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

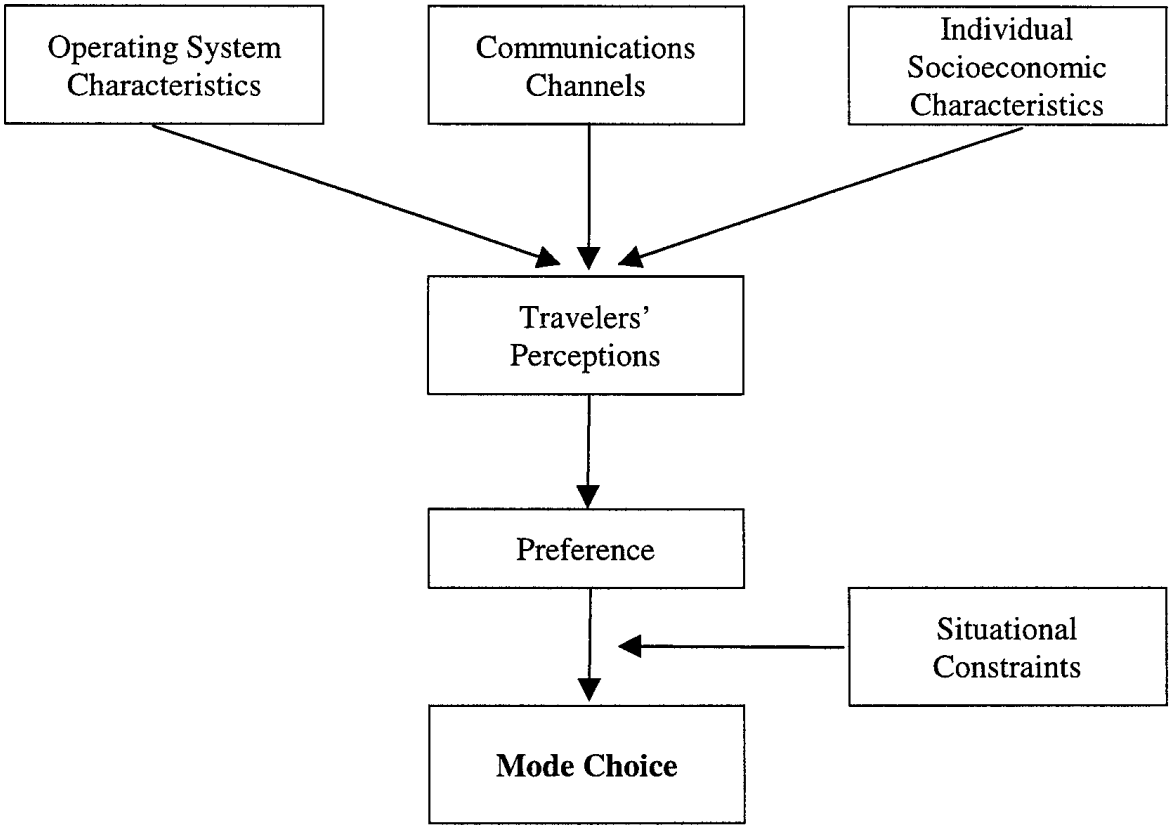
The objective of this literature review is to review and discuss the various transit performance indicators that are most commonly used by transit agencies as a means to monitor, as accurately as possible, the level of transit service offered. We present the measurement of transit performance by:

- 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]

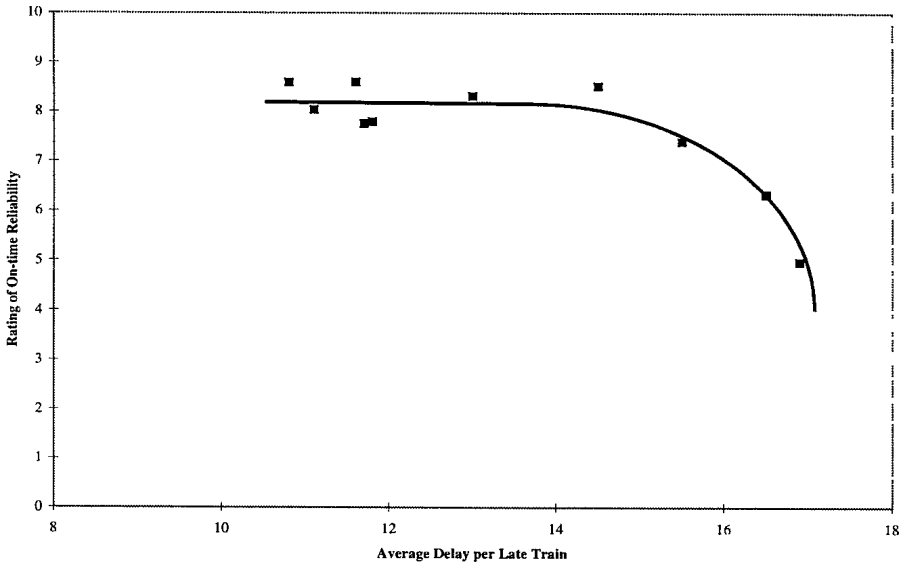
K.E. Proussaloglou and F.S. Koppelman. "Use of Travelers' Attitudes in Rail Service Design." Transportation Research Record, No. 1221, TRB, National Research Council, Washington, D.C., 1989.

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

ENDNOTES

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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