train run is used to support the manual analysis of train delay events and to identify the likely cause of major passenger delays. The report breaks down delay time into an en-route component and a waiting-time (at platform) component. Results so far show that the waiting-time component of delay is generally larger than the en-route component.

Although this discussion has been largely oriented to measurement of the current state of an existing system, the passenger-based aggregate measure can be applied to future systems or to future configurations of existing systems. The real train actions can be replaced by simulated disturbed train actions produced by a train system simulator. The real passenger counts can be replaced by forecast passenger counts. Program 2.3 would be replaced by time-forward matching of trains and passengers.

CONCLUSIONS

With increasing automation in transit operations, the amount of operating data generated will increase. Automated OD ticketing and automated recording of vehicle movement make possible accurate passenger-based performance measurement. The PFM software could be configured to serve any guideway transit system that has data on all train movements and all patron exits by origin. Even automated zone-based or flat-fare ticketing systems, which record entries but not exits, can provide data to supplement manual counts and sampling.

Further research is needed to better understand the relationship between primary vehicle delays, secondary vehicle delays, and passenger delays. When these links are understood, it will be possible to allocate maintenance resources where they will best benefit the passenger. More research is also needed to investigate passenger expectations regarding wait time and timetable adherence and passenger annoyance due to delays of differing lengths.

ACKNOWLEDGMENT

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Monitoring the Quality of Service from the Passengers' Perspective

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ABSTRACT

Management's concern with customer satisfaction and the common methods of gauging patrons' assessment of service are discussed. A method of performing surveys of trains and stations based on sampling techniques is then described. Performed on a periodic basis, the studies have an audit-type quality that helps alert management to potential problems and areas needing further investigation. The results of the studies are reviewed, and sample tables and graphs are presented. As a result of the data generated by the surveys, changes in train schedules were developed and further studies of the vehicle-cleaning process initiated. The increased reliability of the system is shown dramatically in a graph of published travel time variance.

Customer satisfaction is an important concern to managers in any organization but especially to those in a service industry such as public transportation. Being publicly owned, such transportation agencies find themselves subject to even closer scrutiny than private companies. For these and other reasons, senior managers of rapid transit agencies are

anxious to have a tool for assessing the quality of service provided by their agencies. In this way they can be alerted to areas requiring management's attention and to trends that may need further investigation.

Two common methods of gauging patrons' assessment of service are

1. To summarize the number and types of letters and telephone calls received by the general manager and public affairs office or
2. To perform a passenger survey on a periodic basis.

The difficulties with these methods are that they incorporate a great deal of subjective judgment and varied interpretation and that they usually emphasize the negative exceptions in service.

In 1978 management of the Bay Area Rapid Transit (BART) decided that they wanted an assessment mechanism that would provide more uniform objective data, data that could not be obtained by a passenger survey. The result of this perceived need was the Passenger Services Sampling (PSS) Study conducted by Management Services at BART. The purpose of the PSS Study is to provide management with a perspective of the BART system as seen from the patrons' point of view. In a sense, the study gives management a periodic snapshot of the service provided by the BART system.

DESIGN AND DEVELOPMENT

The first step was to determine the variables or items to be used to evaluate service. A preliminary analysis was undertaken to define the passenger services that should be measured. As part of this analysis, the Management Trip Report that had previously been used and the Passenger Services Monthly Patron Complaint Report were reviewed. These reports provided a good first information source for compiling a listing of passenger service parameters that should be measured. These parameters were further refined in meetings with Marketing and Field Services managers until both departments were satisfied with the data that were to be collected. The items included in the study are listed as follows:

1. Station information
   a. Agent in or out of station agent booth
   b. Agent in uniform
   c. Supervisor present
   d. BART police present
   e. Brochures available
   f. Equipment operable (fare gates, ticket machines, elevators, escalators, etc.)
   g. Cleanliness (station, restroom, and elevator)
   h. Announcements heard over P.A. system
   i. Number of rule violations committed by patrons
2. Boarding information
   a. Waiting time
   b. Destination signs working
   c. Train exterior cleanliness
   d. Train operator watching doors
3. Trip information
   a. Trip time
   b. Car interior cleanliness
   c. Car loading
   d. BART police on car
   e. Rule violations committed by patrons
   f. Announcements heard on car

It was determined that the best way to collect the information required would be to employ a group of individuals full time for a given period of time and have them collect data using statistical work-sampling techniques. The study was designed so that it could be conducted by six temporary employees over a two-week period on two shifts. The only special qualification required of the samplers was the ability to learn quickly and follow fairly detailed instructions. One-half day of training was sufficient to prepare the samplers for regular data collection.

