of Albuquerque conducts a resident survey, which includes questions about transit service in the city. Sun Tran accesses the available information, which includes:

- passenger safety and feeling of security,
- transit time and cost considerations, and
- evaluation of transit environment, comfort, and reliability.

It is expected that the collection of such kinds of information will become part of Sun Tran's new performance evaluation process, which is currently under development.

Atlanta, GA: Cobb Community Transit

Cobb Community Transit reports mainly data collected as part of the FTA Section 15. The agency is currently in the early stages of developing a performance evaluation process which is likely to include customer-defined service indicators.

Baltimore, MD: Mass Transit Administration of Maryland

The Mass Transit Administration of Maryland (MTA) has set guidelines for monitoring on-time performance for the different types of service that MTA offers including the radial, crosstown, and feeder bus services. These guidelines, documented in the Mass Transit Administration Service Standards Guide, define a vehicle as being on time if it arrives at a stop one minute early to five minutes late. However, the MTA does not report such performance characteristics on a regular basis.

Boston, MA: Massachusetts Bay Transportation Authority

The Massachusetts Bay Transportation Authority (MBTA) monitors the quality of transit service by collecting information and developing performance measures for the bus, trackless trolley, subway and light rail service. These performance measures are summarized on a monthly basis in the Monthly Management Report.

The measures that are presented in the MBTA report include:

- the mean miles between failures,
- vehicle availability,
- percent of trips not run,
- number of accidents,
- rider complaints by category,
- the number of days vehicles are out of service, and
- the commuter rail on-time performance and rail signal delays.

Chicago, IL: Chicago Transit Authority

The objective of the Chicago Transit Authority (CTA) is to maintain a high level of performance by optimizing a set of key variables that are linked to CTA's mission and stated goals. The CTA's stated goals include convenient on-time service, passenger safety and security, equitable fares, and communication with the public.

CTA reports on the following five key areas of service although it does not make a quantitative link between these aspects of service and the CTA mission and goals:

- average speed,
- geographic service coverage,
- frequency of service,
- span of service (hours of service each day), and
- productivity.

Chicago, IL: Pace Suburban Bus Division of RTA

In 1996, Pace Suburban Bus Service, a public transportation agency headquartered in Arlington Heights, Illinois, began a program integrating customer service perceptions into its daily operations. The purpose of the program was to increase ridership levels. The Customer Satisfaction Index (CSI), a tool to continuously monitor and evaluate services, was developed for this research.

Pace Market Research together with a consulting firm outlined the project research steps. Employees at every level were involved including employee committees to determine the form and substance of the measuring tool. The committees worked on identifying customers, types of services, and "moments of truth;" goals and objectives were also agreed upon.

Two research techniques were undertaken for initial identification of attributes: customers and employees participated in focus groups and completed an extensive questionnaire. The groups identified service elements important to the customer while responses to the questionnaire formed the basis of the satisfaction survey. The satisfaction survey was pretested at the end of 1996.

Full implementation of the CSI began in January 1997. A one-page satisfaction survey, printed in English, Spanish, and Polish, was distributed on-board fixed route buses randomly throughout a four-month period. Pace chose to sample 120 one-way trips from eleven reporting units (nine divisions split between contract carriers operating all day trips and contract carriers operating peak period trips) per period. Results were reported in June.

Pace Market Research presented the results to the management, the Pace Citizens Advisory Board and the Pace Board of Directors. The results are communicated to customers via bus car-cards and in the Pace Rider Report (a quarterly customer newsletter), and to employees by e-mail, through office posters, and in the employee newsletter. This process repeats itself every four months.

Cleveland, OH: Cleveland Regional Transit Authority (RTA)

The Cleveland RTA monitors transit service by collecting information on a variety of transit performance measures. These measures are summarized on a quarterly basis in the Quarterly Management Report, which presents information on:

- the number of vehicle accidents per 100,000 vehicle service miles,
- the number of passenger accidents per 1 million passengers and per 100,000 vehicle service miles,
- the number of customer complaints against transit operators (per 1 million passengers and per 100,000 vehicle service miles),
- transit on-time performance,
- the number of miles between service interruptions,
- the miles between road calls, and
- the number of passenger complaints per 1 million passengers and per 100,000 vehicle service miles.

Furthermore, the RTA measures customer satisfaction quarterly by reviewing the number of commendations about service delivery per 1 million passengers and per 100,000 vehicle service miles. It also keeps track of three other indicators that reflect the ratio of employees in training to the eligible employees; the ratio of employees achieving high performance appraisal ratings to the total number of employees; and the ratio of implemented process improvements to total Quality Improvement Teams formed.

Dayton, OH: Miami Valley Regional Transit Authority (RTA)

According to the Dayton RTA's Service Standards Manual, three performance measures are collected on an annual basis to help evaluate the level of transit service that is offered. These measures reported to the Authority's Board of Trustees include:

- the number of passengers per platform (i.e. revenue service) hour,
- the vehicle load factors with the maximum load factor defined as 140% of the seating capacity, and
- on-time performance which is defined as the number of buses that arrive at checkpoints zero to three minutes after the published time.

Furthermore, the Dayton RTA carries out a passenger survey every two or three years asking passengers to provide trip characteristics information (origin, destination, purpose, etc.) as well as to rate transit service in terms of driver courtesy, vehicle comfort, and other quality of service characteristics.

Detroit, MI: Suburban Mobility Authority for Regional Transportation (SMART)

In Detroit's SMART system, a number of performance indicators are collected on a monthly basis including the following:

- the number of passenger complaints,
- the number of times they return a customer's fare under their money back guarantee policy (their flat fare is $1.50),
- the number of road calls,
- on-time performance which is defined as an early arrival of one minute to a late arrival of five minutes at random checkpoints,
- the number of accidents classified as preventable and non-preventable, and
- the number of miles between accidents.

Jefferson, WA: Jefferson Transit Authority

The Jefferson Transit Authority (JTA) is an example of an agency that focuses its performance measurement primarily on customer-oriented aspects of transit service. The measures that are collected and analyzed on a monthly basis and are reported to the JTA Board include:

- customer contacts and calls,
- passenger complaints by type along with passenger commendations
- passenger service requests,
- the presence and number of bicycles on transit vehicles, and
- the number of road calls required.

Logan, UT: Logan Transit District

The Logan Transit District (LTD) has contracted with DAVE Transportation Services to provide their fixed route bus and demand responsive services. The service provider produces a Monthly Management Report for LTD, which includes information on the following:

- the number of passenger and employee injuries,
- the ridership of the Call-a-Ride service,
- the rates of on-time performance,
- the number of missed and late trips
- the number of preventable accidents, and
- the number of passengers denied a ride because of over-capacity.

Los Angeles, CA: Metropolitan Transportation Authority (Metro)

The Los Angeles Metro collects the traditional measures of revenue service hours and unlinked passenger boardings but in addition reports on a few customer satisfaction indicators that include:

- on-time pull-outs (from the garage into revenue service) for all modes,
- the percentage of buses and light rail vehicles that are graffiti-free,
- the number of passenger complaints,
- accident rate, and
- the number of miles between road calls.

Memphis, TN: Memphis Area Transit Authority

The Memphis Area Transit Authority (MATA) reports on a number of traditional fiscal-, maintenance- and operations-level measures that include total vehicle miles and hours of operation, the number of passengers per mile, per hour, and per scheduled bus, and the time that buses remain out of service.

In addition to these measures, MATA documents the level of transit on-time performance and the level of safety. These measures include:

- the percentage of trips that are on-time, early, or late with separate measures developed for inbound, outbound, and cross-town trips,
- the number of miscellaneous incidents, and
- the number of traffic, passenger, and preventable accidents.

Miami, FL: Miami Metro

Miami Metro publishes a quarterly performance report which tracks the following performance measures:

- the level of on-time performance,
- the number of accidents including preventable accidents,
- the number of passenger complaints, and
- the number of road calls due to mechanical problems.

Muskegon, MI: Muskegon Area Transit System

Muskegon is the smallest transit authority in the state that provides fixed-route service. On a quarterly basis, it submits a report to the state that summarizes the number of passengers per mile and per hour, the cost per mile and per passenger, the farebox recovery ratio, and the number of passenger complaints per 1,000 miles.

New York City, NY: New York City Transportation Authority

The New York City Transit Authority (NYCTA) collects a wealth of transit service-related information on an ongoing basis. It collects traditional measures of transit performance that include measures of the:

- the mean distance between failures;
- subway service throughput (also referred to as "thruput");
- the level of terminal and en route on-time performance;
- the number of delays; and
- excess wait time.

In addition to the service performance measures related to reliability and performance, three NYCTA offices collect a range of attributes reflecting qualitative aspects of transit service. The Division of Operations Planning publishes the Passenger Environment Survey (PES) on the condition of subway stations including:

- the condition of escalators and elevators;
- availability of maps and signs;
- the condition of lights and public telephones; and
- the presence of litter and graffiti.

The PES survey also collects information on the condition of subway cars including information on:

- temperature, air conditioning, and number of operating fans;
- the condition of car windows and floors; and
- the working condition of the public address system.

Furthermore, two other reports are generated by two other NYCTA offices. In particular, the NYCTA Facilities Planning and Car Appearance Division publishes the PEER Report on subway car cleanliness and the Stations Department publishes the Station Cleanliness Report, which provides additional information on station condition.

Philadelphia, PA: Southeastern Pennsylvania Transportation Authority (SEPTA)

SEPTA reports on the following performance measures on an annual basis:

- number of accidents for both passengers and employees,
- the mean distance between failures by mode,
- the percent of public information calls satisfactorily answered,
- percent of scheduled service dispatched as scheduled,
- the level of on-time performance by mode, and
- the number of passenger complaints.

Pittsburgh, PA: Port Authority of Allegheny County (PATransit)

On a monthly basis, PATransit reports the number of passenger complaints and the number of road failures for bus and light rail service to its board of directors. According to the PATransit's Service Standards document, the agency also reports the following measures on an annual basis:

- the percent of trips that are on-time broken out by peak and off-peak periods for both bus and light rail service,
- the number of passengers per vehicle hour for bus and light rail,
- passenger and employee accidents per 100,000 miles,
- the percentage of public information calls answered within 90 seconds,
- the number of complaints per 100,000 passengers, and
- mean distance between road failures.

Furthermore, the PATransit marketing department also undertakes surveys to assess and monitor customer satisfaction with the transit service.

Pocatello, ID: Pocatello Urban Transit

The Pocatello Urban Transit agency reports mainly data collected as part of the FTA Section 15 process. As a result, these performance measures include operating expenses per vehicle revenue mile, per vehicle revenue hour, per passenger mile, and per unlinked passenger trip; and unlinked passenger trips per vehicle revenue mile and per vehicle revenue hour.

The agency is currently working with the local MPO to perform on-board surveys to address operations-related issues such as trip length but not issues related to transit passenger satisfaction.

Portland, OR: Tri-County Metropolitan Transportation District of Oregon (TRI-MET)

Since 1977, TRI-MET has conducted annual surveys of customers to track differences in attitudes, awareness, and satisfaction with TRI-MET's service. They report the percentages of TRI-MET riders who rate the overall transit performance as "excellent," "good," "fair," or "poor".

As part of this survey, TRI-MET collects information and reports performance in the following eight categories:

- feeling of personal safety when waiting for the bus or light rail,
- courtesy of transit drivers,
- availability of shelters to wait for bus or light rail,
- availability of TRI-MET phone operators,
- safe operation of buses and light rail,
- on-time reliability,
- availability of route information, and
- the cost of transit service.

St. Louis, MO: Bi-State Development Agency

The Bi-State agency collects information that focuses mostly on financial indicators published in the Quarterly Performance Indicators Report. In addition to these measures however, the agency also tracks on-time performance and the average number of miles between accidents for both bus and rail service.

San Diego, CA: Metropolitan Transit Development Board (MTDB)

The San Diego MTDB reports very little in the way of customer-focused performance measures. The service performance indicators that they track are based primarily on the total passengers per revenue mile, the subsidy per passenger, and the farebox recovery ratio.

San Francisco, CA: Bay Area Rapid Transit (BART)

BART uses an exhaustive set of performance measures, including some customer-focused measures. They produce an annual Budget Book for their directors, as well as a Monthly Management Book for internal use. BART maintains monthly records of train on-time and passenger on-time rates for both peak and off-peak operations. They also measure car availability and mean time between vehicle-related system delays. BART also maintains its own police force, which reports on safety on BART.