At first the data were gathered on forms designed for manual analysis. Naturally, the analysis of the data and preparation of tables and graphs were extremely time consuming when done manually. Over the years, the data collection form has been changed to a format suitable for direct keypunching of the data (see Figure 1) and a program written to analyze and compile the data. Recently, the computer capability to produce graphs has also been utilized.

The samplers surveyed both stations and trains. In the stations the samplers performed either an abbreviated check or a full check. The abbreviated station check included only a determination of station cleanliness based on standards provided by BART (see Figure 2) and a tallying of passenger rule violations occurring in the station. The full station check included the abbreviated check data and the following information:

1. Elevator call response time,
2. Elevator cleanliness,
3. Agent availability,
4. Presence of officers from BART Police Department (BPD),
5. Brochure availability,
6. Restroom cleanliness, and
7. Other miscellaneous data.

Of the 1,146 station checks made, 575 were full-station checks.

In sampling the trains, the temporary employees noted train arrival time, train destination sign (TDS) operation, vehicle cleanliness (both exterior and interior), announcements, and other information similar to the station sampling data. The samplers traveled back and forth on each section of the system in a leapfrog fashion. They followed the routine shown on the sampling forms. A trip can vary from one station to five stations. The samplers began their trips on the lead car and moved back one car at each station. When the samplers reached the scheduled destination station, they got off and performed the indicated station check, either abbreviated or full. They then rode the next train to their next scheduled destination station. A total of 4,130 station-to-station rides were made.

The samplers also maintained various logs as required, for example, inoperative public address speakers on the vehicles, unsafe or unusual occurrences, and off loads or delays.

RESULTS

The final report on the study includes more than 50 graphs and tables, but four examples will give the overall picture. The observations are summarized in two distinct categories--train sampling and station sampling. Because the charts are similar, only some examples from the train-sampling category will be considered.

In looking at weekday service conditions for the total system (see Figure 3), it can be seen that arrival (T.O.) announcements made by the train operators have increased over the last 4 or 5 years.