Toronto, Ontario: Toronto Transit Commission

The Toronto Transit Commission (TTC) reports on customer satisfaction regarding different elements of transit service to the Board of Commissioners and the Metropolitan Toronto Council. The measures for which customer responses are collected include on-time reliability, feeling of security, employee competence, communication, convenience, and cleanliness. It also reports on performance measures such as:

- passenger complaints which are categorized into 30 different categories such as discourtesy, door operations, and announcements;
- headway adherence which is defined as the percent of trips operated within two minutes of their scheduled headway;
- vehicle delays which are categorized into 19 different groups such as delays due to service disruptions, low voltage, and warning/alarm system;
- mean miles between defects; and
- number of accidents.

Winston-Salem, NC: Winston-Salem Transit Authority (WSTA)

On a monthly basis, the Winston-Salem WSTA reports a few measures that are related to transit performance and include the following:

- transit passengers per mile,
- vehicle accidents per 100,000 miles,
- preventable accidents per 100,000 miles, 100,000 passengers, and 100,000 vehicle hours,
- passenger complaints, and
- number of vehicles out of service.

5. Research on Transit Performance and Transit Customer Satisfaction

In this section we conclude our discussion of service performance measures by reviewing the research literature on issues related to transit performance measures (section 5.1) and later focusing on an emerging wave of transit marketing applications that adopt a consumer-based approach to transit service operations (section 5.2).

5.1 Evaluation of Transit Service Performance

The selected papers on transit service performance are presented in a chronological order to reflect the evolution of thinking about issues related to transit service performance, its measurement, and its evaluation. In the first two papers, Bhandari and Sinha discuss the linkages between changes in transit service and overall performance, while Talley and Anderson focus on the relationship between transit performance and measures of transit service effectiveness and efficiency.

Under the second group of papers, Levinson discusses factors affecting bus travel time performance; Guenthner and Hamat measure bus on-time performance as a function of traffic attributes and schedule structure; Buneman discusses automated data collection methods that can be used to measure and evaluate transit performance; and Guenthner and Sinha propose a planning tool for transit performance evaluation.

The comparative analyses of performance include Fielding's and Anderson's evaluation of transit performance across various transit systems; Bates's comparison of the definitions used by various agencies to measure bus on-time performance; Parkinson's evaluation of rail performance that compares on-time reliability and equipment failure for rail systems; and Fielding's use of a range of traditional operating performance measures to evaluate transit performance across various transit agencies.

Finally, the section concludes by presenting examples of work that focus on individual performance measures. In particular, Senevirante uses a simulation approach to analyze bus on-time performance; Anderson proposes dependability as a measure of on-time performance that is particularly applicable to personal rapid transit systems; Stratham and Hopper present an empirical analysis of bus transit on-time performance by accounting for the effects of scheduling, route, driver and operating characteristics on schedule adherence; and Wilson and MacDorman & Associates summarize the design of service standards for on-time performance and passenger load prepared for the MBTA.

Anil S. Bhandari and Kumares C. Sinha. "Impact of Short-Term Service Changes on Urban Bus Transit Performance." Transportation Research Record, No. 718, TRB, National Research Council, Washington, D.C., 1979.

This article discusses the impacts of changes in service frequency, number of bus stops, and fare on the operations of fixed route bus service. The authors present the model that was developed to predict the impacts on transit performance and discuss the theoretical results, which suggest that significant improvements to the efficiency and effectiveness of bus service are possible.

Wayne K. Talley and Pamela P. Anderson. "Effectiveness and Efficiency in Transit Performance: A Theoretical Perspective". Transportation Research, Part A, Vol. 15A, No. 6, 1981.

This article discusses effectiveness and efficiency of a transit system focusing on how well a transit system meets the goals which have been set out and how well it utilizes the labor and capital resources available to it. The article suggests that a transit system has to maximize its efficiency in order to maximize its effectiveness and discusses the need to monitor transit performance to attain the highest levels of effectiveness and efficiency.

Richard P. Guenthner and Kumares C. Sinha. "Transit Performance Evaluation Model." Transportation Engineering Journal of ASCE, Vol. 108, No. TE4, July 1982.

This paper presents a model that was developed to evaluate the effects of changes in operating characteristics such as fares, service frequencies, route coverage, and route alignment on transit performance. The model is intended for use by bus operators in small to medium sized cities and was applied to several case studies of transit operations in small midwestern cities. The model is a planning tool for testing different operating scenarios and therefore rather theoretical.

Herbert S. Levinson. "Analyzing Transit Travel Time Performance." Transportation Research Record, No. 915, TRB, National Research Council, Washington, D.C., 1983.

This article describes the results of surveys of bus movements in a cross section of U.S. cities. Data were gathered on the speed of vehicles (in CBD, urban, and suburban settings, during peak and off-peak periods), time spent at bus stops, and time spent in traffic delays. The results of this research suggest that reducing the number of bus stops per mile and the amount of dwell time at stops will speed bus operations more than eliminating traffic congestion. This article offers suggestions for transit operators who encounter frequent dissatisfaction among their riders about on-time performance.

Gordon J. Fielding and Shirley C. Anderson. "Public Transit Performance Evaluation." Transportation Research Record, No. 947, National Research Council, Washington, D.C. 1983.

This study focuses on measures of transit operational performance and establishes a framework for comparing the operations of different transit systems. The authors use Section 15 data to compare 311 urban bus systems and come up with peer-group rankings. They develop a triangular conceptual model of transit performance that includes transit service inputs, service outputs, and service consumption. The model helped select a few performance indicators that represent important performance concepts including measures such as:

- vehicle miles per maintenance employee,
- number of passengers per revenue vehicle mile, and
- total vehicle miles per gallon of fuel consumed.

Richard P. Guenthner and Kasimin Hamat. "Distribution of Bus Transit On-Time Performance." Transportation Research Record, No. 1202, TRB, National Research Council, Washington, D.C.

This article identifies on-time performance as one of the most important measures of the quality of transit service and emphasizes that passengers who are confident about the likely wait time for a transit vehicle are more likely to use transit. It points out that the difference between service that is predictably late versus service that is unpredictably late and discusses various reasons for lateness including:

- variable and increased ridership,
- external factors such as trains passing at railroad crossings,
- variable and heavy traffic,
- lack of schedule control on the part of the operator, and
- a published schedule that may be based on unreasonable goals given existing operating conditions.

Transit riders' reactions to the question "How important is on-time performance?" was also analyzed indicating that 25% of the respondents rated on-time performance as "important", 34% as "very important", and 18.5% as "essential". The article also presents a case study of bus on-time performance for several routes serving downtown Milwaukee and derives an analytical gamma distribution that can be used to measure on-time performance using a small sample size; estimate the probability of a bus being on-time; and model passenger waiting times, arrivals, and on-time performance.

Kelvin Buneman. "Automated and Passenger-Based Transit Performance Measures." Transportation Research Record, No. 992, TRB, National Research Council, Washington, D.C., 1984.

This article describes the automated train and passenger tracking system on the BART system. It discusses how the data on train performance and passenger movements can be combined to estimate the number of passengers who experience delays. The article explains in detail the computer model designed to combine the data and make the corresponding estimates.

John W. Bates. "Definition of Practices for Bus Transit On-Time Performance: Preliminary Study." Transportation Research Circular, No. 300, February 1986.

This article offers a short, but concise discussion of the definition of "on-time performance" in the transit industry. A survey of 146 transit agencies was used to identify differences in the definition of on-time performance, the data collection methods for determining if transit service was on-time, and the importance of on-time performance to transit operators.

Transit agencies reported their window for measuring on-time performance by indicating how early and how late a bus could be and still be considered as being on-time. Nearly two-thirds (64%) of agencies allow no early departure, about 80% of agencies consider departures which are three to five minutes behind schedule to be on-time, and nearly ten percent of the respondents allow no deviation from published times. The most common definition of on-time is that buses cannot be early and can be up to five minutes late. However, very few agencies indicated a systematic, statistically based survey procedure for determining whether a transit service was on-time or not. Most agencies reported that it is "very important" to offer transit service that operates on-time while a number of agencies reported on-time performance as "critical" and "essential" to the quality of transit service.

Tom Parkinson. "Rail Transit Performance." Transportation Research Record, No. 1361, TRB, National Research Council, Washington, D.C., 1992.

This article compares about 15 of the most recently built rail systems in North American to evaluate the efficiency of different systems. It discusses rail on-time performance statistics suggesting that 6% of trips in Portland and 2.4% of trips in Vancouver were delayed by two minutes or more. Similarly, Portland averaged 102,600 car miles per in-service failure, whereas Vancouver stated an average of 86,800 car miles per unscheduled train removal from service.

Prianka N. Senevirante. "Analysis of On-Time Performance of Bus Services Using Simulation." Journal of Transportation Engineering, Vol. 116, no. 4, pp. 517-531, July/August 1990.

The author discusses a computer model developed for estimating and evaluating the quality of service (i.e. on-time performance) for fixed route bus services under different operating schedules. The model takes into consideration various factors influencing bus on-time performance such as number of stops along a route, distance between stops, distance from point of dispatch, and dwell time for boarding and alighting passengers. This simulation model could be useful to transit operators in exploring a variety of options for modifying service to meet passengers' demand for on-time performance.

Gordon Fielding. "Transit Performance Evaluation in the USA." Transportation Research, Part A, Vol. 26A, No. 6, pp. 483-491, 1992.

This article discusses traditional performance measures and how they have helped the transit industry focus on cost control during the 1980's. The list includes measures such as:

- cost per revenue mile,
- cost per revenue hour, and
- passengers per revenue mile/hour.

The article further discusses how incentives for rewarding superior performance among transit agencies have not been successful.

J. Edward Anderson. "Dependability as a Measure of On-Time Performance of Personal Rapid Transit Systems." Journal of Advanced Transportation, Vol. 26, No. 3, pp. 201-212.

This article provides a framework for thinking about the nature of on-time performance and ways in which it could be measured. The author proposes the use of "dependability" as a measure of on-time performance. Dependability is defined as the percentage of person-hours experienced by people riding the transit system with no delays. Although in theory such a measure can be calculated for any transit system, the amount of data that would have to be gathered for even a small transit operation make it an impractical measure for most transit systems. The author suggests that dependability could be calculated for emerging personal rapid transit (PRT) system because they will automatically collect all origin, destination, and passenger load data.

James G. Stratham and Janet R. Hopper. "Empirical Analysis of Bus Transit On-Time Performance." Transportation Research, Part A, Vol. 27A, 1993.

This paper focuses on determining the effects of various scheduling, route, driver and operating characteristics on schedule adherence. The authors developed a model that suggested the relative importance the various characteristics had on determining whether or not a bus arrived at a scheduled time point on-time. The model was tested against 1,552 actual observations of bus arrivals at time points from Portland, Oregon's fixed route bus system. The probability of on-time arrival was negatively affected by the number of alighting passengers, the location of the observed time point on the route, and bus headways. This paper provides a means for quantifying the importance of different factors affecting bus on-time performance.

Nigel Wilson and MacDorman & Associates. Design of Service Quality Measures and Planning Standards. Prepared for the Massachusetts Bay Transportation Authority, October, 1994.

This report outlines a process for developing service standards for the Massachusetts Bay Transportation Authority. It includes an overview of the service planning process, a description of service guidelines that specifies measures and standards to meet policy objectives, and a service evaluation process that presents an approach for evaluating existing and proposed services.

The report outlines a more comprehensive service performance monitoring approach for the MBTA that included such measures of operational quality as:

- passengers per vehicle at the maximum load point as a percent of seating capacity, and
- percent of trips that depart within five minutes of scheduled departure times

The report concludes by suggesting an annual review of existing services and outlines an evaluation process for new service requests.

5.2 Linking Transit Service Performance and Customer Satisfaction

The second part of the research literature review focuses on work that has adopted a transit consumer perspective. The research papers and reports presented in this section recognize the need to look at individual travelers and have questioned the notion that operating measures could adequately reflect customer satisfaction. The different perspectives that these pieces of work bring to light help us better understand the factors affecting transit riders' satisfaction and could further be used to help transit agencies to design data collection programs to effectively monitor riders' perceptions and the level of service they offer.

To collect service performance information that is useful to transit agencies and is also behaviorally based and customer-oriented, the performance measures have to:

- cover every aspect of transit operations,
- provide accurate and detailed information,
- cover different transit modes,
- correspond to customer-oriented concepts of transit service,
- be the product of an unbiased data collection methodology, and
- be periodically collected to provide continuity in evaluating transit service.