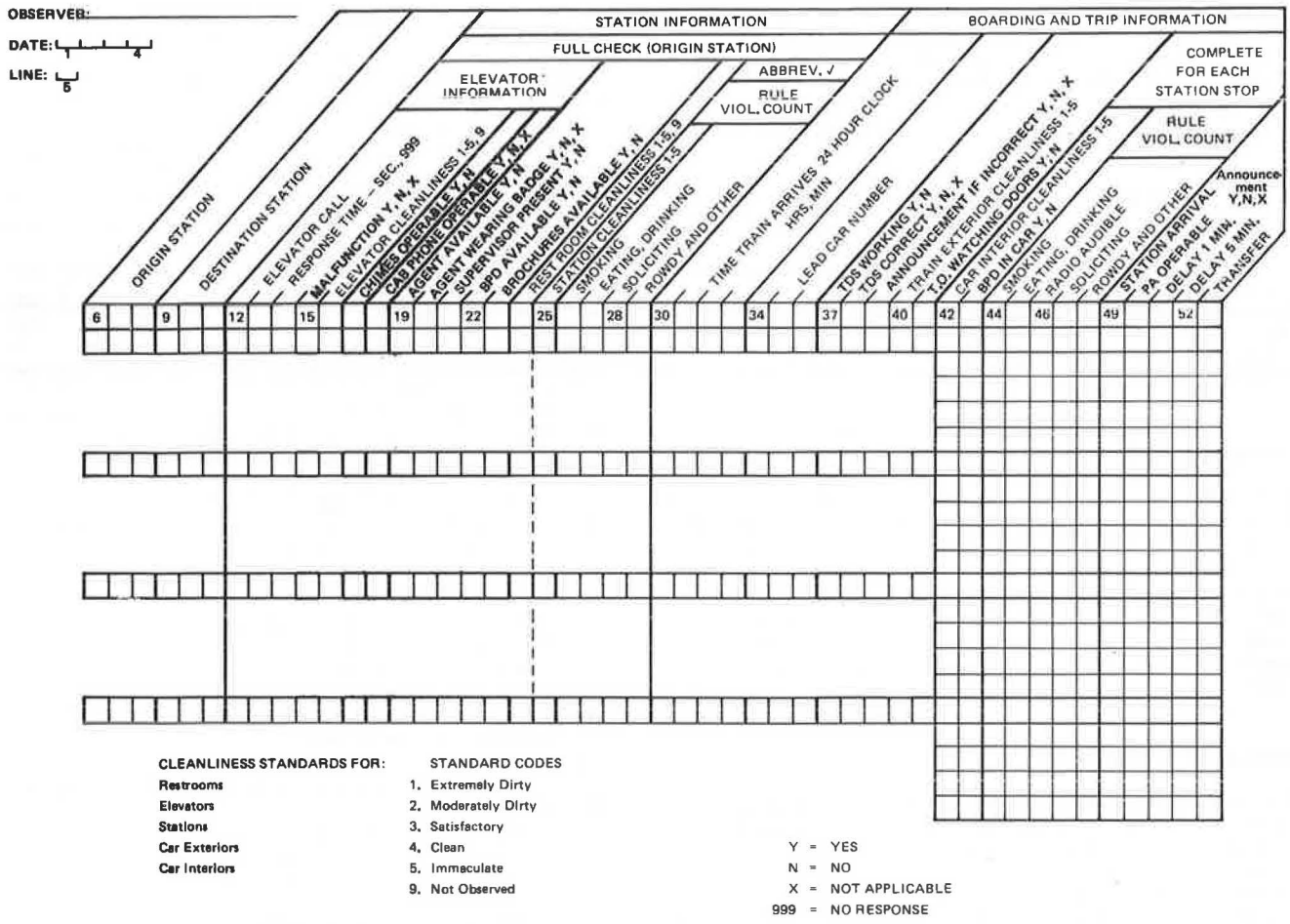

FIGURE 1 Passenger services sampling evaluation form.

The train operators were making arrival announcements 89 percent of the time in 1978 and 94 percent of the time in 1982. Transfer announcements, on the other hand, have dropped from 51 percent in 1978 to 45 percent in 1982. The exterior cleanliness of the trains has fluctuated over the years, decreasing overall. The interior cleanliness of the trains has declined each year. A study was done of the car cleaners last year by one of the other management engineers. Also, the exterior cleaning of the cars is being carefully monitored by the operations staff.

The dramatic decrease in smoking violations on trains between December 1978 and April 1980 can be attributed to two important events:

1. The transbay tube fire in January 1979 and
2. The passage by the state legislature of a $50 fine for smoking in the BART system.

The graph of the published travel time variance in Figure 4 shows the percent variance of actual travel times from published travel times. An obser-

5. IMMACULATE:	Clean station entrances, concourse level, and platform level. No apparent litter, cigarette butts, or overflowing trash cans.
4. CLEAN:	Light littering, cigarette butts, candy wrappers, etc., on floor. Clean otherwise.
3. SATISFACTORY:	Light littering as for a Number 4 rating, discarded newspapers apparent. Spill stains on floors, lightly-soiled ceilings or walls.
2. MODERATELY DIRTY:	Generally dirty appearance. Overflowing trash cans, littering as in Number 3, but more widespread. Spills, dirt and new staining apparent on floors.
1. EXTREMELY DIRTY:	Very dirty station. Trash and spills per Number 2. However, more garbage cans are overflowing, numerous spills, strewn garbage.

FIGURE 2 Station cleanliness standards.

	MAY 82	APR 80	MAR 78
T. O. ANNOUNCEMENTS			
ARRIVAL, % TIME MADE	94	91	89
TRANSFER, % TIME MADE	45	43	51
TRAIN PERFORMANCE			
EXTERIOR CLEANLINESS	2.8	3.6	3.0
INTERIOR CLEANLINESS	3.1	3.2	3.5
PATRON ORDINANCE VIOLATIONS PER CAR	.03	.07	.12
- SMOKING PER CAR	.001	.002	.010*

*DEC 78 DATA

FIGURE 3 Train sampling: weekday service.

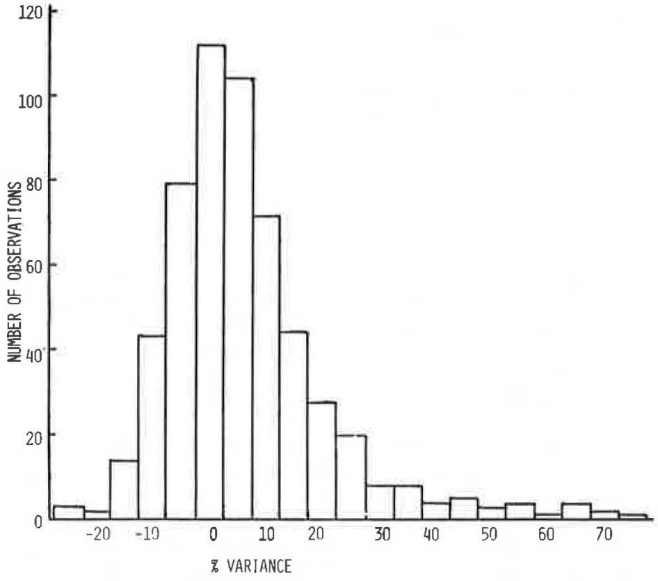

FIGURE 4 Train sampling: published travel time variance (Lines A, C, M, R; weekdays).