In the first paper review, Silkunas considers the measurement of customer satisfaction as the next frontier in understanding transit riders' needs and wants and strongly advocates a consumer-oriented approach to data collection and interpretation. His call for such improvements is reflected on the work undertaken by the Office of the Inspector General at the Metropolitan Transportation Authority in New York City. The work presented here focuses on the evaluation of transit performance measures from a customer's perspective and the definition of customer-driven performance measures.

The remaining three papers focus on recent applications of such customer-oriented measurement and analysis methods in the transit industry. Proussaloglou and Koppelman present the analysis of commuter rail riders' perceptions of service and discuss the linkages between operating measures of level of service and customer perceptions. The "A" Showcase subway line project in New York offers an additional example of exploring the appropriate definition of service measures and relating actual performance indicators to subway riders' perceptions of service. The last paper presents an approach to develop a customer satisfaction index for the mass transit industry by identifying and focusing on opportunities that transit management should pursue to improve customer satisfaction and increase sales. To develop such an index, respondents rate a given product on a number of attributes associated with the product.

Steven Silkunas. "Customer Satisfaction: The Next Frontier." Transportation Research Record, No. 1395, TRB, National Research Council, Washington, D.C., 1993.

This article mostly describes the theory and practice of customer satisfaction in the private sector, and alludes to the need for transit agencies to monitor the satisfaction of their customers in order to maintain their customer base. The article points out that marketing to attract new customers can be expensive, and if existing customers do not remain loyal to the product or service, any gains of new customers will be offset by the disappearance of existing customers. Such a phenomenon is often not noticeable from indicators that remain positive such as revenues or transfers.

On the other hand, complaints should not be seen only as a negative reflection of the product or service, but rather as indicators of areas for improvement. Research indicates that many complaints go unarticulated, and often these unarticulated complaints are the easiest to resolve. With little effort, it is possible to remedy the situation and encourage repeat patronage. The author outlines the agenda for transportation agencies for the 1990's that includes:

- the design of transportation service should be based on market research rather than models or professional judgment;
- service standards such as headways, loading standards and cleanliness should be based on customer demands and view points rather than on industry standards which often fail to relate to a customer's direct experience and lexicon;
- customers should be treated as such, rather than impersonalized into fares or total number of passengers; and
- customer satisfaction should be qualitatively defined, measured and monitored regularly (quarterly, monthly) and at the most basic (route and trip) levels.

Metropolitan Transportation Authority, Office of the Inspector General. An Examination of Selected New York City Transit Authority Performance Indicators for the Division of Rapid Transit. October 1986.

An example of a research effort aimed at evaluating transit performance measures from a customer's perspective is offered by a series of reports and research papers developed by the Office of the Inspector General (OIG) of the Metropolitan Transportation Authority in New York City. The original OIG report addressed the extent to which seven performance measures collected by the operating transit agencies reflected subway riders' experience with the service offered. These measures included:

- terminal on-time performance;
- mean distance between failures;
- terminal and en route abandonments;
- train and car availability; and
- "thruput" defined as the number of trains passing though a station.

In evaluating the appropriateness of these measures, the OIG tested the accuracy and consistency of the various measures by comparing them with data collected independently. As a result of this review, the OIG outlined the features of a passenger oriented model of subway performance that adopted a customer perspective to service evaluation.[1]

A random sampling methodology was used to construct a computerized database of about 50,000 morning rush hour subway trains. The system focuses on actual, not scheduled service and measures aspects of service most meaningful to riders, in terms they can relate to, and on a scale experienced by passengers. Measuring performance according to this principle affects every aspect of research design and analysis, including the selection of measurements points, the definition of a trap and a route, the time periods used, the scale of analysis (system, route, or more detailed) and the statistics to be reported. The basic concept also entails a reconsideration of the way train cancellations, bypasses, service adjustments, extra service, and headway irregularities are treated in measuring on-time performance.

The OIG also examined alternative ways of expressing service reliability.[2] Two indices were developed to measure the regularity of high-frequency transit service and were evaluated using actual data coming from observations of 15 NYCTA bus routes. The headway regularity index measures the deviation from the ideal distribution of headways and ranges from zero, which corresponds to irregular service with bunching of service to one, which corresponds to perfectly regular service.

The passenger wait index measures transit service from the passengers' point of view and is expressed as the ratio of the actual average wait time to the minimum average wait time under perfectly regular service. As the actual wait time for a transit vehicle exceeds the expected wait time, each additional minute increases dissatisfaction with service disproportionately.

The authors argue that both indices have an advantage over traditional measures of transit service because they control for the mean headway allowing comparisons among routes with different headways. One disadvantage of these measures is that they are specifically designed for frequent transit service and do not reflect service characteristics of infrequent transit service where passengers know the schedule and show up in-time to meet that schedule.

Other reports prepared by the OIG adopt a statistical analysis approach in relating on-time performance to factors such as the crowding index, the mean distance between failures, trip length, and headway[3]; examine differences in waiting times, travel times, on-time performance and cancellations by time of day[4]; and relate a measure of subway rider wait time to the overcrowding observed during peak periods while introducing a measure of total on-time reliability.[5]

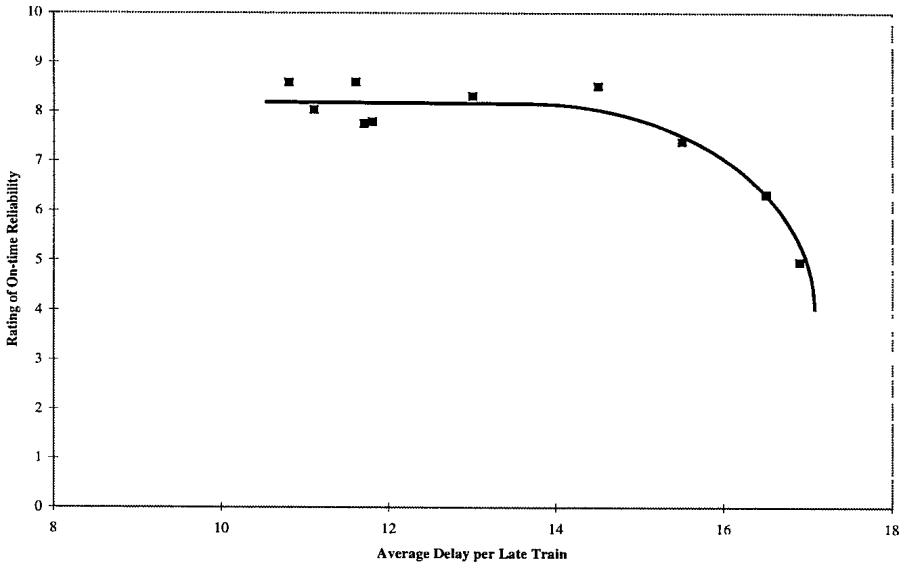
K.E. Proussaloglou and F.S. Koppelman. "Use of Travelers' Attitudes in Rail Service Design." Transportation Research Record, No. 1221, TRB, National Research Council, Washington, D.C., 1989.

This study presents an attempt to develop relationships between service performance measures and riders' perceptions of service. The motivation for such research efforts has been to develop a means of "translating" transit operating concepts into constructs such as ratings of service, with which transit riders can associate more easily. The linkage between measures of performance and travelers' perceptions provides a means for relating the impact of service improvements to changes in riders' perceptions and ultimately their satisfaction with the transit service provided.

The service performance data for Chicago's Metra commuter rail system were compared against commuter rail riders' ratings of rail service along a number of service dimensions. The difference in service performance across the ten commuter rail lines[6] was illustrated in differences in commuter rail riders' ratings of service supporting the correspondence between riders' perceptions and rail service.

Figure G.3 of this appendix provides an example of a strong non-linear relationship between service and commuter riders' perceptions. Although comparisons between the percentage of trains arriving late and riders' on-time reliability ratings did not result in a close relationship, accounting for both the occurrence and severity of delays resulted in a unique performance measure of average delay per train late that properly reflected riders' perceptions.

Figure G.3
Relationship Between Riders' Perceptions and Transit Performance



Charles River Associates. Comprehensive Line Improvement Study. Final Report prepared for the Metropolitan Transportation Authority, Boston, March 1994.

Prior to the implementation of service improvements and a marketing campaign to promote ridership on NYCTA's "A Line" subway, the authority set out to determine what effect these changes would have on riders' perceptions of the service. A passenger survey was used to measure customer perceptions of the service offered on the "A line" and two other subway lines before and after the implementation of service improvements on the "A line". The objectives of the study were to:

- evaluate whether subway service improvements have a positive effect on travelers' perceptions,
- identify links between service measures collected by the transit authority and customer perceptions of the service, and
- quantify the relative importance of and assess the potential ridership impacts of various subway service improvements.

The study examined three types of measures and how riders' ratings of service correspond to these measures including measures of subway level of service, measures of overall subway service and personal security, and measures of subway quality of service. The study established a strong correspondence between improvements in measures of operating reliability (levels of service) that the NYCTA collects and riders' perceptions of such improvements. The measures that NYCTA collects include terminal on-time performance, en route on-time performance, "thruput", variation of scheduled headway, and mean distance between failures.

The items riders were asked to rate included "time lost due to delays", "trains coming as expected", and "trains running on schedule". The line-by-line before and after comparisons conducted for the "A" Showcase subway line study identified a fairly strong correspondence between measures of subway performance and riders' ratings. In particular, terminal on-time performance was strongly related to riders' rating of "time lost due to delays" reflecting the time lost on average during a transit trip. Similarly, three other performance measures including the en route on-time performance, the "thruput" measure, and mean distance between failures correlated very strongly with riders' ratings of "trains come as expected" and "trains running on schedule" reflecting riders' satisfaction with the implemented service improvements.

The study confirmed a qualitative link between riders' ratings of overall subway service and improvements made as a part of the "A" line project reflecting in part the corresponding marketing and information campaign. Riders' higher ratings of personal security reflected a slight increase in police presence, a drop in the misuse of emergency brakes, and improvements in service reliability.

With regard to quality of service, the study did not establish a strong correspondence between riders' ratings of quality of service characteristics (such as car and station cleanliness, station lighting, and graffiti) and the NYCTA's reports that track the condition of subway cars and stations. To that end, the study recommends changes in the definition of the quality of service attributes and the data collection and measurement techniques would significantly further improve the usefulness of these data.

Tri-County Metropolitan Transportation District of Oregon. Customer Satisfaction Index for the Mass Transit Industry. IDEA Program Final Report prepared for the Transportation Research Board, National Research Council, August 1995.

This project applied to the transit industry the Customer Satisfaction Index, which is used in private industry to identify opportunities that management should pursue to improve customer satisfaction and increase sales. To develop such an index, respondents rate a given product on a number of attributes associated with the product. A regression analysis is performed to determine which factors are most closely associated with overall customer satisfaction. The following five transit agencies participated in a test application of the satisfaction index to the transit industry:

- Metro Regional Transit Authority in Akron, Ohio (MRTA);
- Regional Transportation Authority through the Chicago Transit Authority (CTA);
- Metropolitan Council Transit Operations in Minneapolis, Minnesota (MCTO);
- Southeastern Pennsylvania Transportation Authority in Philadelphia (SEPTA); and
- Tri-County Metropolitan Transportation District of Oregon in Portland (TRI-MET).

A telephone survey, using the same questionnaire for all cities and all modes, was conducted among 900 transit users. The questionnaire covered the following areas: overall customer satisfaction with the transit experience, measurement of the transit districts' performance on 35-40 transit attributes, likelihood of using transit again, reasons for using transit, and respondents' demographics.

The study results indicate that customer satisfaction with mass transit is generally good. However, as satisfaction levels decline among transit riders, there is a significant reduction in customer loyalty in terms of using transit again or recommending transit to someone else. Therefore, to improve transit's image and increase ridership among current and potential customers, emphasis should be placed on improving those attributes that distinguish "Somewhat Satisfied" respondents from "Very Satisfied" respondents. The improvement opportunity areas offering the greatest return on investment (the "high leverage" opportunities) are those associated with:

- driver courtesy,
- frequency of service,
- safety (security), and
- cleanliness of vehicles, train stations, and bus stops.

The study also found that cleanliness is closely associated with a perception of personal safety on transit vehicles and at transit stops.