vation of 20 percent variance means that the trip listed as 10 min actually took 12 min or that it was listed as 60 min and actually took 72 min. This lack of differentiation between these two instances, which have different passenger impacts, led to the development of a separate set of graphs showing actual minutes of deviation from published travel times.

The summary graph of performance curves for published travel time (Figure 5) provides a clear picture of how service has improved at BART. In 1979 the patron faced a less than 10 percent probability that the actual travel time would not exceed the published travel time. In 1982 the probability was almost 90 percent that the actual travel time would not be more than the published travel time.

An important consideration for patrons, however, is getting a seat once on the train. Figure 6 shows the average car loading for weekdays on the C Line to Concord. A loading factor of 3 means that all seats are full; 5 represents a crush load with the car at or near maximum loading. As can be seen, in 1980 the homebound trains on the C Line (track 1) were very crowded between 3:00 and 5:00 p.m. Fortunately, conditions have improved since that time.

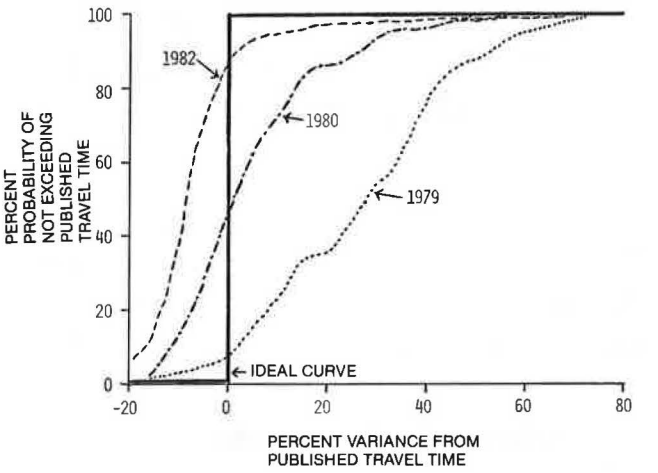

FIGURE 5 Published travel time performance curves.

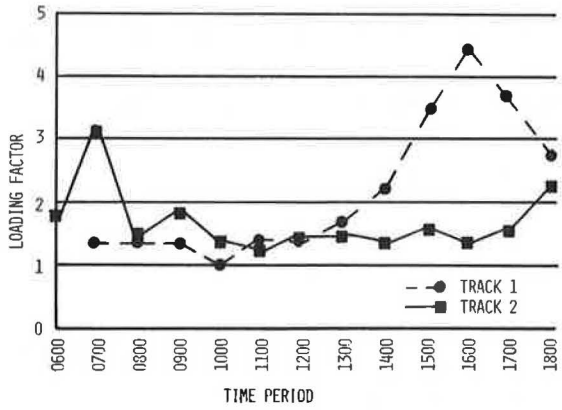

FIGURE 6 Average car loading for weekdays on C Line (1980 data).

These same types of graphs and tables can also be prepared for weekend service and can be broken down by line and even by station. The comparison graphs by years help indicate trends in any category.

BART is fortunate in that much of the travel time data and equipment availability data are being captured through other groups at BART in a more timely and accurate method. For that reason, these items were recently dropped from the PSS Study. The elimination of these indices has helped simplify the sampling procedure and has made the final report of the PSS Study a little easier to assimilate.

CONCLUSIONS AND IMPLICATIONS

As has already been indicated, the decline in the cleanliness of the vehicles, both the exterior and the interior, led to further study and analysis. Data on train announcements has also prompted management to investigate and update the procedures for train operators.

After the initial PSS Study, the train schedule was modified to address the loading problem revealed by the study. Also, the vehicle maintenance shops were supplied with a list of vehicles having inoperative public address speakers. The study also brought to light the problem of poor station signing for elevator location.

These PSS studies have given management some useful information on the impression made on patrons by BART's service. Performing the studies on a periodic basis gives the studies an audit type of character that highlights changes in service. As can be seen from the experience at BART, these sampling studies are effective tools for objectively measuring an agency's performance.

ACKNOWLEDGMENTS

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