The analysis methodology was used to generate index scores for bus and light rail transportation. The index scores indicate how far above or below the average an agency is rated. The distinction for "how well" the transit authorities scored relative to the others is the value of the index comparison. However, it should be noted that only five transit authorities made up the total sample for comparison in this study. The total sample average was set at 100. Table G.4 indicates how the individual transit authorities scored relative to the average and each other.

Table G.4
Bus and Light Rail Index Scores

Transit Authority	Bus Index Score	Light Rail Index Score
MRTA	111	n/a
MCTO	110	n/a
TRI-MET	106	118
SEPTA	91	82
CTA	82	n/a

For these index scores to be more meaningful, data from a wider representation of transit authorities will be necessary. To increase the predictive power of the model generated in this study, additional studies may be necessary using larger sample sizes (minimum 200 interviews per mode, per city) and include expanded attitudinal measures, demographics, and comparisons of modal differences within cities. Open-ended questions could also be added to probe for reasons for riding transit and recommending (or not recommending) transit to other people. Respondents could also be asked what specific improvements they would like to see the transit authority in their area implement.

6. Summary and Next Steps

In this chapter we have conducted a review of the measures used by transit agencies and a review of the literature on transit performance measurement. We have adopted a transit agency perspective to better understand the needs of a transit agency and the kinds of information that can be utilized to help improve the evaluation and enhanced design of transit service.

As part of our review, we have summarized the range of service performance measures that a transit agency uses to monitor how well it is meeting the goal of delivering scheduled service. In addition, Table G.5 includes a detailed list of the performance measures that have been reviewed and are routinely collected by transit agencies. We have grouped these individual performance measures under broadly defined categories that include:

- transit performance and on-time reliability along with breakdowns in transit service and vehicle availability;
- condition of vehicles and facilities;
- passenger safety;
- number and types of accidents and incidents;
- passenger complaints; and
- passenger/agency communications.

Furthermore, we have also discussed the attitudinal studies and customer satisfaction surveys that different transit agencies carry out in an effort to monitor and better understand their riders' needs and wants along with their concerns and evaluation of the service being offered. As part of our review we have also identified previous attempts by transit agencies to identify and collect performance measures that properly reflect transit passengers' experience of service.

Table G.5
List of Measures Collected by Transit Agencies

	Agency	Mode	Frequency
On-Time Reliability			
On-time performance (1 min early to 5 min. late)	Baltimore	bus	
On-time performance (1 min. early to 5 min. late)	Baltimore	rail	
On-time performance (within 5 min. of schedule)	BART	rail	Monthly
Rush rating (Central supervisors' ratings on scale of 1-4)	BART	rail	Monthly
On-time performance (0-5 min. after scheduled, 0 min. early)	Cleveland		Quarterly
On-time performance (0-3 min. from schedule)	Dayton	bus	Yearly
On-time rates, missed and late trips	Logan Transit	bus	Monthly
On-time pullouts	Los Angeles	bus & LR	
On-time performance for in-, outbound trips	Memphis	bus	Monthly
On-time performance	Miami Metro	bus	Quarterly
On-time performance	Miami Metro	rail	Quarterly
Percent on-time performance	Muskegon	bus	Quarterly
Percent non-peak period trips on-time	Pittsburgh	bus	Yearly
Percent non-peak period trips on-time	Pittsburgh	light rail	Yearly
Percent peak period trips on-time	Pittsburgh	bus	Yearly
Percent peak period trips on-time	Pittsburgh	light rail	Yearly
On-time service	Portland	bus & LR	Yearly
On-time performance - need to call for detail	SEPTA	light rail	Yearly
On-time performance	SEPTA	subway	Yearly
On-time performance	SEPTA	suburban	Yearly
On-time performance	SEPTA	railroad	Yearly
On-time performance (1 min. early to 5 min. late)	SMART-Detroit	bus	Monthly
On-time performance (0 min. early to 5 min. late)	St. Louis	bus	Quarterly
On-time performance (0 min. early to 5 min. late)	St. Louis	light rail	Quarterly
Headway adherence	Toronto		
Reliability	Toronto		
Minutes of delay by cause	BART		Monthly
Vehicle delays	Toronto		
Terminal on-time performance (% of trains arriving within 5 minutes)	NYCTA	subway	
En-route on-time performance (% of trains arriving within 5 minutes)	NYCTA	subway	
Throughput	NYCTA	subway	
Accidents and Incidents			
Passenger accidents	Cleveland		Quarterly
Vehicle accidents	Cleveland		Quarterly
Preventable accidents	Logan Transit	bus	Monthly
Accident rates	Los Angeles	bus & LR	
Miscellaneous incidents	Memphis	bus	Monthly
Passenger accidents	Memphis	bus	Monthly
Preventable accidents	Memphis	bus	Monthly
Traffic accidents	Memphis	bus	Monthly
Number of bus accidents	Miami Metro	bus	Quarterly
Number of rail accidents	Miami Metro	rail	Quarterly
Number of preventable bus accidents	Miami Metro	bus	Quarterly
Number of preventable rail accidents	Miami Metro	rail	Quarterly
Employee accidents per 100,000 miles	Pittsburgh	bus & LR	Yearly
Passenger accidents per 100,000 miles	Pittsburgh	bus & LR	Yearly
Number of accidents	Portland	bus	Monthly
Number of accidents	Portland	light rail	Monthly

Table G.5
List of Measures Collected by Transit Agencies, *continued*

	Agency	Mode	Frequency
Accidents and Incidents, *continued*			
Employee accidents (Goal: < 1.9 per 100,000 vehicle miles)	SEPTA		Yearly
Passenger accidents (Goal: < 1.8 per 100,000 vehicle miles)	SEPTA		Yearly
Accidents: preventable and non-preventable	SMART-Detroit	bus	Monthly
Miles per accident	SMART-Detroit	bus	Monthly
Miles per accident (passenger or vehicle) that causes delays	St. Louis	bus	
Miles per accident (passenger or vehicle) that causes delays	St. Louis	rail	
Number of accidents	Toronto		
Accidents per 100,000 miles	Winston-Salem	bus	
Preventable accidents per 100,000 hours	Winston-Salem	bus	
Preventable accidents per 100,000 miles	Winston-Salem	bus	
Preventable accidents per 100,000 passengers	Winston-Salem	bus	
Passenger Complaints			
Number of complaints	Albuquerque	bus	
Complaints against operators	Cleveland		Quarterly
Customer complaints per 1 million passengers	Cleveland		Quarterly
Customer complaints per 100,000 vehicle service miles	Cleveland		Quarterly
Number of complaints about facilities	Cleveland		Quarterly
Complaints (by type)	Jefferson Transit	bus	Monthly
Number of complaints	Los Angeles	bus & LR	
Number of complaints about bus service	Miami Metro	bus	Quarterly
Number of complaints about rail service	Miami Metro	rail	Quarterly
Complaints per 1,000 miles	Muskegon	bus	Quarterly
Complaints per 100,000 passengers	Pittsburgh	bus & LR	Yearly
Complaints per 100,000 riders	Pittsburgh		Monthly
Complaints - how quickly they are resolved	Portland	bus	Monthly
Complaints - how quickly they are resolved	Portland	light rail	Monthly
Complaints (Goal: 5 per 100,000 passenger trips)	SEPTA		Yearly
Number of complaints (total and per passenger)	SMART-Detroit	bus	Monthly
Number of complaints	Toronto		
Number of complaints	Winston-Salem	bus	Monthly
Complaints chargeable	Winston-Salem	bus	Monthly
Passenger/Agency Communications			
Percent of public information calls answered within 90 seconds	Pittsburgh	bus & LR	Yearly
Public information calls (Goal: response to 90% of calls)	SEPTA		Yearly
Communication	Toronto		
Number of commendations	Cleveland		Quarterly
Commendations	Jefferson Transit	bus	Monthly
Customer contacts/calls	Jefferson Transit	bus	Monthly
Service requests	Jefferson Transit	bus	Monthly
Phone operator availability	Portland	bus & LR	Yearly
Route information availability	Portland	bus & LR	Yearly
Interpersonal	Toronto		
Breakdowns in Transit Service			
Mean time between vehicle-related system delays	BART	rail	Monthly
Miles between road calls	Cleveland		Quarterly
Miles between service interruptions	Cleveland		Quarterly
Number of road calls required	Jefferson Transit	bus	Monthly
Miles between road calls	Los Angeles	bus & LR	
Average bus miles per chargeable road call	Memphis	bus	Monthly

Table G.5
List of Measures Collected by Transit Agencies, *continued*

	Agency	Mode	Frequency
Breakdowns in Transit Service, *continued*			
Number of mechanical road calls	Miami Metro	bus	Quarterly
Number of mechanical road calls	Miami Metro	rail	Quarterly
Mean distance between road failures	Pittsburgh	bus & LR	Yearly
Number of road failures per month	Pittsburgh	bus	Monthly
Number of road failures per month	Pittsburgh	light rail	Monthly
Miles between road calls	Portland	bus	Monthly
Miles between road calls	Portland	light rail	Monthly
Mean distance between failures (Goal: 25,000)	SEPTA	light rail	Yearly
Mean distance between failures (Goal: 90,000)	SEPTA	subway	Yearly
Mean distance between failures (Goal: 20,000)	SEPTA	suburban	Yearly
Mean distance between failures (Goal: 55,000)	SEPTA	railroad	Yearly
Mean distance between failures (Goal: 4,700)	SEPTA	surface bus	Yearly
Number of road calls	SMART-Detroit	bus	Monthly
Mean miles between defects	Toronto		
Percent of scheduled trips missed	Portland	bus	Monthly
Percent of scheduled trips missed	Portland	light rail	Monthly
Scheduled dispatches completed	BART		Monthly
Transbay Throughput	BART		Monthly
Terminal abandonments	NYCTA	subway	
Mean distance between failures	NYCTA	subway	
En route abandonments	NYCTA	subway	
Vehicle Availability			
Car availability	BART	rail	Monthly
Time out of service for vehicles	Memphis	bus	Monthly
Daily out of service fixed route	Winston-Salem	bus	
Scheduled service requirements (goal of 98% of scheduled service)	SEPTA		
Train availability	NYCTA	subway	
Passenger Safety			
Safety	BART	rail	Monthly
Passenger and employee injuries	Logan Transit	bus	Monthly
Operational safety	Portland	bus & LR	Yearly
Personal safety while waiting for transit vehicle	Portland	bus & LR	Yearly
Security	Toronto		
Incidence of rules violations	NYCTA	subway	
Condition of Facilities and Vehicles			
Graffiti-free buses and light rail vehicles	Los Angeles	bus & LR	
Condition of shelters	Portland	bus & LR	Yearly
Cleanliness	Toronto		
Passenger environment survey: station and car cleanliness, condition of repair of stations and cars, and information available to passengers	NYCTA	subway	
Station cleanliness report	NYCTA	subway	
Car cleanliness report	NYCTA	subway	Quarterly
Other Measures			
Employee absenteeism	Miami Metro	bus	Quarterly
Employee absenteeism	Miami Metro	rail	Quarterly
Farebox recovery ratio	Miami Metro	bus	Quarterly
Farebox recovery ratio	Miami Metro	rail	Quarterly
Farebox recovery ratio	Muskegon	bus	Quarterly
Farebox recovery	St. Louis	bus	Quarterly

Table G.5
List of Measures Collected by Transit Agencies, *continued*

	Agency	Mode	Frequency
Other Measures, *continued*			
Farebox recovery	St. Louis	rail	Quarterly
Maintenance costs	Los Angeles	bus & LR	
Riders using bike racks on buses	Albuquerque	bus	
Average speed	Chicago-CTA	bus, rail	
Frequency of service	Chicago-CTA	bus, rail	
Geographic coverage area	Chicago-CTA	bus, rail	
Hours of service (span of service)	Chicago-CTA	bus, rail	
Ratio of employees achieving (ER/MR) rating on performance	Cleveland		Quarterly
Ratio of employees in training to employees eligible	Cleveland		Quarterly
Ratio of implemented process improvements	Cleveland		Quarterly
Ratio of quality improvement team members to workforce	Cleveland		Quarterly
Bicycles on transit vehicles	Jefferson Transit	bus	Monthly
Competence	Toronto		
Convenience	Toronto		
Passenger surveys (e.g. driver courtesy)	Dayton	bus	2-3 years
Attitudes, awareness, satisfaction survey	Portland	bus & LR	Yearly
Driver courtesy	Portland	bus & LR	Yearly
Money back guarantee tracking	SMART-Detroit	bus	Monthly

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation