TRANSPORTATION RESEARCH

RECORD

No. 1338

Public Transit

Public Transit: Bus, Paratransit, and Ridesharing

A peer-reviewed publication of the Transportation Research Board

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C. 1992

Transportation Research Record 1338
Price: $22.00

Subscriber Category
VI public transit

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Printed in the United States of America

Library of Congress Cataloging-in-Publication Data
National Research Council. Transportation Research Board.

Public transit : bus, paratransit, and ridesharing.
p. cm.—(Transportation research record ISSN 0361-1981 ; 1338)
ISBN 0-309-05200-9
1. Bus lines—United States—Management. 2. Paratransit services—United States. 3. Ridesharing—United States. 4. Local transit—United States. I. National Research Council (U.S.). Transportation Research Board. II. Series.
TE7.H5 no. 1338
[HE5623]
388 s—dc20
[388.4'0973] 92-21588
CIP

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Contents

Foreword

This Record contains research papers and reports of studies grouped into three parts: bus operations, paratransit, and ridesharing.

The six papers in Part 1 treat a wide range of issues of concern to transit operators. Jackson and Ibarra describe the Southern California Rapid Transit District program aimed at improving the performance of bus lines experiencing persistently poor service reliability. The results of the study support the conclusion that intensive road supervision, coupled with team-oriented approaches to problem identification and resolution, can have a positive effect on service quality. The next two papers should help planners in their development of transit simulation models. Furth and Navick describe a method for synthesizing route origin-destination matrices when limited data are available. Santhakumar and Hariharan report on a study that evaluated the impact of transportation system management options on the performance of a bus route in a medium-sized city in India.

Rural public transportation is the subject of the fourth and fifth papers in Part 1. In their study to develop a methodology to evaluate relative performance of rural transit service, Carter and Lomax found seven measures that could be used to compare the performance of individual agencies. Botha reports on a study conducted to obtain general information on the type of transit and paratransit service utilized in rural Alaska.

The last paper in Part 1 describes the results of a study to demonstrate the effectiveness of a particulate trap oxidizer installation on a four-cycle engine. Wallis and Luffman report that initial temperature testing found the system components to operate within manufacturers' specifications.

Part 2, on paratransit, deals with issues of the transportation impaired, the market segment most beneficially served by paratransit. Lave et al. describe a survey conducted in Chicago to research travel behavior, attitudes toward modes, effective of disabilities on travel, and demographics of the population. It was found that 4.2 percent of the population aged 12 or more in the Chicago Transit Authority service area "have some difficulty traveling." Kihl offers a strategy appropriate for conveying transportation programs, specifically paratransit programs, to seniors. DeAlba describes the components and development of functional certification methods for severely disabled riders who use Chicago's paratransit services.

The papers in Part 3 describe ridesharing studies, the first three conducted in Southern California, which is in the process of making major transportation changes due in large part to the need to improve air quality. Collier and Christiansen report on the annual Commute Study that tracks regional commuting behavior and attitudes of employees from both small and large firms. Chun and Christiansen report on the study they conducted to explore attitudes and perceptions of Hispanics regarding their awareness of ridersharing opportunities. The concept of offering a guaranteed ride home to encourage ridesharing and transit use is growing in popularity. Park reports on the study conducted at the Warner Center to evaluate the effectiveness of this program. Finally, Thayer reports on the effectiveness of California's statewide ridesharing week promotion. It was found that the pledge card promotion had positive impacts.

PART 1

Bus Operations

Service Reliability Program of the Southern California Rapid Transit District: A Test of the Short-Term Impacts on Line 26-51

ROBERT L. JACKSON AND DANIEL IBARRA

In mid-1989, the Southern California Rapid Transit District (SCRTD) implemented an innovative program designed to improve the performance of bus lines experiencing persistently poor service reliability. The Service Reliability Program (SRP) uses specially assigned road supervisors to intensively supervise problem lines and work closely with line operators and other District personnel to identify and resolve the underlying causes of the problems. A quasi-experimental test that was conducted in spring 1991 to quantify the short-term impacts of the SRP on the performance of Line 26-51 (Avalon Boulevard—7th Street—Virgil Avenue—Franklin Avenue) during the morning peak period. Line 38-71 (West Jefferson Boulevard—City Terrace), which did not receive any SRP treatment, was used as an experimental control to strengthen the pre/post design. The results of this test support the conclusion that intensive road supervision, coupled with team-oriented approaches to problem identification and resolution, can have a positive effect on service quality. Without adding service, and despite a small seasonal increase in ridership, improvements were found for various service reliability indicators on the target line (e.g., the number of bunched buses and pass-ups). The quantitative findings were generally corroborated by qualitative assessments made by both Line 26-51 customers and operators. Comparable service reliability improvements were not found on the control line.

The Southern California Rapid Transit District (SCRTD) began devising and testing innovative approaches to using road supervisors in resolving problems of poor service reliability on its bus lines in late 1988. In mid-1989, a large-scale project known as the Service Reliability Program (SRP) was formally implemented. Under this program, specially assigned mobile road supervisors interact with line operators to identify root causes of problems on a line, test alternative scheduling strategies in the field, and work with scheduling and operations planning personnel to adjust schedules or take other actions, as indicated. Once the underlying problems on a line are documented and corrective actions are either implemented or planned, ongoing supervision is maintained via a multiple-line "corridor-based" service management tactic.

An overview of SCRTD's SRP and the various steps involved in the SRP process is given. A special test that was conducted in spring 1991 to quantify the short-term effects of intensive, team-oriented supervision on service reliability, customer perceptions, and operator assessments is summarized. The test provides a much-needed demonstration of applied research in the area of nonautomated bus service management.

Southern California Rapid Transit District, 425 South Main Street, Los Angeles, Calif. 90013.

SERVICE RELIABILITY PROGRAM

Background

The hypothetical causal model of poor service reliability that provided the conceptual underpinnings for SCRTD's SRP is shown in Figure 1. The model suggests that poor service reliability results from two general classes of factors. The first class consists of "transient shocks," all of the various nonregular, and largely unpredictable, occurrences that temporarily disrupt a line's operation (Path A). Inclement weather, detours, bus breakdowns, and accidents are examples of such transient shocks. The second class consists of "chronic problems," insufficient service levels, improper distribution of running time, and habitual rule infractions by one or more line operators (Path B). The model also implies that chronic problems on a line may lead to such operator-experienced outcomes as frustration, dissatisfaction, and apathy (Path C).

According to the hypothetical model, the causal relationship between transient and chronic antecedents and adverse operational outcomes is not necessarily direct. The overarching relationship may be mediated by various factors. In developing the SRP, "maladaptive responses" made by line operators in response to transient and chronic problems were considered important mediating factors. For example, if an operator opts to leave a time point early because of insufficient running time (perceived or real) and service reliability on the line is compromised, then this would be considered a maladaptive response (Paths D–E and F–E).

Following the logic of the model, it became apparent that if the underlying causes of poor service reliability on certain District lines were to be understood and effectively rectified, then a nontraditional approach to field service management would be required. In order to rectify poor service reliability, a rudimentary SRP was implemented on a single SCRTD line in December 1988. Specifically, four road supervisors (two during the morning and two at night) were assigned to intensively supervise SCRTD Line 16 (West 3rd Street Line). Instead of focusing on policing the line, a deliberate attempt

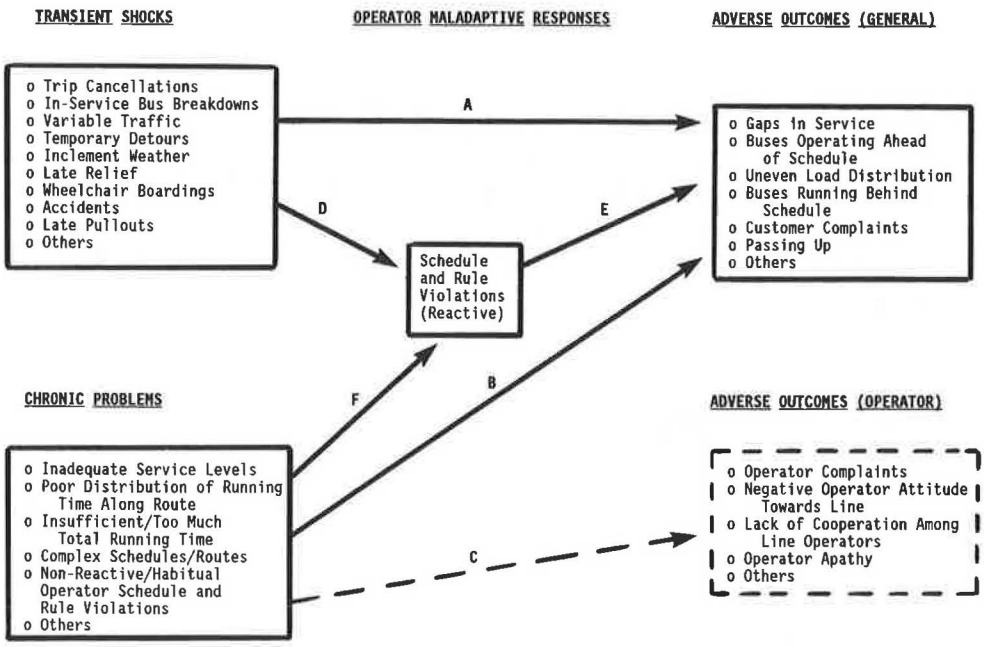

FIGURE 1 Hypothetical causal model of poor service reliability.

was made to work with the operators to identify and resolve any problems that might be contributing to poor service quality.

For example, supervisor interviews with Line 16 operators revealed that a single misplaced time point was causing most of them to run behind schedule leaving the Los Angeles-central business district (CBD). The problem was especially acute during the p.m. peak rush. A minority of operators adapted to this chronic problem by operating ahead of schedule, while the majority of operators adapted by operating late. Once the problematic time point was identified and removed, on-time performance improved from approximately 30 percent to nearly 85 percent during the p.m. peak period. The traditional approach in solving this problem might have been to simply cite those operators who were in violation of schedule rules.

Given the success of the pilot program, the Board of Directors of the SCRTD approved funding for an expanded and more structured SRP beginning July 1989. Since 1989, more than 40 lines have been targeted at various times by the SRP. These lines account for more than 60 percent of the District's total daily ridership. As of September 1991, 22 of SCRTD's 111 full-time road supervisors (20 percent) were assigned to the SRP.

General SRP Process

On the basis of lessons learned from evaluating alternative service management strategies during the past 2 years, a systematic procedure for implementing the SRP on a newly targeted line was adopted. Figure 2 shows the strategic plan known as the "SRP process." The key steps are summarized as follows:

Preimplementation Phase

Step 1: Publicize the Program Previous experience has shown that when the SRP is wel publicized, operators are much more willing to become actively involved. One strategy now used by SCRTD to publicize the program is to hang large SRP banners, posters, or both at the participating divisions.

Step 2: Collect Baseline Data An important feature of the SCRTD's SRP is that attempts are made to systematically evaluate program impacts. Depending on the objectives of the research, several types of evaluation data may be collected, such as point checks, operator opinions, and customer opinions.

Step 3: Conduct a Preimplementation Strategy Meeting Before SRP is implemented on a line, a team meeting between the road supervisors assigned to the line and the scheduling and operations planning personnel is usually held to develop a preliminary implementation strategy.

Implementation Phase

Step 4: Implement Program on Target Line During the first week on a target line, supervisors attempt to interview each operator. The interview is designed to provide operators additional details and objectives of SRP and to solicit comments and specific suggestions concerning problems on the line. A primary goal during the first week is to have operators accept the supervisor as a partner rather than an adversary,

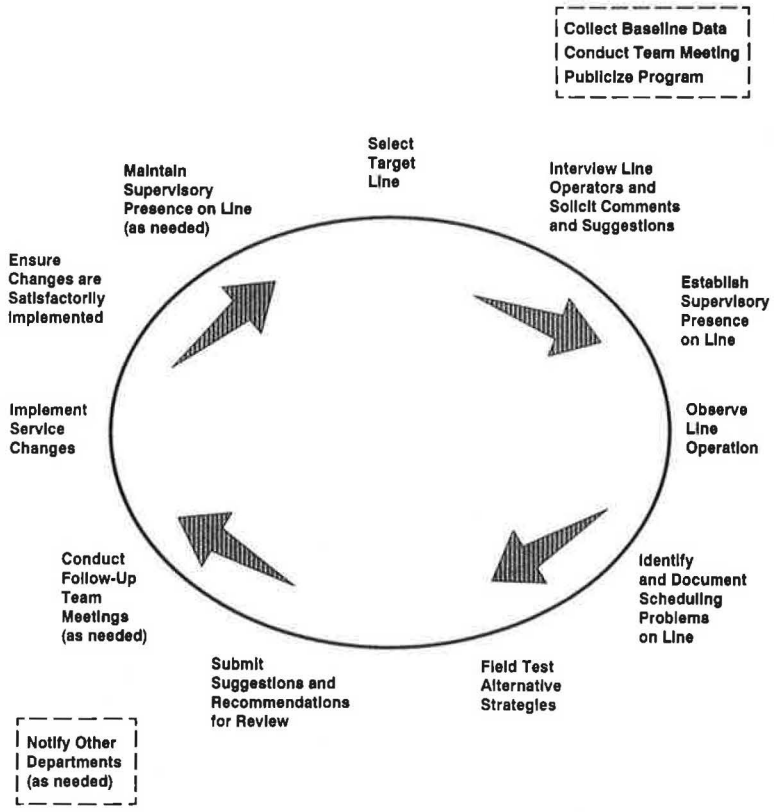

FIGURE 2 General SRP process.

who has a shared interest in resolving problems. Other supervisory activities during the first week include observing the line operation and identifying and correcting possible safety hazards.

Step 5: Devise and Test Strategies to Correct Persistent Problems During the second and subsequent weeks, road supervisors establish a highly visible supervisory presence on the targeted line. Teams of two supervisors (each in a mobile unit) are typically assigned to a line for the period 5:00 a.m. to 9:00 p.m. (two per shift). Once the current schedule is being operated as effectively as possible, road supervisors devise, test, and document alternative strategies to alleviate chronic problems. This unique feature of SRP encourages the road supervisor to both actively manage a line and test new ideas. Specific suggestions and recommendations are then submitted for review by staff in special weekly reports.

Step 6: Hold Follow-Up Team Meetings During the implementation period, follow-up team meetings are held with supervisors, operations control staff, and scheduling/operations planning staff as needed. The purpose of these meetings is to discuss and further refine recommendations made by the road supervisors. The meetings often result in planning or implementation of specific short-term and long-term actions. Changes such as minor running-time adjustments or additional pull-out time allocations are often implemented within 1 to 3 days, and a temporary schedule is issued. Supervisors attempt to keep line operators apprised of the status of pending long-term actions.

Step 7: Monitor Effects of Service Adjustments If schedule, route, or other types of adjustments are implemented, supervisors monitor the line to ensure that changes are working as planned, and the results are reported to scheduling/operations planning staff.

Postimplementation Phase

Step 8: Maintain Ongoing Supervisory Presence on Line Following the period of intensive supervision, SRP road supervisors maintain a long-term presence on the line through corridor-based service management. Under the SRP corridor concept of line management, multiple lines (usually three to five) operating within well-defined bus transit corridors are systematically visited. The goal is to sustain the effect of the initial intensive supervision effort in a cost-effective manner by promoting the perception among operators that a line is being regularly monitored.

The SRP is a nontraditional, team-oriented approach to strategic service management. A unique feature of the program is that it focuses on identifying and correcting underlying scheduling and operational problems that may lead to maladaptive responses by operators. The SRP has enhanced the District's capability to provide timely and effective responses to scheduling problems by expanding communications be-

tween road supervisors and scheduling/operations planning personnel. Previous assessments of the program's effectiveness have shown that when a line is being intensively supervised under the SRP, line operators become more actively involved in identifying problems and suggesting solutions to the problems, passenger loads generally become better distributed, schedule adherence improves, there is a reduction in schedule-related customer complaints, and interdriver cooperation increases (especially for lines operating out of multiple divisions).

TEST OF SRP ON LINE 26-51

To demonstrate the short-term effects of the SRP process on a line's performance, a special study of SCRTD Line 26-51 (Avalon Boulevard—7th Street—Virgil Avenue—Franklin Avenue) was undertaken in April 1991. The line, which carries approximately 26,000 passengers daily, became a candidate for the program when customer complaints, operator complaints, and point-check data indicated that the line was experiencing poor service reliability, including pass-ups.

Hypotheses

Figure 3 shows the previous hypothetical model of poor service reliability as applied to Line 26-51 (pre-SRP). The plus signs in the model indicate that implementing the SRP on Line 26-51 was expected to have a positive impact on all the theoretical links depicted. The factors in the model were derived in large part from information extracted from the preimplementation surveys of Line 26-51 customers and operators. Although the only major transient shock reported by Line 26-51 operators was variable traffic conditions, there were several chronic problems on the line, including a concern that a few operators were not adhering to the schedule. The following hypotheses were tested:

- Hypothesis 1: service reliability would improve on Line 26-51 following implementation of the SRP,
- Hypothesis 2: customer perceptions of the quality of service on Line 26-51 would improve as a result of the SRP,
- Hypothesis 3: Line 26-51 operators would perceive that key scheduling and operational improvements had occurred on their line following implementation of the SRP,
- Hypothesis 4: cooperation among Line 26-51 operators would improve once the SRP was implemented.

Study Design

To test the hypotheses, a pre/post design with an untreated nonequivalent control line was used. Before and during the period when SRP was implemented on Line 26-51 (target line), service reliability was simultaneously monitored on Line 38-71 (control line), which did not receive any SRP treatment. The general form of the design is as follows:

Target line (26-51)	0	0	SRP	0 0
Control line (38-71)	0	0		0 0

The above quasi-experimental design was considered superior to a simple pre/post test, since the use of an untreated control line minimizes the risk of attributing an effect to the SRP when the effect may have been due to more generally occurring phenomena.

Line 26-51 Characteristics (Target)

Line 26-51 consists of two lines that were combined at the end of 1988 in an attempt to eliminate duplicate service along a 3-mi segment and reduce operating costs. Line 26 is the

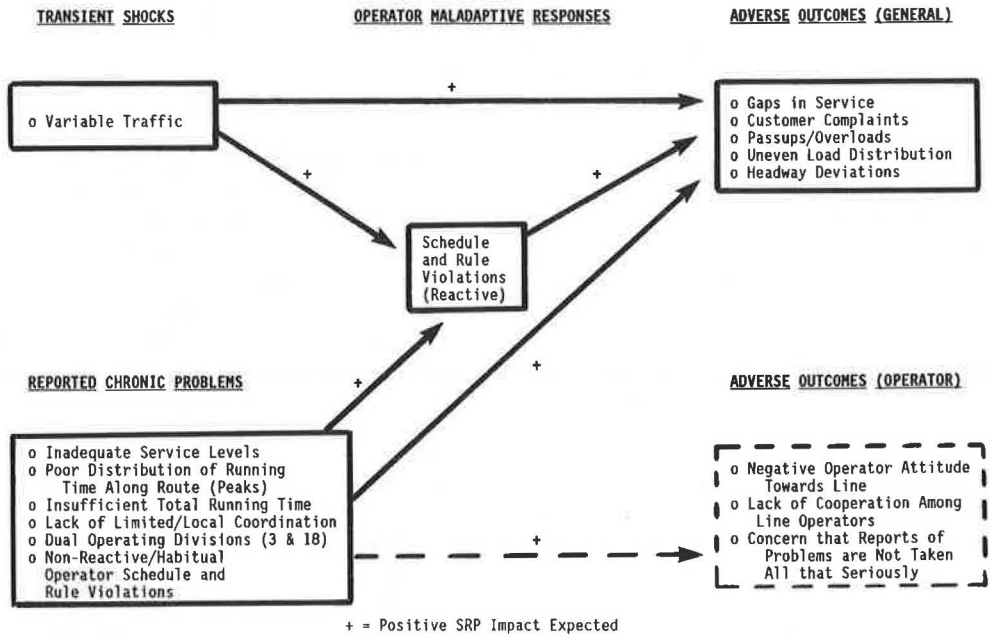

FIGURE 3 Hypothetical model of poor service reliability on SCRTD Line 26-51, a.m. peak.

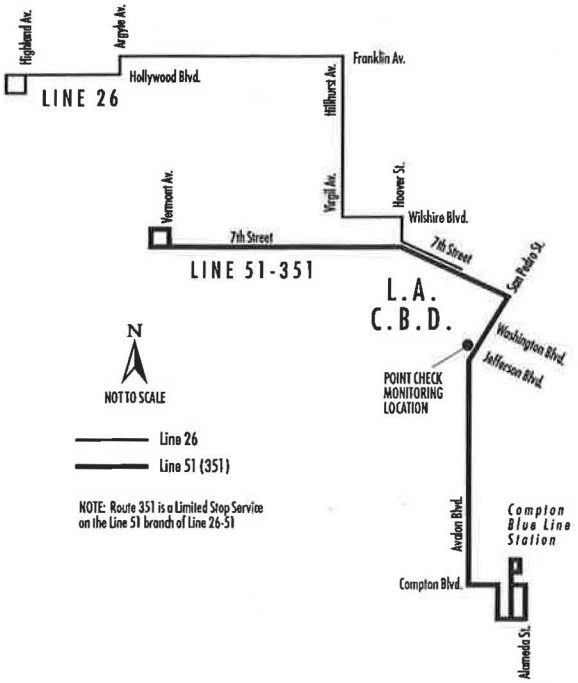

FIGURE 4 RTD Line 26-51 (351).

parent line and Line 51 serves as a branch. Line 26 operates between the Hollywood area and downtown Los Angeles (see Figure 4), while Line 51 operates between the city of Compton and the Los Angeles CBD. Line 26-51 operates out of two divisions and has a total of 26.2 one-way route miles. During the study period, 38 buses were assigned to the line during the a.m. peak. Certain trips on the Line 51 branch operated limited-stop service (via Route 351) along Avalon Boulevard to downtown Los Angeles.

Line 38-71 Characteristics (Control)

Selecting a suitable control line for this study was hampered by the fact that most other high-frequency local lines serving the Los Angeles CBD are either currently part of the SRP corridor service management plan or previously received intensive supervision under SRP. Among the few available candidate lines, Line 38-71 (W. Jefferson Boulevard—City Terrace) was ultimately chosen. Line 26-51 and Line 38-71 are similar in that both consist of two lines, operate through the Los Angeles CBD, and have demand headways and numerous short lines. Unlike Line 26-51, Line 38-71 operates out of a single division (Division 10) and has a longer headway (10 to 12 min during peaks).

Line 38, the parent line, operates from the West Los Angeles Transit Center east toward the Los Angeles CBD along Jefferson Avenue. Line 71, which serves as a branch of Line 38, primarily operates east of the CBD (see Figure 5). Line 38 and the Line 71 branch operate as a single bus route through the CBD, providing direct bus service between Southwest Los Angeles and the USC Medical Center. The combined routes total 18.2 one-way miles. Fifteen buses were assigned to the line during the a.m. peak rush. Line 38-71 carries about half as many patrons daily as the target line (approximately 13,000).

Scope of Study

The focus of this study was the weekday a.m. rush. Restricting the analysis to this period enabled the collection of passenger-waiting-time data and passenger surveys on both the target and control lines. A decision was made a priori to restrict the test to 7 weeks (April 25–June 14, 1991), since operators on both the target and the control lines were scheduled to bid new assignments, effective June 23, 1991, as part of a Districtwide "shakeup."

Outcome Measures

A total of 14 outcome measures were used to test these hypotheses. Simply assessing on-time performance or load variability or both, does not always provide insight into the true impact of an intervention such as the SRP. The specific outcome measures are listed below:

Service Reliability	*Customer Perceptions*	*Operator Perceptions*
Load differences	Overall service quality	Schedule improvements
Schedule deviations	Passing-up	Nonschedule improvements
Bunched buses	Waiting time	Supervisory presence
Gaps in service	Customer complaints	Attitude about working the line
Percentage passed up		
Mean waiting time		

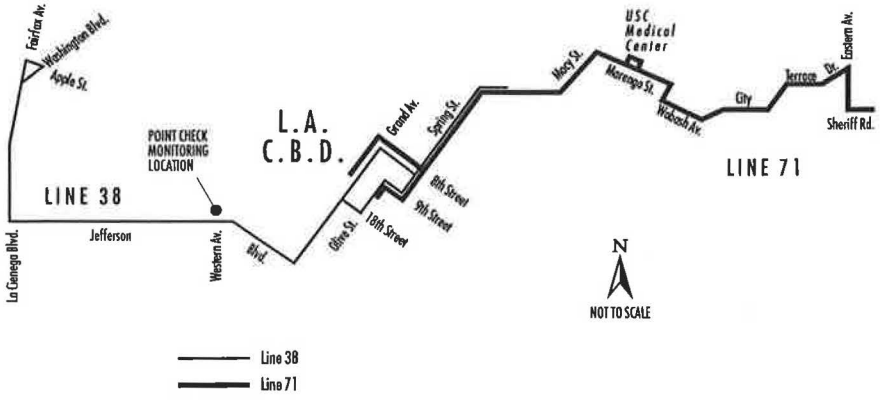

FIGURE 5 RTD Line 38-71.

With the exception of mean waiting time and percentage passed up, the service reliability measures were computed using regular point checks taken at the same location throughout the project. To obtain quantitative passenger waiting-time data and pass-up data (Avalon and Jefferson for the target line and Jefferson and Western for the control line), special checks were conducted at different locations. Specific definitions of the service reliability measures are provided in the next section.

Customer perceptions were made operational by conducting brief, structured interviews at the same location used to collect passenger waiting-time data. This enabled an assessment of whether customer perceptions were corroborated by actual measures of waiting time. Customer complaints were extracted from the complaint data base maintained by SCRTD. Finally, operator assessments of program impacts were obtained from an ad hoc operator opinion survey.

RESULTS

Service Reliability

The hypothesis that service reliability would improve on the target line (Line 26-51) following implementation of SRP, as supported by the data, received considerable support. Table 1 shows the results from the analysis of point checks taken at San Pedro and Washington on the target line before and during the 7-week SRP. Table 2 shows the results of the point-check analysis for the untreated control line (Line 38-71). Table 1 also shows that mean passenger loads on the target line increased from 57 to 61 per bus during the course of the study. This increase can be attributed to a generally occurring seasonal effect, and not necessarily to impact of the SRP.

Standard Deviation of Absolute Load Differences

Absolute load difference on the target line was defined as the unsigned difference in the number of passengers on the current bus versus the previous bus (at San Pedro and Washington). Taking the standard deviation of the absolute load differences gives insight into load variability. The standard deviation of absolute load differences averaged 14.3 during the preimplementation period. Throughout the various periods that the SRP was in place, the standard deviations averaged approximately 12.3 passengers (a reduction of about 16 percent). It was not appropriate to measure load differences at the designated monitoring location for the control line (i.e., Jefferson and 10th), since some of the buses passing the point were on short lines and had fewer passengers.

Standard Deviation of Absolute Schedule Difference

Absolute schedule deviation on the target line was defined as the unsigned number of minutes Line 26–51 buses deviated from the estimated scheduled time at San Pedro and Wash-

TABLE 1 SRP (TARGET) LINE 26-51 SERVICE RELIABILITY INDICATOR*

PERIOD	NO. TRIPS	MEAN DEPARTING LOAD	SD ABSOLUTE LOAD DIFFER.	**MEAN ABSOLUTE SCHEDULE DEVIATION (MINUTES)	**SD ABSOLUTE SCHEDULE DEVIATION (MINUTES)	NUMBER OF BUNCHED BUSES	***NUMBER OF SERVICE GAPS
Pre SRP Implementation							
4/17/91	20	59.8	13.4	3.8	3.1	15	2
4/18/91	21	55.1	13.7	3.5	3.7	13	2
4/19/91	22	56.0	17.8	3.3	2.2	18	3
4/22/91	21	55.6	12.3	3.9	3.2	14	3
Period Av:	21.0	56.6	14.3	3.6	3.1	15.0	2.5
Week 2 (SRP)							
5/7/91	21	58.5	10.9	4.0	2.5	16	3
5/8/91	23	58.3	15.5	4.1	2.4	15	2
5/9/91	22	56.1	10.7	3.1	2.4	12	3
5/10/91	23	61.4	11.4	2.8	2.6	13	3
Period Av:	22.3	58.6	12.1	3.5	2.5	14.0	2.8
Weeks 3-4 (SRP)							
5/15/91	22	62.2	8.8	2.5	2.5	9	2
5/16/91	23	58.4	15.7	3.5	2.0	14	2
5/22/91	22	57.8	9.1	3.7	2.7	10	2
5/23/91	21	63.0	9.3	2.8	2.8	8	2
5/24/91	22	56.6	15.8	2.2	1.6	8	2
Period Av:	22.0	59.6	11.7	2.9	2.3	9.8	2.0
Weeks 5-7 (SRP)							
5/31/91	22	60.8	10.9	3.4	2.1	10	2
6/5/91	20	63.2	13.2	4.1	3.4	8	2
6/6/91	21	59.5	13.6	3.0	2.2	7	0
6/11/91	22	59.4	9.8	4.4	3.6	11	1
Period Av:	21.3	60.7	11.9	3.7	2.8	9.0	1.3

NOTE: Results are based on point checks taken at San Pedro-Washington (6:00-7:45am northbound)

* 6:30-7:45am since headways are 7-8 minutes between 6:00-6:30am

** Not a time point -- estimated "scheduled" times used to obtain deviations

*** Gaps of 10+ minutes

TABLE 2 NON-SRP (CONTROL) LINE 38-71 SERVICE RELIABILITY INDICATORS*

PERIOD	NO. TRIPS	MEAN DEPARTING LOAD	MEAN ABSOLUTE SCHEDULE DEVIATION (MINUTES)	SD ABSOLUTE SCHEDULE DEVIATION (MINUTES)	NUMBER OF BUNCHED BUSES	**NUMBER OF SERVICE GAPS	NUMBER LATE OR EARLY BUSES
Pre SRP (on target line)							
4/17/91	10	43.9	4.2	3.2	2	1	4
4/18/91	10	43.9	3.0	2.5	2	1	2
4/19/91	10	46.3	3.2	2.7	6	1	3
Period Av:	10.0	44.7	3.5	2.8	3.3	1.0	3.0
Weeks 1-2							
5/1/91	8	***49.4	4.4	3.6	4	2	5
5/7/91	10	50.6	4.7	3.4	2	2	4
Period Av:	9.0	50.0	4.6	3.5	3.0	2.0	4.5
Weeks 3-4							
5/15/91	10	42.3	2.8	2.4	4	1	4
5/22/91	10	49.8	3.5	2.0	2	1	4
5/23/91	10	45.0	4.0	3.1	4	1	3
Period Av:	10.0	45.7	3.4	2.5	3.3	1.0	3.7

* Results based on point checks taken at Jefferson & 10th Avenue (6:15-8:15am westbound). Two of the ten scheduled trips terminate at this location. Passenger loads for these trips are zero and, therefore, were not included in the mean departing load variable. The two Jefferson & 10th shortline trips were, however, included in all of the schedule adherence indicators.

** Gaps of 15+ minutes, 7:00-8:00am only, to exclude short line trips.

*** Check began at 6:45am. As a consequence, the passenger load for Bus Run 8 (scheduled time 6:15am) was not available. For the purposes of this analysis, the load was estimated at 48, which is the mean load for Bus Run 8 across all other observations.

ington using estimates because the monitoring location was not a time point. Computing the standard deviation of these schedule differences provided an estimate of schedule variability. A similar measure was computed for the control line, where the monitoring location was a time point.

As Table 1 shows the standard deviation of absolute schedule differences was 3.1 min before implementation of SRP. During the first 4 weeks of the program on the line, this standard deviation was reduced to approximately 2.4 min (23 percent), and averaged 2.8 min during Weeks 5 to 7. The standard deviations for the control line were much more variable than those for the target line, and did not show any clear pattern of improvement (see Table 2). It seems reasonable to suggest that the SRP likely had a positive effect on schedule deviation, especially during the first 4 weeks of the program.

Bunched Buses

The number of bunched buses on the target line was defined as the sum of buses departing within 2 min of each other between 6:00 and 7:45 a.m. inbound at San Pedro and Washington. Table 1 shows that the average number of bunched buses on Line 26-51 decreased over time, whereas an average of 15 buses (71 percent), were involved in "bunching" before the program. During weeks 5 to 7 this average was reduced to nine (43 percent of total). The number of bunched buses on the control line was defined as the sum of buses departing within 5 min of each other between 6:15 and 8:15 a.m. westbound at Jefferson and 10th. On the control line the number of bunched buses remained on average approximately three throughout the study period (see Table 2).

Gaps in Service

A gap in service on Line 26-51 line was defined as any break between buses of 10 min or more between 6:30 and 7:45 a.m. at the monitoring location. For Line 38 (control), a 15-min criterion was used and the time period limited to between 7:00 to 8:00 a.m. because of longer headways before 7:00 a.m. and after 8:00 a.m. Table 1 shows that there was a small reduction in the mean number of service gaps on the target line during the course of the study. By Weeks 5 to 7, the number of gaps reduced to about one to two per day, versus two to three before the start of SRP. Although this finding is consistent with the hypothesis, the same general pattern was found for the control line (see Table 2). This finding must be interpreted cautiously, because the strongest effect was not found on the target line until Weeks 5 to 7, and data for this period on the control line were not available.

Percentage Passed Up

Table 3 shows the percentage of those passed up at Avalon and Jefferson (westbound) between 7:00 and 8:00 a.m. before and after implementation of the SRP. The percentage of those passed up on the target line at this location decreased considerably during the 2-week period following implementation of SRP on the line, whereas the average number of pass-ups for the two preimplementation days for which data were collected is 33 percent. The average for the 4 days when supervisors were intensively supervising the line was 8 percent. It should be noted that on the final day of counting pass-ups (May 7), 28 percent of the patrons were passed up. However, it would appear that passing-up reduced on the target line. It

TABLE 3 PASSENGER PASS-UPS AND WAITING TIME, LINE 26-51 VERSUS LINE 38-71, 7:00 TO 9:00 A.M., PRE/POST SRP IMPLEMENTATION

	MEAN HEADWAY (MIN.)	SD HEADWAY (MIN.)	NUMBER WAITING PASSENGERS	PERCENTAGE PASSENGERS PASSED-UP	MIN. UNTIL FIRST BUS ARRIVED	MEAN WAIT (MIN.)*
Line 26-51 (Target)						
Pre SRP Implementation						
Apr 17	4.3	4.6	59	30.5%	3.1	5.3
Apr 23	4.4	3.6	64	35.9%	3.1	4.2
Average:	4.4	4.1	61.5	33.2%	3.1	4.8
Post SRP Implementation						
Apr 30	4.3	2.8	54	0.0%	2.7	2.7
May 2	3.9	3.9	57	0.0%	3.5	3.5
May 6	4.8	4.3	62	4.8%	3.7	3.9
May 7	4.3	2.7	64	28.1%	3.3	4.4
Average:	4.3	3.4	59.3	8.2%	3.3	3.6
Line 38-71 (Control--No Treatment)						
Pre Implementation of SRP on Line 26-51						
Apr 17	9.5	4.2	44	n.a.	5.2	8.1
Average:	9.5	4.2	44.0	n.a.	5.2	8.1
Post Implementation SRP on Line 26-51						
Apr 29	11.5	7.4	44	n.a.	7.2	8.4
May 6	10.0	3.6	48	n.a.	3.9	7.2
May 7	10.5	7.6	52	n.a.	6.6	8.6
May 13	10.3	2.5	44	n.a.	5.1	8.3
Average:	10.6	5.3	47.0	n.a.	5.7	8.1

n.a. = information not available

Passenger Survey Locations: Line 26-51 Avalon & Jefferson (Westbound)
Line 38-71 Jefferson & Western (Westbound)

* For Line 26-51, the mean waiting time includes an estimate of additional time waited due to passing up (assumes simple queuing behavior). For Line 38-71, the mean waiting time includes additional time due to some persons not boarding short-line trips (assumes at least every other bus is a through bus).

was not possible to gauge pass-ups on the control line since some patrons voluntarily waited for a through bus.

Mean Waiting Time

Mean passenger waiting time decreased on Line 26-51 once the SRP was implemented (see Table 3). The limited data show that the mean waiting time was 4.8 min before implementation and 3.6 min subsequent to implementing SRP. The mean amount of time passengers waited for a bus to arrive actually increased during the implementation period, from 3.1 min preimplementation to 3.3 min subsequent to implementation. The reduction in mean waiting time was because of the fact that pass-ups decreased sharply at the monitoring location. Unlike the target line, there was no improvement in the total mean waiting time on the control line, 8.1 min pre- and post- as shown in Table 3.

Customer Perceptions

Overall Service Quality

The hypothesis that customers would perceive service quality to be improved on the target line following implementation of SRP received strong support from the data. A Kruskal-Wallis one-way analysis of variance (ANOVA) was used to test for changes in perceptions. A statistically significant difference in the ranks was found in the hypothesized direction—chi-square corrected for ties = 4.36, $p < .05$. Customers on Line 26-51 who were surveyed at the same location where passenger waiting-time checks were conducted perceived that there had been a significant improvement in the overall service quality on the line. For the control line, there was no meaningful change in the customers' perceptions of overall line quality. However, because the assessments on Line 38-71 clustered closer to the upper end of the scale and were more positive than those for the target line, the possibility of a "ceiling effect" cannot be ruled out.

Passing Up

A Kruskal-Wallis test was also used to determine whether Line 26-51 customers perceived that they had been passed up less frequently after the implementation of SRP. The resulting chi-square value was 4.03, which is significant at the .05 level. No comparable data were available for Line 38-71, since passing up due to overloaded buses was not a problem on the control line at the monitoring location.

Perceived Waiting Time

Perceived waiting time did not change on the target line during the study period, because the results suggested that Line 26-

51 customers believed that they waited, on average, just as many minutes after SRP was implemented as before. The general pattern of these findings is consistent with the results from the quantitative assessments of pass-ups and waiting time described earlier. Pass-ups decreased, whereas waiting time remained essentially the same. No change was reported for the control line in terms of perceived waiting time.

Customer Complaints

Table 4 shows the number of customer complaints reported on a weekly basis for Lines 26-51 and 38-71, for the period April 1–June 14. Complaints on the target line, which were more than twice those on the control line at the outset, averaged fewer than the control line by Weeks 5 to 7. This pattern of results is most compelling when a nonequivalent control group design is used.

Operator Perceptions

The hypothesis that operators would perceive that significant scheduling and operations-related improvements had occurred on their line following implementation of SRP was supported by the data. However, the hypothesis that cooperation would improve among operators on the line did not receive strong support. Only operators who participated in both the preimplementation and follow-up operator opinion surveys were included in the analysis ($n = 23$).

Assessments of Improvements (Scheduling)

As Table 5 shows, half of the operators on Line 26-51 who were surveyed prior to SRP and again after 5 weeks of implementation perceived that running time during the peaks had improved, at least slightly. The same general pattern of responses was found for all the other scheduling-related items. In contrast, nearly all of the operators on the control line perceived that there was no change in the scheduling-related areas surveyed. It is noteworthy that nearly half of the operators (45 percent) on the target line perceived that some service had been added, when in fact, none had.

Assessments of Improvements (Nonscheduling)

Table 5 also shows the operators' perception of change in factors not directly related to scheduling. Unlike scheduling-related factors, the pattern is muddled. A fair summary, however, would be that in the operators' view, with the exception of traffic, non-schedule-related factors changed very little on the target line, and improved somewhat on the control line. Operators on the target line generally did not directly perceive that cooperation among them had improved following the implementation of SRP.

Supervisory Presence

Table 6 shows the results of a comparison of the preimplementation versus postimplementation responses made by operators on the target line, and Table 7 shows similar information for control-line operators. As might be expected, a statistically significant difference was found for the frequency with which supervisors were observed on the target line ($t = -3.13$, $p < .01$). No statistically significant difference was found for the control on this measure.

Attitude About Working Line

There was also a significant difference, at the .10 level, in the responses made by Line 26-51 operators before and after SRP to the question, "During the past month, how often would you say you enjoyed working Line 26?" Taken together, operator responses were more positive at Time 2 than they were prior to SRP. A comparable change was not found for Line 38-71 operators.

Although the change for the question "How often is lack of cooperation among operators a problem?" was not statis-

TABLE 4 CUSTOMER COMPLAINTS BY WEEK, 5:00 TO 9:00 A.M., LINE 26-51 VERSUS LINE 38-71, PRE/POST SRP IMPLEMENTATION

	Pre SRP					2-4 weeks				5-7 weeks				
	1991 Apr 1	Apr 8	Apr 15	Apr 22	Mean	Apr 29	May 6	May 13	Mean	May 20	May 27	Jun 3	Jun 10	Mean
Line 26-51 (Target)														
Sched--AM Peak	3	4	1	2	2.5	4*	1	0	1.7	0	0	1	1	0.5
Total--AM Peak	3	6	1	3	3.3	4*	1	0	1.7	0	0	2	2	1.0
Line 38-71 (Control)														
Sched--AM Peak	0	1	0	2	0.8	0	3	2	1.7	0	3	1	1	1.3
Total--AM Peak	0	2	1	3	1.5	0	3	2	1.7	0	3	2	1	1.5

* Includes three no-show complaints near same location on the same day.

Sched = Scheduling and operations-related complaints such as passups, early bus, and late bus. Total complaints include such categories as operator discourtesy and accidents in addition to the scheduling and operations complaints (excludes fare-related complaints).

TABLE 5 OPERATOR PERCEPTIONS OF CHANGES ON LINE 26-51 VERSUS LINE 38-71

FACTOR	N	% IMPRVD. SIGNIF.	% IMPRVD. SLIGHTLY	% NO CHANGE	% WORSENED SOMEWHAT	% WORSENED SIGNIF.
Scheduling-related Factors						
Line 26-51 (Control)						
Running Time (Peak)	22	4.5	45.5	50.0	0.0	0.0
Distr. Running Time (Peak)	22	4.5	36.4	54.5	0.0	4.5
Amount of Service (Buses)	22	9.1	36.4	40.9	9.1	4.5
Passups Due to Overloads	23	8.7	34.8	39.1	13.0	4.3
Line 38-71 (Control)						
Running Time (Peak)	15	0.0	6.7	93.3	0.0	0.0
Distr. Running Time (Peak)	12	0.0	8.3	91.7	0.0	0.0
Amount of Service (Buses)	15	0.0	6.7	93.3	0.0	0.0
Passups Due to Overloads	16	0.0	12.5	87.5	0.0	0.0
Non-Scheduling Related Factors						
Line 26-51 (Target)						
Equipment	21	14.3	9.5	57.1	19.0	0.0
Cooperation Among Operators	23	8.7	21.7	47.8	17.4	4.3
Passenger Cooperation	23	17.4	8.7	56.5	13.0	4.3
Traffic	22	4.5	9.1	63.6	13.6	9.1
Line 38-71 (Control)						
Equipment	17	0.0	29.4	58.8	11.8	0.0
Cooperation Among Operators	16	18.8	18.8	62.5	0.0	0.0
Passenger Cooperation	16	6.3	37.5	50.0	6.3	0.0
Traffic	17	0.0	5.9	88.2	5.9	0.0

TABLE 6 OPERATOR PERCEPTIONS, SRP TARGET LINE 26-51, WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST, PRE VERSUS POST

SURVEY ITEM	NO. MINUS (WORSE-ENED)	NO. PLUS (IMP-ROVED)	NO. TIES (NO CHANGE)	Z-SCORE	2-TAIL PROB.	t-VALUE
Enjoy Working Line	3	8	12	-1.73	.08*	-1.93*
Problem Getting Recovery Time	6	6	11	-0.11	.91	0.12
Comfortable Making Sugges. to Supv.	4	5	11	-0.41	.68	-0.37
How Often Supervisors Seen	4	15	4	-2.57	.01**	-3.13**
How Often Called Dispatcher	6	9	8	-0.80	.43	-0.65
How Often A Problem?						
Insuff. Running Time (Peaks)	8	3	9	-1.11	.26	1.28
Poor Distr. Running Time (Peaks)	7	3	11	-0.97	.33	1.10
Insuff. Running Time (Off-Peak)	4	3	13	-0.17	.86	0.00
Poor Distr. Running Time (Off-Peak)	4	1	14	-0.94	.35	1.07
Equipment Breakdowns	4	6	11	-0.56	.57	-0.62
Lack of Coop. Among Operators	5	11	7	-1.06	.29	-1.00
Not Enough Service	5	3	9	-0.70	.48	0.59
Unruly Passengers	3	3	17	0.00	1.00	0.00
Unpredictable Traffic	4	11	8	-1.59	.11	-1.80*
Passing Up Due to Overloads	5	5	13	-0.25	.15	0.22

* significant at .10, two-tailed test
** significant at .05, two-tailed test

t-values shown are from paired t-Test analyses (two-tailed test)

Pre Survey Dates = April 7-12, 1991

Post Survey Dates = May 21-26, 1991, and June 19-30, 1991

tically significant, it should be noted that nearly half (11 out of 23) of the operators on the target line viewed lack of cooperation among operators as less of a problem at Time 2, as shown in Table 6. One plausible reason that lack of cooperation among operators was perceived to be less of a problem, even though the same operators reported that cooperation had not improved, is that the need to engage in maladaptive responses diminished during SRP. The presence of supervisors on the line, along with minor scheduling adjustments, may have reduced the need to operate ahead of schedule or use other maladaptive responses. Although operators may have felt that there was no real change in the level of operator cooperation, the need for such cooperation seems to have lessened during the SRP.

CONCLUSION

Providing reliable bus service is a key goal of most transit agencies. Chronic problems and transient shocks on a line, however, often make achieving this goal difficult. In an effort to better understand the causal relationship between antecedent problems and subsequent poor service reliability, a conceptual model was proffered. The model postulates that

TABLE 7 OPERATOR PERCEPTIONS, CONTROL LINE 38-71, WILCOXON MATCHED-PAIRS SIGNED-RANKS TEST, PRE VERSUS POST

SURVEY ITEM	NO. MINUS (WORSE-ENED)	NO. PLUS (IMP-ROVED)	NO. TIES (NO CHANGE)	Z-SCORE	2-TAIL PROB.	t-VALUE
Enjoy Working Line	5	3	8	-0.35	.36	0.44
Problem Getting Recovery Time	2	8	6	-0.87	.39	-0.64
Comfortable Making Sugges. to Supv.	2	2	11	-0.00	1.00	0.00
How Often Supervisors Seen	2	5	9	-0.59	.55	-0.62
How Often Called Dispatcher	4	2	10	-0.73	.46	0.81
How Often A Problem?						
Insuff. Running Time (Peaks)	5	4	6	-0.23	.81	0.25
Poor Distr. Running Time (Peaks)	4	5	6	-0.77	.44	-0.89
Insuff. Running Time (Off-Peak)	0	6	8	-2.20	.03**	-2.59**
Poor Distr. Running Time (Off-Peak)	1	4	11	-1.48	.14	-1.60
Equipment Breakdowns	1	3	12	-0.54	.58	-0.62
Lack of Coop. Among Operators	0	2	13	-1.34	.18	-1.29
Not Enough Service	5	6	3	-0.71	.48	-0.84
Unruly Passengers	1	5	10	-1.46	.14	-1.73*
Unpredictable Traffic	6	3	6	-0.53	.59	0.56
Passing Up Due to Overloads	2	4	9	-0.94	.35	-1.00

* significant at .10, two-tailed test
** significant at .05, two-tailed test

t-values shown are from paired t-Test analyses (two-tailed test)

Pre Survey Dates = April 7-12, 1991

Post Survey Dates = May 21-26, 1991

the overarching relationship is mediated by, among other things, maladaptive operator responses.

Largely on the basis of the model's logic, SCRTD implemented an innovative program in mid-1989 to deal with the problem of poor service reliability, SRP. Under the program, road supervisors not only intensively supervise lines, but also work with District personnel, including line operators, to identify and resolve root causes. The step-by-step SRP process delineated in this paper can easily be adopted by other transit agencies.

To demonstrate the short-term impacts of the SRP, a pre/post test was conducted on SCRTD Line 26-51. The results from the test support the conclusion that intensive road supervision, coupled with team-oriented approaches to problem identification and resolution, can have a positive effect on service quality. Without adding service, and despite a small seasonal increase in ridership, improvements were found for various service reliability indicators on the target line (e.g., number of bunched buses and pass-ups). The quantitative findings were generally corroborated by qualitative assessments made by Line 26-51 customers and operators.

Although the Line 26-51 test should make an important contribution to the applied research literature on bus service reliability, several limitations must be noted. First, the control line differed in many respects from the target line (e.g., longer headways). This fact necessarily made certain result comparisons between the target and control lines untenable. Second, because of the restricted time frame available for this research, the amount of baseline data was limited. Third, the sample sizes of passenger surveys for each line were very small and taken at a single location. Fourth, the test was restricted to the a.m. peak rush. Whether the present findings can be generalized to the p.m. peak remains to be determined. These and other limiting factors notwithstanding, the results clearly suggest that innovative service management programs such as the SRP can have beneficial effects on line performance, at least in the short term. Future research will address such issues as how long the effect of SRP lasts once the program is removed, and how often the process must be repeated.

ACKNOWLEDGMENT

This project would not have been possible without the support of the following: The Board of Directors of SCRTD; Alan Pegg, General Manager; Arthur Leahy, Assistant General Manager-Operations; Stephen Parry, Director of Scheduling and Operations Planning; Leo Bevon, Assistant Director of Transportation; Ralph Wilson, Assistant Director of Transportation; and Jon Hillmer, Manager of Operations Planning. The authors would especially like to thank the SRP Transit Operations Supervisors and Senior Transit Operations Supervisors for their professionalism, dedication, and effort throughout this project. Several people were instrumental in coordinating program-implementation activities and data collection activities, including Johnnie Johnson, Joseph Brown, Helen Bonnell, Ricardo Aguirre, and Andy Galindez. The authors gratefully acknowledge all other personnel in the Transportation and Scheduling and Operations Planning Departments who contributed to the success of the SRP project. Finally, the authors want to express their appreciation to the operators on Lines 26-51 and 38-71 as well as the customers on these lines who participated in our surveys.

Publication of this paper sponsored by Committee on Bus Transit Systems.

Bus Route O-D Matrix Generation: Relationship Between Biproportional and Recursive Methods

PETER G. FURTH AND DAVID S. NAVICK

Planners must sometimes synthesize transit route origin-destination (O-D) matrices with limited data, usually on-off counts and sometimes a small or outdated O-D survey sample. When a small O-D sample is available, iterative methods such as the biproportional method that begin with the sample as a seed matrix can be used, adjusted to match on-off totals. When only on-off totals are available, the recursive method of Tsygalnitsky has been found to match O-D patterns on some routes better than others. This method is in fact a special case of the biproportional method using an implicit null seed matrix that contains information on directionality and minimum trip length. It illustrates why the recursive method is inappropriate when there is significant competition between routes, and offers a correction for when on-off data have been aggregated to the segment level. Estimation errors are then compared to help indicate how large the seed sample should be in order to produce a more accurate estimate than an estimate produced with a null seed.

A route-level origin-destination (O-D) matrix (trip table) gives the number of passengers traveling between each pair of stops or stations on a transit route in a particular direction. It can be specific to any period of interest, from the individual vehicle trip to an entire day. A route-level O-D matrix is an important descriptor of passenger demand that has been used for such analyses as systematic route evaluations (*1*,*2*), route and schedule design for short-turning (*3*), zonal service (*4*), limited-stop service (*5*), and complementary express and local service (*6*).

A route-level O-D matrix can be obtained by directly sampling passengers. The typical passenger survey, in which passengers fill in a questionnaire asking where they boarded and where they plan to leave, leaves a lot to be desired. Response rates are often low, and vary according to critical factors such as trip length—did the passenger have enough time to fill out the questionnaire?—and origin-stop—did the passenger get a seat? Is this stop in a low literacy neighborhood?—which may bias the results. A special purpose survey method, called by one author the "no questions asked" method (*2*), appears to overcome this nonresponse problem. Passengers are given origin-coded cards when they board and are asked to return the cards when they alight. By careful collection of the cards by alighting stop, O-D information is obtained. Practitioners report response rates of over 90 percent (*2*,*7*). However, this method is not in common use, because it requires one checker at each door and careful pre-trip preparation.

Far more common and easier to obtain than O-D data are on-off counts. In the context of O-D matrix generation, on-off counts represent row and column totals. It is not difficult for a ride checker to obtain a 100 percent sample of on-off counts, and measurement error is generally agreed to be quite small. Therefore an O-D matrix whose row and column totals agree with the on-off counts should be preferred to one obtained by simple expansion of a small O-D sample. Of course, there are many possible O-D matrices whose row and column totals match the on-off counts. The problem of O-D matrix synthesis is to generate an O-D matrix that agrees with a given set of row and column totals and that meets some criteria of being the best or most likely O-D matrix. Ben-Akiva et al. (*8*) describe three methods for combining a small O-D sample with on-off counts: the biproportional method, constrained maximum likelihood, and constrained generalized least squares. All three of these methods involve iterative computations. The first two are preferable because the third sometimes generates negative matrix entries, even though all three yield very similar results. The biproportional method is computationally more attractive, is better known, and has been used in a variety of contexts (*9*–*11*). In further work, Ben-Akiva (*12*) shows how the maximum likelihood approach can be used to derive estimation methods that combine various imperfect sources of information. In an application to transit route O-D estimation, his assumptions about the structure of the nonresponse bias lead again to the simple biproportional method.

It is often the case, however, that a small O-D sample is not available, or that the small sample is so small or suspected of bias that an estimate based on it may not be reliable. A method for synthesizing a route-level O-D matrix from on-off counts alone was proposed by Tsygalnitsky (*13*). It is a very simple method involving a single pass of recursive calculations, and can be done by hand (although use of a spreadsheet or computer program is still advisable). This method has also been used by London Transport in at least one study, presumably having been developed independently (*1*). Tsygalnitsky found that his recursive method fit well with data from Toulouse, France. Simon and Furth (*7*) also tested it against O-D data from two routes in Los Angeles, and again found a good fit, although the fit on one route was better than that on another. Ben-Akiva et al. (*8*) tested the recursive method against O-D matrices generated using the biproportional and constrained maximum likelihood methods for two Boston area routes and found that it yielded matrix estimates that differed substantially from the estimates obtained by the iterative methods based on a small-sample O-D survey.

Although Tsygalnitsky's recursive method and the biproportional method are motivated from different assumptions,

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the recursive method is actually a special case of the biproportional method. The biproportional method takes an initial matrix, called a seed matrix, and factors it to match on-off counts. The seed matrix contains information concerning the preferences for the various O-D pairs. Typically, the seed matrix is an O-D sample. If there is no O-D sample to begin with, a reasonable guess is to use a "null seed," one that assumes that every permissible O-D pair is equally preferred. It is demonstrated that Tsygalnitsky's recursive method is the same as the biproportional method using a null seed.

This insight makes it possible to better analyze which method is more appropriate under various circumstances. A small O-D sample contains valuable site-specific information about O-D pair preferences but is also subject to sampling error and nonresponse bias. A null seed has no sampling error or nonresponse bias but lacks site-specific information. In addition, two common factors—aggregation of stops into segments and competition from other routes—are shown to be in contradiction to the assumptions underlying the null seed, and consequently the recursive method should not be expected to perform well under these circumstances.

BUS ROUTES ANALYZED

Repeated reference is made to four bus routes that have been previously analyzed. Lines 16 and 93, analyzed by Simon and Furth (*7*) are operated by the Southern California Rapid Transit District. For Line 16, virtually complete O-D data, encompassing 266 passengers, were obtained from five inbound short-turning trips over a 5-mi radial route containing 40 stops. For Line 93, virtually complete O-D data were obtained on four a.m.-peak (383 passengers) and four p.m.-peak (273 passengers) trips. Four trips were local trips covering the entire 140-stop route from downtown Los Angeles to the San Fernando Valley, three trips were short-turned in North Hollywood (about 90 stops), and one p.m. trip ran express from downtown to the valley. Routes 77 and 350, analyzed by Ben Akiva et al. (*8*), are operated by the Massachusetts Bay Transportation Authority. These routes were analyzed inbound in the a.m. peak and outbound in the p.m. peak. The available data consist of a small O-D sample augmented by on-off counts. Route 77 is a heavily used radial route, 5.5 mi long, running through the suburb of Arlington into Harvard Square in Cambridge. In the a.m. peak, 2,148 passengers were counted, and O-D data were obtained from 54. In the p.m. peak, 1,617 passengers were counted, with O-D data obtained from 138. Route 350 is 15.2 mi long, with a large collection/distribution section in suburbs north of Boston, connected by express operation to selected stops in Cambridge and downtown Boston. In the a.m. peak, 485 passengers were counted, with O-D data obtained from 76. In the p.m. peak, 200 passengers were counted, with O-D data obtained from 61.

TSYGALNITSKY'S RECURSIVE METHOD

Tsygalnitsky's recursive method proceeds stop by stop, distributing alightings at each stop among origin stops in proportion to the number of people from each origin stop who are eligible to alight. To be eligible, passengers must have traveled a minimum distance, and must not have alighted previously. Taking each stop as a node, with nodes consecutively numbered from 1 to n in the direction of travel, let

t_{ij} = passenger trips from i to j,
$t_{i\cdot}$ = boardings at $i = \Sigma_j t_{ij}$,
$t_{\cdot j}$ = alightings at $j = \Sigma_i t_{ij}$,
m_i = first node at which passengers who board at i are eligible to alight ($m_i \geq i$),
E_j = set of nodes that can serve as origins for passengers alighting at j,
e_{ij} = number of passengers who boarded at i who are eligible to alight at j,
$e_{\cdot j}$ = total number of passengers eligible to alight at $j = \Sigma_i e_{ij}$, and
f_j = fraction of eligible passengers who alight at $j = t_{\cdot j}/e_{\cdot j}$

Initially, set $e_{ij} = 0$ for all (i, j) except when $j = m_i$, in which case set $e_{ij} = t_{i\cdot}$. Computation begins with the first node at which passengers are eligible to alight; call it Node k. After calculating $e_{\cdot k}$ and f_k, let

$$t_{ik} = e_{ik} f_k \qquad \text{for all } i \varepsilon E_k \tag{1}$$

Stop if $k = n$; otherwise update:

$$e_{i,k+1} = e_{ik} - t_{ik} \qquad \text{for all } i \varepsilon E_k \tag{2}$$

and advance to the next node (let $k = k + 1$) and return to Equation 1.

Simon and Furth call this method a fluid analogy, because passengers on the bus are likened to a thoroughly-mixed fluid out of which alighting passengers are drawn at each alighting stop in proportion to their representation in the fluid. Newly boarding passengers are added to the fluid after they have met the minimum travel distance criterion. (This minimum distance may be expressed in stops, distance, or time units, and may vary from stop to stop.) Ben-Akiva et al. (*8*) call it an intervening opportunities method, because it follows the logic of classical intervening opportunities models in giving priority to closer destinations.

BIPROPORTIONAL METHOD

Additional notation that will be used is

s_{ik} = seed matrix,
A_i = overall adjustment factor for row i,
B_k = overall adjustment factor for column k.

The seed matrix contains information about relative likelihoods of O-D pairs to be chosen by travelers. It may be a small-sample O-D matrix or an out-of-date O-D matrix. If no empirical seed matrix is available, a seed matrix can be created by an analyst to reflect information available on preferences between O-D pairs, as done by Furth (*14*) for vehicular traffic at an intersection.

The method is to alternately balance rows and columns to match the desired row and column totals until convergence. Initially, we set $t_{ik} = s_{ik}$. Then, for iteration h, rows are balanced:

$$t_{ik}^h = t_{ik}^{h-1} a_i^h \qquad \text{for all rows } i \tag{3}$$

where the balancing factor a_i^h is the ratio of the desired row i total to the current row i total. Next, columns are likewise balanced:

$$t_{ik}^h = t_{ik}^{h-1} b_k^h \qquad \text{for all columns } k \tag{4}$$

where the balancing factor b_k^h is the ratio of the desired column k total to the current column k total. Since balancing columns upsets the balance of the rows, the process is repeated until convergence is reached, that is, until, after balancing the columns, all the row totals agree (to some arbitrary tolerance) with the desired row totals. Reflecting the logic of the calculations, one name that has been used for this method is "iterative proportional fit." The name "biproportional method" derives from the form of the final estimate for cell (i, k), which is

$$t_{ik} = s_{ik} A_i B_k \tag{5}$$

where the overall balancing factor for row i is $A_i = \Pi_h a_i^h$ and the overall balancing factor for column k is $B_k = \Pi_h b_k^h$. It is well known that the biproportional method has a unique solution (*15*,*16*). In general, there is no closed form or single-pass recursive algorithm for determining the overall balancing factors, which must therefore be found by an iterative method such as the iterative proportional fit.

The biproportional method has been derived in several different ways. Several authors, including Ben-Akiva et al. (*8*) and Lamond and Stewart (*16*), derive it as a case of minimizing a measure of discrepancy between the estimate and the seed. Hauer et al. (*10*) derive it as the most likely realization of a random (either Poisson or multinomial) process in which the seed represents the known ocurrence rates. Ben-Akiva (*12*) derives it as the maximum likelihood estimate of the population trip rates, assuming that the seed is a random sample subject to sampling bias, and the relative bias is a product of two factors, one from the origin stop and one from the destination stop.

RECURSIVE METHOD AS SPECIAL CASE OF BIPROPORTIONAL METHOD

The estimates produced by Tsygalnitsky's recursive method are actually a biproportional form. Implicitly underlying the recursive model is a null seed containing information on whether travel is permitted or not, based on directionality and minimum trip length, given by

$$s_{ik} = \begin{cases} 1 & \text{if travel from } i \text{ to } k \text{ is permitted} \\ 0 & \text{otherwise} \end{cases} \tag{6}$$

The recursive method also implies the following restrictions on the seed: $s_{in} = 1$ for all i, and for all $k < n$, $s_{i,k+1} = 1$ if $s_{ik} = 1$.

Theorem

The recursive method is a special case of the biproportional method in which the seed matrix is the null seed matrix given by Equation 6. More specifically, the recursive estimates $t_{ik} = e_{ik} f_k$ (Equation 1) are equivalent to the biproportional estimates $t_{ik} = s_{ik} A_i B_k$ (Equation 5), where

$$A_i = e_{in} \qquad \text{for all } i = 1, \ldots, n \tag{7}$$

$$B_n = f_n = 1 \tag{8}$$

and

$$B_k = \frac{f_k}{\prod_{j=k}^{n-1} (1 - f_j)} \qquad \text{for all } k = 1, \ldots, n-1 \tag{9}$$

Proof (by construction)

Because the biproportional method has a unique solution, it is sufficient to prove that estimates produced by the recursive method have a biproportional form. Consider column n (i.e., let $k = n$). By inspection, it is clear that Equations 1 and 5 are equivalent. Now consider column $n - 1$ (i.e., let $k = n - 1$). By construction, the recursive method yields $e_{i,n} = e_{i,n-1}(1 - f_{n-1})$ if travel from i to $n - 1$ is permitted. Rearranging, we obtain

$$e_{i,n-1} = \begin{cases} \dfrac{e_{in}}{1 - f_{n-1}} & \text{if travel from } i \text{ to } n-1 \text{ is permitted} \\ 0 & \text{otherwise} \end{cases} \tag{10}$$

Substituting for $e_{i,n-1}$ yields

$$t_{i,n-1} = s_{i,n-1} e_{in} \left(\frac{f_{n-1}}{1 - f_{n-1}} \right) \tag{11}$$

which is a biproprotional form with the balancing factors given by Equations 7 and 9.

Now consider column $n - 2$ (i.e., $k = n - 2$). By similar argument,

$$e_{i,n-2} = \begin{cases} \dfrac{e_{i,n-1}}{1 - f_{n-2}} & \text{if travel from } i \text{ to } n-2 \text{ is permitted} \\ 0 & \text{otherwise} \end{cases} \tag{12}$$

Combining Equations 11 and 12 yields

$$e_{i,n-2} = \begin{cases} e_{in} \dfrac{1}{(1 - f_{n-2})(1 - f_{n-1})} & \text{if travel from } i \text{ to } n-2 \text{ is permitted} \\ 0 & \text{otherwise} \end{cases} \tag{13}$$

Substituting for $e_{i,n-2}$ in Equation 1 with $k = n - 2$ again yields a biproportional form, with balancing factors given by Equations 7 and 9. Similar reasoning can be applied to each successive column $k = n - 3, n - 4, \ldots$ Equation 13 becomes generalized to

$$e_{ik} = \begin{cases} \dfrac{e_{i,k+1}}{1 - f_k} = e_{in} \dfrac{1}{\prod_{j=k}^{n-1} (1 - f_j)} & \text{if travel from } i \text{ to } k \text{ is permitted} \\ 0 & \text{otherwise} \end{cases} \tag{14}$$

from which the equivalence of Equations 1 and 5, using the substitutions given by Equations 7 and 9, is obvious. *Q.E.D.*

This theorem provides a framework for determining which method of transit route O-D matrix generation, the recursive or biproportional method, is better. Because the two methods differ only in which seed is used, the question can be reframed in terms of which seed is better, a null seed or a seed derived from exogenous data such as a small sample. We have already mentioned a few empirical studies of the methods. The remainder of this paper examines theoretical deficiencies of both the null seed and the small sample seed in common situations along with some experimentation, offering further guidance as to which seed is most appropriate in various situations.

One interesting corollary of this theorem is that when the seed has the form of a null seed, the recursive method provides a single-pass algorithm for finding the biproportional solution. Another corollary is that the recursive method is reversible; that is, it will yield the same results if one works backward or forward along the route. In this sense, the recursive method is not myopic like other intervening opportunities models. It appears to be myopic since it determines demand to stops along the route without explicitly considering what opportunities lie further downstream.

FACTORS AFFECTING APPLICABILITY OF RECURSIVE METHOD

The fact that the recursive method is the same as the biproportional method with a null seed helps indicate the types of routes and situations in which the recursive model can or cannot be expected to perform well. It can be expected to perform well when there is little a priori reason to believe that anything other than the popularity of the origin and destination stops is responsible for the demand for travel between O-D pairs. In the two situations suggested by Tsygalnitsky (*13*), a null seed appears plausible. These situations are (a) an express route with a collection segment outside the city and a distribution segment downtown, with travel permitted only between the collection and distribution segment; and (b) a short local route free from interference (e.g., competition) with other routes.

However, there are other situations in which a null seed violates a priori knowledge of trip-making behavior, the foremost being when significant competition from other routes affects demand. For example, imagine a local route between Segment A and Segment E, with several intermediate segments. If there is another route that goes express from Segment A to Segment E, we would expect that the express route would capture most of the demand from A to E. The seed matrix for the local route should therefore have a relatively low propensity for stop pairs that are served by the express route, rather than equal propensities throughout. Likewise, if two local routes begin at a common intersection uptown and end at a common location downtown and use different paths to get there, the travel market that can use either route will be split between the routes, lowering on both routes the propensity to travel between stop pairs served by both routes. Other network effects can affect travel propensity along a route as well. For example, a large transfer volume from a feeder route can influence propensity for travel between that transfer point and other stops on the main route because these transferring passengers may have a high propensity to go to certain portions of the main route, but not to other portions (e.g., there may be a more expedient path to some portions of the main route than via that transfer point).

Long local routes may be another example of the unsuitability of a null seed. Travel propensity is commonly agreed to decline with distance, except for very short distances, where competition with walking yields the opposite effect. On short routes, travel time differences between different O-D pairs are sufficiently minor that an equal-propensity seed is still plausible. But on long routes, even if there is no competition from other routes, propensities should be expected to be smaller for long trips than for short trips. It has yet to be shown how long a route can be before the null seed assumption becomes unrealistic.

Results reported in the literature confirm these expectations. For example, Tsygalnitsky found that his method performed very well on the two routes he tested, one an express route with separate collection and distribution areas, the other a short local route. Simon and Furth (*7*) found that Tsygalnitsky's recursive method worked very well on a short local route, but that on a longer route with competition from express routes, it overpredicted very long trips. It should be noted that, because the average trip length is determined by the given on and off totals on the route, any model for O-D matrix generation must yield the correct average trip length. Therefore, an overprediction of long trips must be accompanied by an overprediction of short trips. Ben-Akiva et al. found that the recursive method overpredicts very long and very short trips, particularly on Route 350, a long route with competition from express service. It is not clear, however, whether the discrepancies on these longer routes arise because of interference from competing routes, from route length, or from using segment-level data.

O-D MATRIX ESTIMATION WITH SEGMENT-LEVEL DATA

An important factor affecting the applicability of the recursive method is whether the on-off counts are by individual stop or by segment (aggregations of stops). With stop-level data, travel along the diagonal of the O-D matrix (i.e., beginning and ending at the same stop) is not permissible, but with segment-level data, travel along the diagonal is permissible. Although the recursive method recognizes only the dichotomy permissible/not permissible (1 or 0), the possibility of intrasegment travel calls for a finer level of gradation. Intrasegment travel in a segment with n stops is an aggregation of n^2 stop pairs. If propensity is 1 for stop pairs for which travel is permissible and 0 for ineligible pairs, then the average propensity for stop pairs contained in that segment is at most $(n - 1)/2n$, which is less than 0.5. Similarly, average travel propensity between nearby segments can be less than 1 if the minimum travel distance is greater than one stop, because the pair of nearby segments could contain stop pairs that are ineligible for travel. In the example given in Figure 1, a null seed containing only 0's and 1's at the stop level is shown to be equivalent at the segment level to a matrix of average

a. Stop-Level Propensity
(Minimum travel distance = 3 stops)

From \ To	1	2	3	4	5	6	7	8	9	10	11	12
A 1	0	0	0	1	1	1	1	1	1	1	1	1
A 2	0	0	0	0	1	1	1	1	1	1	1	1
A 3	0	0	0	0	0	1	1	1	1	1	1	1
A 4	0	0	0	0	0	0	1	1	1	1	1	1
A 5	0	0	0	0	0	0	0	1	1	1	1	1
A 6	0	0	0	0	0	0	0	0	1	1	1	1
B 7	0	0	0	0	0	0	0	0	0	1	1	1
C 8	0	0	0	0	0	0	0	0	0	0	1	1
C 9	0	0	0	0	0	0	0	0	0	0	0	1
C 10	0	0	0	0	0	0	0	0	0	0	0	0
C 11	0	0	0	0	0	0	0	0	0	0	0	0
D 12	0	0	0	0	0	0	0	0	0	0	0	0

b. Segment-Level Equivalent, Showing Average Propensities

From \ To	A (1–6)	B (7)	C (8–11)	D (12)
A (1–6)	6 / 36	4/6	23 / 24	1
B (7)	0	0	2 / 4	1
C (8–11)	0	0	1 / 16	2/4
D (12)	0	0	0	0

FIGURE 1 Stop-level null seed and segment-level equivalent.

propensities that include, besides 0's and 1's, fractional values ranging from 1/16 to 23/24.

Because the recursive algorithm itself does not permit fractional propensities, applying it to segment-level data will bias results, because this method forces all those fractional propensities to be 1's. For example, Ben-Akiva et al. apply the recursive method to segment-level data, setting the minimum travel distance to zero in order to make intrasegment travel permissible. As should be expected, they find that the method predicts too many intrasegment trips. In contrast, Simon and Furth (*7*) and Tsygalnitsky apply the recursive method at the stop level, although the results are often presented at the segment level, avoiding this bias. This effect no doubt accounts in part for the poor fit found by Ben-Akiva et al. using the recursive method.

When only segment-level data are available, a method of synthesizing O-D matrices that is consistent with the recursive method at the stop level is the biproportional method with a seed matrix consisting of segment-level average propensities. An example using data from Line 93 demonstrates how using this "equivalent null seed" avoids the large bias of a naive segment-level application of the recursive method. Table 1 shows four sets of results (presented at the segment level even if the analysis was done at the stop level): (a) the actual O-D matrix; (b) the stop-level estimate using a stop-level null seed (minimum trip length = 2 stops), which is the same as a recursive estimate; (c) the segment-level estimate made using the segment-level equivalent null seed; and (d) the segment-level estimate made using a naive null seed (minimum trip length = 0 segments), which is the same as a recursive estimate made at the segment level. Three different error measures are used: relative root-mean-square error (RRMSE), root-mean-weighted fractional error (RMWFE), and χ^2. The RMWFE can be used to judge whether the actual data obtained agree with the model. Formulas for these measures applied at the segment level are

$$\text{RRMSE} = \left\{\frac{K}{t_{..}^2}\sum_{i=1}^{n}\sum_{j=i}^{n}[(\hat{t}_{ij} - t_{ij})^2]\right\}^{1/2} \quad (15)$$

$$\text{RMWFE} = \left\{\frac{1}{t_{..}}\sum_{i=1}^{n}\sum_{j=i}^{n}\left[\frac{(\hat{t}_{ij} - t_{ij})^2}{t_{ij}}\right]\right\}^{1/2} \quad (16)$$

$$\chi^2 = \sum_{i=1}^{n}\sum_{j=i}^{n}\left[\frac{(\hat{t}_{ij} - t_{ij})^2}{\hat{t}_{ij}}\right] \quad (17)$$

where

t_{ij} = passenger trips from i to j,
$\hat{t}_{ij}$ = synthesized passenger trips from i to j,
$t_{..}$ = total passenger trips, and
K = number of matrix cells containing permissible trips.

The segment-level estimate made using the equivalent null seed is almost as good as the stop-level estimate. The equivalent null seed minimizes aggregation bias, and aggregation error, as shown by the increase in the error measures, is small. The results are markedly worse when the recursive algorithm is applied naively at the segment level. The tendency in this case to predict too many very short and very long trips is clearly seen. The same analysis was performed for Line 16 and similar results were obtained.

An attempt was also made to assess the effect of aggregation bias on the tests performed by Ben-Akiva et al. (*8*). Three segment-level estimates for Route 77 outbound are shown in Table 2: the "best" estimate, a biproportional estimate generated using a small-sample O-D survey as a seed; the estimate using an equivalent null seed based on a minimum trip length of three stops; and the naive estimate using a segment-level null seed (minimum trip length = 0 segments). Because stop-level data were not available, it was impossible to generate a stop-level estimate and compare the results with the true distribution. Measures of error are in comparison with the best estimate. The equivalent null seed estimate approximates what would be obtained from a proper stop-level application of the recursive method. The comparison of these cases clearly shows how the naive segment-level application of the recursive method increases the estimated number of very short and very long trips.

SAMPLING ERROR AND BIAS WITH SMALL-SAMPLE SEED

It may seem that any empirical seed, whether from a small-sample O-D survey or an old O-D survey, would be superior to pleading ignorance and using a null seed. However, a null seed is not such a bad guess for many situations, being consistent with our understanding of travel behavior and having been confirmed on a few test routes. Before an empirical seed is used with the biproportional method or another iterative method, the value of its information content should be considered. Although information content can in many contexts be difficult to judge, in the case of a small-sample O-D matrix

TABLE 1 COMPARISON OF STOP-LEVEL AND SEGMENT-LEVEL ESTIMATES, LINE 93, a.m.

a. Actual O-D Matrix

From | To	1	2	3	4	5	6	7	8	On
1	0	14	9	5	8	7	5	3	51
2		12	10	12	22	25	7	1	89
3			3	18	16	2	18	0	57
4				3	20	12	3	2	40
5					6	25	11	3	45
6						8	28	2	38
7							32	15	47
8								16	16
Off	0	26	22	38	72	79	104	42	383

b. Stop-Level Estimate

From | To	1	2	3	4	5	6	7	8	On
1	0.0	11.6	6.4	7.6	10.3	8.3	5.5	1.4	51
2		14.4	12.1	13.8	20.0	15.6	10.7	2.4	89
3			3.5	11.8	17.2	12.4	9.4	2.7	57
4				4.8	14.0	12.9	6.9	1.4	40
5					10.5	19.5	12.2	2.7	45
6						10.3	25.6	2.2	38
7							33.7	13.3	47
8								16.0	16
Off	0	26	22	38	72	79	104	42	383

RRMSE = 0.352

RMWFE = 0.479

Chi Squared = 47.2

c. Segment-Level Estimate with Equivalent Null Seed

From | To	1	2	3	4	5	6	7	8	On
1	0.0	14.1	5.8	7.0	9.9	7.6	5.5	0.9	51
2		11.9	12.2	14.8	20.7	15.9	11.6	2.0	89
3			4.0	12.0	16.9	13.0	9.5	1.6	57
4				4.2	14.7	11.4	8.3	1.4	40
5					9.8	18.9	13.9	2.3	45
6						12.1	22.1	3.8	38
7							33.0	14.0	47
8								16.0	16
Off	0	26	22	38	72	79	104	42	383

RRMSE = 0.368

RMWFE = 0.513

Chi Squared = 52.2

d. Segment-Level Estimate with Naive Null Seed

From | To	1	2	3	4	5	6	7	8	On
1	0.0	9.5	5.3	7.3	10.6	8.9	7.5	1.9	51
2		16.5	9.3	12.7	18.5	15.6	13.1	3.3	89
3			7.3	10.0	14.6	12.2	10.6	2.6	57
4				8.0	11.7	9.9	8.3	2.1	40
5					16.5	13.9	11.7	2.9	45
6						18.5	15.6	3.9	38
7							37.6	9.4	47
8								16.0	16
Off	0	26	22	38	72	79	104	42	383

RRMSE = 0.534

RMWFE = 0.641

Chi Squared = 94.8

TABLE 2 COMPARISON OF SEGMENT-LEVEL ESTIMATES, ROUTE 77 OUTBOUND

a. Estimate using Small O-D Sample Seed

From | To	1	2	3	4	5	6	7	On
1	0.0	14.6	16.2	3.2	1.6	1.6	92.4	130
2		6.5	56.7	6.5	13.0	84.3	298.1	465
3			9.7	3.2	1.6	38.9	228.5	282
4				6.5	3.2	4.9	197.7	212
5					0.0	9.7	110.2	120
6						40.5	367.8	408
7							0.0	0
Off	0	21	83	19	19	180	1295	1617

b. Segment-Level Estimate with Equivalent Null Seed

From | To	1	2	3	4	5	6	7	On
1	0.0	11.8	16.2	2.4	2.1	14.6	82.9	130
2		9.2	57.9	9.4	8.0	57.0	323.4	465
3			8.9	6.1	5.5	39.2	222.3	282
4				1.1	3.4	31.1	176.4	212
5					0.0	15.4	104.6	120
6						22.7	385.3	408
7							0.0	0
Off	0	21	83	19	19	180	1295	1617

RRMSE = 0.197

RMWFE = 0.427

Chi Squared = 106.3

c. Segment-Level Estimate with Naive Null Seed

From | To	1	2	3	4	5	6	7	On
1	0.0	4.6	12.2	2.2	1.9	13.3	95.8	130
2		16.4	43.5	7.8	7.0	47.6	342.7	465
3			27.3	4.9	4.4	29.9	215.4	282
4				4.1	3.6	24.9	179.3	212
5					2.1	14.4	103.5	120
6						49.8	358.2	408
7							0.0	0
Off	0	21	83	19	19	180	1295	1617

RRMSE = 0.242

RMWFE = 0.407

Chi Squared = 126.1

seed, the information content can be evaluated in terms of bias and sample size.

The main bias in O-D surveys is nonresponse bias, which is present if the response rate is substantially below 100 percent, a condition endemic to surveys on busy bus routes, and the nonresponding population is different in its O-D patterns from the responding population. The differences most often cited are as follows: nonresponders (a) are more likely to come from segments of the route in neighborhoods that have lower literacy or are less cooperative, or both; (b) are more likely to board where the route is crowded and they can't get a seat; and (c) are more likely to be making short trips, leaving them too little time to complete a survey. Fortunately, the first two biases are proportional to the response rates at each origin and each destination stop, and since the biproportional method correctly expands origin and destination totals, these biases disappear, as confirmed by Ben-Akiva (*12*). The third bias, however, remains, and can be significant, though its extent is hard to judge.

The effect of sample size on quality of information in an O-D matrix is also well known. A common rule of thumb is that an observation of fewer than five travelers in a cell is unreliable, since a difference of one or two people can effect an enormous relative change in the value. In the extreme case, a cell with no observations poses a special challenge, since a biproportional estimate for a cell must be zero if its seed value is zero. If a small-sample O-D matrix, aggregated to the segment level, where the segment is the level of the detail one is finally interested in, has a substantial number of cells with fewer than five observations, the information content of the seed may be so compromised by sampling error that it is worse than the information content of a null seed.

For example, the small-sample O-D surveys used by Ben-Akiva et al. (*8*) are all quite small, containing 61, 76, 138, and 54 responses for the four route/direction combinations studied. In the case with the greatest sample size, Route 77 outbound, only 8 of 25 segment-to-segment cells contain five or more observations, and six of these all lie in the same column of the matrix alighting at the last stop. Ten of the 25 cells contain no observations at all. An estimate based on such a seed seems risky.

Ben-Akiva et al. respond to the problem posed by cells with zero observations by offering a correction to deal with these "non-structural zeros." Even with this correction, estimates based on the empirical seed are heavily influenced by patterns that appear in the seed. Their estimate for Route 77 outbound made using this empirical seed (Table 2a, equivalent to their Table 3) contains the peculiar pattern in which, although there is substantial demand from Segments 1 to 7 (92 passengers) and from Segments 2 to 6 (84 passengers), there is virtually no demand from Segments 1 to 6 (1.6 passengers), because in the small-sample O-D survey, no one went from 1 to 6. In contrast, the estimate resulting from the equivalent null seed (Table 2b) has a much more typical pattern, assigning a far larger volume (14.6 passengers) to O-D pair 1–6. Because Route 77 is a short route and, at the time of data collection, had no significant competition from other routes, a null seed seems quite plausible. The question is whether the peculiar pattern found using the small-sample seed is a reflection of true patterns in the population, or just the spurious outcome of a random sampling process.

The effect of sample size can be addressed more rigorously. Ben-Akiva et al. provide equations for determining the approximate standard error of a biproportional estimate based on the number of observations in a cell, and also report approximate standard errors of their estimates. However, because many of their results are reported normalized to a standard grand total, the level of accuracy attained is not immediately apparent. Reversing the normalization, it was found that for the case of Route 77 outbound, the relative standard error of their estimates (standard error divided by estimate) is quite small (below 13 percent) for all six eligible cells in which the destination is Segment 7. These were the cells with many observations in the empirical seed. In the remaining 19 eligible cells of the matrix, the seed contained only 26 observations. Consequently, the relative standard error is greater than 100 percent in a majority of those cells. For the entire matrix, the average passenger volume per eligible cell is 17, and the average approximate standard error is 8.4. With a smaller sample size, as in the other three cases examined by Ben-Akiva et al. (*8*), errors can be substantially larger.

How large should a small-sample survey be for it to be a more reliable seed than an equivalent null seed for O-D matrix estimation? To explore this issue, a Monte Carlo simulation was conducted that repeatedly drew samples at random from the population of passengers surveyed on Lines 16 and 93, the two routes for which complete stop-level data were available. Simulated sampling was done without replacement, and there was no bias in the sampling process. Biproportional estimates were generated for various sample sizes using the simulated sample as a seed and compared with the true distribution. For each sample size, 100 to 200 repetitions were made. The final measure of fit reported is the RMSE as averaged across all cells and all repetitions for a given sample size. The results, shown in Figure 2, show how estimation error decreases with the sample size.

Also shown in Figure 2 is the RMSE resulting from a stop-level estimate using a null seed. While the three cases examined are too few to draw any firm conclusions, the results consistently show that a null seed is better than the ideal small-sample seed with fewer than 100 observations. When real-world sampling biases, response errors, and coding errors are accounted for, the sample size at which a null seed is as reliable as a small-sample survey will be still higher. On the other hand, if the route under study has significant competition from other routes, the null seed model is theoretically flawed, and so a small-sample seed will be preferred even with a sample size under 100.

CONCLUSIONS

Planners who need route level O-D matrices have had two primary approaches to use for generating O-D matrices from on-off counts. One is the biproportional and similar iterative methods that require a seed matrix containing information about relative preferences for O-D pairs. The seed matrix is usually a small-sample O-D matrix. The other technique, Tsygalnitsky's recursive method, is a computationally simple technique that requires no seed matrix. The recursive method is actually a special case of the biproportional model using a "null seed," a seed matrix in which entries are either zero or

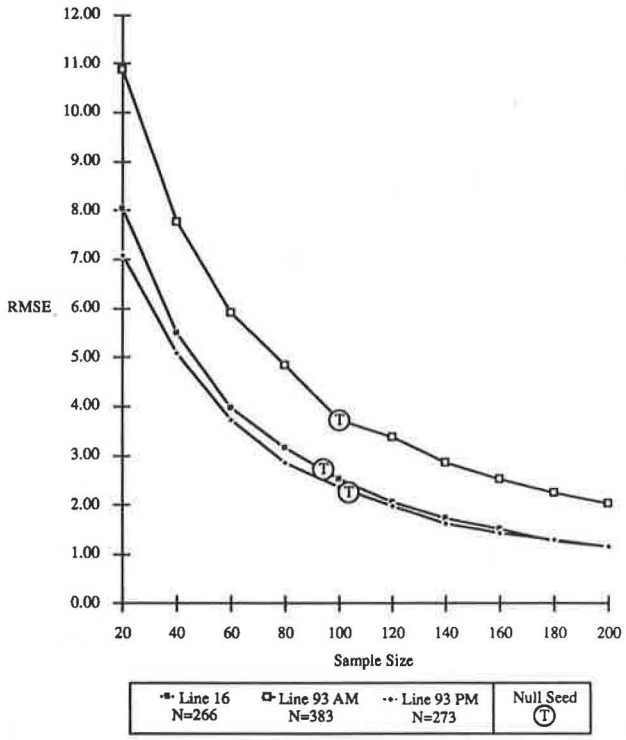

FIGURE 2 Estimation error versus sample size.

one, corresponding to whether travel between stop pairs is permissible based on direction of travel and minimum travel distance. A null seed is theoretically plausible on certain types of routes, such as relatively short routes with little interference (e.g., competition) from other routes. Empirical tests on different bus routes confirm this hypothesis.

The structure of the null seed underlying the recursive method implies that it is unsuitable for application to segment-level data. Instead, the biproportional method should be applied using an "equivalent null seed," a seed whose values are the average stop-level null seed propensity averaged over the stop pairs comprehended in a segment-level pair. This method yields results that closely approximate estimates made using the recursive method with stop-level data. It is probably the best method available for generating a transit route O-D matrix from segment-level data when there is no reliable small-sample survey or old O-D matrix to serve as a seed.

Finally, a comparison of estimation error using an equivalent null seed versus using a small O-D sample seed indicates, at least for the routes tested, that an ideal small-sample survey is preferable to a null seed when the sample size is over 100, and that a null seed is preferable when the sample size is smaller. In real-world applications, modifications to this threshold should be made to account for imperfections in the sampling process and competition between routes.

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Publication of this paper sponsored by Committee on Bus Transit Systems.

Transportation Systems Management Options to Improve Urban Bus Route Performance Using Computer Simulation

S. Moses Santhakumar and P. Hariharan

In view of the increasing demand on public transport in medium-sized cities of the Third World and the limited resources available for improving bus transit, suitable transportation system management (TSM) strategies need to be applied. This study uses a computer simulation model to evaluate the impact of TSM options on the performance of a bus route in a medium-sized city in India. The simulation model was validated with data from a bus route in Tiruchirapalli, and various TSM strategies including increase in running speed, removal of bus stops, operation of special services, and combination of options were simulated. The simulation results were compared with earlier findings in Madras. The conclusions drawn may be extended to other routes in Third World cities. More than 40 percent of the trip time is spent in changing speed because of the presence of a large number of intersections and bus stops. However, increase in speed or speed change rates do not significantly influence the trip time. Removal of two and four bus stops reduces the travel time by 3 and 6 percent, respectively. Combination of removal of stops with an increase in speed and speed change rates by 10 percent doubles the reduction in travel time. The combination of increase in speed and speed change rates with removal of four stops enables the operation of two additional round trips, leading to better utilization of the existing fleet.

The population explosion and the accompanying urban migration have led to the phenomenal growth of cities around the world. Cities in the Third World countries such as India have evolved in a haphazard manner. With increased city sizes, trip lengths have increased, and the burden of commuter travel has fallen upon public transport as longer trips tend to discourage walking and cycling as convenient alternatives (*1*). This enhanced demand will have to be met by improvements to bus transit, because other alternatives such as suburban rail are highly capital-intensive and hence not suited to India. To derive the maximum benefit from the limited resources available for investment in bus transit, suitable transportation system management (TSM) strategies need to be implemented.

This study uses a computer simulation model to evaluate the impact of TSM options on the performance of urban bus routes. A simulation model developed for Madras (*2*) was substantially modified and applied to Tiruchirapalli (Trichy), a medium-sized city in India (*3*). Trichy differs significantly from Madras in area, population, and traffic composition. Parameters influencing bus operation such as route length, passenger demand, spacing of stops, and so on, are also different in the two cities. A number of TSM options have been tried on a typical route in Trichy with a view to identifying those measures that are suitable for Third World cities.

In the present study an effort was also made to combine compatible TSM options and arrive at an optimum combination that would result in maximum reduction in travel time. This reduction was translated into additional round trips that can be operated by the same bus fleet. The impacts of the various options in Trichy and Madras were compared wherever possible. It is hoped that the TSM options effective in the two cities can be applied to other bus routes in Third World cities.

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SIMULATION MODEL

Most of the deterministic models developed for studying bus transit are oversimplified and neglect many aspects of real bus operation by forcing it into a restrictive mold to suit the needs of the model (*2*). The simulation technique with its inherent capability to model random environments is the ideal tool for the study of bus operation (*4*). Random conditions can be replicated in simulation models, facilitating comparison of the impacts of parametric changes under identical field conditions (*5*). Hence simulation has been widely used to model bus transit (*6–9*). The present model, written in GPSS (General Purpose Simulation System) language, is a microsimulation model in which every bus and every passenger is traced (*2*).

The different processes involved in bus operation are shown in Figure 1. The model divides the route into a number of segments bound by critical points at which the bus has to either slow down or stop. The critical points include bus stops, all types of intersections, and police-controlled pedestrian crossings. Buses are generated at the origin, and their movement is governed by the given speed and acceleration or deceleration rates. Passengers queue up at the origin and intermediate bus stops, and their movements are simulated using passenger destination probabilities.

The travel time of the passenger consists of walking time, waiting time, in-vehicle travel time, and concealed waiting time (*2*). Reduction of in-vehicle travel time in a bus route benefits not only the bus passenger, but also the transit operator, since more trips can be operated with the same bus fleet (*10*).

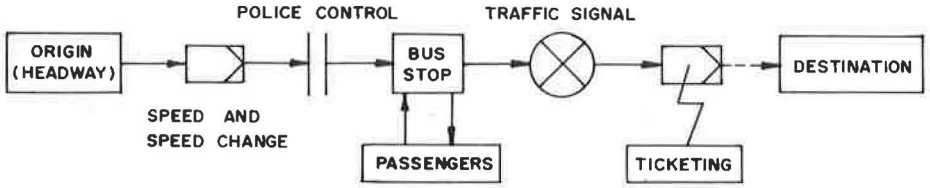

FIGURE 1 Schematic of urban bus route.

The total trip time comprises stopped time at bus stops, ticketing delay, intersection delay, time taken for speed change, and uniform running time. If all of the passengers are not issued tickets at the end of a fare stage, the bus waits at the last fare stage stop to complete the issue of tickets. Such a delay is termed the ticketing delay. Intersection delay consists only of the stoppages at intersections. Uniform running time is the time during which the bus runs at uniform speed.

MODEL VALIDATION

For validation of the model under the conditions in Trichy, a typical bus route from the central bus stand to the Main Guard Gate via Thillai Nagar was chosen (*3*). Various route details such as location of critical points, fare stage stops, origin headways, passenger demand at various points, and passenger destination probabilities were collected. Table 1 presents the parameters of the study route in comparison with the two routes in Madras (*2*).

In order to collect travel time statistics, six trips were made in buses along the route during the evening peak period. The total travel time and stopped time at bus stops were noted. With the above data the simulation model was run for a 2-hr peak period. The simulation was repeated under six different random number streams to minimize the bias due to random numbers. To maintain uniformity, the average of the six simulation runs is taken as the base case for validation and for analysis of options.

The simulation results and field values are compared in Table 2. The total travel time and bus stop time closely agree with the field observations. The *t*-test at the 5 percent level of significance shows that no significant differences exist between field values and simulation results. This indicates satisfactory validation of the simulation model.

From the results of the base-case simulation, the components of travel time were derived as percentage of total travel time and compared with the corresponding values for Madras (*2*) in Figure 2. The components of travel time are similar in both cities, with speed change time, uniform running time, and bus stop time constituting the major portion of travel time.

Speed change operations account for more than 40 percent of trip time, because of the large number of critical points at which the bus has to either slow down or stop. In Trichy, the speed change time is more than in Madras because of the closer spacing of critical points.

Ticketing delay is nearly zero in Trichy, because the buses are operated with two conductors. Intersection delay is also lower in Trichy, because there are fewer signalized and police-controlled intersections where the bus has to actually stop. Most of the intersections are priority-based and buses merely slow down. Uniform running time is the same in all cases.

TABLE 1 DETAILS OF SIMULATED ROUTES IN MADRAS AND TRICHY

Sl. No.	Parameter	Madras Route 18	Madras Route 15C	Trichy Route 36
1	Length (km)	11.2	9.8	7.5
2	Bus stops	16	17	18
3	Signalized intersections	8	5	0
4	Police-controlled intersections	2	3	4
5	Police-controlled pedestrian crossings	4	0	1
6	Uncontrolled intersections	6	11	10
7	Nominal headway at origin (min)	4	13	10
8	Average origin demand (pass/hr)	796	162	300
9	Average traffic volume (pcu/lane/hr)	785	850	915

SIMULATION OF OPTIONS TO IMPROVE BUS TRANSIT

The TSM options studied using the simulation model are

- Variation in nominal running speed,
- Variation in speed change characteristics,
- Removal of bus stops,
- Running of special services,
- Deployment of different types of buses, and
- Relocation of bus stops.

For the analysis of each option, six simulation runs were made using the same random number streams as those for the base-case simulation and the results were then averaged. The base-case results were compared with the simulation results of options under study, and the variations in travel time components under the influence of each option are summarized in Table 3. The 95 percent confidence limits of the mean total travel time established for each option with the use of the *t*-test are given in column 9. Column 10 gives the percentage deviation of the travel time under each option from that of the base case.

Variation of Running Speed

In order to study the effect of running speed on travel-time components, the bus route was simulated with the nominal speed of 35 kph increased by 10 and 20 percent.

TABLE 2 VALIDATION OF SIMULATION MODEL

Parameter	Average Field Value (sec)	Average Model Value (sec)	Difference Absolute (sec)	Difference Relative (%)	t-value at 5% Level
Total travel time	1582.5	1551.8	30.7	−1.9	0.54
Bus stop time	364.7	342.0	22.7	−6.6	0.55

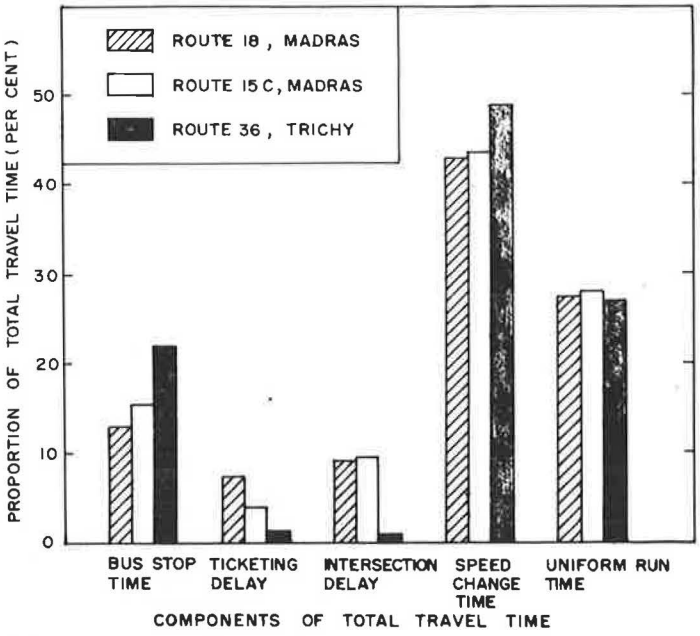

FIGURE 2 Components of total travel time in the simulated routes.

TABLE 3 EFFECT OF VARIOUS TSM OPTIONS ON TRAVEL TIME COMPONENTS

Sl. No.	Option	Bus Stop Time (sec)	Ticketing Delay (sec)	Intersection Delay (sec)	Acc./Dec. Time (sec)	Uniform Run Time (sec)	Total Travel Time (sec)	95% Confidence Limits (sec)	Relative Effect (%)
1	BASE CASE	342	18	7	769	415	1552	—[a]	—[a]
2	NOMINAL RUNNING SPEED								
	(a) Increased by 10%	341	35	24	815	348	1566	N.S.[b]	+0.9
	(b) Increased by 20%	341	38	25	838	304	1546	N.S.[b]	−0.4
	(c) Decreased by 10%	341	31	19	717	503	1611	N.S.[b]	+3.8
3	ACC. AND DEC. RATES								
	(a) Increased by 10%	341	40	32	710	431	1555	N.S.[b]	+0.2
	(b) Decreased by 10%	342	30	22	844	395	1633	±64	+5.2
4	BUS STOP REMOVAL								
	(a) Two stops	327	22	10	686	457	1504	N.S.[b]	−3.1
	(b) Four stops	305	30	10	613	494	1454	±57	−6.3
5	SPECIAL SERVICES								
	(a) Limited stop	77	10	22	305	610	1153	±45	−25.7
	(b) Express	22	0	27	159	686	884	±45	−43.0
	(c) Point-to-point	0	0	27	92	719	825	±44	−46.8
6	TYPE OF BUS								
	(a) Mini bus	330	6	29	769	417	1550	N.S.[b]	−0.1
	(b) Articulated bus	206	62	22	774	414	1476	±64	−4.9
	(c) Double decker	337	45	28	774	412	1579	N.S.[b]	+1.7
7	RELOCATION OF BUS STOPS Distance from intersection								
	(a) Increased to 100m	346	17	28	777	412	1579	N.S.[b]	+1.8
	(b) Increased to 150m	344	17	24	786	401	1573	N.S.[b]	+1.4
	(c) Increased to 200m	345	19	19	793	339	1567	N.S.[b]	+1.3
8	ROAD TRAFFIC								
	(a) Increased by 10%	343	33	22	765	433	1596	N.S.[b]	+2.8
	(b) Increased by 20%	343	35	21	750	463	1613	N.S.[b]	+3.9
	(c) Increased by 30%	342	34	23	732	490	1622	±63	+4.5
9	PASSENGER DEMAND								
	(a) Increased by 10%	363	42	35	775	414	1632	±58	+5.2
	(b) Increased by 20%	379	54	24	775	413	1644	±58	+6.0
	(c) Increased by 30%	395	67	25	771	414	1672	±52	+7.7
10	COMBINATION OF OPTIONS								
	(a) Options 2a & 3a	345	28	25	761	361	1518	N.S.[b]	−2.2
	(b) Options 10a & 4a	311	22	20	677	404	1434	±70	−7.6
	(c) Options 10a & 4b	276	22	24	607	442	1371	±71	−11.7

[a] Not Applicable.

[b] Not significant at 5 per cent level.

TABLE 4 COMPARISON OF SIMULATION RESULTS IN MADRAS AND TRICHY

Sl. No.	Option	Madras Route 18 Travel Time (sec)	Madras Route 18 Relative Effect (%)	Madras Route 15C Travel Time (sec)	Madras Route 15C Relative Effect (%)	Trichy Route 36 Travel Time (sec)	Trichy Route 36 Relative Effect (%)
1	BASE CASE	2297	—[a]	2074	—[a]	1552	—[a]
2	NOMINAL RUNNING SPEED						
	(a) Increased by 10%	2264	N.S.[b]	2051	N.S.[b]	1566	N.S.[b]
	(b) Increased by 20%	2228	−3.0	2024	−2.4	1546	N.S.[b]
3	BUS STOP REMOVAL						
	(a) Two stops	2245	−2.3	2026	−2.3	1504	−3.1
	(b) Four stops	2187	−4.8	1964	−5.3	1454	−6.3
4	SPECIAL SERVICES						
	(a) Limited stop	1629	−29.1	1405	−32.3	1153	−25.7
	(b) Express	1481	−35.5	1346	−35.1	884	−43.0
	(c) Point-to-point	1431	−37.7	1328	−36.0	825	−46.8
5	TYPE OF BUS						
	(a) Mini bus	2272	N.S.[b]	2104	N.S.[b]	1550	N.S.[b]
	(b) Articulated bus	2014	−12.3	1885	−9.1	1476	−4.9
	(c) Double decker	2060	−10.3	1933	−6.8	1579	N.S.[b]

[a] Not Applicable.

[b] Not significant at 5 per cent level.

An increase in running speed of 10 or 20 percent causes no significant change in the total travel time. Small changes in nominal running speed do not affect the travel time, because of the large number of critical points along the route at which the bus has to either slow down or stop. Table 4 shows that the effect of increased running speed on travel time is more prominent in Madras, and this can be attributed to the greater spacing of critical points and the greater orderliness in traffic.

Increase in speed is associated with increased accident risk. Additional expenditure and effort to increase the running speed cannot be justified, especially if the route has a large number of intersections and closely spaced bus stops.

Modification of Speed Change Characteristics

The nominal acceleration rate used in the model is 0.34 m/sec^2 and the deceleration rate is 1.03 m/sec^2. The acceleration and deceleration rates were increased by 10 percent and the system was simulated. Although speed change time forms a major part of total trip time, the increase in acceleration and deceleration rates causes no significant change in travel time. This is similar to the result obtained in Madras (*2*). Speed change time is converted to uniform running time and the net effect becomes negligible, and therefore, this option may not be effective.

Removal of Bus Stops

The effect of bus stop removal was studied by simulating the bus operation with removal of two and then four stops. Passengers at the removed stops were redistributed to the adjacent stops in inverse proportion to the walking distance.

The total travel time is reduced by about 3 and 6 percent with the removal of two and four stops, respectively. Figure 3 shows the effect of stop removal on travel time in Trichy and Madras. It can be seen that stop removal has a greater effect on total travel time in Trichy than in Madras. Removal of stops is a very effective option to reduce the travel time, especially in Trichy where the average stop spacing is as low as 400 m.

Special Services

Limited stop, express, and point-to-point services were simulated with a number of assumptions to arrive at the savings in travel time that can be achieved by operating special services. Total travel time decreases by about 30 percent when special services were operated. The effect of special services is more pronounced in Trichy because of the lower stop spacing in the city. Long-distance passengers will benefit more from the operation of special services. However, this will reduce the frequency at intermediate stops and the effective waiting time of passengers at certain stops will increase.

Type of Bus

Queue length and waiting time at bus stops depend on the capacity of the bus. The normal Indian bus has a nominal

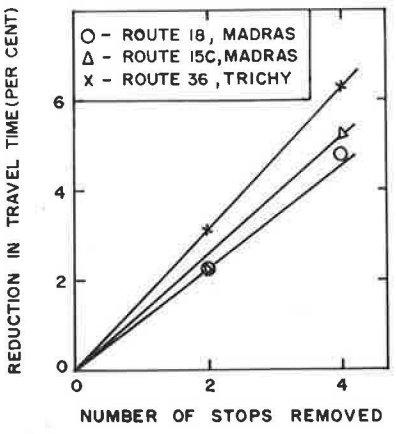

FIGURE 3 Effect of removal of stops on travel time.

capacity of 67. Other types of buses such as minibuses, articulated buses, and double-decker buses have capacities of 44, 97, and 103, respectively, and were simulated on the route.

The total travel time for minibuses does not register any significant change. Because of the presence of four doors in the articulated bus, the bus stop delay decreases, reducing the travel time by a significant 5 percent. There is no significant change in travel time parameters when a double-decker is operated. The reduction in travel time in Madras with the operation of articulated buses and double-deckers is much greater (see Table 4). This can be attributed to the reduction in ticketing delay achieved by using two conductors. Deployment of high-capacity vehicles reduces passenger waiting time and queue length at intermediate stops considerably.

The roads in Trichy are generally narrow, overcrowded, and inadequate to serve the present traffic (*11*). Minibuses are more suitable for narrow roads, and their introduction may lead to a general improvement in traffic conditions. If wider roads are available, high-capacity vehicles may be introduced to reduce passenger waiting time.

Relocation of Bus Stops

Bus stops located near intersections impede the movement of other vehicles and increase accident risk at the intersection. The route under study has five bus stops located at less than 50 m from intersections. These bus stops were moved away in steps of 50 to 200 m and the bus route was simulated to detect any significant changes in relevant parameters.

The simulation results show that relocation of stops causes no significant change in travel time or other relevant parameters. Therefore it is recommended that bus stops be located at a reasonable distance from intersections, and further studies are required to determine the optimal distance.

Increase in Passenger Demand and Road Traffic

Factors affecting bus operation, such as passenger demand and road traffic, may increase over the course of time because of development in the city. The model was used to predict the effects of such changes.

Both the parameters were increased by 10, 20, and 30 percent individually and simulation runs were made. The impact of increase in passenger demand and road traffic on journey speed is shown in Figure 4. The average journey speed in the route is 17 kph. Figure 4 shows that passenger demand influences the journey speed more. The effect of road traffic on the routes in Madras and Trichy is more or less the same, whereas an increase in passenger demand in Madras reduces the journey speed more, because the buses there are already overcrowded. When passenger demand increases, waiting time and queue length increase, especially at intermediate bus stops because of the ceiling on capacity.

COMBINATION OF OPTIONS

In any TSM strategy, a combination of compatible options is preferable to applying individual measures. An effort has been made to identify an optimum combination that will bring about substantial improvement to the operation of bus transit. The results of the simulation of combination of options are presented in Table 5.

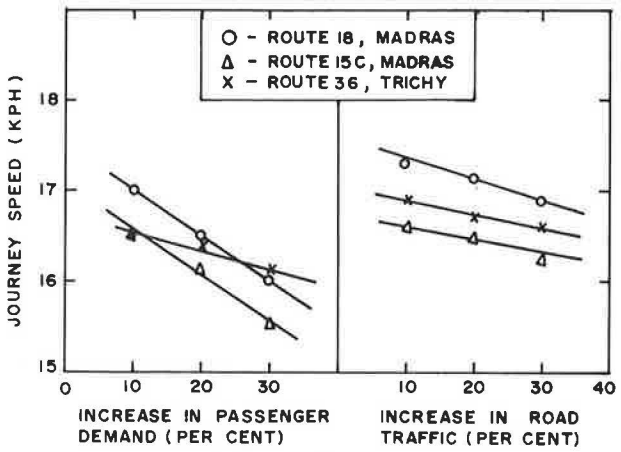

FIGURE 4 Effect of passenger demand and road traffic on journey speed.

Increase in speed and acceleration or deceleration rates are compatible, and a combination of these two options was simulated on Route 36 in Trichy. The results show that no significant change occurs in any of the major components of travel time. The combination is not effective because of the large number of critical points along the route. In order to make the above combination more effective, it was applied in conjunction with stop removal. When two and four stops were removed, the travel time was reduced by 7 and 12 percent, respectively. Bus stop delay and speed change time register significant reductions leading to substantial savings in travel time.

A number of measures have to be implemented to increase the speed and acceleration or deceleration rates. Improvement of road geometry, traffic segregation, proper pedestrian facilities, and effective implementation of traffic rules improve the road conditions. On the other hand, any increase in speed entails higher accident risk. Proper facilities for pedestrians and cyclists must be provided to minimize the risk. The simulation results indicate that improvement in road and traffic conditions combined with the removal of closely spaced stops leads to substantial savings in travel time.

SIGNIFICANCE OF TRAVEL TIME SAVINGS

In developing countries, saving of 1 or 2 min of travel time may not be very significant as perceived by the bus passenger

TABLE 5 EFFECT OF COMBINATION OF TSM OPTIONS

Sl. No.	Parameter	Percentage change due to option: Speed +10% Acc. and Dec. Rates +10% [1]	[1] and Two Stops Removed [2]	[1] and Four Stops Removed [3]
1	Total travel time	−2.2	−7.6	−11.7
2	Bus stop time	0.0	−9.1	−19.3
3	Acc. and dec. time	−1.0	−12.0	−21.1
4	Uniform running time	−13.0	−2.7	+6.5
5	Overall waiting time	−10.7	−15.8	−28.8

TABLE 6 TIME SAVINGS REQUIRED FOR ADDITIONAL ROUND TRIPS

Extra Round Trips	Extra Time Required (sec)	Time to be Saved per Trip in Peak (sec)	Proportion of Total Trip Time Saved (%)
1	1560	64	4.3
2	5248	170	10.9

TABLE 7 TSM OPTIONS LEADING TO ADDITIONAL ROUND TRIPS

Sl. No.	Option	Proportion of Total Trip Time Saved (%)	Number of Extra Round Trips
1	Removal of 4 stops	6.3	1
2	Articulated bus	4.9	1
3	Increase in speed and acc. & dec. rates with removal of 2 stops	7.6	1
4	Increase in speed and acc. & dec. rates with removal of 4 stops	11.7	2

(*12*). But by reducing the time taken for one single trip, additional round trips can be operated by the same bus in a day, and this will lead to better utilization of the bus fleet with an increase in transport supply.

An attempt has been made to determine the travel time saving required for operating one or two extra round trips on Route 36 in Trichy. Each bus is operated for 16 hr, from 6:00 a.m. to 10:00 p.m.; 6 of these hours are peak period and 10 of these hours off-peak. Trip time during off-peak period is assumed to be 90 percent of that during the peak period. One hour will be lost in shift changes and therefore 15 hr is available for effective operation. The bus is assumed to have a layover of 5 min at each end.

The time savings required for making additional round trips are shown in Table 6. Savings of 4 and 11 percent in travel time will enable one and two more round trips, respectively. The TSM options resulting in the required time savings are given in Table 7. Removal of low-demand stops proves to be the most effective option from the standpoint of additional round trips.

CONCLUSIONS

From the simulation study of a bus route in Trichy and comparison with the results obtained in Madras, some general conclusions can be drawn about the operation of bus routes in Third World countries. Of the total trip time, more than 40 percent is spent in acceleration and deceleration, because of the presence of a large number of intersections and other critical points. The journey speeds on the routes in Trichy, as well as in Madras, are as low as 17 kph because of the high frequency of critical points and heavy passenger demand.

TSM options can be implemented to reduce travel time. Increase in running speed or acceleration and deceleration rates does not influence the travel time much, especially on routes with a large number of bus stops and intersections. Removal of two and four stops reduces the travel time by about 3 and 6 percent, respectively. Low-demand or closely spaced stops may be removed even though this will make some of the passengers walk further. Operation of special services will reduce the travel time by more than 30 percent, and this measure will be highly beneficial to long-distance passengers.

Location of stops very near intersections impedes other vehicles and leads to an increase in accident risk. Relocation of such stops will cause no significant change in any of the travel time parameters. Such a measure is recommended for reducing general delay and accident risk at intersections.

Combination of compatible options brings about significant reduction in travel time. Increasing the speed and acceleration and deceleration rates with removal of certain low-demand, closely spaced stops is the optimum measure to get maximum savings in trip time. Removal of four stops in this combination reduces the travel time by more than 10 percent.

Additional round trips can be operated every day by a bus if significant reduction in trip time can be achieved. Removal of four stops with increase in speed and acceleration and deceleration rates by 10 percent will enable operation of two more round trips.

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Publication of this paper sponsored by Committee on Bus Transit Systems.

Development and Application of Performance Measures for Rural Public Transportation Operators

DAVE N. CARTER AND TIMOTHY J. LOMAX

Despite the increased interest in performance indicators for large transit systems, there has been no equivalent effort at establishing similar techniques for small and rural systems. This project has developed a methodology to evaluate the relative performance of operators of rural transit service funded through the Section 18 Program of the former Urban Mass Transportation Administration (now the Federal Transit Administration). It was found that the agencies could be compared using measures of cost efficiency, cost-effectiveness, service utilization, vehicle utilization, quality of service, labor productivity, and accessibility. The transit agencies and the Texas Department of Transportation can use these measures for analysis of performance trends, evaluation of overall system performance, transit planning, and technical assistance. The procedure uses a standard score methodology to compare the performance of individual agencies to the mean of all rural transit operators in Texas. It was determined that the use of peer groups of similar agencies would not significantly change the conclusions. Peer groups would, however, increase the time to prepare a performance evaluation, and the agencies within each peer group would change annually, making trend comparisons more difficult. Transit operators indicated a desire for information and suggestions from staff members of the Public Transportation Division of the Texas Department of Transportation on methods to improve performance. The findings indicate that more review of the statistics provided by the operators and greater communication between the operators and Public Transportation Division staff would increase the usefulness of the performance measures.

The use of performance measures has increased in the past few decades because of the predominance of public ownership and funding programs provided at state and federal levels (*1*). The Federal Highway Administration's Rural Public Transportation Demonstration Program (Section 147) and the Section 16(b)(2) Program and the Public Transportation for Non-Urbanized Areas Program (Section 18) of the former Urban Mass Transportation Administration (now the Federal Transit Administration) have all provided funding and stimulated growth in rural transit service (*2*).

In the past two decades the collection and evaluation of performance statistics has become an important part of transit system planning and management. Government subsidies for transit operating assistance and capital improvements created the need for accountability and control of transit management (*1,3*). Despite the increased interest in performance indicators for large transit systems, there has not been as much effort in establishing similar techniques for small urban and rural systems. The metropolitan transit authorities in Texas are, with their dedicated funding sources and large staffs, typically able to collect and analyze more performance data than municipal or rural transit agencies.

Current uses of transit system performance measures include fund allocation, administrative planning, and comparisons with agencies of similar size or composition. The ability of one agency to compare its performance with that of another agency and with previous operating characteristics is important in the planning process. Performance measures may be used by transit administrators for planning in several ways, including

- Evaluation of overall system performance,
- Evaluation of individual route performance (fixed-route operations),
- Evaluation of a single transit function (e.g., maintenance or procurement),
- Examination of the effects of a fare policy change (fare elasticity),
- Tracing changes in performance over time, and
- Evaluation of the goals and objectives of an agency.

GENERAL RURAL SYSTEM CHARACTERISTICS

As shown below, there are significant service and demographic differences between rural and urban transit systems that should be considered in the development of appropriate planning and evaluation techniques.

- Rural transit providers operate in large areas that have low population.
- Residents of rural areas generally have lower income levels than their urban counterparts.
- Rural transit providers often do not operate a fixed-route service. Operations are usually demand-responsive or subscription service.
- The objectives of rural systems are more concerned with providing transportation to transit-dependent groups (elderly, youth, low income, handicapped, etc.) than with reducing traffic congestion.

PERFORMANCE MEASUREMENT

Performance is a general term referring to any evaluation or comparison measure (*1*). Specific measures that define perfor-

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mance include effectiveness, efficiency, impact, productivity, and quality of service (*2*). Each of these measures has certain indicators that are used to signify transit performance for each particular measure. Not all agencies, states, and research studies use the same terms for performance measures; some previous studies have used only efficiency or effectiveness. Indicators that describe impact, productivity, and the quality of service may be used but are classified as either efficiency or effectiveness measures.

Three elements—demographic factors, service descriptors, and performance indicators—are necessary to compare transit services fairly. There are several very important differences among demographic factors, service descriptors, and performance indicators.

Demographic factors (service area size, population, etc.) describe the inherent characteristics of a service area. These factors can be used to establish peer groups for comparison. A peer group consists of transit agencies with similar service and area characteristics. Similar agencies may be grouped to avoid the comparison of agencies that lack similar demographic factors or performance expectations.

Service descriptors, simple input or output data such as total vehicle-miles or passengers, indicate the quantity of service provided. They do not give an indication of efficiency, effectiveness, impact, or quality. Therefore, they cannot be considered performance indicators. Descriptors may show the quantity of service provided but do not indicate the quality of service provided.

Performance indicators can measure the efficiency, effectiveness, impact, or quality of transit service. Service descriptors and demographic factors are used to calculate performance indicators. For example, the result of dividing total passengers by total miles produces a performance indicator for service utilization (i.e., passengers per mile of service). Indicators of effectiveness typically include passenger descriptors, such as total passengers, fare-paying passengers, elderly or handicapped passengers, or transfers. Cost per passenger would be a measure of cost-effectiveness and cost per mile would measure cost efficiency.

Efficiency is a measure of how well a system is using its resources to provide transit service. Effectiveness can be defined as the use of output to accomplish goals, or the benefit the public actually receives from the services. Briefly stated, efficiency is "doing things right" and effectiveness is "doing the right things" (*4*).

Performance measure categories and their associated indicators are given in Table 1. A performance measure may have more than one indicator associated with it; for example, cost per passenger trip, revenue per passenger trip, and revenue recovery ratio are indicators of cost-effectiveness.

TABLE 1 PERFORMANCE MEASURES AND INDICATORS

Performance Measure	Performance Indicators
Cost Efficiency	Cost per mile Cost per hour Cost per vehicle Revenue recovery ratio
Cost Effectiveness	Cost per passenger trip Revenue per passenger trip Revenue recovery ratio
Service Utilization/Effectiveness	Passenger trips per mile Passenger trips per hour Passenger trips per capita
Vehicle Utilization/Efficiency	Miles per Vehicle
Quality of Service	Average speed Vehicle-miles between road calls Vehicle-miles between accidents
Labor Productivity	Passenger trips per employee Vehicle-miles per employee
Accessibility	Vehicle-miles per capita Vehicle-miles per service area

NONURBANIZED TRANSIT SYSTEMS IN TEXAS

In 1988 there were 37 transit providers in Texas that received federal financial assistance through the Section 18 Program, which was established by the Surface Transportation Assistance Act of 1978 for public transportation in nonurbanized areas. This program is not a social service program for the elderly or handicapped, and should not be confused with the UMTA Section 16(b)(2) program. The Section 16(b)(2) transit providers were not analyzed in this project because of their diverse service objectives and characteristics.

The goal of the Section 18 Program is to increase the access of people in rural areas to health care, shopping, education, recreation, and employment, as well as public services. The Section 18 Program provides administrative, capital, operating, and planning assistance for transit services that originate or end in a rural area, or both. Maximum federal participation for grants in this program is 80 percent for capital and administrative expenses and 50 percent for net operating expenses. Planning and technical assistance expenses are reimbursable at 100 percent.

USE OF PERFORMANCE MEASURES BY STATE AND RURAL TRANSIT ADMINISTRATORS

The use of performance measures for transit service dates back to the 1950s (*1*). In 1958, the Commission on Urban Transportation published two manuals (*5,6*) on procedures for measuring transit service and establishing warrants for new services. These manuals were written primarily for administrators' use in monitoring transit operations.

The current use of transit performance standards and guidelines by other state transportation agencies is important for comparison with Texas procedures. The use of performance and demographic data by the Texas Department of Transportation (TXDOT) for fund allocation and performance measurement is the topic of this paper.

The objective of this research was to ensure that descriptive and comparable transit operating data are being collected by Texas transit providers and that these indicators can be used to increase their performance. In recognition of the need for good evaluation techniques and the limited funding available for collection and analysis of performance data in rural and small municipalities, the following will be addressed:

1. Examination of data collected by municipal and rural transit agencies in Texas and other states to identify the most useful descriptive data for transit performance.

2. Analysis of operating and financial guidelines that have been developed for municipal and rural transit agencies in Texas and other states.

3. Development of a methodology to evaluate rural transit systems in Texas.

4. Illustration of use of the methodology by state agencies to assist the rural transit operators.

Use in Other States

A total of 15 states including Texas were contacted regarding their use of transit performance measures. The extent to which transit performance indicators are used by the states contacted is shown in Table 2.

Some of the states contacted are required by legislative mandate to use performance measures for evaluation or fund allocation. Other states, however, use performance measures on a discretionary basis. The Indiana Legislature gave the Indiana Department of Transportation (INDOT) the authority to establish a fund-allocation methodology. In response, in 1989 INDOT implemented a performance-based allocation formula, whereas the North Carolina Department of Transportation's Public Transportation Division uses a population-based allocation formula (*7*). The distribution of funds in North Carolina is also discretionary.

The states that use performance measures typically rely on cost efficiency, cost-effectiveness, and service utilization, along with some service descriptors. Performance measures of vehicle utilization, labor productivity, and accessibility are currently not being used by any of the states contacted. Ohio is the only state that currently uses measures of service quality and safety. When a complete year's worth of data has been compiled, Texas transit agencies are now required by the legislature to collect accident and breakdown rates, which may be used as measures of service quality and safety.

Some of the states contacted do not have procedures or guidelines for rural transit system evaluation and comparison. For example, Michigan, depending on the objective of the evaluation, determines which performance indicators are important and which transit providers should be used for comparison. Table 1, therefore, may not credit each state with all of the indicators they may use for evaluation and some individual transit agencies may monitor their own perfor-

TABLE 2 SUMMARY OF STATE FUNDING FORMULA AND PERFORMANCE EVALUATION VARIABLES

DEMOGRAPHIC FACTORS	TX	FL	GA	IN	IA	LA	MI	MN	MT	NY	NC	OH	OK	OR	PA
Population	F	F	-	-	-	-	-	-	F	-	F	-	-	F	-
Service Area	F	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SERVICE DESCRIPTORS															
Passenger Trips	-	-	-	-	P	F	-	-	F	-	-	-	P	F	-
Miles[1]	-	-	-	-	P	F	-	-	-	-	-	-	P	F	-
Net Public Debt	-	-	-	-	P	-	-	-	-	-	-	-	-	-	-
PERFORMANCE MEASURES															
Cost Efficiency															
Revenue Recovery Ratio	F	-	-	F	-	-	-	-	-	-	P	-	-	-	P
Derived Income	-	-	-	-	-	-	-	-	F	-	-	-	-	-	-
Cost per Mile	F	-	P[2]	-	-	-	-	-	-	-	-	P	P	-	P
Cost per Hour	-	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Cost Effectiveness															
Cost per Passenger	P	-	-	-	-	-	-	-	-	-	P	P	P	-	P
Service Utilization															
Passengers per Capita	F	-	-	F	-	-	-	-	-	-	-	-	-	-	-
Passengers per Mile	P	-	-	F	-	-	-	-	-	-	P[3]	P	-	-	P
Passengers per Hour	-	-	-	-	-	-	-	-	-	-	P[3]	P	-	-	-
Vehicle Utilization															
Miles per Vehicle	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Quality															
Average Speed	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vehicle-Miles per Road Call	P[4]	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Safety															
Accidents per 100,000 Miles	P[4]	-	-	-	-	-	-	-	-	-	-	P	-	-	-
Labor Productivity															
Miles per Employee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Passengers per Employee	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Accessibility															
Vehicle-Miles per Capita	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vehicle-Miles per Service Area Size	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

F - Used in a fund allocation formula
P - Used for performance evaluation
1 - Vehicle, Revenue, and/or Passenger Miles
2 - The Georgia DOT sets a cap on cost per vehicle-mile which transit providers must not exceed if state funding is received.
3 - North Carolina's Public Transportation Division requires that each transit route meet a baseline of 1.5 passengers per mile and 10 passengers per hour.
4 - Texas is now collecting accident and breakdown rates which can be used for measures of service quality and safety.

Source: For more information, contact individual state organizations.

mance and set their own goals and standards without guidelines from their state's department of transportation.

Fund Allocation

Each state's allocation procedure varies according to administrative objectives, available funds, available transit data, and commitment to the program. Some states have an allocation formula that is used to determine each transit agency's grant based on several demographic factors, service descriptors, and performance measures. There are several very important differences among demographic factors, service descriptors, and performance measures. All three elements are necessary to compare transit services fairly.

Only four states contacted (Texas, Louisiana, Montana, and Indiana) currently use performance-based fund allocation methods. Oregon discontinued using a formula because of dramatic shifts in passenger and mileage values. Michigan has an incentive bonus program to encourage transit providers to improve performance.

The purpose of any performance-based allocation procedure should be to give agencies of all sizes incentives to improve performance. The degree to which each state achieves this goal, however, is uncertain. Montana's formula, for example, does not consider cost-effectiveness or service utilization (*8*). Louisiana's formula uses two service descriptors (passenger trips and vehicle-miles) but does not use any performance indicators. On the other hand, the allocation method used in Texas uses three performance indicators and two demographic factors in order to distribute funds to rural transit agencies.

Peer Grouping

The use of peer groups for service comparison may be necessary if transit agencies have significantly different operations or service area characteristics. Transit providers should be compared with similar agencies. However, administrators should be careful in the determination of peer groups and what constitutes a "similar" agency. Simply dividing agencies into operation groups (fixed-route, demand-responsive, etc.) may not provide fair comparisons since demographic and service characteristics may vary within these groups. Service area size, population characteristics, and service objectives may also be required in order to evaluate or compare agencies.

METHODOLOGY FOR COMPARISON OF NONURBANIZED TRANSIT SYSTEMS

In this section the procedures developed to compare the nonurbanized Section 18 transit agencies in Texas are discussed. Data collection, performance measurement, standardized scores, and peer grouping are explained in the following sections.

Source of Data

In 1988 and 1989 the Public Transportation Division of TXDOT provided the Texas Transportation Institute (TTI) with quarterly reports submitted by each agency. The quarterly data were combined to represent a full year and analyzed to determine which service descriptors could be utilized for performance evaluation and comparison. The data included the

- Number of vehicles,
- Fares received (beginning in the fourth quarter of 1989),
- Passenger trips,
- Total vehicle-miles,
- Total expenses,
- Cost per trip,
- Cost per mile, and
- Passengers per mile.

Data availability was a problem with the 1988 and 1989 quarterly reports. Two transit providers failed to submit a quarterly report in 1988 and 12 contractors failed to submit one or more 1989 quarterly reports. It would seem unreasonable to compare the performance of the 37 agencies when one-third of the contractor data is incomplete.

Although it would be advantageous to evaluate each agency's change in performance over time, 2 years of data are insufficient to indicate a trend. The agencies can be compared with their peers and eventually with their performance in previous years. Guidelines for the preparation and interpretation of trend data are also presented.

Performance Measures

The seven performance measures identified are cost efficiency, cost-effectiveness, service utilization, vehicle utilization, quality of service, labor productivity, and accessibility. Each type of performance measure should be analyzed to evaluate the performance of transit providers in all service areas.

The indicators used to represent each performance measure are given in Table 3. They were chosen on the basis of data availability and how well they represent the performance measure. Only data that are either currently available or required by Texas legislative mandate were used. The data appear to be adequate for performance evaluation, and therefore, additional collection is not necessary.

Quality of service and labor productivity are not represented by an indicator because of insufficient data collection in 1988 and 1989. Effective September 1, 1989, Texas House Bill 1263 requires recipients of public transportation funds to collect data concerning the number of accidents per 100,000 vehicle-miles and the total miles between mechanical breakdowns. When these data are available, they will indicate the safety and quality of transit service and should be monitored on a regular basis for evaluation and comparison purposes.

Cost Efficiency

Total vehicle-miles per total expense measures the amount of output for each dollar of expense. This is the opposite of the more familiar cost per vehicle-mile. The inverted form provides for better graphic presentation and comparison. When a system's performance improves, the value for the indicator increases.

TABLE 3 PERFORMANCE INDICATORS USED IN THIS STUDY

Performance Measure	Performance Indicators
Cost Efficiency	Total vehicle-miles per total expenses
Cost Effectiveness	Passenger trips per total expenses
Service Utilization/Effectiveness	Passenger trips per total vehicle-miles
Vehicle Utilization/Efficiency	Total vehicle-miles per vehicle
Quality of Service	Accident rate per 100,000 vehicle-miles[1]
	Mechanical break down rate[1]
Labor Productivity	Passenger trips per employee[2]
Accessibility	Total vehicle-miles per capita

[1] Not available in 1988 or 1989. Will be available in future years.
[2] Plans to collect this data for rural Texas transit operators are not currently being considered.

Cost per service vehicle was considered for use as an indicator of cost efficiency. However, vehicle-miles per expense is more descriptive as an indicator of amount of output per cost. Total cost per vehicle-mile is also used in the current Section 18 funding allocation formula. Legislative mandate through Texas House Bill 1263 requires that all service providers receiving federal funding must report operating cost per revenue-mile. Cost per hour is also an indicator of cost efficiency, but currently it is not available because hours of operation are not included in the quarterly report.

Cost-Effectiveness

Passenger trips per total expense indicates the number of passengers who are served per dollar of expense. This is also the opposite of cost per passenger trip. The inverted form is used for graphic presentation and comparison. Cost per passenger trip is dependent upon the length of the trip as well as ridership. This may bias the factor against agencies that operate in counties with a dispersed population.

Revenue recovery ratio (revenue per expense) also indicates cost-effectiveness. Revenue data were included on the quarterly report forms beginning in 1989. Revenue recovery ratio could be used in future evaluations of transit service, and is currently being used in the fund allocation formula.

Cost per passenger trip was used as an illustration of cost-effectiveness. In the future, the revenue recovery ratio should be as illustrative as cost per passenger trip and will be required for purposes other than performance measures. All Section 18 contractors are now required by Texas House Bill 1263 to report both operating cost per passenger and revenue recovery ratio.

Service Utilization and Effectiveness

Passenger trips per vehicle-mile indicates the extent to which transit service is utilized by transit system patrons. Service utilization may also be represented by passenger trips per capita and passenger trips per hour.

Passenger trips per vehicle-mile is also used because it is more representative of service utilization for nonurbanized transit agencies than passenger trips per capita. This is because of problems with the current procedure used to determine the nonurbanized service area population. The current funding allocation formula includes passenger trips per service area population.

Vehicle Utilization and Efficiency

Total miles per vehicle indicates the extent to which each transit vehicle is being utilized. The transit service provided is summarized by the annual number of miles traveled per vehicle. A high value may not indicate superior performance. It may be indicative of an agency with fewer vehicles than are desirable for the number of passengers carried or service area.

Accessibility

Accessibility is the measure of how available transit service is to the service area population. Accessibility can be indicated by vehicle-miles per capita or vehicle-miles per square mile of service area. Both indicators utilize a demographic factor (e.g., population or service area) to determine accessibility.

Vehicle-miles per capita was used in this analysis rather than vehicle-miles per square mile of service area. This indicator better reflects an agency's performance, because the service area populations have been adjusted by the Public Transportation Division to try to reflect only nonurbanized areas. Service area size, on the other hand, includes any urbanized area within the agency's jurisdiction. For this reason, vehicle-miles per capita was chosen as the performance indicator to measure accessibility.

Standardized Scores

Comparison between a group of similar agencies requires that an average performance be estimated. An individual agency's performance can then be compared with the average performance of the group. The agency can determine if it is performing above or below average, but it may be difficult to determine if its performance is significantly higher or lower than average. Eventually, levels of desirable performance indicators could be established, but not enough data are currently available for such analysis.

A standardized score can be calculated to determine by how many standard deviations the performance of an agency is above or below the mean. A standard score is calculated by subtracting the peer group average (sample mean) from the agency's indicator value and dividing it by the peer group sample standard deviation for a particular indicator. (Eq. 1).

$$\text{Standard score} = \frac{\text{agency value} - \text{peer group mean}}{\text{peer group standard deviation}} \quad (1)$$

A standard score of zero represents the mean of the peer group for any performance indicator, and a standard score above zero represents above-average performance for the system. A very strong performance exists when an agency's standard score is greater than one standard deviation above the mean, and a negative standard score indicates comparatively poor (but perhaps explainable) performance.

Determination of Peer Groups

The advantage of using peer groups for the evaluation of more than one agency is that fewer inappropriate comparisons may be made. A comparison of two or more transit agencies would not appear as useful if the agencies were not similar in size and service characteristics. It would not appear appropriate to compare the city of Eagle Pass, which operates only two vehicles to provide transportation for medical and social services, with a large agency such as Capital Area Rural Transportation System (headquartered in Austin), which covers nine counties and operates 66 vehicles.

The rural public transportation system in The Woodlands is another example of a potential outlier. It is a park-and-ride lot operation to Houston, rather than a localized rural transit service.

The use of peer groups, however, does have several disadvantages:

- Additional work for evaluation and fund allocation,
- Reduced size of comparison group, and
- Annual change in peer groups.

Several possible factors that might produce relevant peer groups were identified. Demographic factors (service area population, service area size, and service area population density) were used as possible peer group indicators because of their availability and use in the current fund allocation procedure. In addition, service descriptors (total vehicle-miles, passenger trips, and number of service vehicles) could also be used.

In comparisons dependent on high ridership, classifying agencies based on population would seem to eliminate the advantage that operators in relatively large rural population areas would have. Using service area size as a peer group determinant would possibly reduce the negative appearance of high vehicle mileage for operators in large counties, particularly in West Texas and the Trans-Pecos area. The use of population density to group similar agencies could balance the inequity between agencies that operate in sparsely developed rural areas and those that provide service in somewhat more populated areas.

Grouping agencies by total vehicle-miles would tend to lessen the possibility of an unfair comparison of agencies that provide more specialized services, such as transporting one or two passengers per week to a distant hospital. The use of passenger trips as a peer-grouping indicator tends to ignore any relation to averge trip length. Using the previous example, agencies that transport a few passengers to a distant location could be grouped unfairly with agencies that simply have low ridership. Using service fleet size (number of vehicles) would group providers of like size, but could ignore important factors such as population density.

Evaluation of contractors was also performed without peer groups as a means of determining the desirability of using peer grouping to enhance the comparisons.

Analysis of Peer Group Identifiers

An analysis was performed to determine which peer identifier(s) would be the most useful for grouping purposes. The analysis procedure is summarized below.

- Step 1: Before any standardized scores were calculated, peer identifiers were compared with performance indicators to determine if any relationship between them exists. For instance, vehicle utilization (vehicle-miles per vehicle) is probably not related to the population of the service area. Therefore, it would not be appropriate to use service area population as a peer identifier for vehicle utilization even if the standard scores appeared to be reasonable for that particular indicator.
- Step 2: Standard scores for each performance indicator were calculated in all possible peer groups, and all in one group, to determine if any peer identifier produced a considerable number of outliers. An outlier is a value that deviates from the sample mean to such an extent that it would be statistically improbable. For example, a contractor's standard score of 2.5 for one indicator (assuming a normal distribution) would imply that the agency performed better than 99.4 percent of the other contractors in the same peer group. One agency with such a score would not be considered outside expected values. The presence of two outliers is less desirable, but not unacceptable. However, the presence of three or more outliers would give cause to question whether or not the peer identifier being considered is effectively grouping similar agencies.
- Step 3: Outliers, however, may cause the appearance that one contractor is outstanding in a peer group and the rest are performing poorly. Peer group indicators that produced the greatest number of deviant standard scores for each performance measure in relation to the other groups, or the highest occurrence of outliers, were dropped from further consideration.

The results of this analysis indicate that the use of peer groups for the Section 18 contractors is not necessary at this time. Comparison of the contractors without the use of peer groups produced no deviant scores.

Of the possible peer group identifiers, however, fleet size appears to be the best alternative if peer grouping is desired. Using fleet size as a peer identifier produced only five scores that were deviant from the other identifiers. The other peer group identifiers ranged from 10 to 20 deviant scores.

TRANSIT SYSTEM COMPARISON

In 1988 and 1989, the performance of the agencies was compared in the six following areas:

- cost-effectiveness,
- cost efficiency,

- service utilization,
- vehicle utilization,
- accessibility, and
- trend in annual standard scores.

Tables 4 and 5 present the performance indicator values calculated for each performance measure for 1988 and 1989, respectively. The standard score for each agency's performance is also shown in Tables 4 and 5. The standard score compares the agency's performance with the mean performance of the peer group. Each standard score represents the number of standard deviations that separate the value from the mean.

A standard score of zero represents the mean performance of the peer group. Therefore, a positive standard score represents above-average performance, and a negative standard score represents below-average performance. In general, a positive score greater than one standard deviation above the mean indicates a strong performance. A negative score indicates comparatively poor (although perhaps explainable) performance.

It should be noted that a negative score does not necessarily mean that an agency is performing poorly relative to the goals and objectives of that agency. It is possible that the agency is performing well (meeting its goals and objectives), but is still performing below the mean of its peer group. Likewise, it is also possible that an agency with a positive score is performing poorly, but has performance indicator values better than the mean of the peer group. A strong performance is therefore considered to be greater than one standard deviation above the mean.

When several years of data are available, it will be possible to evaluate each agency's trend in performance. This trend is an important measure of performance. An agency whose performance improves because of the effort of its administration should be commended for its improvement. An agency whose performance is better than average but is declining should evaluate its service and attempt to improve.

It is important that all of the performance measures and their indicators be examined before a conclusion or corrective action is made to improve the overall performance. There are certain relationships between the performance measures that must be considered when evaluating an agency. Each performance measure and indicator is influenced by several common factors (e.g., vehicle-miles). For example, if an agency travels more miles, its total expense will increase. This may increase the cost per passenger trip (if number of passenger trips does not significantly increase) and decrease the agency's cost-effectiveness. The agency's cost efficiency, however, may actually increase, because its total expense may increase in a

TABLE 4 1988 PERFORMANCE INDICATOR VALUES AND STANDARD SCORES

Contractor Location	Cost Effectiveness (Passenger per Dollar)		Cost Efficiency (Miles per Dollar)		Service Utilization (Passengers per Mile)		Vehicle Utilization (Miles per Vehicle)		Accessibility (Miles per Capita)	
	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Alice	0.15	-0.47	0.83	0.25	0.18	-0.60	23,034	0.63	4.87	-0.28
Amarillo	0.04	-1.58	0.90	0.50	0.04	-1.36	29,991	1.50	2.13	-0.42
Aspermont	0.05	-1.48	0.77	0.01	0.07	-1.25	17,430	-0.08	5.03	-0.27
Austin	0.17	-0.34	0.76	-0.03	0.22	-0.41	18,513	0.05	9.34	-0.06
Beeville	0.21	0.13	0.58	-0.68	0.37	0.40	15,533	-0.32	4.35	-0.31
Bryan	0.20	0.03	0.78	0.06	0.26	-0.18	20,878	0.35	6.19	-0.22
Cleburne	0.11	-0.89	0.43	-1.23	0.26	-0.21	13,851	-0.53	0.61	-0.50
Columbus	0.12	-0.80	0.60	-0.60	0.20	-0.53	18,768	0.09	9.09	-0.07
Conroe	0.47	2.59	0.68	-0.30	0.68	2.09	23,074	0.63	3.18	-0.37
Crosbyton	0.14	-0.58	0.93	0.62	0.15	-0.78	13,819	-0.54	7.82	-0.13
Crowell	0.27	0.71	0.34	-1.56	0.80	2.76	5,984	-1.53	1.50	-0.45
Denison	0.15	-0.54	0.67	-0.37	0.22	-0.41	14,789	-0.42	6.00	-0.23
Denton	0.16	-0.44	0.81	0.17	0.19	-0.55	21,273	0.40	0.94	-0.48
Galveston	0.25	0.50	1.32	2.02	0.19	-0.56	22,666	0.58	102.00	4.66
Glen Rose	0.12	-0.81	0.82	0.20	0.15	-0.82	22,476	0.55	34.12	1.21
Greenville*										
Kingsville	0.20	-0.06	0.62	-0.53	0.31	0.10	10,595	-0.95	3.46	-0.35
Lamesa	0.19	-0.13	0.38	-1.41	0.49	1.06	8,790	-1.17	1.82	-0.44
Laredo	0.11	-0.88	0.49	-1.02	0.23	-0.36	14,203	-0.49	20.22	0.50
Levelland	0.09	-1.10	0.56	-0.77	0.16	-0.73	16,647	-0.18	3.69	-0.34
Lufkin	0.32	1.20	0.69	-0.28	0.47	0.94	23,944	0.74	3.15	-0.37
McAllen	0.43	2.25	1.37	2.22	0.31	0.11	33,164	1.90	47.19	1.87
Mineral Wells	0.25	0.48	1.16	1.44	0.22	-0.43	25,928	0.99	6.97	-0.18
Rio Grande City	0.33	1.22	0.76	-0.01	0.43	0.71	10,449	-0.96	3.43	-0.36
San Angelo	0.25	0.44	0.40	-1.33	0.61	1.72	5,440	-1.60	2.20	-0.42
San Antonio*										
San Saba	0.23	0.29	0.56	-0.76	0.41	0.65	9,969	-1.02	4.92	-0.28
Sinton	0.14	-0.57	0.65	-0.42	0.22	-0.40	37,653	2.47	2.45	-0.41
Sweetwater	0.30	0.99	0.52	-0.90	0.58	1.55	12,867	-0.66	0.89	-0.49
Terrell	0.31	1.04	1.20	1.61	0.26	-0.22	9,488	-1.09	11.93	0.08
Uvalde	0.13	-0.75	1.03	0.98	0.12	-0.95	13,485	-0.58	4.82	-0.29
Victoria	0.25	0.50	1.06	1.09	0.24	-0.31	15,464	-0.33	3.80	-0.34
Waco*					0.10					
Weatherford	0.11	-0.93	1.05	1.05		-1.05	30,389	1.55	5.08	-0.27
Average	0.20		0.77		0.30		18,082		10.43	
Std. Deviation	0.10		0.27		0.18		7,918		19.63	

* New System in 1989, No 1988 Data.

smaller proportion than its total vehicle-miles. The additional vehicle-miles will also decrease its measure of service utilization (passenger trips per vehicle-mile) and increase its measure of vehicle utilization (vehicle-miles per service vehicle).

Tables 4 and 5 indicate that only a few agencies produced performance scores greater than two standard deviations above the mean. In addition, a clear pattern for those few scores did not occur.

With the exception of accessibility, all the performance indicator values are normally distributed. The accessibility values are skewed because several areas produced very high values that pulled the average up and distorted the standard deviation. This result indicates that an evaluation of performance should not be based on a single score. If possible, it is important to evaluate all of the performance measures and a trend in performance over several years.

CONCLUSIONS AND RECOMMENDATIONS

Data Availability

This study utilized 1988 and 1989 quarterly report data submitted by Section 18 systems to TXDOT. Two Section 18 systems failed to submit a 1988 quarterly report, and 12 Section 18 systems failed to submit one or more quarterly reports in 1989. It would seem to be unreasonable to compare the performance of 37 agencies when more than one-third of them are represented by incomplete data; the Public Transportation Division provided annualized 1989 data. The annualized data were determined by averaging the existing quarterly data and estimating the missing data for an agency that failed to submit a report.

It was recommended that TXDOT improve the collection of quarterly report data from all agencies receiving state funds. This would improve the ability of TXDOT to compare and evaluate the performance of the agencies on a yearly basis, and ensure the fair and equitable allocation of funds using the fund allocation formula. The formula is based on data submitted in the quarterly reports; therefore, incomplete data may jeopardize the results of the allocation process.

Performance Indicators

The Section 18 transit agencies were compared using the following five performance measures: cost-effectiveness (passenger trips per expense), cost efficiency (vehicle-miles per expense), service utilization (passenger trips per vehicle-mile), vehicle utilization (vehicle-miles per service vehicle), and accessibility (vehicle-miles per capita).

Two additional performance measures (quality of service and labor productivity) were identified in this project but were not utilized in the comparison of transit agencies because of

TABLE 5 1989 PERFORMANCE INDICATOR VALUES AND STANDARD SCORES

Contractor Location	Cost Effectiveness (Passenger per Dollar)		Cost Efficiency (Miles per Dollar)		Service Utilization (Passengers per Mile)		Vehicle Utilization (Miles per Vehicle)		Accessibility (Miles per Capita)	
	Value	Score	Value	Score	Value	Score	Value	Score	Value	Score
Alice	0.21	0.01	1.05	0.47	0.20	-0.54	24,436	1.02	6.72	-0.15
Amarillo	0.03	-1.48	0.66	-0.35	0.05	-1.59	23,547	0.90	2.38	-0.46
Aspermont	0.05	-1.36	0.79	-0.08	0.06	-1.52	17,877	0.15	5.68	-0.22
Austin	0.17	-0.31	0.72	-0.22	0.24	-0.28	19,580	0.38	9.28	0.04
Beeville	0.19	-0.15	0.47	-0.76	0.41	0.93	12,438	-0.57	4.02	-0.34
Bryan	0.13	-0.64	0.48	-0.73	0.27	-0.01	16,725	-0.00	3.23	-0.40
Cleburne	0.15	-0.51	0.56	-0.57	0.26	-0.08	14,305	-0.32	0.63	-0.59
Columbus	0.12	-0.73	0.83	0.01	0.15	-0.91	16,088	-0.08	1.56	-0.52
Conroe	0.29	0.69	0.45	-0.80	0.64	2.59	26,031	1.23	2.61	-0.44
Crosbyton	0.11	-0.83	0.69	-0.29	0.16	-0.81	11,672	-0.67	7.23	-0.11
Crowell	0.24	0.27	0.44	-0.83	0.55	1.92	14,390	-0.31	3.15	-0.40
Denison	0.16	-0.44	0.70	-0.26	0.22	-0.39	13,967	-0.36	5.67	-0.22
Denton	0.15	-0.53	0.81	-0.04	0.18	-0.68	22,027	0.70	1.16	-0.55
Galveston	0.21	-0.00	0.78	-0.10	0.26	-0.08	16,059	-0.09	56.21	3.41
Glen Rose	0.09	-0.99	0.79	-0.07	0.12	-1.14	24,893	1.08	43.18	2.48
Greenville	0.55	2.98	2.95	4.52	0.19	-0.62	6,569	-1.34	0.48	-0.60
Kingsville	0.16	-0.39	0.51	-0.68	0.32	0.31	7,541	-1.21	1.79	-0.50
Lamesa	0.17	-0.29	0.42	-0.86	0.41	0.97	8,312	-1.11	2.00	-0.49
Laredo	0.25	0.38	0.84	0.02	0.30	0.19	19,826	0.41	44.35	2.56
Levelland	0.12	-0.78	0.91	0.19	0.13	-1.06	19,009	0.30	7.29	-0.11
Lufkin	0.34	1.13	0.79	-0.07	0.43	1.08	38,151	2.82	3.90	-0.35
McAllen	0.36	1.35	1.17	0.74	0.31	0.25	14,467	-0.30	35.29	1.91
Mineral Wells	0.23	0.23	0.96	0.29	0.24	-0.23	21,613	0.64	4.98	-0.27
Rio Grande City	0.27	0.54	0.60	-0.49	0.45	1.26	8,883	-1.03	3.21	-0.40
San Angelo	0.25	0.38	0.47	-0.76	0.54	1.85	6,411	-1.36	2.85	-0.43
San Antonio	0.33	1.04	1.40	1.23	0.23	-0.29	11,533	-0.69	0.88	-0.57
San Saba	0.23	0.20	0.58	-0.53	0.40	0.89	10,416	-0.83	4.91	-0.28
Sinton	0.14	-0.61	0.54	-0.61	0.25	-0.17	36,110	2.56	1.88	-0.50
Sweetwater	0.21	0.03	0.54	-0.60	0.39	0.80	11,573	-0.68	1.41	-0.53
Terrell	0.12	-0.76	0.63	-0.42	0.19	-0.61	14,134	-0.34	15.55	0.49
Uvalde	0.14	-0.59	0.98	0.32	0.14	-0.95	13,359	-0.44	5.23	-0.26
Victoria	0.22	0.15	0.93	0.23	0.24	-0.24	16,763	0.00	3.43	-0.38
Waco	0.54	2.88	1.72	1.90	0.32	0.29	7,432	-1.23	1.24	-0.54
Weatherford	0.11	-0.86	0.92	0.20	0.12	-1.13	22,660	0.78	4.92	-0.28
Average	0.21		0.83		0.28		16,729		8.77	
Std. Deviation	0.12		0.47		0.14		7,584		13.90	

insufficient data. Quality of service is indicated by the number of accidents per 100,000 vehicle-miles and the number of vehicle-miles between breakdowns. In 1989, the Texas legislature mandated that transit providers receiving state funds report these indicators. It is recommended that when one full year's worth of data are available, quality of service also be used as a performance measure for transit service evaluation.

The cost efficiency and cost-effectiveness of an agency can also be indicated by its fare recovery ratio (revenue per expenses). This indicator represents the percentage of expenses incurred to provide transit service that are recovered from fare collection. Data reported on the quarterly reports are now used to calculate this indicator for use in the fund allocation formula.

Revenue recovery ratio was not used for performance evaluation in this study because the 1988 and 1989 revenue data, which were reported semiannually, could not be expanded to a yearly basis. In the fourth quarter of 1989, agencies began reporting revenue data in their quarterly reports, and those revenue data are used to represent this indicator in future service evaluations, as well as in the fund allocation formula.

Improvement is another important measure of performance. When several years of data are available, it will be possible to evaluate each agency's trend in performance. An agency whose performance is better than average, but is declining, should evaluate its service and attempt to improve it. If an agency has negative standard scores (below-average performance) that are improving, there is an indication that the agency's administration is attempting to correct and improve its performance. It is recommended that Texas use the procedure developed in this project on an annual basis in order to evaluate each agency's performance trend.

Accessibility is a performance measure that indicates how available the transit service is to the service area population. Accessibility is an important measure of performance to large fixed-route systems. However, accessibility may not be a practical measure for nonurbanized transit agencies, which generally do not operate a strictly fixed-route service. Many of the contractors provide only a demand-responsive or subscription service. More research is necessary to determine if this measure is acceptable for use with nonurbanized systems. It is recommended, however, that this measure be calculated with several years of data before it is determined to be a poor indicator of performance.

Use of Performance Measures

The standard score profiles developed in this study provide only a relative indication of performance for each contractor. The evaluation of an agency should consider the individual operations and objectives of that particular agency. It is important to evaluate the overall performance of the agency and not just one indicator of service.

There is a desire among the contractors to know how they can improve their performance, not simply that they need to improve. Since each agency operates under different conditions and objectives, TXDOT should consider counseling each contractor on an individual basis. One agency contacted during this research project recommended that TXDOT visit each contractor and evaluate its operations. This process has generally been well-received when implemented in other states.

The performance measure technique developed in this paper uses relative, rather than absolute, measures. Transit operators can be compared with previous-year operations of their system and with other similar operations. However, there are no standards to estimate what a "good" level of cost-effectiveness or efficiency is for a rural transit operator. As performance measures become more widely utilized, more information may be available to evaluate absolute performance values. These will also be subject to the problems of peer group determination and differing transit provider goals and objectives that are inherent in performance comparisons.

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Publication of this paper sponsored by Committee on Rural Public and Intercity Bus Transportation.

Rural Public Transportation in Alaska: Present and Future Options

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Environmental conditions and the isolation of communities in Alaska impose unique constraints on transportation. As a result, public transportation plays a more important role than would be experienced elsewhere. The objectives of this paper are to report on a study conducted to obtain general information on the type of transit and paratransit service options currently utilized in rural Alaska and to discuss issues related to future implementation of public transportation as well as future studies and information exchange. It was found that a wide range of options was utilized. Although it is not surprising that a taxi service is found in very small communities, the existence of a regular bus service there is unexpected. However, there is room for further implementation of public transportation in Alaska. Documentation on the use of public transportation in rural Alaska is largely nonexistent. Communities in Alaska could benefit greatly from the dissemination of public transportation case studies. These studies include the organization and regulation of public transportation, joint use of vehicles, and increased use of public transportation during emergencies and periods of inclement weather. The Rural Technology Transfer Program of the Federal Transit Administration could play a valuable role in the exchange of useful information.

The objectives of this paper are to report on a study conducted to obtain general information on the type of transit and paratransit service options currently utilized in rural Alaska (*1*) and to discuss issues related to future implementation of public transportation as well as future studies and information exchange. The focus was on local and regional transit and paratransit services insofar as they benefit communities on a regular basis. Intercity public transportation was not included.

By way of introduction, it should be noted that the environmental conditions and the isolation of communities in Alaska impose unique constraints on transportation. Walking and bicycling are especially difficult during the frequent periods of inclement weather, and other forms of transportation are also severely hampered at these times. During periods of very harsh, cold weather, large numbers of vehicles are immobilized. This was, for instance, very apparent during the winter of 1988–1989 when temperatures of −60°F were not uncommon and remained below −30°F in some areas for extended periods. The result is that even those who do own vehicles experience problems with transportation.

Because of the severe weather conditions, public transportation plays a more important role in rural Alaska than would be the case in other geographic areas, and a higher level of expertise is necessary to enable transit companies to cope with such conditions.

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The isolation of communities also makes the role of public transportation more important. Although no statistics on vehicle ownership were obtained, it may be surmised that isolation decreases private vehicle ownership. There is simply less reason to own a vehicle when there are not many destinations reachable by road. When travel needs do arise, the need for substitute modes of transportation, including public transportation, should increase.

Alaska's limited accessibility is demonstrated on the map of the major road system (Figure 1). Not only the very small communities but Juneau also, the third-largest community in Alaska, has no access to a regional road system.

The degree of isolation is also demonstrated by an analysis of the access that Alaskan communities have to major transportation systems. The surface transportation systems considered are regional road systems, local road systems, coastal access, and river access. A total of 258 rural communities were classified according to population (figures obtained from the Alaska Department of Community and Regional Affairs) and access to surface transportation systems (Table 1). All but a few Alaskan communities for which statistics were not available and Anchorage, which cannot be classified as rural, are included.

The results of the classification show that only 22 percent of the communities have access to a regional road system. It is also evident from the statistics that the Alaskan communities are predominantly very small, which is not conducive to having public transportation systems.

A brief outline of the study approach and some of the constraints therein will be presented before the results of the study on the utilization of public transportation service options are discussed. Next, issues related to future implementation of public transportation options as well as future studies and information exchange will be presented. Finally, a summary of the major conclusions and recommendations will be provided.

STUDY APPROACH

Methodology

Very little information and documentation exist on rural public transportation in Alaska. At the time of the study there was no central agency that collected information or regulated or monitored public transportation in Alaska. One of the primary motivations of this study was to obtain general information on existing public transportation systems that could serve as a basis for further detailed study and research.

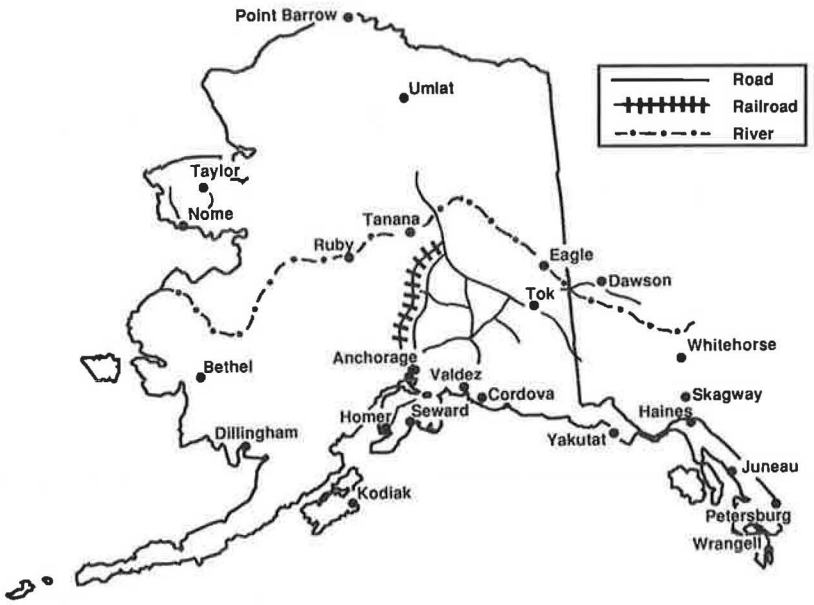

FIGURE 1 Major Alaskan road systems.

TABLE 1 SUMMARY OF ACCESS CHARACTERISTICS OF CITIES IN ALASKA

Population	Coast	River	RRS[a]	LRS[b]	Coast & LRS	River & LRS	Nothing	Total
>10000	1		1					2
	0.4%		0.4%					0.8%
5000-10000	2		1		1			4
	0.8%		0.4%		0.4%			1.6%
1000-5000	8	1	12		4			25
	3.1%	0.4%	4.7%		1.6%			9.7%
200-1000	55	35	21		3	2	1	117
	21.3%	13.6%	8.1%		1.2%	0.8%	0.4%	45.4%
0-200	48	32	23	1	2	3	1	110
	18.6%	12.4%	8.9%	0.4%	0.8%	1.2%	0.4%	42.6%
TOTAL	114	68	58	1	10	5	2	258
	44.2%	26.4%	22.5%	0.4%	3.9%	1.9%	0.8%	100%

[a] RRS - Access to major regional road systems.
[b] LRS - Access to local road systems only.

For this study, it was decided to use a mail survey as the major source of information on existing public transportation systems. It was decided to send the survey to all communities in which public transportation services could be expected to exist. This included the communities in which it was known that public transportation systems were in operation as well as other communities of similar size and type.

Available documentation was reviewed to determine where public transportation systems were in existence. Personal interviews with transportation officials were used to supplement this information, since it became clear at a very early stage that very little documentation was available.

All the communities in Alaska except Anchorage were considered in the study. The Fairbanks area was retained as part

of the study sample even though its population of 60,000 exceeds the rural area population limit defined by the former Urban Mass Transportation Administration [now the Federal Transit Administration (FTA)]. FTA defines a small city or rural area as having a population of less than 50,000 (*2*); however, the Fairbanks population is dispersed over a relatively large area. This gives it a rural character and made it appropriate to include it in the study sample.

It should be noted that the study was carried out under some constraints. Lack of road access and the great distances between communities in Alaska make personal contact expensive. It is therefore difficult to obtain information and clarify issues. In many cases, even communication by telephone is difficult. Also, as a result of the lack of technical personnel, technical data are not collected for public transportation in many communities.

Classification of Rural Transit and Paratransit Service Options

As a basis for this study, a classification of public transportation service options was required. After consideration of several detailed classifications (*2–5*), the classification used in the project was simplified to the following:

- Regular transit
  - —Conventional bus
  - —Commuter or shuttle bus
  - —Ferry
- Paratransit
  - —Limousine
  - —Taxicabs
  - —School bus
  - —Car rental
  - —Charter bus
  - —Carpool
  - —Vanpool
  - —Dial-a-ride bus
  - —Jitney
  - —Subscription bus
- Other shared transportation
  - —Services for the elderly and handicapped
  - —Other transportation for community services

Because of the small community populations, rail-based options were omitted from the classification. Both general and target market options were included, that is, those options that are available to the general public as well as those only available to specific segments of the public.

ALASKAN PUBLIC TRANSPORTATION SYSTEMS

Document Review

The only document available that focused on existing public transportation in Alaska was a report prepared by Peter Eakland and Associates (*6*) for the Alaska Municipal League and the Alaska Department of Transportation and Public Facilities (AKDOT&PF), which primarily addressed meetings held in communities throughout the state of Alaska. This report, together with the State Transportation Policy Plan (*7*), management plans for UMTA Section 18 funds (*8*) and Section 16(b)(2) funds (*9*), as well as various lists related to the funding of public transportation in Alaska, gave some information on existing public transportation systems at various dates. To illustrate, a summary of the systems existing in 1981–1982 (primarily obtained from the Eakland report and the State Transportation Policy Plan) is presented in Table 2. It should be noted that the information obtained was sometimes vague. Only those systems that were identified with a reasonable amount of certainty were included in the table. Since this information was used only as the basis for the mail survey, accuracy was not critical.

TABLE 2 EXISTING TRANSIT AND PARATRANSIT SYSTEMS (1981–82) OBTAINED FROM REVIEW OF AVAILABLE INFORMATION

	Number of Communities	Population Range
Regular Transit		
Conventional bus	11	237 - 73,540
Commuter/Shuttle bus	3	524 - 44,280
Ferry	-[a]	-
Paratransit		
Limousine	6	565 - 27,141
Taxicabs	15	712 - 44,280
School bus	14	565 - 27,141
Car rental	-	-
Charter bus	-	-
Car pool	-	-
Van pool	-	-
Dial-a-ride bus	-	-
Jitney	-	-
Subscription bus	-	-
Other shared transportation		
Services for the elderly and handicapped	2	3,705 - 4,303
Other transportation for community services	28	565 - 44,280

[a]No data reported

Results of Document Review

The document review indicated that several types of public transportation were being utilized. An important observation was that public transportation systems were operating not only in the larger centers, but also in the smaller centers. Whereas taxicab service might be expected in the small centers, it was surprising to find that a regular bus service existed not only in a large community, such as the Fairbanks North Star Borough, but also in several smaller communities. Publicly owned as well as privately owned systems were in operation.

Since the review indicated that public transportation systems existed in all types and sizes of rural communities, it was decided to include all the rural communities in the survey. As mentioned before, the lack of information necessitated that the survey be directed to obtain general information on the type of public transportation service available. This information can then be used as a basis for more detailed future studies.

Personal Interviews

Personal interviews were conducted with four AKDOT&PF transportation officials and one local authority representative. The interviews with transportation officials confirmed the conclusions reached on the basis of the document review. Some interesting facts related to public transportation in Alaska were also revealed:

1. In some communities, because of the lack of roads, water and air transportation, together with all-terrain vehicles (ATVs) and snowmobiles, is the only means of transportation available.
2. Airplanes and boats are not widely used as local public transportation. Nevertheless, there are exceptions. At least one mining company in the Juneau area transports its employees to the work site by boat on a daily basis.
3. The combination of the Alaskan physical environment, the distribution of the population over a large area, and the relative smallness of the communities has resulted in some unique forms of what may be broadly defined as paratransit. Privately owned vehicles, which include ATVs and snowmobiles, are used on a pooled basis. An example of this is an air carrier agent in some villages who makes regular trips to the airport to meet incoming airplanes and transports people either in a trailer hooked to an ATV or in the back of a truck.
4. Joint use of vehicles is made. In at least one community, Kaltag on the Yukon River, a city-owned school bus is used to convey passengers to the airport free of charge.

As a result of this preliminary analysis, it was decided to provide adequate opportunity for additional comments in the questionnaire used in the mail survey to allow for the inclusion of unusual transportation situations. It was also decided to include a question on the joint use of school buses.

Mail Survey

The primary objective of the mail survey was to determine what type of public transportation service was provided within each community. In order to obtain a clearer picture of the service, additional data were requested. Space does not allow the inclusion of the questionnaire used in the mail survey, but the contents are summarized.

Data on the purpose of service, ownership, vehicles, seats available, operating hours, fares, ridership, routes, regulating agencies, times during the year when service is available, and general comments were obtained for the service options that were expected to be encountered frequently: conventional bus, commuter bus, ferryboat, limousine, taxicab, school bus, and car rental. For the options carpool, vanpool, charter bus, dial-a-ride, jitney, and subscription bus, the respondents were requested to check whether these types of services were available and make general comments. Additional questions were included on the availability and type of services for the handicapped and elderly, as well as on the joint use of school buses.

Since the document review indicated that public transportation systems may exist in communities of all sizes, questionnaires were sent to all 203 cities and boroughs in Alaska for which addresses were available. The questionnaires were addressed to the city or borough manager, administrator, or clerk. The responses were, in many cases, completed by another city or borough official.

Results of the Mail Survey

Seventy-seven communities returned the questionnaire. Each of the public transportation service options reported in the mail survey was cross-classified according to the factors of population (as reported in the survey) and the type of major transportation system to which the community had access. The reason for the classification was to determine if there was a correlation between these two factors and the number and types of public transportation services.

The results are presented in Tables 3 through 9 and summarized in Table 10. When two or fewer communities reported a particular service option, which was the case for ferry systems, a data table was not created. With one exception, ferry systems were part of the Alaska Marine Highway System, which primarily serves the intercity market, and therefore they did not qualify as local public transportation.

Based on the data and the comments from the respondents, some major conclusions and observations were made, some of which reaffirmed the conclusions from the document review and personal interviews:

1. A wide range of public transportation service options has been implemented. The one option that was not utilized at the time of the survey was dial-a-ride bus for the general public. However, the responses indicated that such systems were being utilized for transportation of the elderly and handicapped.
2. The data set proved to be too sparse to draw general conclusions regarding the influence of population and accessibility to major transportation systems on the increase and decrease in implementation of public transportation service options.
3. The options implemented cover a wide range of community sizes. As was found in the document review, regular bus service was reported in communities with small popula-

TABLE 3 STATISTICS FOR CONVENTIONAL BUS

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Nothing	Total
> 10,000	1		1					2 29%
5,000–10,000	1							1 14%
1,000–5,000	1		1					2 29%
200–1,000	2							2 29%
0–200								
Total	5 71%		2 29%					7 101%

[a]Access to major regional road systems.
[b]Access to local road systems only.

TABLE 4 STATISTICS FOR COMMUTER SHUTTLE SERVICE

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Nothing	Total
> 10,000								
5,000–10,000	1				1			2 33%
1,000–5,000			3		1			4 67%
200–1,000								
0–200								
Total	1 17%		3 50%		2 33%			6 100%

[a]Access to major regional road systems.
[b]Access to local road systems only.

TABLE 5 STATISTICS FOR LIMOUSINE SERVICE

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Total
> 10,000					1		1 20%
5,000–10,000	1				1		2 40%
1,000–5,000	1						1 20%
200–1,000	1						1 20%
0–200							
Total	3 60%				2 40%		5 100%

[a]Access to major regional road systems.
[b]Access to local road systems only.

tions. One community reporting a regular bus service had a population of only 324. Although the definition of regular bus service in such a small community may bear further consideration, the example of Ketchikan definitely indicates that a regular bus service can be established in such a community. At the time of the survey, Ketchikan had a population of 12,982 and its bus service had more than one vehicle, operating with very specific hours and fares, as well as detailed ridership records.

The existence of a bus service in such small communities may be an indication that, in general, the isolation of Alaskan communities and the harsh environmental conditions lead to a greater need of and use for public transportation.

4. Unconventional transportation modes appear to play an important role in public transportation in Alaska. Several communities mentioned the use of riverboats, snowmobiles, ATVs, and airplanes in the context of local public transportation.

5. Some communities took the opportunity to express their need for public transportation in the section provided for general comments. Some needs were based on economic reasons, and others were related to "captive" riders, that is, those

TABLE 6 STATISTICS FOR TAXICABS

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Total
> 10,000			1		1		2 8%
5,000–10,000	2		1		1		4 17%
1,000–5,000	5		3		3		11 46%
200–1,000	4	2					6 25%
0–200	1						1 4%
Total	12 50%	2 8%	5 21%		5 21%		24 100%

[a]Access to major regional road systems.
[b]Access to local road systems only.

TABLE 7 STATISTICS FOR SCHOOL BUSES

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Total
> 10,000			1		1		2 6%
5,000–10,000	2		1				3 10%
1,000–5,000	4		4		3		11 35%
200–1,000	4	6	3				13 42%
0–200	1	1					2 6%
Total	11 35%	7 23%	9 29%		4 13%		31 99%

[a]Access to major regional road systems.
[b]Access to local road systems only.

TABLE 8 STATISTICS FOR CAR RENTAL

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Total
> 10,000			1		1		2 11%
5,000–10,000	3		1				4 22%
1,000–5,000	3		3		3		9 50%
200–1,000	2	1					3 17%
0–200							
Total	8 44%	1 6%	5 28%		4 22%		18 100%

[a]Access to major regional road systems.
[b]Access to local road systems only.

who do not have other means of transportation. It is important to note that some of the factors influencing these needs are related to unique Alaskan conditions such as a lack of roads, harsh weather, and a wilderness environment. Some communities indicated that public transportation was needed during periods of inclement weather, emergency situations, and also to provide children with a safe means of getting to and from school. Attacks by wild animals were included as one of the dangers. Others thought that increased public transportation would lead to benefits for commercial fishing, hunting, and tourism.

Some respondents reported that individuals provided transportation on an "as needed" basis in the absence of public transportation. Others stated that they were skeptical of the potential financial burden of a public transportation system.

6. There appears to be a substantial amount of what is termed "helping out" other people with transportation. In a place like Alaska, "helping out" in extreme weather condi-

tions or emergencies or in the absence of public transportation appears to mean something different from the usual "helping out." Severe weather conditions prevail for a large part of the year and "helping out" may occur more often out of real necessity than mere convenience. In some responses, "helping out" was clearly stated as a substitute for public transportation.

7. Most responses to the questions on regulating agencies indicated that the municipality was the regulating agency. In a few cases (for limousine service, taxicabs, and car rental) the state of Alaska was listed as the regulating agency.

8. Joint use of school buses occurred only in 6 of the 31 school bus systems reporting.

FURTHER CONSIDERATIONS

Implementation of Public Transportation Options in Alaska

The results of the study lead to the conclusion that there are opportunities for further implementation of public transportation service options in all of the communities except those with a population greater than 10,000. The case of limousine service is an example. Only two communities in the 5,000 to 10,000 population category and one in the 1,000 to 5,000 category reported a limousine service. Since the survey showed that a limousine service may be feasible in such communities,

TABLE 9 STATISTICS FOR SPECIAL TRANSPORTATION FOR THE ELDERLY AND HANDICAPPED

Population	Coast	River	RRS[a]	LRS[b]	Coast and LRS	River and LRS	Total
> 10,000			1		1		2 8%
5,000–10,000	2		1		1		4 16%
1,000–5,000	3		2		3		8 32%
200–1,000	5	3	1				9 36%
0–200		1	1				2 8%
Total	10 40%	4 8%	6 24%		5 20%		25 100%

[a]Access to major regional road systems.
[b]Access to local road systems only.

TABLE 10 SUMMARY OF PUBLIC TRANSPORTATION SYSTEMS REPORTED IN MAIL SURVEY

	Number of Communities	% of Total Number Reporting	Population Range
Regular Transit			
Conventional bus	7	9%	324 - 60,000
Commuter/Shuttle bus	6	8%	1,207 - 12,982
Ferry	1	1%	12,982
Paratransit			
Limousine	5	6%	712 - 29,946
Taxicab	24	31%	55 - 60,000
School bus	31	40%	165 - 60,000
Car rental	18	23%	202 - 60,000
Charter bus	8	10%	712 - 60,000
Car pool	1	1%	29,946
Van pool	1	1%	29,946
Dial-a-ride bus	-[a]	-	
Jitney	1	1%	132
Subscription bus	2	2%	1,207 - 3,700
Other shared transportation			
Services for the elderly and handicapped	25	32%	45 - 60,000
Other transportation for			
community services	59	77%	45 - 29,946
Total Responses	77		

[a]None reporting

it is possible that there are other communities in these categories that could benefit from this service.

Another example of an opportunity for further implementation of service options is vanpools and carpools. Juneau was the only city that indicated an operating vanpool or carpool system. Locations that have concentrated employment centers, such as the University of Alaska in Fairbanks, may also benefit from such programs.

The question arises as to how further implementation may be effected against the background of poor communication and lack of technical staff in isolated communities. A desirable approach to the problem would be for experts to analyze and advise on the situation in each community. Questions related to locating appropriate experts and who will bear the responsibility for the cost of analysis and implementation will have to be resolved. In the long term, federal, state, and local agencies can work to find solutions to these problems.

Further Studies and Information Exchange

Further study and information exchange can be very helpful in the short term. The results of studies and other information relevant to public transportation in Alaska can be used by the Alaskan communities to decide on appropriate public transportation service options and to improve existing service. Case studies of successful public transportation operations for each type of service option would be very useful. In addition, other transportation issues that are relevant to the Alaskan situation warrant further study.

The pooling and organization of resources call for further investigation. Some responses to the mail survey indicated that private vehicles were sometimes used for public transportation, including automobiles, trucks, riverboats, snowmobiles, and ATVs. This points to some very informal means of "pooling" resources. Since some of the community structures are based on different customs, a special approach may be used in the organization of pooled resources and public transportation. A study of these organizational structures may benefit other communities in Alaska and elsewhere that encounter similar conditions.

The regulation of public transportation in Alaska, or the lack thereof, is also an issue that warrants further study. Regulated or nonregulated models that work well in some communities may be suitable for other communities. It should be noted that overregulation in these types of communities may prevent the provision of much-needed transportation options.

Another issue that warrants further consideration is the joint use of vehicles for different purposes in the formal sector of public transportation. Six communities reported multiple uses of school buses in the mail survey. It would appear that there should be more opportunity for joint use in small communities that have various needs but limited resources. School buses could, for instance, be used for mail delivery or for transportation of the elderly and handicapped either during the time of transporting students to and from school or outside these hours. During the interviews with transportation officials, however, it was noted that there may be some problems in the administration of a system used by different groups for different purposes, for instance, problems with priorities of use and cost allocation. These issues may be explored further together with the regulatory issue.

A study of the possible increased use of public transportation during emergencies or periods of inclement weather would also be worthwhile. As mentioned before, because of their greater expertise public transportation agencies may be better qualified to cope with these situations than members of the general public. A discussion with transportation officials on this issue revealed that although this may be a reasonable objective, some problems would have to be overcome to fully implement the desired service. One of the problems is availability of labor, because the service that can be provided during periods of emergency or inclement weather is limited by the number of trained drivers. Perhaps a driver pool similar to volunteer fire-fighting organizations could be developed.

It could be cost-efficient to develop a sketch-planning technique for the purpose of assessing the applicability of different public transportation options to the various types of communities in Alaska. A brief examination of available sketch-planning methods, such as those outlined in the *Guide to Screening Community Paratransit Service* (*5*) and *Analyzing Transit Options for Small Urban Communities—Analysis Methods* (*10*), led to the conclusion that these methods are generally not suitable for use in Alaska. They require a substantial amount of data and are, for the most part, unsuitable for such small communities. For instance, planning nomographs based on population are not calibrated for the low population of Alaskan communities.

Studies can be carried out and disseminated by government organizations, academic institutions, and consultants. The Rural Technology Transfer Program (RTTP) was established by FTA for the purpose of developing and facilitating the exchange of information and technology among rural public transportation operators and agencies. The program is administered by the state of Alaska. RTTP could play a valuable role in the studies and serve as a means to exchange information among the communities.

SUMMARY OF MAJOR CONCLUSIONS AND RECOMMENDATIONS

The major conclusions and recommendations are summarized below:

1. There is very little documentation available on public transportation systems in Alaska.
2. The existing public transportation systems in Alaska cover a very wide spectrum of both paratransit and transit options. These systems range from some unique forms of what may be termed paratransit to regular bus service.
3. The public transportation systems in Alaska appear to be unique in that public transportation options are utilized in very small communities.
4. The need for public transportation in Alaska is related to economic reasons and the lack of an alternative means of transportation. Because of the harsh environmental conditions in Alaska, the lack of an alternative means of transportation is a more compelling reason for having public transportation than might be the case elsewhere.

5. There appears to be room for further implementation of public transportation in Alaska.

6. Topics that may warrant further study and development include

(a) Cases of successful public transportation operations.

(b) The organization of informal pooling of vehicles. Models that work well in Alaskan communities should be identified. Special attention should be given to the different lifestyles and cultures present in Alaska.

(c) The regulation or lack thereof of public transportation in Alaska.

(d) The joint use of vehicles for public transportation.

(e) Increased use of public transportation in Alaska during periods of inclement weather or other emergency situations.

(f) Sketch-planning techniques for the type of communities encountered in Alaska.

7. RTTP, established by FTA, can play a valuable role in serving as a means to exchange information on public transportation.

ACKNOWLEDGMENTS

This research was funded by TransNow at the University of Washington (sponsored through the U.S. Department of Transportation UTC Grant Program); the School of Engineering at the University of Alaska, Fairbanks; and the Alaska Department of Transportation and Public Facilities. Support was also provided by the Department of Civil Engineering and Applied Mechanics, San Jose State University.

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Publication of this paper sponsored by Committee on Rural Public and Intercity Bus Transportation.

Particulate Trap Installation in a MAN Articulated Transit Bus

DANIEL H. WALLIS AND WILLIAM E. LUFFMAN

The increasing Environmental Protection Agency standards for diesel engine exhaust emissions are forcing the transit industry to find a means of cleaning up the air. A particulate trap oxidizer system is currently accomplishing this task on two-cycle transit bus engines. At Phoenix Transit System this same technology is being applied to a Maschinenfabrik Augsburg-Nürnberg AG (MAN) four-cycle engine to demonstrate that four-cycle exhaust can also be cleaned. The particulate trap system installation in the MAN bus is summarized. The initial temperature testing was conclusive that all system components were operating within component manufacturers' specifications. Smoke opacity testing on the particulate-trap-equipped bus resulted in readings of 0 percent smoke opacity compared with a similar MAN bus with as much as 27 percent opacity. Operating data are being collected to determine if the system is applicable to a four-cycle transit bus engine in a desert environment similar to that in Phoenix, Arizona.

The transit industry is currently being pressured by federal government, city government and citizens to clean up the air. In 1994, the Environmental Protection Agency (EPA) will be introducing standards for diesel engines that cannot be met unless current diesel engines are redesigned, another form of fuel is used, or a means to filter the exhaust to meet the new requirements is provided.

The retrofitting of current operating diesel engines with an exhaust filter system is a viable means of meeting future EPA standards. These systems also have the potential to be applied to new engines to meet the standards required for the manufacturer without redesigning the engine. Currently, a particulate trap oxidizer system is available as a retrofit package for a two-cycle Detroit Diesel engine. The same particulate trap system has been adapted to a four-cycle transit bus engine at Phoenix Transit System (PTS). Two MAN articulated transit bus exhaust systems were retrofitted using the Donaldson dual-trap electric oxidizer system. The initial retrofit package cost is approximately $16,000 each.

The particulate trap system replaces the original muffler system of the four-cycle MAN MLUM D2566 engine. The MAN bus (Figure 1) was chosen to demonstrate that the smoke from a four-cycle diesel engine, which normally has increased opacity over that of a two-cycle engine, can be eliminated. PTS is evaluating the particulate trap system in the following areas: (a) its applicability in extreme heat conditions encountered in the desert environment, (b) whether the system will cause any adverse side effects, and (c) if the use of a four-cycle engine, which produces hotter exhaust gases than a typical two-cycle, will tend to magnify the extreme operating conditions.

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OPERATIONAL CHARACTERISTICS

The Donaldson dual particulate trap system is designed to filter up to 85 percent of the diesel-emitted particulate. The system used by PTS consists of three components: a ceramic wall-flow monolith filter element, regeneration system, and the controls that bring about regeneration. When the engine is started, the particulate trap system will direct the exhaust flow through the trap assembly filter element that is the most full. This is determined through a series of calculations by the electronic controller that monitors engine air flow, temperature readings, and differential pressure across the filter elements. Exhaust flow continues through the filter until it is loaded to the maximum allowable level, at which point the exhaust flow is diverted to the other trap assembly. The loaded filter is regenerated to remove the particulate and is then left idle until the next loading cycle.

INSTALLATION

Planning

The first step was to evaluate how the components of the particulate trap package would be oriented to occupy the space available. Careful inspection was conducted to determine if all the components could be located close together. In addition, the location of each component was carefully evaluated for ease of serviceability. After measurements were taken, sketches were drawn to get a complete understanding

FIGURE 1 MAN articulated transit bus with a four-cycle engine.

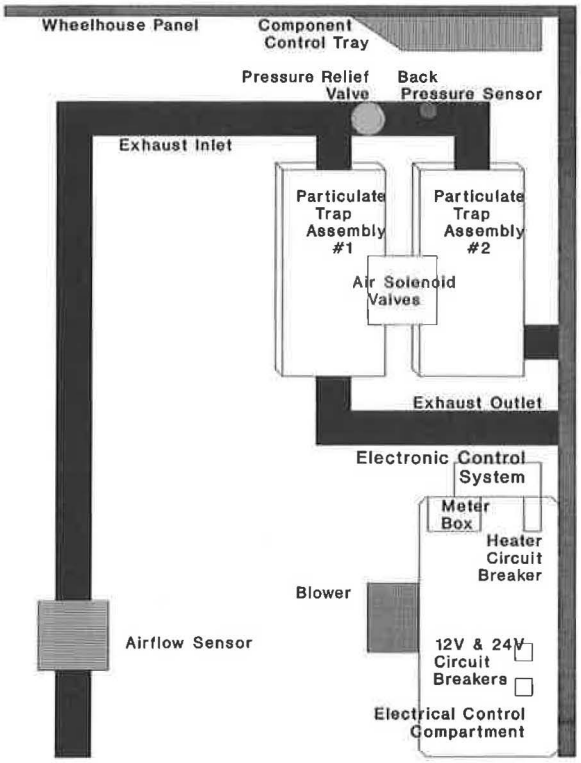

FIGURE 2 Schematic of dual particulate trap system installed in a MAN articulated bus.

of the overall retrofit. Using the sketches, all the components were laid on the floor to visualize the orientation and location of the final installation.

One mechanic was chosen to complete the entire installation. This provided a better control and continuity throughout the installation and also reduced the instruction time required when several individuals are involved in a large, continuous project.

Procedure

The Donaldson dual particulate trap system (schematic shown in Figure 2) was installed in the MAN articulated bus with minimal modifications to the water lines and the exhaust system. The original muffler system (Figure 3) was removed, leaving only two muffler supports and the exhaust piping from the engine. Both of the supports were shortened, one was repositioned, and two were added and aligned to provide support to the front and rear of each trap at a height to ensure sufficient ground clearance.

One modification required to make the particulate trap system conform to the MAN four-cycle engine was to shorten the trap exhaust-pipe-inlet assembly provided in the Donaldson package. This allowed a straight section to be inserted to connect the existing exhaust piping to the inlet assembly. An additional bracket was added to support the inserted piping span. The shortening of the inlet assembly required the exhaust back-pressure relief valve and the exhaust back-pressure sensor to be relocated on the inlet assembly. It was also important to keep the exhaust outlet pipes as short as possible to minimize the back pressure and to maintain separation and to avoid opposite flow into the nonoperating trap. The last modification pertained to the three coolant water lines, which occupied the space required by the larger particulate trap system. The modified lines were routed in a manner to provide clearance and system integrity.

The air flow sensor was positioned between the engine intake manifold and the intake air cooler. This location is different from the two-cycle engine system where the sensor is located between the engine air filter and the turbocharger compressor inlet. Because of space restrictions, this was the only placement possible without major system modifications.

The electronic control system is housed in a single sealed box designed so that it can be mounted on the bus exterior. In an attempt to minimize the wiring lengths required, the box was mounted within the same cavity as the particulate traps, near the exhaust outlet pipes. The component control tray, which contains the pressure sensors, electrically operated air solenoid valves, and two filter heater relays, was located on the forward side of the wheelhouse panel to control wiring and minimize hose lengths. The blower that supplies the necessary air to sustain regeneration was mounted on the back side of the electrical control compartment. The air solenoid valves, which control the air supplied by the blower, were mounted above the traps. They were connected to the blower with heater hose, and to the traps with corrugated steel tubing for protection from the heat generated by the traps.

To maintain an operational record of the particulate trap system, a meter box was installed in the side electrical com-

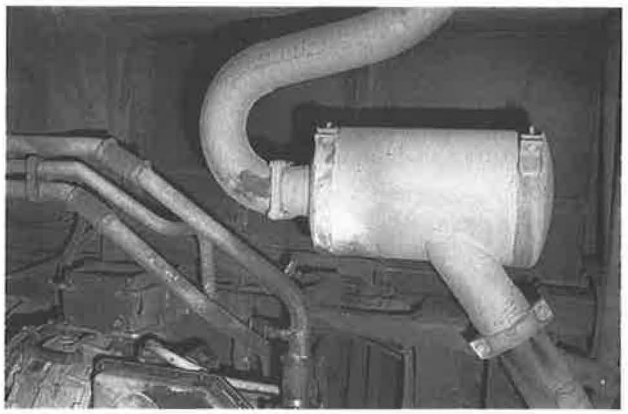

FIGURE 3 Original muffler system.

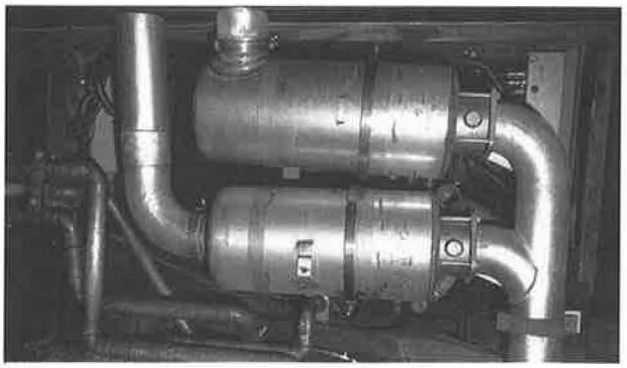

FIGURE 4 Dual particulate trap system.

TABLE 1 ADDITIONAL MATERIALS REQUIRED

Mounting Materials	
Quantity	Description
3	2" Rubber Bushing
1	14" x 14" x 1/8" Steel Plate
6'	1 1/2" x 1 1/2" x 1/16" Steel Square Tubing
3'	2" x 1/8" Steel Flat Bar
2'	1 1/2" x 1 1/2" x 1/8" Steel Angle
5'	5" Exhaust Pipe
1	5" Exhaust Pipe Clamp/Support

Plumbing Materials	
Quantity	Description
9'	2" Copper Tubing
6	2" Copper 90's
7'	1 1/2" Copper Tubing
5	1 1/2" Copper 90's
1	2" x 2" x 1 1/2" Copper T Connector

partment. The meter box monitors critical data relative to the operation of the entire system, such as total run time, run time on each trap, and the number of regenerations per trap. Using the meter box, PTS is obtaining a detailed log of the operational characteristics of the particulate trap system. Also mounted inside the electrical control compartment were the 12-volt and 24-volt system circuit breakers, and the heater circuit breaker to allow for easy servicing when necessary.

A 7-psi pressure switch was integrated into the generator oil supply line to signal the particulate trap system run-relay switch when the bus engine is operating. A pressure switch was used in place of the generator R-terminal to avoid possible voltage spikes. The completed installation of the Donaldson dual particulate trap system in a MAN articulated transit bus is shown in Figure 4.

Materials

The materials required to install a dual particulate trap system on a MAN bus are outlined in Table 1, which shows all materials needed in addition to the particulate trap system kit.

Time

The time required to install the entire particulate trap system was shortened for the second installation because of the knowledge gained from the first installation. The second installation necessitated only 100 hours, whereas the first installation took approximately 25 percent more time.

INITIAL TESTING RESULTS

Tests were conducted to determine what temperature the components of the particulate trap system were being subjected to. Thermocouples were located on all the system components and temperatures were recorded during transit bus operating conditions. All tests were conclusive that the components were operating within the manufacturers' component/temperature specifications.

Testing was also conducted to determine the opacity of the exhaust emissions. Three different operational load tests were done: idle, pull-off, and 80 percent of governed speed, which is the Arizona state emissions test. Both of the particulate-trap-equipped buses recorded an opacity level of 0 percent for all levels of load testing. A control bus similar to the particulate trap buses was tested for comparison purposes. The opacity levels of the control bus were 2, 27, and 3 percent, respectively.

Further testing is planned on a mobile emissions tester capable of testing heavy-duty vehicle emissions using the EPA test cycle. The tester is a joint project between the former Urban Mass Transportation Administration (now the Federal Transit Administration) and the Department of Energy (DOE). DOE has contracted with West Virginia University for the development and operation of the equipment. In addition, PTS is planning to conduct testing quarterly at the Phoenix facility using an opacity meter.

CONCLUSION

The stricter EPA standards are forcing the transit bus industry to search for solutions to meet these requirements. A particulate trap retrofit can solve this problem on a two-cycle diesel engine. PTS is demonstrating that the Donaldson particulate trap system can be adapted to a MAN four-cycle engine, resulting in exhaust emissions comparable with the future EPA guidelines.

ACKNOWLEDGMENT

Phoenix Transit System would like to thank the Arizona Department of Environmental Quality for the grant support to fund the research and experimentation involved with the particulate trap retrofit project. In addition, a special thanks must be given to the Donaldson Company for their continuous technical support provided throughout the project.

Publication of this paper sponsored by Committee on Transit Fleet Maintenance.

PART 2

Paratransit

Methodology for Conducting a Transportation Survey of Persons with Disabilities

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The methodology described here was used to conduct a survey of persons with disabilities living in the area served by the Chicago Transit Authority (CTA). The survey was designed to learn about the travel behavior, attitudes toward modes, effect of disabilities on travel, and demographics of this population. The effectiveness of the survey is measured by the level of response from those receiving the survey. The substantive results of the survey are reported elsewhere. The survey was conducted just before the beginning of service, and intended to serve as a baseline for comparison of future survey results. It consisted of three parts. A telephone screening survey was used to obtain a random sample of persons with disabilities as well as to ascertain the incidence of disabilities in the total population. This survey revealed that 4.2 percent of the population in the CTA service area age 12 or over "have some difficulty in traveling." These respondents, plus a sample drawn from a list of registrants for the CTA's paratransit service, were mailed a 7-day travel diary, followed by telephone administration of a questionnaire covering travel behavior, preferences, attitudes, and demographic information. In spite of the length of the diary and the relatively long telephone survey, the overall response rate was 52.3 percent, aided by a $5 financial incentive, extensive telephone follow-up, and the credibility of the sponsoring organizations.

In 1985, several persons who used wheelchairs filed suit against the Regional Transit Authority (RTA) and the Chicago Transit Authority (CTA), charging that they had been illegally denied access to public transit. The 1989 settlement of the suit included the following terms:

1. The CTA would operate 700 lift-equipped buses on selected routes for 5 years. An evaluation conducted during the 5-year period would determine the unit cost of lift-assisted bus ridership and other performance indicators. (A survey was cited in the settlement agreement as one of the evaluation techniques.)
2. The CTA would make their entire fleet accessible with wheelchair lifts if, after 5 years, the cost of rides assisted by lifts was close to the cost of CTA's Special Services rides (door-to-door reservation service offered by private contractors using small buses, vans, and sedans). If not, the CTA had to operate the 700 buses with lifts only until their retirement.

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Subsequently, the RTA adopted a regional transportation policy calling for accessible mainline bus services, and the Americans with Disabilities Act was passed, rendering portions of the settlement order pointless. Nevertheless, the RTA and CTA elected to proceed with the survey because of its value as a tool for monitoring and improving accessible service.

The specific objectives of the survey were to

- Relate demographic, geographic, and personal factors to travel behavior;
- Develop a factor that would increase observed lift-use ridership to account for the fact that only one-third of the bus fleet was accessible;
- Identify impediments to lift use;
- Identify attitudes toward Special Services;
- Identify changes in travel behavior among the population of disabled persons as a result of the implementation of lift-equipped bus service; and
- Document the changes in attitudes toward public transit among persons with disabilities after lift-equipped bus service is initiated.

The benchmark survey was conducted in fall 1990 just before the introduction of the first of 700 mainline buses with wheelchair lifts. Comparisons between data from this survey and follow-up surveys planned for coming years would reveal the impact of accessible public transportation on the lives, behavior, and attitudes of mobility-limited individuals.

OVERVIEW OF METHODOLOGY

An overview of the various issues in planning and designing the survey is described in this section. Greater detail is provided in subsequent sections.

Definition of the Population

The population surveyed consisted of persons who have difficulty in traveling because of blindness or inability to walk or climb stairs (represented by the second largest oval in Figure 1). This is a subset of the population containing all persons with disabilities (represented by the largest oval in Figure 1). This target population was chosen because it was thought to contain those persons who would benefit from the introduction of wheelchair lifts. To concentrate on the ages

when persons are most likely to be independent travelers, the population was restricted to those 12 years of age or over.

Another subpopulation of interest consisted of those persons eligible for CTA's Special Services program, as shown by the third oval in Figure 1. To be eligible for CTA's Special Services, a person must be unable to use regularly scheduled public transportation for one or more of the following reasons:

- Meeting the legal definitions of both blindness and deafness,
- Meeting the legal definition of blindness and not possessing the mobility skills to travel fully independently, or
- Having great difficulty in climbing, or being unable to climb, three standard motor coach steps.

A physician's certificate verifying the eligibility conditions is necessary. Not all persons eligible have chosen to be certified for CTA service, presumably because they travel by other modes or they do not travel at all. The population of those certified, shown as the shaded oval in Figure 1, was of particular interest because their response to lift service is an important factor in policy formulation and planning.

Determining Sample Size

The target population of persons with disabilities was estimated to contain 30,000 to 50,000 persons. The usual practice to find a sample would be to randomly select a sufficient number of names to ensure that the error from sampling did not exceed a specified percentage. Originally, a completed sample of about 4,000 was envisioned to ensure that it could be divided into a number of subgroups of at least 400 each, such as wheelchair users, and to ensure a sample large enough to allow analysis of these subsets with a tolerable sampling error. A large sample was also desired so that if the same group were surveyed in the future, a sufficient number could still be contacted in spite of attrition. When economic realities of conducting the survey became clear, the 4,000 sample was abandoned for a sample of about 1,000 completed surveys.

Selection of Sampling Frame

One means of selecting a sample is by randomly selecting names from a list enumerating the population. No such comprehensive list of persons with disabilities exists in Chicago. Although a number of lists of persons with disabilities are maintained by social service agencies, advocacy groups, and government agencies, many are privileged, restricted by law or by agreement. Moreover, the amalgamation of all such lists would certainly not comprise the total population, so a sample from the lists would be biased. Therefore, it was decided to adopt the relatively expensive procedure of telephoning randomly selected numbers to find a small but relatively unbiased sample. This telephone survey, or "screening survey," resulted in a sample of 243 persons in 227 households who represented the population of all persons with transportation disabilities.

Special Services users formed a population of interest to transit planners and policy makers, because they are likely users of accessible service, and they could provide an informed opinion on paratransit service. Although about 20 percent of the screening sample consisted of Special Services users, this was too small to support analysis. Therefore, an additional sample of about 1,900 persons was selected from the list of registrants for CTA's Special Services. Over 800 completed surveys were received from this group, a large enough sample so that this sample, together with the smaller sample of all persons with transportation disabilities, provided a sufficiently large sample to support conclusions about the two populations and their differences.

Another sampling isssue was the number of days to be included in the diary. Since it was expected that the trip-making rate of the subject population would be considerably lower than the average for the total population, around three trips a day, there was concern that a sample of 1,000 persons would result in too few reported trips to support conclusions if the usual 1- or 2-day record of travel was collected. This sample is usually collected with a question such as "Please describe all the trips you made yesterday." Therefore, it was decided to ask each respondent to provide a full 7 days of

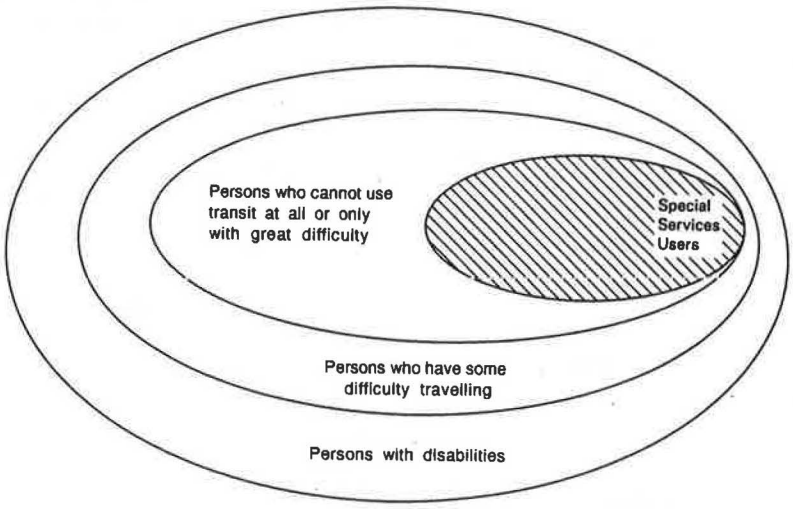

FIGURE 1 Populations of persons with disabilities.

trip-making data. The week of trips would also provide sufficient data to identify patterns on the different days of the week.

In summary, two samples were surveyed. The first consisted of the 243 persons with transportation disabilities identified in the telephone screening survey, shown as a rectangle containing the number 243 in Figure 2. This sample included persons who were eligible and who registered to use Special Services, which is indicated by the overlap of the rectangle with these two populations. The second sample consisted of the 1,959 names selected at random from the list of persons registered for Special Services, shown as the second rectangle in Figure 2.

Selection of Mode of Administration

The concern about nonresponse bias suggested the use of a telephone survey, which usually results in higher response rates than a mailed survey. Statistics compiled by Survey Sampling, a firm specializing in random-digit sampling, indicate that 94.1 percent of the households in the Chicago metropolitan service area have telephones, making telephone interviewing a slightly less-comprehensive means of conducting a general population survey than door-to-door interviewing. Telephone interviewing has some other advantages over other data collection methods. Compared with door-to-door interviewing, telephone surveys are substantially less time consuming, costly, and dangerous. Finally, telephone interviewing yields higher participation rates and better-quality data than can be obtained from a mail survey.

There are also shortcomings to telephone surveying. Persons with disabilities tend to have low household incomes, and thus are less likely to have telephone service. Moreover, many persons who live in group or institutional settings typically do not have their own telephones. Finally, interviewing by telephone may cause underrepresentation of individuals with communication impairments or limitations, including the deaf and non-English-speaking. In spite of these problems, which were considered minor, telephoning was selected as the major means of administering the survey.

The 7-day diary presented a problem for telephone surveying, since existing studies suggested that people cannot accurately recall trips made several days in the past. This fact argued for collecting trip-making records contemporaneously, either by having them recorded by the respondent or by having interviewers make daily telephone calls to respondents. Since daily calling appeared to be prohibitively costly, it was decided that the diary would be a mailed, self-reporting format and the rest of the survey would be conducted by telephone. It was hoped that urging respondents to call for more information would encourage respondents to participate.

Use of Cash Incentives

Mailing of a survey with a token cash incentive enclosed is believed to be effective in encouraging the return of the survey. It was decided to include $1 with the diary when mailed, and to promise a second cash payment of $4 upon completion of the telephone survey.

Avoiding Nonresponse Bias

The resulting survey design, which combined a 7-day diary and a 20- to 30-min telephone survey, was ambitious in that it required considerable effort by the respondents—effort that could discourage participation, especially among the high proportion of older respondents in the population. Low participation raises the possibility of a substantial nonresponse bias, that is, a skewing of the results if the persons who refuse to respond are significantly different from those who do respond. To control this bias, a number of measures were taken to ensure a target response rate of 50 percent, which was deemed to be sufficiently high to allow valid conclusions. The

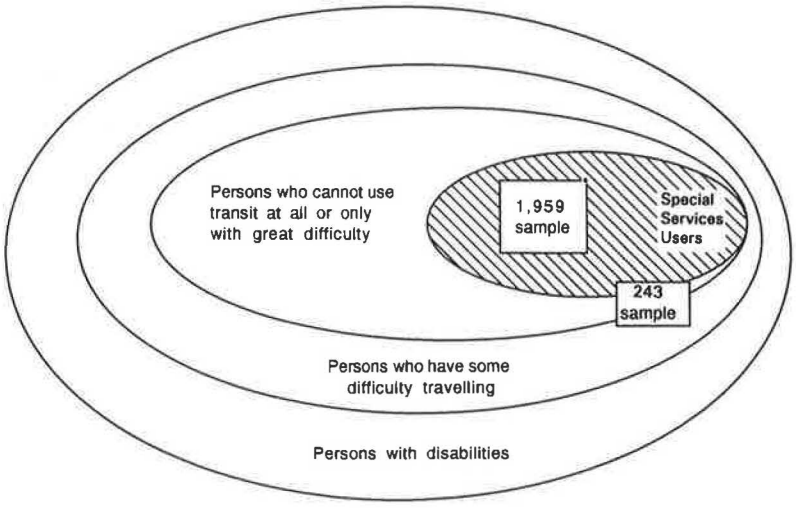

FIGURE 2 Source and size of two samples.

measures used to increase the rate of response included extensive pretesting to ensure that the conduct of the survey did not discourage respondents, extensive follow-up to offer help and encourage responses, small cash incentives, and the identification to the respondents of a number of sponsoring organizations to establish credibility for the survey.

Trips Wanted but Not Made

Since one purpose of the survey was to extrapolate observed trips to estimate the number that might occur when more buses in the system became accessible, respondents were asked to identify the trips they wanted to make but did not make on each day. The literature contains caveats against asking people whether they will make hypothetical trips or use hypothetical modes, so some skepticism concerning this part of the diary is justified. On the other hand, such questions have been used successfully for demand estimation when they have been specific and tied to performing daily functions, as was done in this case. However, the use of this approach is as much a research effort as a data collection effort. The ability to survey several times over a period of years may provide a unique test of this means of assessing latent demand.

METHODOLOGY

Overview

As described above, a three-part survey was used consisting of a telephone screening survey to identify persons with disabilities in the general population, a self-completion travel diary to gather information on individuals' actual and desired travel behavior during a 1-week period, and a telephone interview, called the telephone survey, to elicit disability, attitudinal, and demographic data. The following sections cover the methodologies used for each component of the survey and the method of pretesting.

Telephone Screening Survey

Purpose

As noted above, a screening survey, conducted among a random sample of households served by the CTA, had the following purposes:

- To determine the percentage of households in the CTA service area containing one or more persons with mobility limitations,
- To obtain some basic information about individuals with mobility limitations, and
- To recruit 200 to 400 mobility-limited individuals to receive the diary and participate in the telephone survey, by which they would provide the basis of comparison to reveal the differences between the Special Services registrants and all persons with mobility limitations.

Procedure

To ensure that households with both listed and unlisted telephone numbers were represented, the numbers used were computer-generated random combinations of digits within the valid telephone exchanges for the CTA service area.

Two general questions on transportation were asked to initiate the interview. In addition to having research value for the CTA, these questions served as "warm-ups," confirming the survey's bearing on transportation issues and making respondents comfortable before answering personal questions about mobility limitations. Recognizing the influence of question wording on individuals' willingness to identify themselves or members of their households as having an impairment, it was decided to use the phrase "difficulty in traveling" on the grounds of simplicity and general comprehensibility, rather than such terms as "mobility limitation" or "disability."

A sample of 9,000 randomly generated telephone numbers with the exchanges used in the 38 communities in the CTA service area was purchased from a vendor. Interviewers were briefed on the purpose of the study and the procedures for administering the screening questionnaire. They also took part in mock interviews that emphasized the importance of tact and sensitivity in interacting with participants.

Interviewing began in September 1991 and concluded in early November 1991. Interviewers made three attempts to reach a head of household at each working telephone number in the sample.

Results

A classification of the screening telephone calls is as follows:

Item	*No.*
Total calls	15,150
Incomplete calls	
No answer/busy/call back	6,515
Disconnected/business/FAX	2,425
Answering machine	1,838
Foreign language	100
	10,878
Initial refusals	987
Terminations—out of area	213
Nonqualifying households interviewed	
No mobility-limited members	2,745
Nonqualifying medical condition	10
All mobility-limited members under age 12	3
	2,758
Qualifying households interviewed	
Recruited for diary receipt and telephone survey	227
Refused recruitment	87
	314

The screening survey found that 10.2 percent of the households in the CTA service area contain one or more persons aged 12 or over who had "some difficulty in traveling." The household data translate to the finding that 4.2 percent of the total population have mobility-limiting disabilities. A total of 243 mobility-limited individuals in 227 households were re-

cruited for participation in the diary and telephone portions of the survey.

Of the calls that reached a respondent at a working residential telephone number, 23.1 percent resulted in an initial refusal to participate in the survey. Additionally, just over one-fourth (27.7 percent) of the qualifying households interviewed in the screening survey refused recruitment for the remainder of the survey.

Evaluation of Procedure

A number of findings concerning the efficacy of the telephone screening survey are described below.

- Telephone interviewing using random-digit sampling was an appropriate and workable, but time-consuming, method of conducting the screening survey. The purchased sample of telephone numbers contained a high proportion of nonresidential and nonworking numbers, which had to be called before being eliminated. This consumed a good deal of time. Nevertheless, randomly generated numbers must be used in order to include unlisted as well as listed telephone numbers, because the characteristics of households with unlisted telephone numbers may differ significantly from those with listed numbers.
- Cooperation with the survey was excellent. According to Survey Sampling, the average noncooperation rate for telephone surveys conducted in the North Central census region, which includes Illinois, is 42.9 percent. In this study, only 23.1 percent of all calls that reached a respondent at a working residential telephone number resulted in an initial refusal. Respondents' willingness to cooperate was due in large measure to the credibility of the survey's sponsor, the RTA, and to the brevity of the interview, as well as to interviewer training that stressed the importance of attempting to persuade those expressing reluctance to participate.
- The questionnaire for the screening survey was easy to administer. Respondents had no difficulty in understanding the questions. The lead-in questions on general transportation issues served a valuable purpose by easing respondents into the mobility-limitation questions, which might otherwise have seemed abrupt and offensive.
- Few foreign language households were found. Of the households containing no mobility-limited individuals, 2.8 percent were interviewed in Spanish, and 3.2 percent of the households identified as having one or more mobility-limited members responded in Spanish. The only other foreign language encountered in more than a handful of households was Polish, spoken by less than 1 percent of the individuals contacted in the screening survey.
- Despite efforts to make the survey as comprehensive as possible, some segments of the mobility-limited population were excluded. Mobility-limited persons in hospitals, nursing homes, and other institutions were not included because of logistical difficulties. A few individuals with hearing impairments may have remained unidentified as a result of the close resemblance between the high-pitched tone emitted by facsimile machines and the sound heard on reaching a telephone device for the deaf (TDD). According to Bell's Service Center for the Disabled, most TDDs are operated by government offices and public agencies, and households with TDDs frequently have lines connected to standard telephones for the use of non-hearing-impaired family members. This information suggests that the number of residential TDDs occurring in the screening survey sample was small.

Other factors bearing on the comprehensiveness of the screening survey included the decision not to recruit the small number of individuals identified as having temporary conditions, those expected to persist for less than 2 months, on the grounds that their choice of travel mode was unlikely to be changed by a temporary disability, and the tendency of very elderly persons and of individuals reporting that they never leave their homes to refuse recruitment for the diary and telephone parts of the survey. Thus, the sample recruited through the screening survey may slightly overrepresent the younger and more active segments of the general mobility-limited population.

Pretest of Diary and Telephone Interviews

Procedure

Pretesting is a standard survey procedure to discover and correct any problems or weaknesses in the study plan and the survey instruments before undertaking the main survey. In this case it was also used to evaluate alternative strategies for achieving a high response rate.

The procedure for conducting the pretest was essentially the same as the final survey described below, although some improvements were made as a result of the pretest.

The cover letter accompanying the transportation diary was designed to

- Communicate the nature, purpose, and legitimacy of the research effort;
- Emphasize the importance of participating;
- Encourage recipients to seek help in filling out the diary; and
- Test various strategies for achieving a high response rate.

In pursuit of the last objective, four different versions of the pretest cover letter were used. One version asked respondents to return their completed diaries to the RTA and offered a bonus of $2 for those completing the full study. The second version used the RTA return address but offered a bonus of $4. The third version used the name of the consultant as the return address and offered a $2 bonus. The last versions used the consultant's name and offered a $4 bonus.

Evaluation

The following conclusions are based on the pretest findings.

In general, the study design functioned as expected. Placing the diary in respondents' hands by mailing it and asking them to keep track of their own travel gave them a sense of personal involvement in the project. Administering the remaining por-

tions of the survey by telephone provided an important opportunity to correct the diary data.

The response rate of 42.6 percent was above the norm for conventional mail or telephone surveys. A key element in achieving a high level of response was the combination of the initial cash incentive of $1 and the bonus check on completion of the main survey. The incentive created good will by demonstrating the RTA's interest in their opinions and represented a significant amount of money for some respondents, many of whom have household incomes of less than $5,000 per year.

Telephone contacts played a significant role in encouraging diary recipients to participate in the survey. The pretest results revealed that many of the mobility-limited individuals represented in the study had little formal education. This fact, coupled with individuals' physical, cognitive, or other impairments, made it difficult for them to read, understand, and, in some cases, write in the diary. Although interviewers making reminder calls encountered few overt refusals to participate, they found many instances in which recipients had been unable to understand what they were supposed to do and had simply set the diary aside. Therefore, the primary objective of the telephone follow-up effort shifted from reminding to explaining and offering assistance.

In addition to contributing to the level of response, the telephone contacts fostered good will toward the survey effort by giving diary recipients opportunities to express their considerable frustration with the Special Services program.

Recipients found it difficult to absorb the written instructions for filling out the diary. In sorting and editing the returned diaries and in speaking with recipients, the study team identified a number of common misunderstandings about the procedures for completing the diary:

1. Individuals doing little or no traveling were convinced that their opinions could be of no value. Even after pointing out that there was a "made no trips today" box on each page of the diary, interviewers had difficulty persuading housebound persons or their families to participate.

2. Those claiming not to use public transportation or Special Services also believed that the RTA would not be interested in including them in the survey. Other individuals thought that they should record only the trips they made via Special Services.

3. A number of diary recipients did not understand the importance of recording trips at the time they were made and of providing information for consecutive days. Some individuals supplied details of trips they had taken over the past several years ("Let me tell you about my 10 best trips!"). The reminder calls disclosed that many individuals believed that they should wait to begin the diary until they made a trip, and that they should record information only for days on which they went somewhere.

4. The "trips wanted but not made" pages baffled a sizable number of diary recipients. Why the RTA would want to know about "imaginary trips," as one respondent put it, required considerable interviewer ingenuity to explain. Moreover, for many individuals represented in the study, the knowledge that they could not go anywhere made it almost impossible for them to say what they would have done if their mobility limitations and the unavailability of suitable transportation had not hindered them.

While pointing up the need for clearer and more effective instructions, the pretest did not reveal any significant problems with the diary's 7-day format or with the categories of information requested for each trip.

The pretest supported a decision to use the RTA's address and to offer a $4 check in the main survey. The overall returns showed that individuals who received the cover letter specifying that the diary be returned to the RTA were somewhat more likely to participate than were those whose letters mentioned returning the diary to the consultant. The distinctly higher response rate generated by the offer of a bonus check for $4, rather than $2, made it worthwhile to offer the larger amount to individuals in the main study sample.

Diary Distribution and Telephone Interviews

Procedure

From the list of persons registered for the CTA Special Services, CTA selected every sixth record from a random starting point, creating a random sample of users. These names together with the names of persons recruited in the screening survey were placed in a data base, and a unique identification number was assigned after duplicates from the two lists were eliminated.

The use of personalized letters and the inclusion of a $1 cash incentive are recognized direct-mail and mail survey techniques to encourage recipients to read the cover letter and to reinforce the message that each individual's participation is valued. To reinforce the legitimacy of the project, the letter was printed on RTA stationery and included a list of cosponsoring organizations that serve persons with disabilities. The letter also provided help for recipients by listing a toll-free telephone number, the number of the RTA Public Affairs Office, and the RTA's TDD number.

A sample "trips made" page of the diary is shown in Figure 3 and a sample page for "trips wanted but not made" in Figure 4. The respondents were asked to provide the following information: origin and destination, time started and time arrived, purpose(s), mode(s) (for "trips made"), and reasons for not making trip (for "trips wanted but not made").

Formatting the diary proved to be a challenge. The experience of the Chicago Area Transportation Survey (CATS) suggested that better returns resulted when data for a trip were arranged vertically, rather than horizontally. On the basis of this experience, each diary page was made large enough to contain four vertically oriented boxes, representing four trips. The need to ensure the readability of the type, given the prevalence of vision impairments in the large elderly population of persons with disabilities, also argued for the use of large diary pages. Therefore the dairy was printed on 8½- × 14-in. pages in landscape orientation and folded in half to create a 7- × 8½-in. booklet that would be portable and easy to mail.

To overcome confusion that surfaced during the pretest of the transportation diary, the following six bullet points were printed on the front cover of the diary:

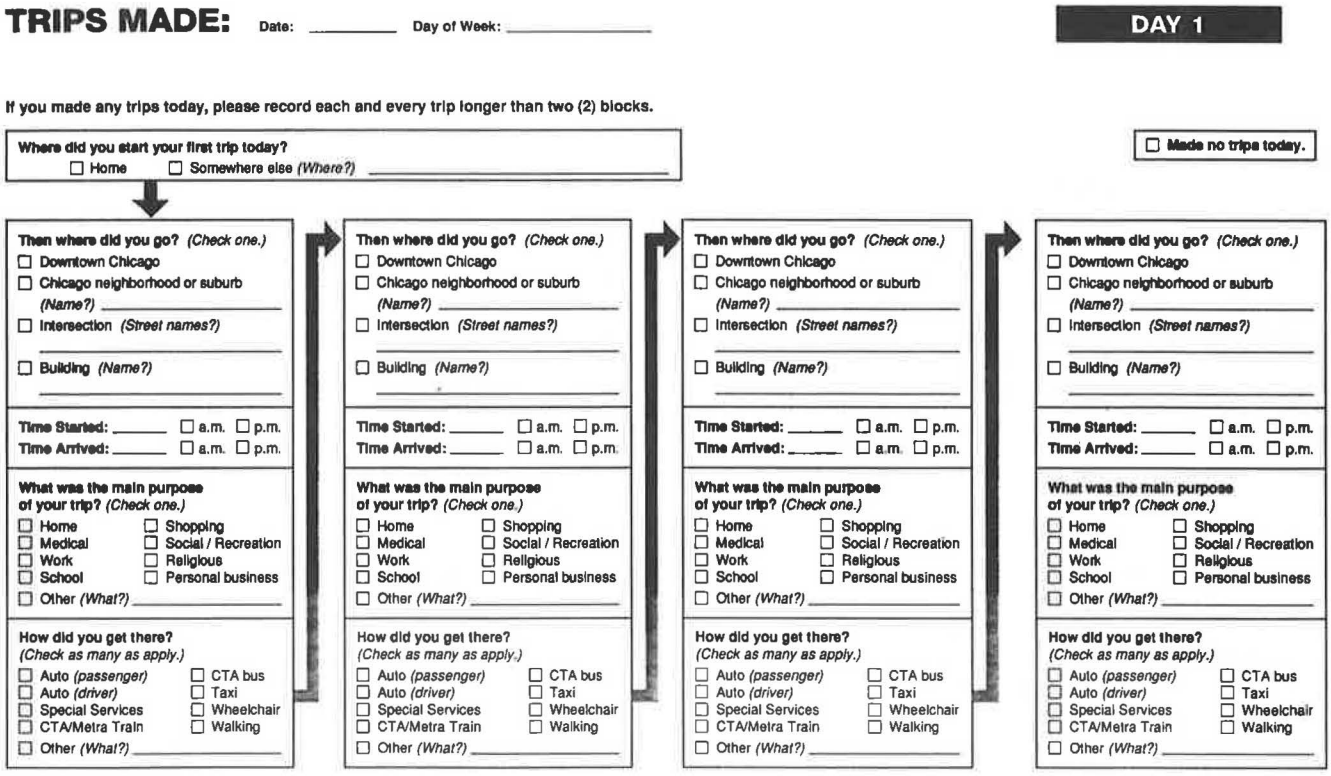

FIGURE 3 "Trips Made" page from travel diary.

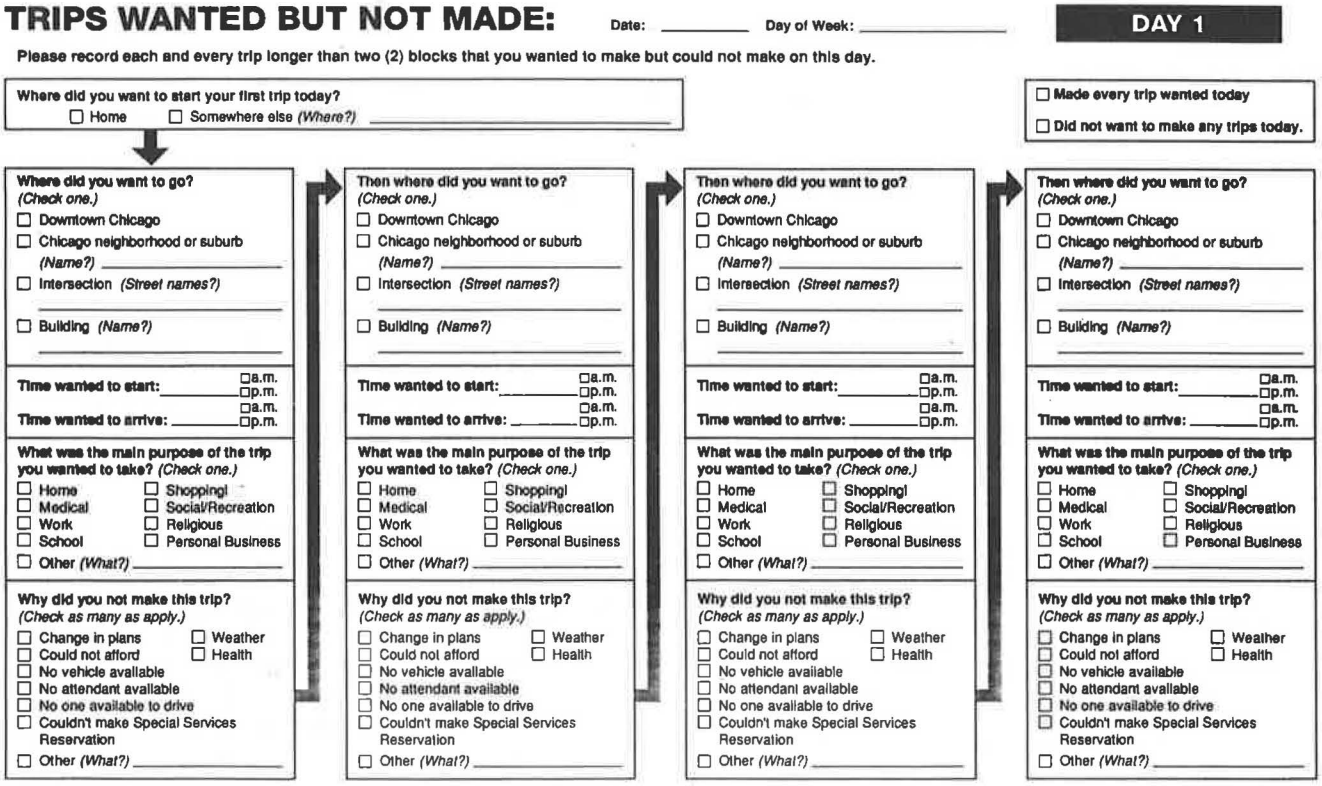

FIGURE 4 "Trips Wanted" page from travel diary.

- Start immediately. Don't wait until you make a trip to begin.
- Fill out the diary for seven consecutive days.
- Record trips as you make them. Don't record past or future trips.
- Fill out the diary even if you don't go anywhere.
- Fill out the diary even if you don't use the RTA or the CTA.
- Read the instructions and examples in the diary first.

To help individuals recognize that they could record days on which they did not make or did not want to make any trips, the pertinent sections in the diary instructions were highlighted and the "made no trips today" and "did not want to make any trips today" boxes were made prominent.

Because difficulties in understanding the written instructions for the diary were prevalent in the pretest sample, interviewers offered to fill out diaries for individuals. Additionally, the consultants started new diaries in the office for individuals whose original diaries came back with such major errors that they could not be corrected. Travel data for these individuals were also obtained through daily calls.

The Chicago grid system was used to code the trip origins and destinations recorded in the transportation diaries. Because spatial references according to the Chicago grid are in common use in Chicago and the suburbs, this approach made coding easier than it might have been in other cities.

The 1,959 diary packets were mailed in early November 1990. A phone contact was made immediately after the diary mailing so that interviewers could brief respondents on the proper procedures for completing the diary before they had the chance to fill it out incorrectly or set it aside. Interviewers made three attempts to complete a call at each working number. Reminder postcards, sent about 1 week after the mailing of the diaries, served to remind individuals who were finishing up their diaries to return them, and informed those who had not yet gotten started that they could still participate. Another postcard to nonresponsive individuals was mailed about 3 weeks later. Five days later, interviewers began telephoning nonrespondents to see whether they would agree to receive daily calls to collect their travel information.

Diary correction and telephone calling began about 3 weeks after the mailing and continued for 7 weeks. Interviewers made at least four attempts to conduct telephone interviews with individuals who had completed transportation diaries. Letters were mailed to more than 70 respondents with incomplete study materials who could not be reached by telephone.

The average amount of time required to administer the telephone questionnaire was just under 25 min. To achieve this time, interviewers skipped the opinion questions when interviewing someone other than the mobility-limited individual, except in cases where the interviewee was communicating with the mobility-limited person and relaying his or her responses during the interview.

During the data collection phase of the main survey, over 300 calls for assistance from survey participants were handled by the consultants.

In developing the coding schemes for the transportation diary and telephone questionnaire, the answers on more than 25 percent of the completed documents were examined. Coded documents were inspected for completeness and accuracy. The data were entered and 100 percent verified. Data cleaning efforts included correcting day-date inconsistencies in the travel data and checking out-of-range codes.

Results

The breakdown of the diaries mailed and returned is summarized as follows:

Item	*No.*
Main study diaries mailed	1,959
Diaries believed to have reached qualified respondents	1,779
Diaries sent back, not completed	75
Unusable diaries	36
Usable completed diaries	
Filled out by recipients	677
Done or redone in office	325
Done in person	8
	1,010

The results of the telephone interviews of those who returned diaries were as follows:

Item	*No.*
Interviews attempted (based on usable diaries)	1,010
Total calls made to correct diaries and conduct interviews	2,102
Break-offs and refusals	33
Unable to contact for interview	43
Deceased after completing diary	3
Complete interviews	931

Of the individuals who received diaries and were qualified to participate in the main survey, 56.8 percent completed usable diaries and 92.2 percent of those individuals completed the telephone interview. The overall response rate for the main study was 52.3 percent. The results for the two samples were essentially identical: 52.4 percent (814 persons) of the Special Services registrants responded and 51.5 percent (117 persons) of the screening sample completed the survey.

Evaluation

The following findings provide an assessment of the main survey.

- The survey plan was effective in achieving a high response rate. The methodology employed in the main survey accomplished the RTA's objective of producing a response rate over 50 percent.
- The characteristics of the Special Services and screening survey samples had important consequences for the execution of the survey. Interviewers for the main telephone survey uncovered a potential source of bias when some diary recipients told them of fears that their Special Services privileges would be withdrawn if they did not report enough travel activity. Concerns over the possible loss of service may also have fostered the belief held by some individuals that they should report only trips made on Special Services.
- Recipients seemed to feel that the information provided in the cover letter was useful. Several inquiries and appreciative comments were received about the list of organizations included with the cover letter.

- Many individuals required assistance with the diary. Diary data were collected by telephone for more than one-third of the individuals who participated in the full study, because either the individuals could not fill out the diaries themselves or they had mailed back unusable diaries. This telephone collection was something of an experiment. Before the daily calls started, there was some concern that individuals might object to the repeated phone contacts. Another consideration was that respondents might not have been reachable on a daily basis, which could have introduced gaps and biases into their travel data.

The actual experience of conducting the daily diary calls did much to lessen these concerns. In general, individuals were relieved to have someone else take responsibility for filling out the diary. Many looked forward to the interviewer's call each day and expressed disappointment when the diary was completed. Nor did respondent availability prove to be an insurmountable problem. Interviewers who were unsuccessful in reaching respondents one day usually managed to speak with them the next day. In general, respondents seemed able to recall their wanted trips for 1 or 2 days before a contact, because this population probably makes relatively few trips.

- The follow-up procedures were effective. Timed to take place just after individuals received the diary, the telephone contacts encouraged recipients to begin filling it out, while the postcard, mailed 1 week after the diary, reminded them to send it back.

An additional follow-up effort, undertaken in mid-December 1990, brought in a number of diaries by mail, but was most effective in recruiting individuals to participate by telephone. The relative ease with which 100 previously nonresponsive individuals were persuaded to provide daily diary information supported the conclusion that their previous failure to respond had been due primarily to an inability to fill out the diary, not to an unwillingness to participate.

- The telephone questionnaire presented some difficulties for respondents. The telephone interview was particularly long for the elderly who participated in this survey. Questions asked about services the respondent did not use confused respondents. Questions that required the respondents to understand the difference between regular, mainline bus transit and Special Services caused difficulties, as did questions that required them to remember which mode was being discussed in a series of questions. Questions constructed so that they seemed repetitive, such as asking for ratings on a number of characteristics, annoyed a number of respondents. On the other hand, there was generally no resistance to terms used to discuss disabilities, contrary to fears expressed by some reviewers before the survey.
- Only a limited number of in-person interviews was required. The number of persons requesting face-to-face help proved to be considerably smaller than anticipated, since most respondents were able to participate by telephone.
- Mother nature helped the survey. In November and December when the preponderance of the trip data was collected, the weather was unseasonably mild and dry. Daytime temperatures ranged from the upper 40s to the low 70s, with rain falling on only a few days, conditions favorable to tripmaking that probably did not distort individuals' travel behavior.

RECOMMENDATIONS

The survey team's experience in planning and administering the 1990 survey led to the following recommendations for possible future replications of the survey.

1. Consider collecting all travel data, including the diary, by telephone. Using trained interviewers to record trip information offers the advantages of higher response rates; more complete, higher-quality data; and substantial time and cost savings by eliminating the need for follow-up efforts, diary correction, and extensive assistance to respondents. The feasibility of this approach was demonstrated by the actual completion of 325 transportation diaries by telephone.
2. Maintain the two-sample design of the survey. The two-sample design provides a cost-effective means of studying both populations of mobility-limited individuals that may be affected by accessible services.
3. Simplify the telephone questionnaire. The questions that were difficult for the respondents should be simplified.
4. Continue to provide a financial incentive and a free help number. The cash incentives seemed to be an important inducement to participation. The toll-free number encouraged respondents to call with their questions, which were useful in making the survey team aware of methodology that needed improvement.
5. Consider strategies for ensuring that individuals who make few or no trips are represented. Persons who do little or no traveling resisted participation in a survey about transportation, so that persons with the most severe mobility limitations are underrepresented in the 1990 survey. If future studies aim to develop a comprehensive picture of the mobility-limited population, finding ways to secure the participation of individuals who do not travel will be important.

ACKNOWLEDGMENTS

The authors acknowledge the assistance of the working group for the design and oversight of the survey, which included William Stage from the RTA; Darwin Stuart, Diane Mitchell-Bey, Sarah LaBelle, and James Mulqueeny, all of the CTA; Drew Browning, Gloria Nichols, Lei-Ann Marshall-Cohen, Jo Holzer, Larry Gorski, and Linda Hoke, members of the Joint Implementation Committee, an 11-member committee formed to advise and oversee the implementation and evaluation of lift-equipped, mainline bus service; Ashref Hashim of The Blackstone Group; and Ashish Sen of the University of Illinois, Chicago.

Publication of this paper sponsored by Committee on Paratransit.

Marketing Rural Transit Among Senior Populations

MARY KIHL

Transportation systems designed to respond to the needs of older residents are frequently underutilized. The reasons are related to the quality of the system itself or to the level of senior involvement in the design. One aspect that is frequently overlooked is the way the availability of the system is communicated to senior residents. This study focuses on developing responsive rural transportation systems and targeting their appeal to senior residents. Strategies developed by marketing analysts will be reviewed as will perspectives on senior attitudes offered by gerontologists. On the basis of these reviews, the study proceeds to propose strategies appropriate for conveying transportation innovations to the heterogeneous rural senior population.

Many western societies are experiencing the rapid growth of the proportion of residents over 65. For the United States, census projections estimate that this group will make up 13 percent of the total population in the year 2000, and half of these seniors are projected to be over 75. The number of older residents living in rural areas has increased disproportionately. Given changing life-styles, an increasing number live alone. They rely on driving their own cars to access goods and services and, generally, to retain their independence. Over the years drivers' licenses have helped define a life-style built on expectations of continued mobility, in which travel distances were less significant than access to desired goods and services (*1*). For many, particularly those in rural areas, driving is perceived as a necessity, since there are limited forms of alternative transportation. Consequently, most elderly residents continue to drive even if their reflexes are no longer sharp enough to respond to critical driving cues (*2*).

In an effort to provide alternatives to the personal automobile for this elderly but decidedly independent segment of society, transportation planners have expanded on the concept of rural public transportation by introducing shared-ride systems. Yet the proportion of older residents responding has been disappointing. Where available, specialized transportation systems are often well used but involve only a small segment of the eligible population (*3*).

There are no doubt many reasons for this lack of responsiveness. Some may be an indictment of the quality of existing systems. Analysts have noted the lack of responsiveness of existing rural systems in terms of dependability and destinations served. Another factor is the negative image that the elderly associate with publicly provided services.

This study reflects on a related but different dimension of the problem—the apparent limited perception of individual differences on the part of both those designing rural transportation systems and those presenting them to potential riders. Perspectives on senior attitudes offered by gerontologists will be reviewed and strategies developed by marketing analysts assessed. On the basis of these reviews, the study proposes strategy specific to developing and marketing alternative rural transportation systems. The premise is that thoughtful integration of planning and marketing can assure a more broad-based ridership.

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APPEALING TO THE SENIOR MARKET

Market analysts note that those over 65 are far from being a single cohort. They differ markedly in attitude, activity patterns, consumption, and media selection, much as any other age group does (*4*). In fact, transportation planners have identified as many as seven different life-style groups among those over 65 (*5*). Most older residents have retirement in common, but even this is changing because of age discrimination laws. Many continue to work until at least 70, and some even longer.

In assessing social activities and patterns of those over the rather arbitrary age of 65, market analysts generally subscribe to the sociological theory known as the activity theory, which holds that seniors do not disengage from the fast-paced world, but rather carry into old age the activity patterns typical of middle age (*6*). Although physical deterioration makes the complete carryover idealistic, an overwhelming number of seniors perceive themselves as being in an extension of middle age (about 10 to 15 years younger than their chronological age), and act and respond accordingly (*7*). Consequently, older residents react negatively to products and programs presented as exclusively associated with "the elderly" (*8*). An overwhelming majority of older individuals will not associate themselves with a product modeled by someone who appears to be their chronological age or older (*9*).

With the effort to move away from stereotypes and toward perceiving older persons as a heterogeneous group, analysts have presented several different approaches to the elderly market. Since consumers typically perceive themselves to be at least 10 years younger than their chronological age, some advertisers have suggested beaming the appeal at the perceived or "cognitive" age, rather than the chronological age of the consumer. Barak and Schiffman found that as the chronological age of the respondent increased, the more likely he or she was to identify with a younger group. Although 60 percent of those with chronological ages in the fifties perceived themselves to be in their forties, 76 percent of those with a chronological age in the eighties emerged with a cognitive age in the seventies (*10*).

As applied to rural transit, it is difficult to encourage an individual with a chronological age of 75 and a cognitive age of 60 to take advantage of a social service vehicle perceived to be "for old people." However, it may be possible to attract her or him to an alternative mode billed as a "new concept in rural transportation"—a shared-ride rural taxi, for example.

Another team of product researchers (*11*) go beyond the cognitive age studies and distinguish seniors at any age in terms of life-style. They suggest that there are two major groups of seniors: the "self-sufficient" and the "persuadables." Although the self-sufficient group reflects an internal locus of control and will engage in risk taking, the persuadables are susceptible and generally unwilling to take risks. These persuadables are advice seekers, with limited confidence in their own opinions. Within the self-sufficient group there are two subgroups. These are categorized, as shown in Figure 1, as the "active integrated" and the "routinized."

The active integrated are economically self-sufficient, well-educated, and self-motivated; they are opinion leaders who give, rather than request information. In retirement they physically enjoy life and are very agreeable about trying new products. In contrast, the routinized live within a more limited income and are less active. Nevertheless, they are self-confident and adjust well to changes caused by aging and retirement. Although they are not social isolates, they are self-directed and more interested in their daily routine. However, they do keep up with world events (*11*).

In sharp contrast, the two subgroups among the persuadables are the "homebodies" and the "groupers." The homebodies show a resignation to life that approaches apathy. They make minimal new social contacts and make their home the center of their lives. They retain long-established behavioral patterns and are unlikely to try anything new. In contrast, the groupers are very sociable and seek acceptance. They have financial means to satisfy their desires, but lack self-confidence in following through on the actions required to fulfill those desires. They fear becoming homebound and are preoccupied with their health. They continue a high activity level in order to ward off incapacity due to aging (*11*). This is the group most often found in senior centers.

SELF SUFFICIENT	PERSUADABLE
Active Integrated	**Homebodies**
• self confident • influential in dealing with others • satisfied with respect to financial status • enjoy shopping • watch "60 Minutes" and PBS • read magazines • entertain at home	• emotionally dependent • conservative, traditional, risk-averse • don't adjust to change • stay at home • watch comedies, gameshows, soap operas • limited social contact • read local newspapers
Routinized	**Groupers**
• self confident • limited income • well adjusted • interested in daily routine • entertain at home • read books • watch evening news and news interview shows • read newspapers	• highly social • seek acceptance • limited self confidence • fear being home bound • concerned about health • highly involved • achievement oriented • watch family TV • read newspapers

FIGURE 1 Characteristics of the four senior citizen market segments [based on data by Day et al. (*11*); category labels simplified].

Given these widely diverse groups, advertisers are urged to perceive a complex market. Different messages are needed to appeal to each of these groups. The distinctions among the groups are also reflected in their choices of media. Whereas the self-sufficient, active-integrated group are heavy readers of magazines and will most likely watch public television, the routinized are more likely to watch the evening news. In general, the persuadables read few magazines. The homebodies are best reached through television or daily local newspapers, and rarely listen to the radio. In contrast, the groupers read the daily newspaper, and also watch public television and listen to classical music on the radio (*11*). Davis and French (*4*) suggest that advertisers unable to target a specific group should put primary emphasis on newspapers, because they are used highly by almost all groups. A study by Schreiber and Boyd found that 30 to 50 percent of all seniors in all educational groups surveyed regarded newspapers to be the most credible source of advertising. Television was a distant second, with radio being far less appealing to seniors at all educational levels (*12*).

The traditional wisdom is that seniors rely on internal, personal, informal sources of information (*13,14*). However, there is a sizable segment of the senior population that can be reached by formal external information sources, such as those provided by advertisements. A national study by Lumpkin and Festervand (*14*) found that older consumers use independent sources of information such as mass media in planning purchases. However, they rely heavily on salespeople for recommendations and verification. This verification probably replaces the reinforcement they no longer receive at home (*15*).

A serious factual approach in advertising is most appropriate for attracting the self-sufficient, active-integrated seniors. Testimonials from credible sources can be useful (*4*). Perhaps even more effective would be small trial packages, discount coupons, or product demonstrations, which would allow seniors to make their own decisions without a heavy personal investment (*16*). The need is to overcome seniors' lack of innovativeness while avoiding any indication of condescension (*17*).

In summary, to present a product to a broad range of citizens over age 65 is a far more complex assignment than initially perceived. In fact, differences in orientation and lifestyle may require a variety of approaches. This process becomes even more complex in the development and marketing of a public service.

DEVELOPING ALTERNATIVE TRANSPORTATION SYSTEMS

For rural transportation specialists, the need is to design or redesign systems so they will appeal to a diverse senior population. Then they must be presented in such a way that encourages a broad group of seniors to use them. Unfortunately, system developers have too often overlooked the diversity of the senior population both in planning and in information dissemination. Too often systems are instituted because a similar system operates in a nearby area, and they

are not designed for the individuals who might be willing to use them.

There is a need to be more aware of both cognitive age considerations and life-style differences in the development of alternative transportation systems. An important first step is to define the target audience. Does the potential rider pool consist exclusively of those among the frail elderly population who value the association with the other regular riders as much as the trip itself? In contrast, does the pool include independent-minded individuals who find their mobility threatened when increasing physical disabilities limit their ability to drive? Although the former group would be content with a special service van, the latter, much larger group might be better served by some type of shared-ride automobile or minivan service.

A shared-ride automobile, a rural jitney service, would be designed to appeal to seniors who wish to retain their active life-style but who for varying reasons are now reluctant to drive. It would operate on a demand-responsive basis and would be available for any trip purpose.

In household telephone surveys and follow-up trip logs in rural Iowa and Missouri completed by seniors in 1990 an overwhelming preference for automobile transportation was found. Ninety-one percent of all trips were made in a private automobile, a proportion slightly higher than the approximately 85 percent reported as a national average for rural Americans in the Nationwide Personal Transportation Study (*18*).

If unable or hesitant to drive themselves, these automobile-oriented senior respondents would ride with a friend or relative, but at the same time, many indicated that they did not wish to impose on another person's schedule. A flexible automobile-based shared-ride system seemed to respond to these needs. When the respondents to a survey conducted in western Illinois were asked whether they would be interested in using such a system, 41 percent replied with enthusiasm. They envisioned using such a service for visiting, shopping, and recreation, as well as for trips to the doctor (*19*).

The cognitive age of individuals who would be most likely to use such a shared-ride system would be in the upper sixties, whereas their chronological age would most likely be over 75. Respondents in their sixties typically felt "too young" for such a service, and a number of those in their nineties felt that they were "too old to travel around independently" in such a service. Those giving their chronological age between 75 and 85 were very enthusiastic (*19*).

In terms of life-style, those expressing interest in a shared-ride system saw it as an extension of their independence: "That would mean that I won't have to rely on my nephew or impose on my neighbors." "That would mean that I could go shopping whenever I wished, rather than waiting for my daughter-in-law to get time off from work." Such individuals would be more likely to be numbered among the "self-sufficient" than among the "persuadable groupers." These are the individuals who typically do not attend congregate meals at the senior centers. In fact, only 16 percent of these respondents indicated that they would like to travel to senior centers.

Current travelers in the more typical rural public transit van generally have higher cognitive ages, even though their chronological ages are similar to the more independent shared-ride enthusiasts (*20*). In terms of the life-styles suggested above, these van riders can best be described as groupers. They are social and positive, enjoy interaction, have limited self-confidence, and enjoy television programs. They are very concerned about their health and the possible consequences of being homebound. These are the types of individuals who enjoy preestablished programs and the sociability of interacting with friends in these programs. These are regular participants in programs at the senior centers, and enthusiastically participate in group events such as "Senior Fairs." At one such fair in northern Iowa health booths are very popular, but most people come for dancing and a common meal. The typical age of the participants is 75 to 85, with hardly anyone under the age of 75 attending.

There are no doubt a number of variations on both the shared-ride automobile and the van or minibus systems. However, these concepts provide a fairly strong contrast. To develop a system that will have broad appeal in a particular setting, full involvement of the senior residents in an area is essential. Planning committees need to reflect a wide variety of perspectives. The input for service alternatives cannot come exclusively from ridership surveys and frequent rider advisory groups, because these sources generally suggest tinkering with the existing system rather than recognizing a need for a different system. Household surveys and discussions with senior members in a wide variety of organizations, library patrons, local cafe or convenience store patrons, church groups, and clinic outpatients will generate a far more complete view of unmet needs and suggestions for new service design. It might be that a system needs to provide both a van for group travel and shared-ride automobiles for individual trips.

Once the concept has been developed, new approaches will be needed to attract a broad base of the population. Professional marketing experts agree that the appeal must not play to the negative connotations associated with "old" or "elderly." Pictures of older people being assisted onto a van may be reassuring to a few who know they need help, but, such photographs would turn aside a sizable number of potential riders who could benefit from an alternative to the automobile. They already think of rural public transit as "for old people" and connect it with nutrition sites rather than personal transportation needs. Announcements need to be upbeat, and stress the benefit of continued independence. Spokespeople should be carefully selected to reinforce this active, upbeat image.

Given the variety of life-styles indicated in the marketing literature, it is important not to rely on just one approach or avenue of information sharing. Relying on senior centers to disseminate information about a new transportation service may not be appropriate unless the plan is to introduce modifications to an existing service.

A television news story featuring a ribbon-cutting on a new shared-ride system might capture the interest of the self-sufficient group. Ideally, the news story would feature interviews with individuals who appear to be upper-middle-aged discussing plans to use the new service to go shopping or to the bank. But even the self-sufficient would be unlikely to perceive the concept as relating to them without reinforcement from newspapers, public service announcements, and fliers readily available in neutral sources such as libraries, banks, or pharmacies.

Restaurants or fast-food shops offering senior discounts are potential locations for succinctly worded fliers that contain a recognizable logo and familiar slogan, such as "RIDES for safe, reliable transportation," or "RIDES will get you there." The fliers should include a boldly printed telephone number for information.

Feature articles or discussions in newspapers would capture the interest of some of the persuadables, as long as articles appeared more than once, and preferably in different sections of the paper. Perhaps an initial news story could be followed by a letter to the editor giving personal testimony.

To be fully effective in translating information into action, however, announcements would need to be reinforced by endorsements from friends or associates. This is particularly true for the persuadable, homebodies and groupers. Most older residents have about 15 friends who provide companionship, support, and information, and these friends not only serve as sources of information, but they also sift and validate information coming from other sources (*21*). Therefore, it would be an effective marketing strategy to attract a core group of well-respected senior residents who could serve as a volunteer advisory board for the new system. They would not only provide essential citizen participation and feedback, but also serve as ambassadors for the system. This approach served very effectively for OATS, a nonprofit transportation system operating across most of Missouri (*22*). Announcements in church newsletters would help, as would opportunities to discuss the service in clubs, service groups, or church settings. For the persuadable groupers radio call-in shows might also be of help.

This strategy of multiple appeals is particularly important in relating to older adults, because the ability to recall declines with age. A study by Stephens and Warrens found that product recognition was greatly increased by repeated exposure (*23*). Full recall is essential if an individual is to make the effort to voluntarily get involved in a program or take advantage of a new service.

Key marketing strategies that would appeal to a broad range of the senior residents of a community are summarized below.

- Set up an advisory group broadly representative of the senior population, and encourage members to solicit riders personally as well as in presentations to groups.
- Present an image that is not associated directly with age or the elderly.
- Get program introduction and milestone coverage on local television news.
- Provide news stories in a variety of local and regional newspapers. Repeat news features and repeat display of number to call in association with the upbeat image of the system.
- Encourage letters to the editor or other unofficial endorsements, such as on call-in radio shows.
- Place announcements in church newspapers, cafes, libraries, pharmacies, doctors' offices, and restaurants with senior discounts.

Once instituted, the system could promote itself by establishing a single dedicated telephone number, preferably one that can easily be associated with the service, such as 788-RIDE. The number should be answered personally at all times, and having a dedicated line would limit confusion, facilitate scheduling, and provide quick professional, yet personalized, responses to concerns (*24*).

Once the system has been launched, follow-up would be critical, especially for those seniors who need to be convinced that the system really works before committing to it. News briefs and testimonials are helpful. Personal contact with doctors, physical therapists, and clergymen, who can in turn recommend the system to clients or parishioners, can help considerably. Awards for bringing along a friend or an acquaintance can encourage persuadables.

CONCLUSION

Successful program development is associated with successful marketing. Unless the needs of a targeted public are reflected in a program, no amount of marketing can entice them to take advantage of it. On the other hand, unless a broad range of citizens is aware of the program, it will quickly become the province of the few, and substantial need will go unaddressed. This is particularly clear in addressing the transportation needs of senior populations. It is easy for planners to grasp one concept and present it as a solution and then wonder why so few become involved. A sufficient variety of transportation alternatives is needed to appeal to the different life-styles represented by the senior population. They need to be effective in meeting not only the needs of nondrivers, but those of concerned, insecure older drivers as well.

It is essential not to stereotype seniors by attributing to them any single set of characteristics. In fact, it is the traditional negative stereotype of seniors that they themselves react against. To be successful, any alternative transportation system will have to be sensitive to the wide array of characteristics and vastly different life-styles. A rural transit system will need to offer services to appeal to both the self-sufficient and the persuadable categories of senior residents.

Market analysts are determined not to end up with an inventory they cannot sell. By the same token, transportation planners must certainly be determined that the rural transportation systems they develop will have a strong appeal to the diverse senior population.

ACKNOWLEDGMENT

The author wishes to acknowledge partial assistance from the Midwest Transportation Center in funding this research. However, all opinions are those of the author alone. She also wishes to acknowledge the major contribution of Constance Hadden, graduate student in community and regional planning, in assembling literature noted in the paper.

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Publication of this paper sponsored by Committee on Public Transportation Marketing and Fare Policy.

Evolution of Functional Eligibility and Certification for Paratransit Service: The Chicago Experience

MANUEL DE ALBA

The recently adopted Americans with Disabilities Act (ADA) identifies eligibility and certification as critical determinants in paratransit services. The ADA has also set guidelines for paratransit operators to develop functionally based certification methods predicated on the applicant's ability to use mainline services rather than on their medical condition. The Regional Transportation Authority paratransit services have gradually developed the components to enable functional certification of severely disabled riders. These components include the development of standardized paratransit eligibility in a region with multiple paratransit operations, a functional certification method for the blind, and conditional and functional certification methods for the developmentally disabled. It is expected that certification methods developed through coordination with regional transit operators and state agencies have well positioned paratransit operations in northeastern Illinois to serve riders as envisioned under the ADA.

As a way to serve different user groups, paratransit services have operated in the Chicago area since the 1970s. During the late 1970s suburban services began as community-based services primarily geared to elderly riders. Additional paratransit service in the suburbs for severely disabled riders was implemented in 1987. In late 1981, the Chicago Transit Authority (CTA) established city paratransit services for severely disabled riders to meet federal Section 504 requirements. CTA paratransit service was initially operated using accessible 20-passenger wheelchair-lift-equipped buses driven by CTA operators and has since shifted to a contract operation.

During the early 1980s the demand for paratransit service dramatically increased. As CTA's paratransit service became more established, the community brought pressure to expand eligibility, service levels, and hours. The CTA responded by expanding paratransit eligibility to ambulatory disabled riders who had difficulty using mainline bus service. Application language was developed to reflect a policy of functional certification, and an attempt was made to link paratransit eligibility with the functional ability of applicants to use mainline bus service. However, an early decision was made allowing medical doctors the ability to certify potential paratransit applicants. In practice, many doctors used what is referred to as "diagnosis-based eligibility," and applicants were certified for paratransit solely on the basis of having a specific illness instead of on their ability or inability to use mainline bus service.

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Throughout the early 1980s, suburban paratransit service continued to be provided on a local community basis. Many riders were qualified for reduced fares due to age eligibility. Disabled persons were also eligible for reduced-fare benefits. The disabilities that granted reduced-fare benefits were also used as the basis for the community-based system eligibility, which was much broader than the CTA paratransit eligibility and therefore, provided benefits to individuals with hearing and visual impairments. These community-based systems are very localized in their coverage and do not necessarily connect with other systems to facilitate smoother travel. As a result, these systems are not considered further in terms of the network of services that serve the population eligible for ADA paratransit.

In 1987, Pace, the suburban bus division of the Regional Transportation Authority (RTA), began to provide paratransit service to nonambulatory disabled riders in wheelchairs. This service operated in suburban areas that covered several communities and required applicants to undergo a medical certification process similar to that used by the CTA. The new suburban paratransit service was developed to meet federal guidelines under Section 504 of the Rehabilitation Act of 1973. Pace's experience in the suburbs was similar to CTA's experience within their city service area. Suburban paratransit gained popularity, and demand for services increased.

Also in 1987, Metra, the RTA's commuter rail division, began to operate a paratransit service for nonambulatory individuals in wheelchairs who were unable to use commuter rail trains. Metra's paratransit service became known as Rail Corridor Accessibility Program (RCAP).

DEVELOPMENT OF REGIONAL ELIGIBILITY CRITERIA

A number of different eligibility criteria were in place for different services by late 1988. Suburban paratransit and commuter rail paratransit services were limited to those who used wheelchairs. CTA paratransit service in the city was open to ambulatory and nonambulatory disabled riders, and was linked in part to the functional criteria. People with disabilities had to apply and be certified for each of the three services separately, which caused a great deal of frustration in the disabled community.

Paratransit services operated in an environment where both the demand for service and the unit cost were increasing dramatically. In addition, community members had taken legal

action to bring about mainline accessibility on the CTA bus system. These circumstances led the RTA and the transit agencies to reevaluate the type of services provided and subsequently led to the development of a regional approach to serve riders with disabilities.

A regional plan development process was undertaken and three committees were set up: a policy committee made up of board representatives from each transit agency, a staff committee made up of staff representatives from the transit agencies, and a consumer advisory committee. The process evolved over a period of nearly a year and culminated in the adoption of regional policies by the RTA board known as the Regional Plan for Transportation of the Disabled (Regional Plan). This plan established the regional policy of providing service primarily through the accessible mainline with supplemental paratransit services. The policies called for the agencies to encourage the use of accessible mainline service by persons with disabilities. The Regional Plan also encouraged coordination of services between modes and transit providers, which was facilitated by the establishment of standardized eligibility for most paratransit operations.

Paratransit service was established to serve severely disabled individuals. For the first time, regional eligibility for all paratransit services allowed a single certification process throughout the six-county service area. The RTA policies adopted as part of the Regional Plan also called for the expansion of paratransit eligibility criteria to serve two additional groups not previously served: the blind, and persons with developmental disabilities or mental illness. The emphasis in the Regional Plan policies was on functional eligibility.

ADOPTION OF THE AMERICANS WITH DISABILITIES ACT (ADA)

A key element within Regional Plan policies was the change in the philosophy of service delivery. Prior to the Regional Plan, the RTA and transit agencies were committed to paratransit as the primary way to serve severely disabled riders. Through the Regional Plan, RTA adopted a policy of mainline accessibility and supplemental paratransit. This philosophy was in part a reaction to the direction in which federal policies were headed at the time. In 1989 it became apparent that federal policies were going to be enacted into what became the Americans with Disabilities Act of 1990 (ADA) (*1*). At the time it was unclear what federal eligibility standards would be enacted, although they were expected to be within the framework of supplemental paratransit service to a mainline-accessible system. RTA's Regional Plan eligibility and certification procedures were adopted with the understanding that they would be changed to comply with ADA requirements when the final regulations were developed.

ELIGIBILITY EXPANSION FOR THE BLIND

Under the guidelines of the Regional Plan, paratransit eligibility was to be expanded to individuals who were legally blind and unable to successfully complete a mobility training course. This eligibility was consistent with the policy of encouraging mainline usage. Initially, the task of converting policy into operating procedure appeared to be a great challenge, because it was difficult to differentiate between blind individuals who were able to complete a mobility training course and those who were unable to do so. An initial review indicated that most blind individuals in the region had access to mobility training either through a school program or as adults through the Illinois Department of Rehabilitation Services (DORS), a state agency. Many of those who had already completed orientation and mobility training used mainline services on a daily basis for work and school trips.

Outside the RTA region, it was found that different approaches had been taken to serve the blind. A review of other major paratransit operations found that eligibility for most systems was not functionally based. Pittsburgh's Access, one of the nation's largest paratransit services for the disabled, certified legally blind applicants that had not been mobility trained for a period of up to 6 months, during which individuals would obtain orientation and mobility training. Metrolift in Houston and Metro Mobility is Minneapolis/St. Paul provided service to anyone diagnosed and medically certified as blind.

RTA began to work with orientation and mobility instructors to develop a certification process and to ensure that anyone seeking training would be able to receive it. Because the Regional Plan recognized eligibility on the basis of functional ability, a diagnosis-based approach, like that of Houston or Minneapolis/St. Paul, was found to be outside the intent of Regional Plan policies and subsequently outside the intent of the ADA regulations. The Illinois Department of Rehabilitation Services, (DORS), conducted functional mobility evaluations of their clients on a regular basis. These evaluations were conducted by orientation and mobility instructors and were available to all their clients. Because DORS is a state agency, all blind residents of the state of Illinois had access to their services.

The evaluation assessment used by DORS included 10 functional levels. These ranged from the lowest level, in which a person travels indoors with a sighted guide to the highest level, in which a person is able to travel independently in unfamiliar areas. Similar evaluation methods were also in place for those under age 18 through the school special education programs, and both programs were linked to training programs that allowed individuals to enhance their orientation and mobility skills.

Subsequent work with DORS led to the adoption of their evaluation scale. The RTA then contacted all special education programs within the region to familiarize them with the program and its intent. The certification process that was enacted required applicants to first be certified legally blind by a medical doctor. Adult applicants were to then contact DORS or other approved agencies and undergo a functional evaluation by an orientation and mobility instructor. Applicants under 18 were also required to be certified legally blind by a medical doctor. They were then required to contact their local special education program for an evaluation of their mobility skills.

RTA certification procedures essentially granted paratransit certification to anyone who was legally blind and lacked mobility skills to travel independently. Certification was granted for a period ranging from 6 months to 4 years. After 4 years, applicants were required to be reassessed by undergoing the

same procedure. As part of RTA establishment of this certification procedure, orientation and mobility instructors were encouraged to certify applicants based on their ability to use mainline service. Instructors were discouraged from certifying applicants on the basis of economic status or the availability of mainline service. This latter point was of concern primarily in suburban areas where mainline transit is operated on a less dense network.

During the development of the certification process for blind applicants, the transit agencies expressed concern regarding the expansion of eligibility at a time when paratransit service was unable to meet demand. After an extensive review, it was concluded that the RTA should adopt an approach to provide incentives and encouragement for the blind to use mainline services whenever possible. This was to be achieved through fare incentives and attendant programs. RTA's regional certification process for blind applicants was put in place in early 1990. The language outlined in Figure 1 was used for certification by orientation and mobility instructors.

ELIGIBILITY FOR DEVELOPMENTALLY DISABLED AND MENTALLY ILL

A few months after the certification process for the blind was in place, RTA staff began to develop a certification process for persons with developmental disabilities and mental illness. A two-step process similar to that for the blind, that is, medical and functional certification, was sought for this group of riders. Staff from the RTA and the transit agencies worked with state agencies that serve this group to develop such a certification process. However, it was initially impossible to develop a method to link an individual's mental functional limitation with his or her inability to use mainline public transit service.

From these efforts, it became evident that many individuals in this group were physically able to use mainline services with the assistance of an attendant for orientation. In keeping with Regional Plan policies, which encouraged the use of mainline services by those with disabilities, the CTA developed a demonstration project to serve riders who were able to use mainline services with the assistance of an orientation attendant. CTA's attendant subsidy program was designed to provide a monetary incentive to use mainline services by allowing both the eligible rider and an attendant to pay a reduced fare.

Although the attendant subsidy program benefitted some riders with developmental disabilities and mental illness, a certification process had yet to be instituted. In August 1991, final rules for the ADA were released that specifically require paratransit eligibility to include individuals who, because of a mental impairment, are unable to independently board, ride, or disembark from any vehicle on the mainline system. This emphasized the need to develop a functionally based certification process.

RTA staff once again conducted a review of national experience and found that most paratransit systems used medical certification to determine eligibility for this group of riders. Some of the paratransit providers interviewed also indicated that they were dissatisfied with certification procedures based solely on medical certification. The review found that many systems had emphasized mainline approaches to serving persons with developmental disabilities or mental illness and that a number of transit systems had worked with local community agencies to develop training programs for the use of mainline services.

Subsequent work with the Illinois Department of Mental Health and Developmental Disabilities (DMHDD) and DORS, the state rehabilitation agency, found that assessment methods existed and can be used to determine levels of independent living skills for both developmentally disabled and mentally ill individuals. It was also found that these assessments were conducted on a regular basis for DMHDD and DORS clients. Evaluations were conducted by Qualified Mental Health Professionals (QMHPs) or Qualified Mental Retardation Professionals (QMRPs), most of whom are certified by the state of Illinois and also have specific university degrees and work experience. Since both DORS and DMHDD are state agencies, all residents of the state of Illinois have access to their services.

Three applicable functional evaluation assessments were in use for adults: the Inventory for Client and Agency Planning (ICAP) (*2*), the Scales of Independent Behavior (SIB) (*3*),

TO BE FILLED BY AN AUTHORIZED EMPLOYEE OF APPROVED AGENCY ONLY FOR APPLICANTS WHOSE SOLE QUALIFYING DISABILITY FOR PARATRANSIT IS LEGAL BLINDNESS.

APPLICANTS FOR RTA PARATRANSIT SERVICE MUST BE SEVERELY MOBILITY LIMITED PERSONS.

Is individual enrolled in an orientation/mobility training course now? __ yes __ no

Has individual ever been enrolled in an orientation/mobility training course? __ yes __ no

If no, would individual benefit from successful completion of such a course? __ yes __ no

How long will applicant require RTA Paratransit service? __ 6 months __ 1 year __ 2 years

In your opinion, could the condition that qualifies the applicant for RTA Paratransit service improve over time? __ yes __ no

THIS IS TO CERTIFY THAT THE APPLICANT MEETS THE DEFINITION OF LEGAL BLINDNESS AND DOES NOT CURRENTLY POSSESS MOBILITY SKILLS TO ENABLE HIM/HER TO TRAVEL FULLY INDEPENDENTLY.

SIGNATURE STATE MEDICAL LICENSE # DATE

(note: actual application form continues)

FIGURE 1 Paratransit application form.

and the Specific Level of Functioning (SLOF) (*4*). ICAP and SIB are used for persons with developmental disability and SLOF is used for persons with mental illness. The assessments consisted of evaluations in several functional areas to determine independent living skills. Evaluation methods were also in place for those under age 18 through the special education programs in the school systems.

RTA's certification process was put in place in May 1992 and was designed to consider eligibility based on whether the applicants could use mainline service for all, some, or none of their trips. This was to be determined by a QMHP using the results of the assessment in combination with his or her evaluation. The language in Figure 2 was developed by QMHPs, QMRPs, or school evaluators to determine certification of those who have a developmental disability or mental illness and an inability to use mainline bus or rapid transit services.

CURRENT AND FUTURE PARATRANSIT ELIGIBILITY

RTA certification procedures for the developmentally disabled and mentally ill represent significant changes from those for the physically disabled and visually impaired. Certification is based on an assessment by a QMHP or QMRP who is able to make a determination based on a functional test. This represents a major change from established certification processes, which primarily use medical doctors. Another signifi-

RTA Paratransit Professional Certification Form
to be completed by certifier

FOR THOSE WHO ARE APPLYING ON THE BASIS OF DEVELOPMENTAL DISABILITY OR MENTAL ILLNESS, **AND** AN INABILITY TO USE MAINLINE BUS OR RAPID TRANSIT SERVICE.

THIS SECTION MUST BE FILLED OUT BY A) AN INDIVIDUAL WHO IS BOTH STATE CERTIFIED AND A QMHP OR QMRP, B) A QMHP OR QMRP AT A DMHDD FUNDED PROVIDER AGENCY, OR C) QUALIFIED SCHOOL PERSONNEL.

NOTE: YOU MUST ALSO ATTACH A STATEMENT OF ELIGIBILITY FOR SPECIAL SERVICES ON YOUR PROFESSIONAL OR AGENCY STATIONERY.

Certifier, please answer all questions below:

1) Has applicant been assessed using either an SIB, ICAP, VACG, SLOF or by qualified school personnel within the last three years? __ yes __ no

   • If yes, please indicate method: __SIB __ICAP __VACG __SLOF __school assessment
   date of assessment _____/_____/_____

   • If no, applicant must be assessed using either an SIB, ICAP, VACG or SLOF assessment (or a school assessment if enrolled in a Special Education program), before being considered for RTA Paratransit.

2) Based on the SIB, ICAP, VACG, SLOF, or school assessment **and** your professional evaluation, the applicant:

_____ **Does not meet the eligibility for RTA Paratransit (is able to use mainline bus or rapid transit services for all trips independently in unfamiliar areas.)**

_____ **Meets eligibility for RTA Paratransit for some trips (is able to travel on mainline bus or rapid transit services independently on some trips.)**
Please list trips that applicant is able to travel independently:
Origin/Destination :_____
Origin/Destination :_____
Origin/Destination :_____
Origin/Destination :_____
Origin/Destination :_____
• Has the applicant ever received orientation/mobility training from a qualified orientation/mobility instructor? __ yes __ no
• Can the applicant benefit from receiving orientation/mobility training? __ yes __ no

_____ **Meets eligibility for RTA Paratransit for all trips (is not able to travel independently on any trip using mainline bus or rapid transit services.)**
• Has the applicant ever received orientation/mobility training from a qualified orientation/mobility instructor? __ yes __ no
• Can the applicant benefit from receiving orientation/mobility training? __ yes __ no

3) If applicable, how long will applicant require RTA Paratransit? __6 months __1 year __2 years

4) If applicable, in your professional opinion, could the condition that qualifies the applicant for RTA Paratransit improve over time? __ yes __ no

SIGNATURE	STATE LICENSE #	DMHDD AGENCY #	DATE
PRINT OR TYPE NAME		POSITION	TELEPHONE
OFFICE ADDRESS		CITY STATE	ZIP

FIGURE 2 Paratransit certification form.

cant change is the adoption of conditional eligibility, which allows the transit system to identify those mainline trips for which the applicant has been trained. Paratransit service is then provided for all other trips. The intent is to establish a method that will allow the agencies to determine trip-by-trip eligibility in the future, as outlined by ADA.

In late 1992, RTA expects to conduct a thorough revision of existing certification procedures for all applicants. The goal is to develop a single certification process for all applicants, regardless of disability, that is based solely on an individual's functional ability to use mainline bus and rapid transit services. Because it will be a number of years before all mainline bus and rapid transit services in the region are accessible, a number of riders will be eligible under the ADA transitional category. This will require the development of a system that allows screening to determine eligibility on a trip-by-trip basis, providing paratransit service where mainline accessibility is yet to be implemented. In order to determine eligibility for every trip request, computer-based evaluation methods are being developed.

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Publication of this paper sponsored by Committee on Paratransit.

PART 3
Ridesharing

The State of the Commute in Southern California

CHERYL COLLIER AND TORBEN CHRISTIANSEN

The 1991 State of the Commute Study, conducted by Commuter Transportation Services (CTS), was based on a telephone survey of 2,568 commuters residing within the counties of Los Angeles, Riverside, San Bernardino, Ventura, and (for the first time) Orange. The survey provides updated information on commuters' travel behavior and attitudes toward the commute, traffic congestion, alternative travel modes, employer transportation programs, and high-occupancy-vehicle (HOV) lanes. It is the only study of its kind that tracks regional commuting behavior and attitudes on an annual basis and represents employees of both small and large firms. In a region that is undergoing tremendous changes in transportation—implementation of the South Coast Air Quality Management District Regulation XV and the Ventura County Air Pollution Control District Rule 210, development of commuter rail lines, and experimentation with "smart" corridors—the need exists to measure progress within the entire Los Angeles region between census reporting periods. The State of the Commute Study helps address that need.

A commuter travel characteristic of particular interest is how commuters get to work and back. Data on the primary transportation mode used (3+ days per week) from the 1991 State of the Commute Study are compared with those from the previous surveys in Table 1. A greater geographical area was covered in 1991 than in previous years, because Orange County commuters were incorporated in the study for the first time. Most tables in this paper highlight findings both with and without Orange County data, so that comparisons with data from previous surveys can be made.

As the total counts for the surveys show, roughly 500 individuals responded to this survey in 1989; 1,200 in 1990; and 2,510 in 1991. Although a larger amount of random error is associated with the smaller sample size, it still provides an acceptably accurate (worst case: ±4.5 percent) estimate. A 2.0 percent sampling error is normally associated with sample sizes of 2,500. (See discussion of sampling methodology at the end of this paper.)

Although the difference in the drive-alone rate between the 1991 and the 1990 surveys was not significant, the difference between the 1991 survey (excluding Orange County) and the 1989 survey was significantly different. Therefore, as a percentage of all commuters, there were fewer commuters driving to work alone in 1991 than there were in 1989.

Of particular interest is the percentage of commuters who regularly (3+ days per week) drive alone to work but who also use secondary forms of transportation at least part of the week. Although the percentage of those who regularly drive alone did not change from 1990, the percent of those who regularly drive alone but who once or twice a week use an alternative form of transportation did slightly increase: 4.1 percent in 1990 and 6.5 percent in 1991.

In an attempt to determine more information on the characteristics of those who drive alone to work, the following information was revealed. Eighty-one percent of men who commute drive alone to work as opposed to 76 percent of women. Ninety-three percent of senior managers drive alone to work as opposed to 67 percent of maintenance workers. Production and secretarial or clerical workers are most likely to carpool. Eighty-eight percent of Asians and 84 percent of whites drive alone to work on a regular basis as opposed to only 68 percent of blacks and 67 percent of Hispanics. Eighty-nine percent of all respondents report always having a vehicle available for getting to work. Eight percent claim that a vehicle is sometimes available, and 3 percent state that a vehicle is never available. This is consistent with data from previous surveys. The average (median) number of motorized vehicles (including automobiles, trucks, vans, and highway motorcycles owned or leased) per household is two.

ONE-WAY COMMUTING DISTANCE

In 1991 the average (mean) distance to work was 16.6 mi, and the median distance, 11 mi. The differences in trip distance between survey periods were not statistically significant. Those individuals whose primary travel mode is driving alone commute a mean distance to work of 16 mi. Those commuters who carpool travel a mean distance of about 19 mi to work and those who use public transit travel 13 mi. Table 2 shows the differences in travel distance for all respondents from 1989 through 1991.

Freeway users travel an average of 25 mi to get to work, whereas those who do not use a freeway travel an average of 8 mi.

Employees at sites that have more than 100 employees travel an average of 17.5 mi to get to work, whereas employees at sites that have fewer employees travel an average of 16 mi. Therefore, ridesharing is a viable option for all employees, regardless of the size of work force.

COMMUTING TIME TO AND FROM WORK

It takes commuters an average (mean) of 33 min to get to work. The median for the trip to work is 27 min. The mean time for the trip home is 38 min, with a median of 30 min. This represents an increase in travel time from 1989 but a

Commuter Transportation Services, Inc., 3550 Wilshire Boulevard, Suite 300, Los Angeles, Calif. 90010.

TABLE 1 PRIMARY TRAVEL MODE

Travel Mode	1989 Freq.	1989 %	1990 Freq.	1990 %	1991 Freq.	1991 %	1991 (excl. Orange) Freq.	1991 (excl. Orange) %
Drive Alone	418	83%	944	79%	2,014	79%	1,590	78%
Carpool	55	11	174	14	334	13	281	14
Vanpool	1	0	5	.5	13	1	10	1
Bicycle	10	2	10	1	14	1	11	1
Motorcycle	3	1	2	0	8	0	6	0
Public Bus	9	2	52	4	120	5	109	5
Commuter Rail	NA*		NA*		5	0	4	0
Private Bus	1	0	5	.5	6	0	5	0
Walk or jog	3	1	16	1	34	1	27	1
	500	100%	1,208	100%	2,548	100%	2,043	100%

* NA = Not asked in the 1989 Survey or 1990 Survey

decrease in travel time from 1990. Results from the 1989 survey showed an average (mean) travel time to work of 26 min, with a median of 20 min, and an average of 30 min to return home, with a median of 25 minutes. In 1990, it took 34 min on average to get to work in the morning, with a median of 30 min, and a mean of 39 min in the evening, with a median of 35 min.

WORK PLACE ARRIVAL AND DEPARTURE TIMES

Table 3 shows that commuters reported to work earlier in 1991 than they did in 1989. The average arrival time at work within the peak hours is 7:50 a.m. Departure times were consistent with the results in 1990. The average departure time from work during the peak hours is 4:45 p.m.

PARKING

Ninety-three percent of area commuters receive free parking at their work sites. The employee's share of parking is shown in Table 4. The differences between the surveys were not statistically significant. It is worth noting, however, that free parking in the region is still abundantly available.

Of the employees who pay for parking, 50 percent pay less than $40 per month with an average (mean) per month of $58.26. Although the number of cases here is too few to accurately assess the situation the region with respect to parking fees paid, the information does indicate the distribution of parking fees paid by respondents to the survey. It appears that there may be a shift in the percentage of commuters paying $100 or more for parking per month, but additional research is needed to make a more accurate assessment. Over half of those who report paying for parking claim that they pay for it in full; however, only nominal fees are being paid. The true cost of parking is not adequately reflected here. Employees are unaware that employers are still paying the bulk of the parking expense.

FREEWAY BEHAVIOR

Fifty-one percent of all participants travel on a freeway as part of their commute. In 1990 this proportion was 53 percent and in 1989, 57 percent. This represents a decrease since 1989 in the percentage of commuters using a freeway as part of their commute. Hispanics are less likely than blacks, whites, or Asians to travel on a freeway as part of their commute.

SIDE TRIPS TAKEN BEFORE OR AFTER WORK

One-fifth of all respondents reported that they made a stop on the way to work the day they were surveyed. Of these, 46 percent claimed that they make this stop 5 days a week. The most significant reasons for the stops include

- Eating or socializing (27 percent),
- Taking a child to daycare or school (20 percent), and
- Picking up or dropping off fellow pooler (13 percent).

TABLE 2 ONE-WAY COMMUTING DISTANCE

Distance	1989 Freq.	1989 %	1990 Freq.	1990 %	1991 Freq.	1991 %	1991 (excl. Orange) Freq.	1991 (excl. Orange) %
Under 5 miles	94	19%	253	22%	537	22%	438	22%
5 to 9 miles	108	23	254	22	503	20	394	19
10 to 14 miles	85	17	182	15	415	16	316	16
15 to 19 miles	64	13	126	11	260	10	212	10
20 to 24 miles	48	10	116	10	214	8	168	8
25 to 29 miles	26	5	54	5	145	6	116	6
30 to 34 miles	16	3	40	3	137	6	122	6
35 to 39 miles	10	2	25	2	87	3	68	3
40 to 44 miles	4	1	29	2	61	2	50	3
45+ miles	33	7	90	8	180	7	146	7
	488	100%	1,169	100%	2,539	100%	2,030	100%

TABLE 3 ARRIVAL AND DEPARTURE TIMES

Arrival at work

Time (A.M.)	1989 Freq.	1989 %	1990 Freq.	1990 %	1991 Freq.	1991 %	1991 (excl. Orange) Freq.	1991 (excl. Orange) %
Before 7:00	76	15%	338	23%	609	24%	492	24%
7:00 to 7:29	70	14	148	12	313	12	246	12
7:30 to 7:59	59	12	194	16	376	15	292	14
8:00 to 8:29	97	20	176	14	380	15	299	15
8:30 to 8:59	65	13	122	10	278	11	216	10
9:00 to 9:29	58	12	100	8	164	6	138	7
9:30 to 10:00	16	3	63	5	100	4	81	4
After 10:00	52	11	80	12	336	13	283	14
	493	100%	1,221	100%	2,556	100%	2,047	100%

Departure from work

Time (P.M.)	1989 Freq.	1989 %	1990 Freq.	1990 %	1991 Freq.	1991 %	1991 (excl. Orange) Freq.	1991 (excl. Orange) %
Before 4:00	108	22%	334	32%	816	32%	663	32%
4:00 to 4:29	52	11	133	11	305	12	245	12
4:30 to 4:59	52	11	168	14	334	13	269	13
5:00 to 5:29	124	26	200	16	454	18	355	17
5:30 to 5:59	52	11	106	9	205	8	158	8
6:00 to 6:29	37	8	77	6	171	7	143	7
6:30 to 7:00	16	3	39	5	104	4	79	4
After 7:00	40	8	155	7	162	6	131	7
	481	100%	1,212	100%	2,551	100%	2,043	100%

In addition, of those who make a stop, 13 percent make a second stop on the way to work and 30 percent of all those who reported that they made a second stop did so 5 days a week.

A closer look at those making these stops shows no significant differences between stops made and ethnicity or sex. However, there were real differences with regard to the purpose of the stops made. Blacks are far more likely to make stops to take a child to daycare or school than any other ethnic group. Whites are far more likely to stop to eat or socialize. Of the women making stops, 34 percent stop to take a child to daycare or school as compared with only 9 percent of men. Men are twice as likely to stop to pick up a pooler, eat or socialize, or shop on their way to work as women.

With respect to the trip home, 29 percent reported that they made a stop the day they were surveyed. Of these, 41 percent claimed that they make this stop 1 or 2 days a week, and 24 percent claimed that they make this stop 5 days a week. The most significant reasons for the stops include

- Buying groceries or going shopping (31 percent),
- "Other" (19 percent), and
- Picking up a child from daycare or school (14 percent).

In addition, 23 percent of the respondents reported making a second stop on the way home. Of all the commuters who make a second stop on the trip home, 25 percent do so 5 days a week. More commuters make stops on their trip home than they do on their trip to work. However, they stop fewer days a week.

The percentage of commuters making stops on either their trip to work or their trip home is consistent with the findings in 1990. However, commuters are making their initial stop both on their way to work and on their way home more frequently than they have in the past. In addition, more commuters made a second stop on their trip home in 1991 than in previous years.

NEED FOR CAR DURING THE WORK DAY

Roughly 55 percent of the respondents claimed that they need their cars at work 5 days or more a week for business or personal trips. Another 22 percent claimed that they do not need their cars at work. The remaining 23 percent are dispersed as to the number of days they need their cars at work. The number of respondents needing a vehicle 5 or more days

TABLE 4 EMPLOYEE SHARE OF PARKING COST

Proportion Paid by Employee	1989 Freq.	1989 %	1990 Freq.	1990 %	1991 Freq.	1991 %	1991 (excl. Orange) Freq.	1991 (excl. Orange) %
All	27	6%	42	4%	100	4%	80	4%
Some	16	3	24	2	87	3	61	3
None	429	91	1,127	94	2,377	93	1,911	93
	472	100%	1,193	100%	2,564	100%	2,052	100%

a week has been steadily increasing since 1989, and further research is needed to assess the purposes of these trips. Senior managers reported needing their vehicles more days a week than any other occupational type.

With the possible exception of senior managers, part-time ridesharing—that is ridesharing 1 or 2 days a week—is a viable option for 45 percent of all commuters. Allowing upper management, maintenance, sales staff, or production workers the use of a company car during the day for business purposes only if they rideshare, rather than allowing them the use of a company car for all purposes, would assist in making ridesharing more attractive.

CARPOOL CHARACTERISTICS

Persons who reported that they commute in carpools were asked how many people they pool with and what their relation is to them. Average carpool ridership is 2.63 persons, including the respondent. These data are comparable with data from previous studies.

Respondents were asked to describe their relationship to other pool members, with household members and nonhousehold relatives in separate categories. Household members constitute the single most common group of carpoolers; 53 percent of carpoolers are household members. This figure has been steadily increasing since 1989. Coworkers are the next most common type of carpool members (34 percent). Friends and neighbors account for 15 percent of carpool members and nonhousehold relatives 6 percent. Those respondents who mentioned that they ride with coworkers or friends and neighbors were then asked if these names were originally from a matchlist. Those from a matchlist represent 15 percent of carpool members, a substantial increase from previous surveys.

As a group, 20 percent of Hispanics carpool to work on a regular basis as opposed to 14 percent of blacks, 11 percent of whites, and 7 percent of Asians.

Respondents reported being in their current carpool or vanpool an average (mean) of a little over 2 years and a median of 1 year. Fifty-six percent claimed to have been in their current carpool 1 year or less. As a group, carpoolers travel an average (mean) distance of 18.7 mi to work.

TRANSIT CHARACTERISTICS

Those who reported traveling to work on a bus, either public or private, at least 1 day a week were asked how long they have been riding the bus. Bus riders claimed to have been riding the bus an average (mean) of 4 years and a median of 3 years. Fifty percent reported riding the bus 2 years or fewer, whereas 5 percent reported riding the bus 10 years or more and five individuals reported 25 years of bus ridership. Nearly 70 percent of bus riders reported using the bus 5 or 6 days a week to get to work. The mean trip distance to work for bus riders is 13.4 mi.

Sixteen percent of blacks ride the bus regularly to work as opposed to 10 percent of Hispanics and 1 percent of whites.

All respondents (except current bus riders) were asked if there was a bus that they could take to get to work; 39 percent responded affirmatively.

AWARENESS OF EMPLOYER PROGRAMS

Respondents were asked, "What, if anything, does your employer do to encourage employees to rideshare? By rideshare I mean using carpools, vanpools, buses, walking, or bicycling to work." Specific programs were mentioned and respondents were asked whether their employer offered such a program (Table 5).

TABLE 5 EMPLOYEE AWARENESS OF EMPLOYER TRANSPORTATION PROGRAMS

Employer Program	1989 %	1990 %	1991 %	1991 (excl. Orange) %
Offers Flexible Work Hours	32%	42%	35%	35%
Offers 4/40 Work Schedule	NA*	14	13	14
Offers 9/80 Work Schedule	NA*	7	9	9
Assists In Forming Carpools And Vanpools	8	26	25	25
Provides Ridesharing Info	14	28	22	23
Guarantees A Ride Home In Case Of An Emergency	32	19	17	17
Provides Preferred Parking Spaces To Ridesharers	11	16	13	12
Registers Employees With Commuter Computer	11	14	10	10
Provides Bus Information Routes And Schedules	12	14	11	11
Provides Free/Low Cost Parking To Ridesharers	10	11	9	9
Subsidizes Ridesharing	NA*	8	9	9
Sells Bus Passes	4	6	7	7
Offers A Company Car During The Day To Those Who Rideshare	19	6	6	6
Has Contests/Prizes For Ridesharers	3	6	6	6
Gives Each Employee A Monthly Allotment Of Money To Reduce Commuting Costs	NA*	4	6	6

* NA = Not Asked in the 1989 Survey

Employees in 1991 were far more aware than they were in 1989 of programs such as flexible work hours, rideshare information dissemination, carpool and vanpool formation assistance, and preferential parking for ridesharers. Awareness of all employer programs decreased from 1990 to 1991 when results from these years are compared.

With respect to employer size, 61 percent of the respondents reported working at sites with fewer than 100 employees, and 39 percent claimed to work at sites with more than 100 employees. Of those working at sites with fewer than 100 employees, 37 percent work at sites with fewer than 25 employees, and 24 percent work at sites with 25 to 99 employees. In the 1990 survey, 58 percent reported working at sites with fewer than 100 employees, and 42 percent worked at sites with more than 100 employees. The difference between the two surveys is significant. There were more respondents to the 1991 survey working at sites with fewer employees than there were in 1990. This question was not asked in 1989.

Half of all respondents reported that their employer offers no transportation programs to encourage use of alternative modes. This figure ranges from 34 percent at sites with more employees to 66 percent at sites with fewer employees.

As can be seen in Table 6, awareness of employer transportation programs is much greater at larger firms, those with more than 100 employees. The increase in the number of commuters surveyed at smaller firms may explain the reduction in awareness of all employer programs when results are compared from 1990 and 1991. Other reasons for the decline in awareness may include factors related to the recession and a leveling-off of employer promotional activities, perhaps because of the recession.

The disparity between the large and small firms is not too surprising given the fact that firms with 100 or more employees in Los Angeles, Orange, Riverside, and San Bernardino counties are required by the South Coast Air Quality Management District to reduce commute trips. Furthermore, firms with 50 or more employees in Ventura County are required by the Air Pollution Control District to reduce commute trips. Larger firms are more likely to devote a greater amount of financial and staffing resources to transportation programs, and CTS works primarily with the larger firms. The more density at the employment site, the more opportunity there is to rideshare.

With awareness of transportation programs higher at the larger firms, one might question whether this in turn leads to a greater use of transportation alternatives. In fact, there are significant differences between travel mode and firm size. Seventy-three percent of those at sites with more than 100 employees drive alone to work on a regular basis as opposed to a 78 percent drive-alone rate at firms with 25 to 99 employees and an 84 percent drive-alone rate at sites with fewer than 25 employees.

Respondents who claimed that their employer offers various transportation programs at the work site were also asked whether they had used these programs. In general, if respondents were aware of a program, about one-third participated in it. Those programs that triggered higher participation rates included flexible work hours, transportation allowance, and a compressed work week. Eighty-two percent of those aware of flexible work hours have actually participated. Fifty-three percent of those aware of a transportation allowance have used it; 49 percent aware of a 4/40 work schedule and 44 percent aware of a 9/80 work schedule have actually used it. Ten percent of area commuters stated that they are currently on either a 4/40 or 9/80 work schedule. Six percent work a 4/40 schedule and 4 percent work a 9/80 work schedule. In general, participation in transportation programs is much higher at work sites with more than 100 employees.

TABLE 6 EMPLOYEE AWARENESS OF EMPLOYER TRANSPORTATION PROGRAMS BY EMPLOYER SIZE

	Number of Employees at the Work Site		
Employer Program	Less than 25	25-99	100+
Offers Flexible Work Hours	36%	32%	38%
Offers 4/40 Work Schedule	11	10	17
Offers 9/80 Work Schedule	8	6	11
Assists In Forming Carpools And Vanpools	8	16	46
Provides Ridesharing Info	5	14	44
Guarantees A Ride Home In Case Of An Emergency	15	17	19
Provides Preferred Parking Spaces To Ridesharers	3	6	27
Registers Employees With Commuter Computer	1	5	23
Provides Bus Information On Routes And Schedules	3	6	22
Provides Free/Low Cost Parking To Ridesharers	1	10	17
Subsidizes Ridesharing	1	5	19
Sells Bus Passes	1	5	14
Offers A Company Car During The Day To Those Who Rideshare	2	5	10
Has Contests/Prizes For Ridesharers	0	2	15
Gives Each Employee A Monthly Allotment Of Money To Reduce Commuting Costs	3	6	9

TELECOMMUTING

Ten percent of the respondents to the 1991 survey reported that they have an opportunity to work at home instead of going to their regular place of work. This finding is consistent with those from previous surveys. Roughly 90 percent of those with the opportunity to telecommute actually do. A new question was added in the 1991 survey to determine the number of days that workers telecommute; the results showed an average of 4 days a month.

When opportunity to telecommute was broken down by occupation, significant differences appeared. For example, 27 percent of senior managers said that they have the opportunity to telecommute, whereas only 4 percent of maintenance workers and 3 percent of production workers have the opportunity. Interestingly, only 9 percent of middle managers have the opportunity to telecommute. There is therefore quite a discrepancy between middle managers and senior managers with regard to the opportunity to telecommute. Likewise, there is a positive correlation between annual household income and the opportunity to telecommute; those with the higher income are more likely to have the opportunity to telecommute. Men were more likely than women to have the opportunity to telecommute.

COMMUTER ATTITUDES

Commuters were also asked to compare (when applicable) their 1991 commutes with their commutes in 1990. Table 7 shows commuters' assessments from each of the surveys.

The majority of commuters believe that the flow of traffic on freeways and streets was worse in 1991 than it was in 1990. However, a trend is developing, with more commuters reporting that freeway traffic is better than it was in 1990.

With regard to surface street travel, commuters were more inclined to rate traffic as better than it was in 1990.

An additional question was asked in 1991 regarding travel time. Commuters were specifically asked whether their commute time was longer in 1991 than it was in 1990. Forty-seven percent answered in the affirmative, and this means that a little over half of the commuters did not believe that their travel time was longer in 1991.

OVERALL SATISFACTION WITH THE COMMUTE

Respondents were asked to rate their overall satisfaction level with their commute using a scale of 1 to 9, where 1 represents the greatest level of dissatisfaction and 9, the greatest level of satisfaction. Given commuters' assessment of traffic conditions, their overall commute ratings are relatively high. For the trip to work, the mean satisfaction level is 5.9. Eighteen percent of all area commuters give their trip to work a 9, the highest rating. Only 7 percent rate their trip to work 1, the lowest rating. The mean satisfaction level is consistent with that in 1990. The mean satisfaction level for the trip home is 5.7. Again, 17 percent of the commuters give their trip home the highest rating, 9. This finding is consistent with the results in 1990. Interestingly, the range of satisfaction between the morning and evening commutes has definitely narrowed, because commuters now are more inclined to rate their trip home higher and their trip to work lower than commuters in 1989 did. The results also indicate that although commuters

TABLE 7 COMPARISON OF CURRENT TRAFFIC WITH THAT IN 1990 AND IN 1989

Freeways						
		To Work			To Home	
Traffic Now Is:	1989	1990	1991	1989	1990	1991
Better Than Year Ago	5%	7%	12%	4%	8%	10%
Same As Year Ago	23	26	24	25	29	25
Worse Than Year Ago	72	67	64	71	63	65

Surface Streets						
		To Work			To Home	
Traffic Now Is:	1989	1990	1991	1989	1990	1991
Better Than Year Ago	13%	10%	15%	15%	10%	13%
Same As Year Ago	29	35	34	30	35	36
Worse Than Year Ago	58	55	51	55	55	52

are certainly not satisfied with their commutes, they are not completely dissatisfied, either.

Those who walk, use commuter rail, buspool, or bicycle are the most satisfied with their commutes, and those who motorcycle are the least satisfied.

As Table 8 shows, there was considerable difference in satisfaction levels when trip distance was considered. Considering that 60 percent of respondents believe that freeway traffic was worse in 1991 than it was in 1990 and nearly 50 percent believe that surface street traffic was worse in 1991, a greater degree of dissatisfaction might be expected. However, people are highly adaptable when faced with the gradual onset of a problem. In addition, factors other than traffic may affect the assessment of the overall commute.

A new question was added in 1991 asking respondents to rate the level of stress of their commute using a scale of 1 to 9, where 1 represents the lowest level of stress and 9, the highest. The mean stress level for the commute is 4.4. Fourteen percent rate the stress level of their commute as either an 8 or 9. In general, commuters do not feel that their commute is particularly stressful.

COMMUTER CONCERNS

Respondents were asked which factors they consider when choosing their means of transportation to work. The five most-mentioned factors are

- Convenience and flexibility (37 percent),
- Travel time (28 percent),
- Lack of access to alternative travel modes (21 percent),
- Availability of a vehicle at work (16 percent), and
- Availability of a vehicle before or after work (11 percent).

In 1990 the most-cited factors were convenience and flexibility (33 percent), travel time (23 percent), available travel options (20 percent), and commuting costs (10 percent). Although the same three factors placed at the top both years, a greater emphasis was placed on these factors in 1991. Interestingly, even during a recession, commuting costs fell from fourth to sixth place in the 1991 survey.

Because of the heightened awareness of environmental issues, particular attention was placed on air quality and energy savings as factors to consider when selecting travel modes. Six percent of the respondents consider energy and fuel conservation when choosing their travel mode. Less than 1 percent state improvement of air quality and less pollution as motivating factors in choosing their travel mode.

CONSIDERATION OF ALTERNATIVE MODES

As a hypothetical question, drive-alone respondents were asked if they would consider trying an alternative mode of transportation 1 or 2 days a week, just to see if they like it. Alternatives were mentioned to respondents one at a time. Commuter rail and bicycling were added to the 1991 survey. If a respondent said yes to any of the alternatives, the interviewer probed to find out whether the alternative was something he or she would definitely try or something he or she might try.

Table 9 shows that there clearly is more interest in trying carpooling and vanpooling than any other transportation alternative. Women are far more likely to consider travel alternatives (55 percent) than are men (40 percent). With regard to occupation, middle managers are the most receptive to transportation alternatives, and maintenance workers are the least receptive. Employees at larger firms (more than 100 employees) are more receptive than employees at smaller firms (fewer than 25 employees). Asians are far more receptive to trying travel alternatives than any other ethnic group.

Typically in survey questions of this type, participants respond more favorably to the question than actual behavior would indicate. It would be safe to presume, however, that with the right mix of incentives and promotions, many of those who expressed a definite interest in carpooling or vanpooling (and some who displayed a mild interest) would in fact be encouraged to give it a try. The hope would be that once an individual felt comfortable in the pooling arrangement, he or she would continue on a regular basis.

ATTITUDES TOWARD AND USE OF HOV LANES

Of the 1,306 respondents who travel on a freeway as part of their commute, 33 percent have HOV lanes available to them and 67 percent do not. The percent of commuters with HOV lanes available is considerably higher than it was in 1990. However, if Orange County is omitted, the percentage of freeway users who have HOV lanes would fall to 27. This figure is consistent with the finding in 1990. Therefore, the addition of Orange County increases the percentage of commuters with HOV lanes available.

TABLE 8 COMMUTE SATISFACTION BY TRIP DISTANCE

	Satisfaction Ratings (1 = Low Satisfaction, 9 = High Satisfaction)	
Distance	Trip to Work	Trip Home
Less than 5 miles	6.9	6.7
5 to 9 miles	6.3	6.2
10 to 14 miles	5.9	5.7
15 to 19 miles	5.8	5.5
20 to 24 miles	5.5	5.3
25 to 29 miles	5.0	4.8
30 to 34 miles	4.5	3.9
35 to 39 miles	5.3	5.0
40 to 44 miles	4.8	4.4
45 miles and over	4.9	4.6

TABLE 9 LIKELIHOOD OF ALTERNATIVE MODE USE

	Definitely Would Try			Might Try			Would Not Try		
Travel Mode	1989	1990	1991	1989	1990	1991	1989	1990	1991
Carpool	37%	16%	16%	25%	25%	31%	38%	59%	53%
Vanpool	24	13	12	24	23	27	52	64	61
Commuter Rail	NA*	NA*	11	NA*	NA*	18	NA*	NA*	71
Taking the Bus	12	6	7	17	11	18	71	83	75
Bicycling	NA*	NA*	8	NA*	NA*	11	NA*	NA*	81
Walking or Jogging	7	6	8	8	6	10	85	88	82

* NA = Not asked in the 1989 or 1990 Surveys

Of the individuals who have access to commuter lanes, 34 percent use them and 66 percent do not. Of those who use the commuter lane, 85 percent believe that the lane saves them time. In 1990, 93 percent believed that the lane saved them time. When respondents were asked how much time is saved, the mean response was 18 minutes and the median was 15 min (one way).

Those who do not have access to commuter lanes on freeways were asked if the availability of these lanes would encourage them to carpool, vanpool, or take the bus. Of these commuters, 54 percent consider the lanes an encouragement and 46 percent do not. These data are consistent with those in previous surveys.

IS THE COMMUTE GETTING BETTER?

This is without a doubt the most-asked question when findings from the State of the Commute Study are announced. When one looks at habitual behavior for an entire region, a change in such behavior usually occurs very slowly. Drastic changes from one year to the next are rare. Overall, there was little change in 1991 compared with 1990. There are, however, early indications that conditions are improving.

Is the commute getting better? The answer to this question depends on the definition of "better."

- If "better" means a reduction in commute time, then the commute is getting slightly better. Commuters report commute times both on their trip to work and on their trip home as shorter in 1991 than in 1990.
- If "better" means that more people are ridesharing, then the commute is getting better. More commuters carpooled and rode the bus on a regular basis in 1991 than they did 2 years ago. There was little change from 1990 to 1991. However, in 1991 there was an increase in the percentage of commuters who are utilizing alternative transportation modes as secondary forms of transportation.
- If "better" means that commuters are more satisfied with their commutes, then there was no change in the commute during 1990 and 1991.
- If "better" means that the traffic flow on both freeways and surface streets is better, then there was no change in the commute during 1990 and 1991.
- If "better" means that awareness of employer transportation programs is higher, then the commute is not getting better. Although awareness is still considerably higher than it was in 1989, awareness in all transportation programs decreased from 1990. This may be a reflection of surveying relatively more commuters working at smaller firms where awareness of programs is much lower, rather than an actual decrease in program awareness.
- If "better" means that commuters are more willing to consider transportation alternatives, then the commute was better in 1991 than in 1990 but not as good as it was in 1989. It is hoped that this trend in willingness to consider transportation alternatives will continue to rise during the coming years. With additional travel restrictions, employer incentives, and travel options, more commuters will be encouraged to consider alternatives to driving to work alone.

The fact that the commute has changed little from 1990 should not be interpreted negatively. In a region that grew by 600,000 people in 1990 alone, keeping conditions from worsening is quite an accomplishment.

Although there was little change in the State of the Commute Study from 1990 to 1991, CTS is optimistic that trends are emerging. CTS hopes to see the number of commuters utilizing transportation alternatives, whether as their primary or secondary form of transportation, continue to increase; more commuters participate in the various transportation programs offered by employers, and more employers offer such programs; cities provide more transportation alternatives for their employees; commute time stabilized, if not reduced; commuters not simply adjusting to their commutes but becoming more satisfied with them; and above all, reduced congestion and improved air quality.

SAMPLING METHODOLOGY

Data for the 1991 State of the Commute Study were obtained through 2,568 completed telephone surveys. A 2.0 percent sampling error is normally associated with sample sizes of 2,500, which means that if this survey were conducted 100 times, one would be confident that 95 times out of 100 the characteristics of the sample would reflect the characteristics of the population within plus or minus 2.0 percent.

CTS contracted Survey Sampling, Inc. to draw a sample based on random-digit dialing. This method was used rather than directories because of the high proportion of unlisted telephone numbers in the Los Angeles area. Random-digit dialing avoids the bias introduced by using only listed telephone numbers.

English and Spanish versions of the questionnaire were available to meet the language requirements of respondents. Five hundred surveys were completed in each county in order to make county comparisons possible. A 4.5 percent sampling error is normally associated with sample sizes of 500.

Each survey began with the screener question, "How many persons 18 years or older in your household work full-time outside the home?" Actual selection of eligible respondents was based on the person who had the most recent birthday. This process was used in order to avoid the possible bias of surveying a disproportionate number of women and children, since they are more likely to answer the telephone. Once all surveys had been completed, responses were weighted by the number of eligible respondents within the household. This ensures that small households are not over-represented in sample statistics. Furthermore, when data are analyzed at the regional level, they were additionally weighted by county population on the basis of 1990 census figures. Ideally, weighting would be based on number of commuters in each county. Population estimates were used, because they are the most accurate and have been updated recently. Weighting data by population ensures that less-populated counties do not carry as much or more weight than highly populated counties.

Publication of this paper sponsored by Committee on Ridesharing.

Hispanic Market Research in the Southern California Market

DEBORAH CHUN AND TORBEN CHRISTIANSEN

The United States, and Southern California in particular, has experienced tremendous growth in the Hispanic population during the past 10 years. Commuter Transportation Services conducted research to explore attitudes and perceptions of Hispanics versus the general population regarding awareness of the rideshare message. This study examines both primary (1991 State of the Commute Study and focus groups) and secondary research in order to develop strategies tailored to reach the Hispanic market with the rideshare message.

Southern California has experienced rapid growth in the Hispanic market population in recent years. As a result, Commuter Transportation Services, Inc. (CTS) believed that it was important to evaluate the Hispanic market in terms of how its needs relate to CTS. CTS has not conducted any previous research on the Hispanic market, so the major objective of this paper is to evaluate the ridesharing message to the Hispanic market by means of gauging attitudes toward ridesharing, media messages, terminology, and collateral materials.

METHODOLOGY

This paper is a combination of both primary research (research conducted for the first time) and secondary (previously published) research, which will give the reader sufficient understanding of this market segment.

Specific research sources are as follows:

- Demographic analysis—1990 census data were used to segment the Hispanic population at the national level as well as at state and regional levels.
- Secondary research—data were gathered and segmented into three major areas of interest:
  - –Language and culture,
  - –Marketing and advertising strategies, and
  - –Media usage.
- Primary research—two projects were undertaken by CTS to further evaluate the Hispanic market:
  - –1991 State of the Commute Study—an annual survey conducted by CTS to evaluate behavior and attitudes of commuters in the Southern California region. An in-depth analysis of Hispanics who participated in the survey was completed for this paper.
  - –Focus groups—three focus groups were conducted with Hispanics to explore attitudes, motivation, and reaction to the ridesharing message. One group was conducted with English-speaking Hispanics, and the other two groups were conducted with Spanish-speaking Hispanics.

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DEMOGRAPHIC ANALYSIS

Hispanics in the United States

On a national level, the Hispanic population has grown rapidly, particularly in the past decade. Recent data from the 1990 census indicate a growth pattern that exceeds that of any other minority group. In 1980 the Hispanic population was 14.6 million, whereas in 1990 it had grown to 22.4 million, an increase of 53 percent, which now equates to 9 percent of the total U.S. population. In contrast, African-Americans grew by less than 1 percent and now represent 12 percent of the total U.S. population. If growth rates continue at present rates, Hispanics could be the largest minority group within the next 10 years (*1*).

Nationally, the term "Hispanic" encompasses people from many countries of origin including Mexico (63 percent), Central and South America (12 percent), Puerto Rico (11 percent), and Spain (8 percent) (*2*). Two-thirds of all Hispanics in the United States live in just three states: California, Texas, and New York.

Hispanics are more likely to have larger families than non-Hispanic households (3.8 persons per Hispanic household versus 3.1 persons per non-Hispanic household); less formal education (of Hispanic young adults ages 25 to 34, 60 percent have completed high school, whereas for non-Hispanics the figure rises to 89 percent); higher unemployment rates (in a study conducted in 1989 the unemployment rate for Hispanics was 7.8 percent, whereas for non-Hispanics it was only 5.2 percent); and lower income levels (the median family income level for Hispanics in the Los Angeles area was just over half that of non-Hispanics, $22,030 versus $41,100). A higher proportion of Hispanics are employed in lower-paying jobs, which may be less stable, contributing to a lower overall standard of living. Hispanics also have a much lower median age (25.9 years) than non-Hispanics (33.2 years) (*3*).

Hispanics in California

Over one-third of the U.S. Hispanic population resides in California, with a growth rate of over 3 million, or nearly 70 percent within the last decade (*4*). In 1980, the census reported 4.5 million Hispanics; this number grew to 7.7 million

in 1990. Currently, the ethnic breakdown in the state is as follows: 57 percent Anglo, 26 percent Hispanic, 9 percent Asian, 7 percent African-American and 1 percent Other (*4*).

About 4.5 million people of Hispanic origin live in the five major counties of Southern California: Los Angeles, Orange, Riverside, San Bernardino, and Ventura, accounting for nearly one-third of the total population of the region (*5*). Table 1 presents a breakdown of the ethnic makeup of these counties.

As indicated in Table 1, the Hispanic population is larger than any other minority group. Much of the growth has been attributed to a high birth rate, immigration from other countries, and in-migration from other states. Among the Hispanics in Southern California, two-thirds (66 percent) are of Mexican ancestry, 15 percent are from Central America, 11 percent are born in the United States, and 8 percent are from South America and the Caribbean region (*5*).

Southern California has a high concentration of traditional (mainly Spanish-speaking) Hispanics because of the large number of recent immigrants. Sources have shown that 49 percent use only or mostly English, 21 percent use only or mostly Spanish, and the remaining 30 percent use both languages equally.

Because the median age is younger than that of the general population, with over half (59 percent) of Hispanic adults under the age of 35, there are large numbers of those who are currently in the labor force.

Due to prior settlement patterns and residential segregation, the Hispanic population is heavily concentrated in certain geographic areas. More than half of the Hispanic population in Los Angeles County live in zip code areas that are predominantly Hispanic (*5*).

SECONDARY RESEARCH

This section is a compilation of published secondary research and in-depth interviews with various Hispanic community and business leaders regarding the Hispanic market. It has been divided into the three sections, Language and Culture, Marketing and Advertising Strategies, and Media Usage.

Language and Culture

As stated previously, the Hispanic market consists of many different subcultures, which may need customized approaches from a marketing standpoint. However, since Mexicans make up two-thirds of the Hispanic population in Southern California, one marketing approach may be sufficient (M. Valencia, unpublished data).

Recent studies have shown that most Hispanics take one full generation to become assimilated into the American culture. Very few adults who are not born in the United States assimilate easily. The first generation of children born in the United States assimilates easily, but as they grow up, many of them return to their cultural roots. If present in-migration as well as immigration trends continue, unassimilated Hispanics will increase from 38 percent of the Hispanic population to 66 percent of the population by the year 2000, indicating a need to continue bilingual efforts (*6*).

Regardless of assimilation rates, nearly all Hispanics believe it is very important to pass their culture on to their children. English and Spanish coexist among Hispanics, with many believing that their children should be bilingual. In fact, bilinguals are the fastest- growing segment of the Hispanic population.

The family is the center of activity, with Hispanics embracing more of a "we" than a "me" approach to life. Traditional family values, combined with the importance of the Catholic church, are key elements to recognize, since these bonds cross all lines of origin, assimilation, and social standing. Studies indicate that over 70 percent of Hispanics are Roman Catholics, and the church not only serves spiritual needs but also acts as a center for social and community events and holiday celebrations (*7*).

As leading consumer marketers have discovered, events and activities that allow interaction (sporting events, carnivals, picnics) are good vehicles to consider when the Hispanic market is targeted. A genuine interest (presence and not just money) is of utmost importance, because Hispanics will resent those who sponsor events for only one year and then do not sponsor them the following year (F. Medina, unpublished data).

To summarize, the following quote is appropriate: "Change happens slowly, and immigrants reshape America almost as much as America changes them."

Marketing and Advertising Strategies

In the past decade, marketers have realized the potential buying power of the Hispanic market and have begun to target it as a separate entity from the general market because of its increased size. Public relations is the cornerstone of a suc-

TABLE 1 ETHNIC ORIGIN BY COUNTY

	Los Angeles	Orange	Riverside	San Bernardino	Ventura
Anglo	41%	65%	64%	61%	67%
Hispanic	38%	23%	26%	27%	26%
Asian	10%	10%	3%	4%	5%
African-American	11%	2%	5%	8%	2%
Other	*	*	2%	*	*
TOTAL	100%	100%	100%	100%	100%

* Less than 1%

cessful campaign, but awareness needs to build slowly, with community outreach a key issue in targeting Hispanics.

Studies by large packaged goods companies have shown that Hispanics are very brand-loyal; that is, they place a lot of value on brands that they know and trust. When deciding on strategies, certain guidelines have surfaced (*8*):

1. Promotional vehicles such as sweepstakes are very popular with Hispanics. Coupons are not; Hispanics view them as similar to food stamps and are hesitant and ashamed to use them on a regular basis.
2. Advertising should focus on informational needs and less on entertainment; Hispanics are eager to learn about the product or service and require less entertainment to be interested in watching or listening to the ad.
3. Caution should be used when translating English advertising into Spanish. Literal translations have sometimes resulted in disastrous communications, so it is important to know what the Spanish meaning of a word is. For example, Braniff Airlines used the phrase "fly on leather," which when translated literally into Spanish (*vuela en cuero*) means "fly naked."
4. The spokesperson for this market needs to be someone with whom the Hispanic market can identify, relate to, and respect. It is important that the advertising be socially acceptable, not clash with the culture, and not overuse stereotypes (e.g., mariachi singers).

The most successful marketing strategies link advertising efforts with strong promotional efforts. For example, Adolph Coors Company devoted $60 million in 1986 to the Hispanic Agreement, which was devoted to creating a corporate presence in the Hispanic market. This was accomplished by providing over 100 programs ranging from special events throughout the country to scholarship awards, contributions, and distributorships. Coors sponsored a multitude of events (such as the Hispanic Heritage Festival, softball games, dances, and concerts), which allowed consumers the opportunity to sample their product, and thereby build up awareness of the brand and increase sales (*8*).

Other companies, such as Eastern Airlines, conducted extensive research to determine the optimal strategy for reaching Hispanics. They found that although in the general market the primary reason for air travel is business-related, the Hispanic travel market is for personal reasons, usually visiting friends and relatives. Their strategy was to execute an advertising campaign using a three-step approach:

1. Develop Eastern's corporate image in order to make the Hispanic consumer aware of its services and schedules, and play up the solid background of the corporation. The perception of a company's strength is important to the Hispanic consumer.
2. Segment the Hispanic group by ethnic subgroups to promote as specific destinations cities from which that Hispanic subgroup has immigrated. For example, in Southern California, where the majority of Hispanics are of Mexican origin, cities in Mexico would be targeted in advertising.
3. Highlight vacation-oriented packages, which include features such as tours, car rentals, and hotels. This ties everything together, providing the consumer with the convenience of an all-in-one package.

This three-step strategy was successful for Eastern Airlines and their advertising agency, Campbell-Ewald Latina, resulting in high awareness among Hispanics, who made Eastern the airline of their choice (*8*).

In the case of Arrowhead Drinking Water, which is a Southern California brand of bottled water, research indicated a higher-than-average usage of the product among Hispanics than that of the general market because that bottled water is very common in Mexico. However, the Hispanic market share was much higher for the competitive brand, Sparkletts. Focus groups and in-depth interviews with Hispanics uncovered that pronunciation was a key issue—"Sparkletts" was very easy for Hispanics to pronounce, whereas "Arrowhead" was not. Advertising was developed in which a Hispanic mother teaches her daughter how to pronounce "Arrowhead." This resulted in an increased awareness and recognition of the brand and, consequently, higher sales (D. Chun, unpublished data).

Bank of America recently commissioned a Hispanic artist, Carmen Lomas Garza, to design original artwork that was featured in their bilingual check series to honor traditional Hispanic culture. Response to the new product has been positive, and shows that the bank is committed to this growing segment of the population. In addition, Bank of America has stressed the importance of hiring Hispanics to work within its organization and to target customer service, especially catered to Hispanics, as key goals for the future (Hispanic Research Seminar, unpublished data).

Media Usage

In response to the phenomenal growth in the Hispanic population, numerous media vehicles have been developed in the past decade. The emphasis is to appeal to a bilingual audience, since this is the fastest-growing segment of the Hispanic population.

Bilingual Hispanics feel comfortable speaking English in the workplace but tend to speak Spanish at home, which is why an abundance of Spanish-language television and radio stations has evolved in recent years. English-speaking Hispanics, on the other hand, have blended into the mainstream population, so it is difficult to examine their media habits separately from those of the general population.

Experts in the field agree that television and radio are the best media to use, since Hispanics are more likely to be involved in activities with large groups of people and these media are conducive to those situations. Television can also explain more easily and answer questions regarding a product or service (*9*).

In Southern California there are three major television stations catering to Hispanics: KMEX, KVEA, and KWHY (business during the day and Spanish-language in the evening). Spanish-language television has evolved from primarily novellas (Spanish soap operas) to a mix of programs comparable with those on English-language television stations (A. Martinez, unpublished data).

Hispanic radio stations, which have existed in Southern California since the 1950's, have experienced the largest growth due to improved technology, more aggressive promotion and publicity, and the increase in population. In the most recent Arbitron ratings for the first quarter of 1991, radio station KLVE ranked seventh out of 80 stations in the area. For a

15-min period they recorded 61,200 listeners, as compared with the first-ranked station, KOST, which recorded 90,400 listeners in the same time period (*10*). Different types of stations have developed, ranging from KWKW, which bills itself as *un amigo de la gente* (a friend of the people), to KTNQ and KLVE, which project a more upscale image.

In the 1990 Radio Market Guide, the seven Los Angeles-based Spanish stations generated an estimated $40 million in advertising revenue. Radio analyst Allen Klein states: ". . . the Spanish stations are all making money and having million-dollar months; they have established themselves as big-time players now." Since English-speaking Hispanics have blended into the mainstream, their radio station preferences mirror those of the general population.

In the area of publications, specific audiences are being targeted. *La Familia de Hoy* and *Mi Bebe* are aimed at bilingual Hispanic women, with the intent of helping them assimilate into United States culture. *VISTA*, a weekly insert distributed to newspapers throughout the country, is targeted to upwardly mobile Hispanics who want to keep in touch with their cultural roots. *La Opinion*, published in the Los Angeles area, is the largest and oldest Spanish-language daily newspaper in the nation. Published since 1925, *La Opinion* had a circulation growth of 72 percent in the last 5 years and a 24 percent market penetration among Spanish-language dominant adults. The *Los Angeles Times* publishes *Nuestro Tiempo*, a bilingual section focusing on issues of particular interest to bilingual Hispanics, on a biweekly basis. A recent study determined that one in five regular newspaper readers reads both Spanish and English.

Newspapers are read more frequently by men with higher annual household incomes ($35,000 or more). Reasons for reading newspapers are the following: (a) it is the best way to get the complete story, (b) it is necessary to understand the issues, and (c) it is enjoyable.

PRIMARY RESEARCH

Two major research studies were undertaken by CTS to analyze and recommend strategies for effectively targeting the Hispanic population with the rideshare message—the 1991 State of the Commute Study and Hispanic focus groups.
The third annual State of the Commute Study was conducted with randomly selected commuters to evaluate their behavior and attitudes toward ridesharing. The survey was conducted in five counties of Southern California: Los Angeles, Orange, Riverside, San Bernardino, and Ventura. A total sample size of 2,568 was used. This analysis examines the 577 respondents who identified themselves as Hispanics.

In the second study, three focus groups were conducted with Hispanics (one group with English-speaking Hispanics and two with Spanish-speaking Hispanics) to explore attitudes, motivation, and reaction to the ridesharing message. Qualified respondents were of Hispanic origin, 18 to 49 years of age, and employed full time. Men and women participating used a range of different commuting options, including driving alone, carpooling, and transit. Feedback on ridesharing terminology and reaction to current television and radio advertising was also explored. The focus groups were conducted by Carlos Garcia of Garcia Research Associates, Inc., a market research consultant who specializes in the Hispanic market.

1991 Commuter Survey Results

Of the 2,568 people surveyed for the 1991 commuter survey, 577 (23 percent) identified themselves as Hispanics. On the basis of the language used in the interview, the Hispanics can be divided into English-speaking (63 percent) and Spanish-speaking (37 percent). The non-Hispanics in the survey were segmented into white, black, Asian, Native American, and Other. Although there are significant commute-related differences between the non-Hispanic groups, these groups will be considered as one for purposes of this analysis.

Travel Mode

The primary travel mode to work (3+ day a week) of English-speaking Hispanics is very similar to that of non-Hispanics, with rideshare rates around 22 percent. Spanish-speaking Hispanics, on the other hand, have a much higher ridesharing rate (52 percent). Of these, carpooling (31 percent) and transit (16 percent) are the most utilized rideshare travel modes. Even among Spanish-speaking Hispanics who are primarily solo drivers, only 82 percent drive alone every day as opposed to 94 percent of non-Hispanic solo drivers and 93 percent of English speaking Hispanic solo drivers.

The finding that ridesharing is more common among Spanish-speaking Hispanics is also supported by the finding that 26 percent of the full-time solo drivers have rideshared within the last 3 years compared with 13 percent of English-speaking Hispanic and 10 percent of non-Hispanic solo drivers. English-speaking Hispanics generally give the same reasons as non-Hispanics for terminating their rideshare arrangement: (a) change of job or residence, (b) change in work schedule, or (c) termination of the arrangement by other ridesharers. These reasons are cited less by Spanish-speaking Hispanics, who are more likely to report needing a car before or after work, getting a car, or getting their car fixed as reasons for terminating their rideshare arrangement.

In general, all Hispanics have used their current rideshare mode for a shorter length of time than non-Hispanics. Hispanic bus riders have been using the bus for an average of 3 years and 9 months, whereas the average non-Hispanic bus rider has used the bus 1 year longer. Hispanic carpoolers have been in their current carpool for an average of 1 year and 10 months compared to 2 years and 4 months for non- Hispanics. A probable explanation for these differences is that Spanish-speaking Hispanics tend to have been at their current work location for a shorter length of time than non-Hispanics.

Compared with non-Hispanics, Spanish-speaking Hispanics are much more likely to carpool with relatives than to carpool with coworkers. English-speaking Hispanics are more likely to carpool with nonhousehold relatives and coworkers than to carpool with household members. Hispanics (regardless of language) do not differ significantly from non-Hispanics in the extent to which they carpool with people from matchlists (an individually tailored computer-generated list that provides up-to-date ridesharing information); approximately 16 percent of all carpool partners are from a matchlist.

Factors Important to Mode Choice

Table 2 shows that for Spanish-speaking Hispanics, the most important factor in choosing a particular travel mode is lack of alternatives: 39 percent of Spanish-speaking Hispanics cite having no alternative as a reason for their current travel mode, whereas only 22 percent of English-speaking Hispanics and 19 percent of non-Hispanics give this reason. In a comparison of travel modes for those who claim that they have no alternative to their current travel mode, 85 percent of non-Hispanics drive alone, but 68 percent of English-speaking Hispanics and only 40 percent of Spanish-speaking Hispanics drive alone. In other words, when non-Hispanics and English-speaking Hispanics claim that they have no alternative to their current mode, they usually drive alone. Spanish-speaking Hispanics, however, rideshare when they have no other option, indicating that driving alone is not as likely to be an option for them.

A large number of Spanish-speaking Hispanics rideshare because they have no other option available. This is not surprising considering that 17 percent (versus 3 percent of English-speaking Hispanics and 1 percent of non-Hispanics) report never having a vehicle available for commuting. Similarly, only 66 percent of Spanish-speaking Hispanics report always having a vehicle available for commuting (versus 93 percent of non-Hispanics and 86 percent of English-speaking Hispanics).

Table 2 also shows that Spanish-speaking Hispanics are more likely than the other groups to cite comfort and relaxation and safety as reasons for their mode choice and less likely to cite convenience and flexibility, having a car available at work, and a dislike of being dependent on others. The most important difference between English-speaking Hispanics and the other two groups is that they are much more likely to mention a dislike of being dependent on others as a reason for their mode choice.

When solo drivers were probed as to what alternative travel modes they might consider trying, Spanish-speaking Hispanics were far more likely than the others to say that they would consider using the bus (51 percent versus 22 percent of English-speaking Hispanics and 23 percent of non-Hispanics). For all three groups, approximately 47 percent indicated that they were likely to try carpooling. However, Spanish-speaking Hispanics seem more hesitant to try carpooling; only 7 percent of Spanish-speaking Hispanics said that they would definitely try carpooling (versus 16 percent of English-speaking Hispanics and non-Hispanics). According to the focus group findings, this hesitation could be caused by a fear of carpooling with unknown persons.

TABLE 2 MOST IMPORTANT FACTORS DETERMINING MODE CHOICE

	Spanish speaking Hispanics	English speaking Hispanics	Non-Hispanics
No other option available	39.1%	22.3%	19.4%
Travel time	30.1%	25.8%	29.3%
Convenience/Flexibility	14.9%	34.6%	39.1%
Having car before or after work	12.8%	10.8%	11.1%
Comfort/Relaxation	11.9%	8.0%	8.0%
Safety	10.9%	2.3%	6.4%
Having car available at work	9.8%	11.9%	18.1%
Dislike being dependent on others	4.4%	15.8%	7.3%

Totals exceed 100% due to multiple responses

TABLE 3 COMMUTE DISTANCE AND TRAVEL TIME

	Spanish speaking Hispanics	English speaking Hispanics	Non-Hispanics
Mean distance, miles	13.7	16.0	17.4
Mean trip time, to work minutes	26.0	31.0	35.0
Mean trip time, to home minutes	35.0	39.0	39.0

TABLE 4 COMMUTE SATISFACTION

	Spanish speaking Hispanics	English speaking Hispanics	Non-Hispanics
Commute to work	6.9	6.2	5.7
Commute home	6.6	6.0	5.5

Commute Characteristics

On the average, Spanish-speaking Hispanics have short commutes; 51 percent commute less than 10 mi one way (versus 43 percent of English-speaking Hispanics and 40 percent of non-Hispanics). As seen in Table 3, the average commute distance for the three groups varies from 13.7 mi (Spanish-speaking Hispanics) to 17.4 mi (non-Hispanics). The average total trip times (to and from work) range from 61 min (Spanish-speaking Hispanics) to 74 min (non-Hispanics).

Table 4 summarizes commute satisfaction. Spanish-speaking Hispanics are generally more satisfied with their commute than the other two groups. On a scale from 1 (least satisfactory) to 9 (most satisfactory), Spanish-speaking Hispanics rated their trip to work at 6.9 and their trip home at 6.6, whereas English-speaking Hispanics rated their trips to and from work at 6.2 and 6.0, respectively. Non-Hispanics rated their trip to work at 5.7 and their trip home at 5.5.

Employer-Provided Trip Reduction Programs

In general, Spanish-speaking Hispanics are less likely to be aware of alternative work arrangements such as telecommuting, flexible work hours, and compressed work weeks. However, when Spanish-speaking Hispanics are offered these alternatives, they are more likely than others to use them. Although English-speaking Hispanics are as likely as non-Hispanics to be offered these programs, they are less likely to take advantage of them.

With respect to rideshare incentives (rideshare matching, sale of bus passes at the worksite, etc.), Spanish-speaking Hispanics are less likely both to be aware of what is being offered and to use most of these incentives. English-speaking Hispanics are as likely as non-Hispanics to be offered and to use most of the incentives. One exception is bus passes, with 7 percent of all three groups reporting that their employer sells bus passes. Fifty percent of both English-speaking and Spanish-speaking Hispanic groups have purchased bus passes from their employer, whereas only 20 percent of non-Hispanics have done so.

One of the reasons Spanish-speaking Hispanics are less likely to be offered employer incentives is that 50 percent work for businesses with less than 25 employees (versus 27 percent of English-speaking Hispanics and 38 percent of non-

Hispanics), and these employers are not as likely to offer incentives. However, even Spanish-speaking Hispanics at larger firms are somewhat less likely to be aware of employer incentives than the other groups. One possible reason for lower awareness of employer programs among Spanish-speaking Hispanics may be that the programs are promoted primarily in English.

Awareness of CTS and RIDE-number

The data in Table 5 (percentage of affirmative responses) show a much lower awareness of CTS and the RIDE-number among Spanish-speaking Hispanics. Furthermore, even among the Spanish-speaking Hispanics who have heard of CTS or the RIDE-number, the knowledge of why someone would contact either CTS or the RIDE-number is very limited; for example, only 9 percent believe that rideshare information is provided (versus 59 percent of English-speaking Hispanics and 52 percent of non-Hispanics). One result of this low level of awareness is that only one of the Spanish-speaking Hispanics in the survey had contacted CTS. This finding is confirmed by the CTS Teleservices Department, which finds that less than 5 percent of the incoming phone calls are from Spanish-speaking callers.

Fewer Spanish-speaking Hispanics than English-speaking and non-Hispanics use the freeway as part of their commute (41 percent versus 53 percent of non-Hispanics and 48 percent of English-speaking Hispanics). Compared with the other two groups, however, their lower awareness of CTS and the RIDE-number is not dependent on their lack of freeway usage. The awareness level is low even among those Spanish-speaking Hispanics who use the freeway (and see the freeway signs), therefore indicating that the freeway signs are not readily understood by Spanish-speaking Hispanics (see Table 5).

Demographic Characteristics

The demographic profile of the Hispanic respondents from the 1991 commuter survey fits very closely with that of external sources; for example, they are younger and have lower income levels than the general population. The average Spanish-speaking Hispanic household has slightly more working adults (2.0) than the non-Hispanic (1.7) and English-speaking Hispanic (1.8) households. However, only 36 percent of the Spanish-speaking Hispanics interviewed were women (versus 50 percent of non-Hispanics and 43 percent of English-speaking Hispanics), which may indicate that fewer Spanish-speaking Hispanic women work outside the home. Despite having fewer working adults, the average non-Hispanic and English-speaking Hispanic household owns or leases 2.7 cars or light trucks, whereas the average Spanish-speaking Hispanic household only owns or leases 1.6 cars or light trucks. Lower income levels are also more common for Spanish-speaking Hispanics, with 88 percent having an annual household income below $35,000 (58 percent below $20,000), as opposed to 51 percent of English-speaking Hispanics and 26 percent of non-Hispanics.

Hispanics in general have been in their current jobs for a shorter length of time (4 years) than non-Hispanics (5 ½ years). Spanish-speaking Hispanic households also tend to move more frequently, with the average time at the current address being slightly less than 4 years compared with slightly more than 7 years for the other two groups. Although Spanish-speaking Hispanics have been at both their current home and work locations for a shorter period of time than the other groups, they are somewhat less likely to cite commute-related issues as a reason for moving or getting a new job.

In terms of job classification, Spanish-speaking Hispanics are much more likely than non-Hispanics to be in production, maintenance, or sales and service occupations than to be employed in secretarial, professional, or management positions. English-speaking Hispanics are also much more likely to be in maintenance and production positions than to be senior managers or professionals, but are just as likely as non-Hispanics to be in secretarial or sales and service occupations.

TABLE 5 HEARD OF CTS AND THE RIDE-NUMBER
(Percentage affirmative responses)

	Spanish-speaking Hispanics	English-speaking Hispanics	Non-Hispanics
Heard of CTS	11.8%	30.9%	40.5%
Heard of the RIDE number	11.2%	34.1%	40.4%
Among freeway users:			
Heard of CTS	11.2%	38.5%	45.1%
Heard of the RIDE number	10.9%	42.2%	43.1%
Heard of and contacted CTS or the RIDE-number	.7%	10.7%	9.7%

Summary and Recommendations

The 1991 commuter survey data clearly show that Spanish-speaking Hispanics differ dramatically from non-Hispanics on commute-related characteristics, whereas English-speaking Hispanics are fairly close to non-Hispanics on most of them.

With a rideshare rate above 50 percent, the effort to change behavior among Spanish-speaking Hispanics appears to be limited. There are indications in the data, however, that ridesharing is done out of necessity rather than out of choice. It might be beneficial to educate Spanish-speaking Hispanics on rideshare alternatives and on CTS' services to ensure continued ridesharing if and when driving alone becomes an option. The data indicate that Spanish-speaking Hispanics currently have very limited information on CTS' services and that the information they do have is inaccurate. It seems reasonable, therefore, to increase the communication of the rideshare message and CTS' services in Spanish.

The data also indicate that Spanish-speaking Hispanics are less likely to be aware of incentives offered by employers. It is advisable for CTS to develop programs to assist smaller as well as larger firms in marketing their ridesharing programs to Spanish-speaking employees because of the large number of those that work for smaller firms.

Finally, there appears to be an opportunity to encourage rideshare behavior among English-speaking Hispanic solo drivers through guaranteed-ride-home programs, part-time ridesharing, and increased use of available alternative work schedules.

Hispanic Focus Group Highlights

- Hispanics are positively oriented to the ridesharing concept for several reasons, encompassing both economic survival issues (needing to share to make ends meet) and cultural qualities (preferring to do things in groups).
- There is little awareness of the 380-RIDE telephone service or park-and-ride lots and no previous usage. Reasons include less usage of freeways, quickly disappearing telephone numbers in the TV ads, and resistance to dealing with strangers for carpooling. Communication to increase understanding of the telephone number and the rideshare service and how it works is essential.
- The "Mom" advertising campaign has proven to be very effective in stimulating ad awareness and detailed ad recall. The word "rideshare" is known from those commercials, although the telephone number is presented too quickly to be effective. The concept of a "matchlist" is not presented or explained in these ads.
- The real barriers to carpooling are fear of unknown persons and their habits, insurance issues, having to pick up children after work, and having to go out of one's way.
- The best real motivators for carpooling are the savings in gasoline and wear and tear on the vehicle, employer's incentives such as raffles, parking, money for gas, etc.
- The best abstract motivators are making friendships and helping the environment and the community.
- The key problem of the matchlist should be dealt with head-on: the fear of having to deal with unknown people. A telephone interview could be used to cover basic issues like schedules and personal habits. An attempt to find common ground such as church groups, children in school, and so forth, should be made and personal meetings and trial periods should be suggested.
- The second most important barrier to use of the matchlist, car insurance issues, should be defused by explaining to consumers what insurance parameters must be met and what is covered and not covered by the liability insurance of the driver and by their own insurance.
- Bilingual brochures that rely on minimum verbiage, maximum graphics, and bright, primary colors should be used. Suggested locations for distributing these brochures include grocery stores, Department of Motor Vehicles offices, and utility payment locations.
- Work with employers (including smaller firms) should be continued to encourage ridesharing by offering preferred parking to those who rideshare, holding meetings in which ridesharing is discussed, encouraging employers to sponsor raffles and contests for those who rideshare, and distributing brochures or posters in lunchrooms.
- The only appropriate translation for Ridesharing is *Compartir Su Viaje* ("share your trip"). The English word "ride" is widely used and is in fact how Hispanics in Los Angeles refer to carpooling: *Me dan ride* ("they give me a ride"). However, respondents did not seem to make the connection between "380-RIDE" and the word "ride" as it is used among Hispanics. Other terms such as "vanpooling," "buspooling," or "matchlist" are not known and are not directly translatable.
- Hispanics understand the word "ridesharing" to mean only sharing a ride, as in carpooling, and no other shared riding option (such as vanpooling or buspooling) is included in this definition. A special effort would be required to change this current understanding of the term.
- A logical preliminary step would be to encourage Hispanics to carpool with those they already know and work with. The next step would be to encourage carpooling with those they know but don't necessarily work with, and the last step in this familiarization process would be a matchlist approach.

OVERALL CONCLUSIONS AND RECOMMENDATIONS

The following overall conclusions and recommendations are made:

1. Basic terminology ("ridesharing," "carpool," "matchlist," "CTS," "RIDE number") is not familiar to Hispanics in general, and would benefit from increased exposure by means of a variety of media, including television, radio, newspaper, and bilingual collateral materials. Additionally, literal translations of terms do not always have the same meaning. Future materials should be tested with the appropriate audience to determine their validity.
2. The current "Mom" television and radio campaign is effective in increasing awareness and recall of the message of ridesharing. A more thorough explanation of the RIDE number is necessary, however, since the concept of calling for information on ridesharing has not been understood.
3. Community events are very important to Hispanics, so possibly a rideshare fair could be organized in conjunction with other community events to familiarize them with the ridesharing message. As shown by other companies, CTS should be prepared to enter into a long-term relationship with the Hispanic community rather than making a one-time effort, in order to show true commitment. In addition, continuation of bilingual services in the Teleservices Department (where commuters can call in to receive a personalized matchlist) would be helpful to this market segment.
4. As with the general population, the key issue is how to alleviate fear of contacting people on the matchlist. Hispanics in particular are hesitant to contact a stranger to carpool with them. It may be necessary to offer basic instruction on using a matchlist with the provision of a "get acquainted" meeting beforehand.
5. Because of economic factors, many Hispanics use public transportation. However, as their economic status increases, the challenge for CTS is to encourage them to avoid switching to a drive-alone mode.
6. Hispanics have shown less awareness of employer-related incentives to ridesharing. Employers with large concentrations of Spanish-speaking employees need to be specifically targeted and introduced to CTS' products and services, perhaps by having special briefings designed for them.
7. A corridor-like promotion designed specifically for the Hispanic market would be feasible, because of the concentration of Hispanics in geographic areas.
8. Children and family are focal points of the Hispanic family; therefore, promotions designed with these in mind would make a lot of sense. For example, the "Smog is not healthy for children" promotion from CTS' Public Relations campaign (Summer 1990) is a concept that could possibly be successful in Spanish.

9. Hispanics believe that the term "ridesharing" means only carpooling and does not include transit or vanpooling. Education is needed to familiarize people with the meaning of ridesharing.

10. Collateral pieces and brochures should be written in English on one side and Spanish on the other side rather than having English-only and Spanish-only pieces.

11. The motivating factors to encourage participation in ridesharing include sharing the cost of gas and wear and tear on the car and employee incentives such as raffles, free parking, and money for gas.

12. Hispanics are concerned with insurance issues and need to be educated on the parameters of what is and is not covered by liability insurance for both drivers and riders.

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Publication of this paper sponsored by Committee on Ridesharing.

Evaluation of Second-Year Effectiveness of Guaranteed Ride Home Service at Warner Center Transportation Management Organization

CHRISTOPHER PARK

The concept of offering a "Guaranteed Ride Home" (GRH) to employees in case of emergencies to maintain and encourage ridesharing and transit use has grown in popularity among transportation management associations and single employers during the past few years, especially in Southern California. The Warner Center Transportation Management Organization was one of the first organizations to design and offer such a service to its entire membership as early as 1989. To date, there has been little information on the impact of GRH services in maintaining and recruiting solo drivers for alternative forms of transportation such as carpooling, vanpooling, buspooling, and public transit. Data are provided through the evaluation of Warner Center's second year of offering a comprehensive GRH Service to its 45 member companies, which employ over 33,000. The study identifies 600 employees who began carpooling, vanpooling, or riding a bus during the past year and indicated that the GRH service most influenced their decision to do so. In addition, 50 percent of those surveyed said that the GRH service was important in their decision to rideshare or take transit. Furthermore, a majority of management believe that the service is a vital part of their overall rideshare incentive package. Overall costs, usage, and responsiveness of the service are also identified. The conclusion reached is that this service costs very little, was used very little, but was abused very little. However, it successfully removed an important roadblock to ridesharing and transit use by converting a significant number of solo drivers.

Warner Center Transportation Management Organization (TMO) has offered a comprehensive Guaranteed Ride Home (GRH) service to its 7,500 ridesharers and transit riders since June 1989. The service provides employees with a free ride home in a taxi or rental car in the event of emergencies during the work shift.

The Warner Center is 1,100-acre mixed-use development in the West San Fernando Valley of Los Angeles, with an employee population of approximately 40,000. The Warner Center TMO consists of 45 corporate members and 4 building owners and represents approximately 90 percent of the total Warner Center labor force. The TMO was formed in 1989 to maintain an adequate level of mobility in the Warner Center area by providing commuters with an attractive choice of transportation options. The Warner Center TMO offers a number of ridesharing incentives, including the GRH program, and has established an extensive carpool network, vanpool program, and private express lines.

During the past 2 years, the TMO has closely monitored the GRH service. An outside consulting firm, Transportation Management Services, was used to evaluate results from the first year of GRH service and reported that program objectives were being met and that there was very little abuse of the service. TMO staff conducted the second-year evaluation, and discovered that although the service had continued to be very effective in recruiting ridesharers and has had very little abuse, it has been utilized infrequently.

GENERAL FINDINGS

To help evaluate the effectiveness of GRH, the TMO reviewed a variety of surveys and detailed records and made the following findings:

1. Over 600 employees who began carpooling, vanpooling, or riding a bus during 1990 identified GRH as the service that most influenced their decision to do so.

In order to quantify the number of employees ridesharing because of the GRH service, the TMO designed a standard attitudinal questionnaire and asked all company members to distribute it to their employees, with the goal of gathering center-wide data about the GRH program from all members. Commuter Transportation Services compiled the attitudinal survey responses and issued a report revealing that GRH was maintaining and recruiting many ridesharers and transit riders among TMO members.

2. Of the employees surveyed, 59 percent said that GRH was important in their decision to carpool, vanpool, or ride a bus. This significant finding reveals that over half of the employees surveyed considered GRH important when deciding whether to rideshare or take transit.

3. Member Employee Transportation Coordinators (ETCs) were also surveyed, and the majority believe that GRH is a vital part of their overall rideshare incentive packages. This finding confirms that members see GRH as an important TMO service.

4. The proportion of employees who are aware of GRH is 56 percent. Although it is good that over half of the employees know about GRH, it is disturbing that almost half do not. This suggests that continuous marketing campaigns are needed to communicate the availability of GRH.

Warner Center Transportation Management Organization, 21600 Oxnard Street, Suite 460, Woodland Hills, Calif. 91367.

FINDINGS REVEALED FROM PARTICIPANTS

In addition to finding out employees' attitudes about GRH, the TMO also tracked each GRH participant's experience and opinions. The TMO utilized two forms to help monitor this service: a voucher form and a follow-up confirmation report.

Voucher Form Responses

The voucher form is used for two reasons: to verify that the employee is eligible to use this service and as a coupon to pay for the actual ride. The TMO compiled statistics from those who used the voucher forms and identified whether the rider used a taxi or rental car. Taxis were used if rides were within 20 mi, and rental cars if rides were over 20 mi. It is important to note that the statistics reflect the respondents who answered the question. Some participants did not answer each question and, as a result, are not reflected in the data.

The following information was derived from these vouchers.

Transportation Mode

The statistics below show that most rides were taken by vanpoolers. The reason for this could be that the TMO operated a large fleet of 73 vanpools, carrying over 1,000 riders each day. Another reason for the high use of the GRH service among vanpoolers could be that they are continually reminded of the service and tend to vanpool full time because they pay a monthly rate. Participants who carpool tend to commute shorter distances than vanpoolers, and less often.

The following statistics were compiled in response to the question about mode used to get to work:

	No. of Rides		
Mode	*Rental Car*	*Taxi*	*Total*
Carpool	17	34	51
Vanpool	48	39	87
Bus	8	5	13
Other (bike, walk)	0	0	0
Total	73	78	151

Type of Emergency

Interestingly, although the TMO had assumed that child-related emergencies would occur most often, employee illness and overtime were the most frequent reasons for using the service. Family illness is that involving a spouse or other relative (other than children). However, the TMO will continue to target this service at working parents because of their fear of being unavailable to attend to their children's needs.

Responses to the question about type of emergency are as follows:

	No. of Rides		
Emergency	*Rental Car*	*Taxi*	*Total*
Employee illness	16	27	43
Child need	8	14	22
Family illness	15	3	18
Overtime	18	13	31
Carpool driver ill	2	9	11
Car/van breakdown	2	4	6
Employee terminated	0	1	1
Death in family	3	5	8
	64	76	140

Distance

It is clear that employees living far from the work site tend to rideshare and are most likely to take advantage of the GRH service. The average rental-car use distance is 55 mi: taxi use, 26 mi; and total average, 41 mi. The employee may use 150 mi free in a rental car, and this is considered adequate on the basis of normal demand.

Interestingly, taxis were supposed to be used for those traveling under 20 mi, but it was discovered that most taxi trips were over this limit. The TMO suggests many reasons for this occurrence. First, ridesharers tend to commute longer distances to work, thus needing a rental car for the over-20-mile trip. However, it was discovered that many are unable to rent a car. Some were under the age of 21, which prohibited them from renting a car, some worked later shifts when the rental agency was closed, and others were either physically or mentally unable to drive a car. ETCs have the flexibility to decide which vendor to use for a particular circumstance. They are only required to document their reasons for utilizing another vendor. Although it is true that the long taxi rides were much more expensive than a rental car would have been, the occurrences were infrequent.

Location of Emergency

About 60 of 150 rides, or roughly half, need to stop someplace before going home and the majority rode home in a taxi. The most common destination was a parking lot to pick up their car. Another common destination was the doctor's office. This reinforces TMO's marketing effort to let employees know that, if necessary, they will be taken to another emergency destination before they are taken home.

Responses to the request to identify emergency locations other than home at which riders needed to stop are as follows:

	No. of Rides		
Location	*Rental Car*	*Taxi*	*Total*
Van stop	2	25	27
Doctor's office	3	8	11
Hospital	6	3	9
School	2	2	4
Other	2	7	9
Total	15	45	60

Some similar programs in Los Angeles choose to call their programs "Guaranteed Return Trip," because they believe that home is not the only destination desired. The Warner Center TMO, however, retained "home" in its name because all participants ultimately needed a ride home after attending to their emergencies at other locations.

Follow-Up Confirmation Report Responses

The TMO requires all participants to complete a confirmation report within 30 days after the ride so that the TMO can verify their eligibility and for satisfaction with the service. The report asks for specific information, including the names and phone numbers of their carpoolers, and reconfirms the type of emergency. The report also asks questions about response time; importance of GRH service in decision to carpool, vanpool,

or use transit; and comparison of experience with service and expectations.

At the end of the follow-up confirmation report, the TMO allowed participants to write any positive or negative comments. The majority of the comments were positive. Here is a sampling:

> "Very pleased with service." "This is a good program. Thank you." "Very satisfied with the service." "Took too long (40 minutes)." "Great Service." "Good service." "Pleased with service." "Employees at rental agency were very courteous." "After having used this service in time of need—and no hassles—makes vanpooling a real pleasure and dependable." "Keep up program. It's very good." "I am very satisfied with service."

Response Time

The largest percentage, 38, were picked up within 10 min and 34 percent were picked up within 20 min. This justifies the claim that employees do not have to wait long for their rides. The TMO had believed that 20 min was a reasonable wait. Research into longer wait times revealed that the vendor was confused about the pickup location. This usually occurred at the larger employer complexes with many entrances. The rental-car agency provided a shuttle service to pick up and return employees to their work site, but taxis appeared to respond more quickly than the shuttle.

Answers to the question about response time are as follows:

	No. of Rides		
Response Time (min)	*Rental Car*	*Taxi*	*Total*
0–10	8	30	38
10–20	22	12	34
20–30	14	5	19
30–40	5	1	6
40+	2	2	4

Importance

These data confirm that employees are either staying in their ridesharing and bus-riding arrangements or starting them because the GRH service is available.

Reponses to the question about effect of GRH service on decision to use carpools, vanpools, or transit are as follows:

	No. of Rides		
Response	*Rental*	*Taxi*	*Total*
Very important	59	71	130
Somewhat important	7	8	15
Not important	0	0	0
	66	79	145

Comparison of Experience with Expectations

The following data were collected in response to the question "How has your experience with this service compared with expectations?"

	No.of Rides		
Response	*Rental Cars*	*Taxi*	*Total*
Exceeded	17	20	37
Satisfied	24	28	52
Fallen short	3	1	4
	44	49	93

These data reveal that the majority using this service believed it to be equal to or better than their expectations. The TMO assumed that participants' expectations were favorable to begin with. High-quality, colorful brochures and posters were distributed to assure employees that GRH is a dependable, professional service.

USAGE

The statistics in Table 1 give a detailed picture of the use and costs of the GRH service. The average number of rides monthly is 21. A grand total of 245 GRH rides was provided. Only 10 participants used the service more than once. The TMO estimates that a grand total of 7,500 Warner Center commuters currently do not regularly drive alone and are therefore eligible for this service. As a result, only 3 percent of those eligible actually used this service.

COSTS

The TMO paid a total of $13,606 for GRH rides. This breaks down to be an average of $53 per ride. Taxi costs are slightly less than rental-car costs. Although it can be said that each ride is costly, the service is needed very infrequently. Therefore, the TMO improved its public relations with little actual cost.

LIMITED ABUSE

Abuse of this service, (i.e., not following GRH policies) was extremely low, 3 percent. The TMO believes that this is because most employees would not leave work just because they knew that a free ride was available. In addition, the TMO designed a good monitoring system to limit abuse. The employee must gain prior approval from an authorized company representative and acquire a voucher form before using the service.

TMO employer members are each responsible for administering the GRH service correctly. All members must sign an agreement stating that the employer will reimburse the TMO for any abuse by their employees. The employer may then decide whether or not to have the employee reimburse them. The TMO investigated the few cases of participant abuse. All employers with abuse cases reimbursed the TMO, and it was found that all participants reimbursed their employer when asked.

The abuse was more by employees who used rental cars than those who rode taxis. The opportunity to abuse rental-car use is clear: employees could easily keep the rental car longer than allowed. The rental period is 24 hours. The few participants who rented a car on Friday and didn't return it on Saturday claimed that they had not been told they could not keep the car all weekend, even though this limit policy is clearly stated on the back of the voucher. There were no cases in which ineligible employees who drove alone utilized this service.

The one case of taxi abuse involved a participant who used the GRH service after an on-the-job injury, which is not

TABLE 1 MONTH-TO-MONTH STATISTICS, JUNE 1990 THROUGH MAY 1991

RENTAL CAR USE

	6/90	7/90	8/90	9/90	10/90	11/90	12/90
# RIDES	18	10	12	14	6	12	10
Average cost	$ 62	55	62	53	64	54	52
Total cost	$1,114	549	748	737	385	649	524
Abuse	0	1	1	0	0	1	0

	1/91	2/91	3/91	4/91	5/91	Total/Average
# RIDES	11	7	11	7	10	128 / 11
Average cost	$ 54	62	55	51	57	$57
Total cost	$ 597	437	605	361	666	$7,372/$614
Abuse	0	1	0	1	0	5 / 4%

TAXI USE

	6/90	7/90	8/90	9/90	10/90	11/90	12/90
# RIDES	6	6	*	10	8	13	5
Average cost	$ 42	68	*	87	49	60	43
Total cost	$ 254	410	*	869	390	784	215
Abuse	0	0	*	0	0	1	0

	1/91	2/91	3/91	4/91	5/91	Total/Average
# RIDES	13	11	16	11	18	117 / 10
Average cost	$ 55	54	48	39	45	$49
Total cost	$ 717	596	765	429	805	$6,234/$520
Abuse	0	0	0	0	0	1 / .9%

* Numbers from 8/90 are included in 9/90 figures.

	RENTAL CAR USE Total	RENTAL CAR USE / Average	TAXI USE Total	TAXI USE / Average	TOTAL USE TOTAL	TOTAL USE /AVE
# RIDES	128	11	117	10	245	21 Per Month
Average cost		$57		$49		$53
Total cost	$7,372	$614	$6,234	$520	$13,606	$567
Abuse	5	4%	1	.9%	6	3%

allowed. Each employer is responsible for transporting an employee either home or to acquire medical attention if an on-the-job accident occurs. An ETC had incorrectly approved this case.

SUMMARY

The Warner Center TMO believes that the statistics compiled provide substantial evidence that participants were very pleased with the GRH service, and this program has continued to be successful in sustaining and recruiting ridesharers and transit riders. The TMO intends to continue offering this service to its members, with an emphasis on conducting extensive marketing strategies to ensure that a majority of Warner Center employees are well informed of its availability.

Publication of this paper sponsored by Committee on Ridesharing.

Effectiveness of a Statewide Ridesharing Promotion: California Rideshare Week

MARIA THAYER

California's annual statewide ridesharing promotion reaches more people and attracts more participants each year because increasing resources are committed by the state department of transportation and local agencies. Private-sector contributions of money, products, and services are leveraged by public funding. The promotion is coordinated by a statewide coordinating committee, and local ridesharing agencies are responsible for adapting the promotion to their own region. Commuter participants in the promotion pledge to use a commute alternative for one day. Surveys of participants indicate that there has been some long-term change in commute mode, particularly occasional carpool use. At one agency, commuters who requested ridematching assistance through pledge cards were more likely to be placed in carpools, but less likely to be placed in vanpools, than commuters who requested assistance through other means. Commute characteristics and motivation of pledge card applicants suggest that the promotion attracts applicants who may not otherwise utilize ridematching services. The promotion has had a significant effect on local ridesharing agencies, and has generated a sudden increase in demand that could lower the quality of service provided.

The passenger capacity of vehicles carrying people to work in much of the United States is underutilized: average ridership in private cars is barely more than one person, and in most places public transit has room to spare. Using transportation resources more efficiently by increasing the use of commute alternatives depends less on public capital investment than on successful efforts to change commuter behavior. However, the effectiveness of spending money and resources on marketing ridesharing is often difficult to measure.

Since 1986, ridesharing agencies throughout California have participated in an annual statewide promotion that seeks to raise commuter awareness of the economic and environmental importance of ridesharing. Held in September or October, California Rideshare Week (CRSW) features extensive media and corporate involvement. The California State Department of Transportation (Caltrans) is the official sponsor of the campaign, printing marketing materials and contributing funds for advertising and promotional items. Response to CRSW has grown each year, as have the resources that Caltrans and California's 17 ridesharing agencies have committed to it.

The statewide coordination of CRSW is carried out by a steering committee composed of one representative from each of the five major urban ridesharing agencies and two representatives from nonurban agencies, who represent and report back to other nonurban agencies. In addition, there are one or two committee members from Caltrans headquarters who have a total of one vote. The committee chair rotates each year among agencies. The first of the committee's 8 to 10 planning meetings is held in December the year before the promotion. Meeting locations alternate between northern and southern California.

The steering committee's main tasks concern the theme and focus of CRSW. The design and content of marketing materials are subject to the approval of the committee, which tries to reach a consensus. The larger agencies share the task of preparing the graphics, and the materials are printed by Caltrans. The committee helps determine how Caltrans' budget for CRSW promotional items will be spent and how the items will be distributed among the agencies. Committee members have the responsibility for soliciting statewide prizes to be awarded to participants in CRSW and other statewide sponsorships, and the committee also determines solicitation guidelines for local prizes.

According to the meeting minutes of March 11, 1986, for the Committee for Regional Ridesharing Coordination's subcommittee for the Statewide promotion, the stated objective of the first statewide CRSW was to "get people talking about transportation for one week." This emphasis on public awareness has continued, Caltrans' contribution of funds for advertising is used to leverage free coverage in the form of public service announcements (PSAs), interviews, and newspaper coverage. Corporate sponsors and cosponsors are recruited to supplement the funding provided by Caltrans and other regional agencies with money, products, or services.

For the past 3 years, the main corporate participant has contributed money specifically for media events to generate coverage of the promotion. In addition, the Governor's Transportation Awards ceremony is held during this week. Recipients are honored for their achievements and contributions to ridesharing or transportation demand management. Local government endorsements for the promotion are pursued using the Governor's proclamation of CRSW as a model.

As a result of these strategies, media awareness of CRSW has increased with each of the five annual campaigns. In 1986 it was estimated that Caltrans' $30,000 budget for CRSW generated $60,000 worth of pro bono work and contributions in addition to free publicity. The 1989 campaign generated a million dollars' worth of free publicity (TV, radio, and print) and reached an estimated 8 million people. In 1990 Caltrans' $1 million budget for the production and placement of television, radio, and newspaper advertising for CRSW leveraged $3 million worth of broadcast and print media coverage; $1 million in print publicity in newspapers with a combined circulation of 37 million.

The CRSW promotion also targets employers, especially in regions where the local agency has an employer-centered

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program. Marketing materials designed and printed for CRSW include campaign planning guides for employers. Publicity items purchased through Caltrans' budget for CRSW are often provided to employers for distribution to commuters. The statewide nature of the campaign is utilized to attract the participation of statewide employers headquartered in California. These employers are invited to join a statewide partnership.

In some areas, heightened public awareness generated by CRSW centers on a specific day on which commuters are asked to try an alternative to driving alone to work. This "don't drive alone day" performs the important function of translating awareness into action. Like the "Great American Smoke-Out," it provides an incentive and encouragement to change habitual behavior for one day. There is some evidence that changing behavior for one day or short periods of time can result in long-term change (*1*). This special day also offers the potential for measurable or perceptible results, or both, in terms of decreased traffic congestion and increased transit ridership. In 1990 increases in highway speeds of up to 8 mph were reported in southern California, whereas ridership on the Bay Area Rapid Transit (BART) increased 20 percent. Other San Francisco area transit carriers also reported heavier loads. However, traffic accidents clogged freeways in the San Francisco region, and some newspapers in southern California reported no change on the highways, so campaign results may not have been apparent to drivers in those regions.

CRSW PLEDGE CARDS

In 1989 and 1990, cards that commuters could use to pledge to use a transportation alternative during CRSW were distributed in all regions of California. Pledge cards were entered in a drawing for donated prizes, an incentive for this more formal commitment from commuters. Returned pledge cards provide the opportunity to study some aspects of the CRSW promotion and to assess how it affects the commuters of California.

Figures 1 and 2 show the increase in the number of pledge cards distributed by and returned to California's major urban ridesharing agencies in the 1989 and 1990 CRSW promotions. In 1990, in addition to printed pledge cards, advertisements with clip-out pledge cards were run in newspapers in all areas except San Francisco, and resulted in the distribution of 157 percent more cards statewide. Returned cards increased by 76 percent. Although Commuter Transportation Services in Los Angeles experienced the greatest numerical increase, the greatest percentage increase was in San Diego.

In the major urban areas (top five rows, shown in boldface, in Table 1), return rates ranged between 1 percent of cards distributed in Orange County and 2.5 percent of cards distributed in San Diego. The three locations with the highest return rates, Santa Barbara, San Luis Obispo, and the North Coast, were characterized by comparatively low numbers of pledge cards distributed, no clip-out newspaper ads, and no employer- or school-focused promotions.

Analysis of returned cards in Los Angeles, San Francisco, and Bakersfield indicated that although the majority of the commuters who pledge to use commute alternatives usually drive alone to work, the campaign seems to reach an audience that is more favorably inclined to ridesharing than the general public. Use of carpools and vanpools, transit, and other commute alternatives is higher among pledge card respondents than that shown by the 1980 census in San Francisco and Bakersfield and by a 1989 survey of commuters in Los Angeles (*2*).

The findings of a postpromotion mail survey administered to a sample of pledge card respondents in Los Angeles indicate that returned pledge cards cannot be used for an accurate count of cars removed from the road by use of alternative commute modes (*3*). Although the wording of the pledge card seems to indicate a firm commitment on the part of those commuters who take the time to return them, the survey found that only 60 percent of drive-alone commuters actually tried a different means of transportation during Rideshare Week. Most respondents who were already using a transportation alternative when they sent in the pledge card used their usual means during Rideshare Week. The Los Angeles survey, however, showed that CRSW's effect on the awareness and behavior of drive-alone commuters persists beyond the promotion. Occasional carpool usage among respondents increased after CRSW, mostly among those who usually drive alone. In addition, more than 40 percent of the drive-alone commuters reported that their awareness of ridesharing benefits had increased as a result of Rideshare Week.

Pledge cards are also used to introduce commuters to the services provided by the local ridesharing agency. On one panel of the card there is a section for requesting information or ridematching services. A significant percentage of returned

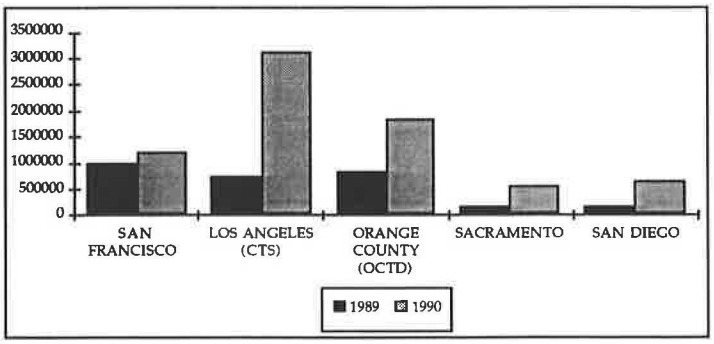

FIGURE 1 Number of pledge cards distributed in major urban areas.

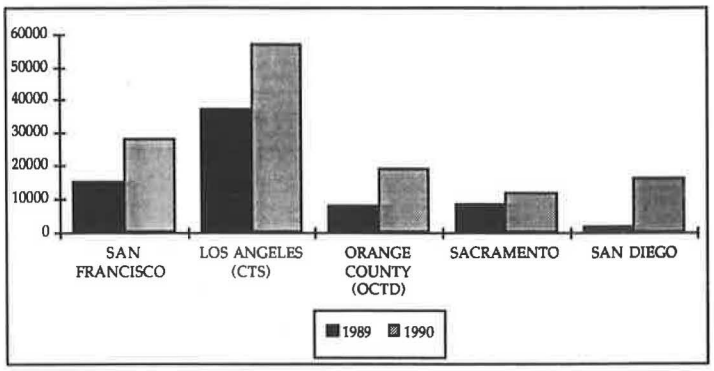

FIGURE 2 Number of pledge cards returned in major urban areas.

pledge cards request further information from the agency which tends to concentrate the bulk of the agency's work into the month of CRSW. In San Luis Obispo, the 582 requests for matchlists received from CRSW in 1990 represented 78 percent of the agency's fiscal year goal for applications processed. In San Francisco, the number of requests for ridematching services from new clients was 71 percent greater than the October average of the previous 5 years.

CASE STUDY: CRSW IN THE BAY AREA

At RIDES for Bay Area Commuters, San Francisco Bay Area's regional ridesharing agency, CRSW has become the major promotional event of the year. The in-house CRSW committee is formed and convened in January, and follow-up meetings take place in November and December after the promotion. Each department has at least one member on the committee, and some departments have several. As a major urban agency, RIDES is also very involved in CRSW at the state level. In 1990 RIDES was responsible for the design of the pledge card and employer guide as well as for the solicitation of some statewide and local prizes.

Like California's other ridesharing agencies, RIDES is responsible for adapting the CRSW promotion to its region and developing strategies that are compatible with its regular program. Determining how the CRSW resources allocated to RIDES will be used, and the developement of the year's "media event" funded by the main corporate sponsor are local decisions. To distribute pledge cards, RIDES uses a mixture of employer involvement and direct distribution. County task forces are established to facilitate pledge card distribution and to plan additional promotional activities for CRSW. In 1990 the seven task forces together included about 130 representatives from business, public agencies, community organizations, and media. Using staff and community volunteers, RIDES also arranges for pledge cards to be handed out to commuters on all the Bay Area's bridges. In 1990, RIDES sent 15,000 pledge cards to former clients of its ridematching service. By using a network of employer and media participants, RIDES has been able to amplify the effect of its own commitment of resources to CRSW.

TABLE 1 PLEDGE CARD RETURN RATE, 1990

Cards Distributed and Percentage Returned by Location		
Area	Cards	Return Rate
San Francisco	**1,200,000**	**2.3%**
Los Angeles (CTS)*	**3,100,000**	**1.8%**
Orange County (OCTD)*	**1,825,000**	**1.0%**
Sacramento*	**555,000**	**2.2%**
San Diego*	**630,000**	**2.5%**
Fresno*	364,000	0.9%
Kern*	104,000	1.5%
San Joaquin/Stanislaus*	336,000	0.6%
Monterey	8,000	5.0%
Santa Cruz*	104,000	1.3%
Santa Barbara	9,000	11.1%
North Coast	1,000	10.0%
San Luis Obispo	19,000	10.6%
Merced	85,000	1.2%
Solano	60,000	1.3%
Redding*	4,000	0.5%

* denotes locations where newspaper clip-out ads supplemented printed pledge cards.

Table 2 presents an overview of some of the aspects of RIDES' involvement in CRSW (information for 1984 and 1985 is included as a baseline). The corporate funding for a media event was used in 1988 to organize caravans of vanpools during the morning commute, in 1989 to host the Governor's Transportation Awards banquet in San Francisco, and in 1990 for the construction of a canvas covering that converted a demonstration van to a dinosaur (dubbed "Drive-Alone-A-Saurus"). This van was driven on freeways during the commute hours and appeared at a children's fair to celebrate CRSW. The Bay Area's 1989 campaign also featured a distribution of pledge cards through a chain of convenience stores. Table 2 shows that the promotion caused an increasing proportion of the year's applications to be received and processed in a brief period. In 1986, 18 percent of the fiscal year's new applications were received in October and November; in 1990, 29 percent of the year's total arrived during the same period.

At RIDES, response (measured by ridesharing applications) to the five statewide CRSW promotions has been greater each year. In 1986, 785 requests for ridematching assistance were attributed to the employer-focused CRSW campaign in the Bay Area that year. In 1990, 4,500 new requests were received as a result of CRSW. Figure 3 shows that sources of returned pledge cards shifted between 1989 and 1990, the years of the pledge card distribution. In 1989, 18 percent of returned cards had been handed out on one of the Bay Area bridges compared with 6 percent in 1990. The mailing to former RIDES clients in 1990 was the source of 8 percent of the returned cards. This is a response rate of 13 percent in contrast to 2.3 percent for cards distributed in other ways.

TABLE 2 OVERVIEW OF RIDES' CRSW CAMPAIGNS 1984–1990

	1984	1985	1986	1987	1988	1989	1990
Scope	Sub-regional	Regional	Statewide	Statewide	Statewide	Statewide	Statewide
# Events	11	14	40	56	8	Not avail.	26
Pledge cards distributed				20,000[a]	25,000[b]	800,000	1.2 million
Pledge cards returned				1,243	2,108	15,000	28,000
Ridematching Applications returned	Not Avail.	Not Avail.	785	2,019 (events)	304 (events) 446 (pledges)	2,668 pledges	4,500 pledges
Total Sept new apps	2,644	2,496	1,921	1,927	3,094	3,039	3,409
Total Oct new apps	2,184	2,635	2,205	2,703	2,781	5,189	5,312
Sept-Oct % of year	20%	20%	18%	20%	20%	29%[c]	29%
Corporate Participation						99 employers & sponsors	156 corporate participants
Media: PR Activities				200 packets mailed	Caravans "Pool-party" news releases to all media 10,000 newsletters 700 emp. pack	Corporate/retail promo. Banquet PSAs to all radio stas. news rels,FYI all media	"Drive-Alone-A-Saurus" Kids Fair CRSW press packets
Reporting		yes	14 radio stas. 3 TV stas. 11 newspapers	yes	7 radio stas. 20 newspapers 50 radio stas. involved-(PSAs)	30 newspapers, TV and radio coverage	BTBU: 15 newspapers 2 TV stations many radio CRSW: radio & TV coverage, 9 newspapers
Paid spots				7 radio stas.	37 spots/3 sta	radio & T.V.	radio & T.V.
Sponsorship					KGO Radio	X-100 radio	KPIX TV KCBS radio SF Examiner
RIDES' CRSW budget					$16,361[d]	$17,000[e]	$28,000[f]
RIDES' total Caltrans funding	$1,298,500	$1,446,400	$1,406,400	$1,410,210	$1,430,210	$2,481,000	$3,079,000

[a] Pledge cards were distributed only in one county (Marin) in RIDES' service area.
[b] Pledge cards were again distributed only in Marin county.
[c] the Loma Prieta earthquake was a major source of new applications in October 1989.
[d] Does not include any staff time.
[e] Does not include any staff time.
[f] Includes staff overtime but not regular time.

RIDES' CRSW APPLICANTS

In the course of a client survey administered in October and November 1990, applicants for ridematching services who had contacted RIDES in response to CRSW that year were compared with typical RIDES applicants to determine the efficacy of the CRSW campaign on RIDES' services. A random sample of 10 percent of the CRSW applicants already in RIDES' data base was drawn, and 281 surveys were conducted by telephone. Comparisons were made with the responses of 430 applicants who had contacted RIDES for reasons other than the promotion. Responses are valid at the 95 percent level for confidence intervals of plus or minus 5 percent for the non-CRSW applicants and plus or minus 6 percent for the CRSW applicants.

It is important to note that the sample of CRSW respondents included only those who used the pledge card to request ridematching services—about 18 percent of those who returned pledge cards to RIDES. Their characteristics should not be extended to all commuters who pledge to participate in CRSW, because the two groups may differ significantly in motivation and interest.

It is interesting to note that although Table 3 shows that commuters who respond to CRSW are more likely to use transportation alternatives than the general population, the drive-alone percentage and round-trip mileage of RIDES'

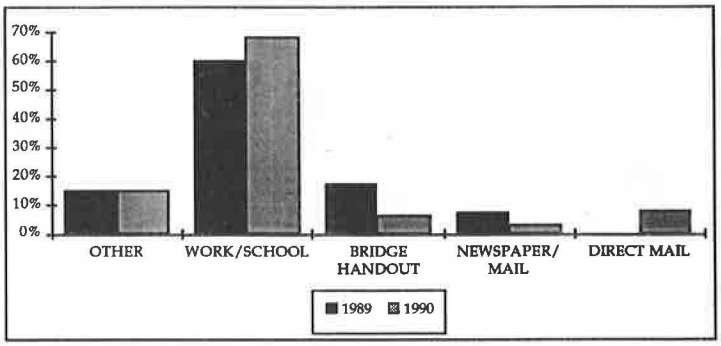

FIGURE 3 Source of returned pledge cards.

TABLE 3 PLEDGE RESPONDENTS AND POPULATION: USUAL COMMUTE MODE

	Location and Group by Modal Choice (%)			
	Drive Alone	Car/Vanpool	Transit	Other
Los Angeles				
Pledge cards*	57%	38%	11%	19%
1989 survey	79%	14%	4%	3%
San Francisco				
Pledge cards	58%	19%	17%	6%
1980 census	63%	16%	11%	10%
Bakersfield				
Pledge cards	66%	11%	5%	17%
1980 census	72%	19%	1%	8%

* multiple responses permitted

CRSW applicants are more similar to those of the average Bay Area commuter than those of RIDES' non-CRSW applicants (Figure 4). This indicates that CRSW is effective in attracting applicants who may not otherwise use ridematching services.

CRSW applicants also differ from RIDES' other applicants in their motivation to join a carpool or vanpool, as shown by Figure 5. A fourth (25 percent) of the CRSW applicants reported that conservation was a factor in signing up with RIDES. This is almost twice the percentage for non-CRSW applicants. CRSW applicants were also much more likely to mention traffic congestion, demonstrating the effectiveness of the "Beat the Backup" slogan of the Bay Area's campaign which was developed by KPIX-TV.

The differences between CRSW applicants and others who requested matchlists from RIDES suggest that the CRSW group was "educated" into signing up, whereas the non-CRSW applicants were led to RIDES as a solution to a problem they were experiencing. Ridesharing both as a conservation measure and to reduce traffic congestion contributes to the public good. An individual doesn't receive much for his or her effort unless many other people make the same effort. The CRSW campaign convinced applicants to try ridesharing because it would improve conditions in the Bay Area.

The third major motivating factor for CRSW applicants was the cost of driving and of gasoline. In this, they were joined by the rest of RIDES applicants, who mentioned cost almost twice as often as any other reason. However, CRSW applicants were much less likely to be motivated by the distance of their commute, the wear and tear on their car, a dislike of driving, and inadequate unavailable transit.

The CRSW campaign also attracted applications from those who wanted information about RIDES rather than a matchlist. About 10 percent of the promotion applicants reported that they signed up because they were curious and were not interested in ridesharing—three times the rate of typical applicants. Although the matchlist and associated materials effectively inform these applicants of RIDES' services, "just curious" applicants are a threat to the quality of service provided to other applicants; they are more likely to decline an invitation to join a carpool or vanpool when another applicant contacts them.

One of the most meaningful indications of the value of CRSW is that 20.5 percent of promotion applicants report that RIDES' service helped them form, join, or expand a carpool—a greater percentage than for RIDES' non-CRSW applicants (Figure 6). It appears that the CRSW promotion in 1990 convinced commuters of the value of ridesharing. The pledge card presented them with the opportunity to receive a matchlist, and through the matching service they found carpools. The "placement rate" (percentage of applicants who are able to form, join, or expand carpools or vanpools) of a ridesharing agency is one of the most frequently used measurements of program success. The carpool placement rate of CRSW applicants suggests that RIDES' services and promotion activities are complementary.

CRSW applicants have a much lower vanpool placement rate than RIDES' other applicants, 3 percent as compared with 12.3 percent. Differences in commute characteristics, such as the lower commute mileage of promotion applicants, probably contributes to this disparity. In 1990 the average round-trip commute distance of vanpoolers registered with RIDES was 72 mi, compared with 47 mi for RIDES' clients overall (*4*). In addition, the availability of vanpool seats does not increase to accommodate large influxes of new applicants; therefore, the applicants received during any major promotion or transportation energency are likely to have a low vanpool placement rate.

In addition to commute mileage, several indicators of successful carpool and vanpool placement have emerged from studies of RIDES' applicants (*4*). The small percentage of applicants who reported that they never received their matchlist are less likely to find a carpool or vanpool than those who

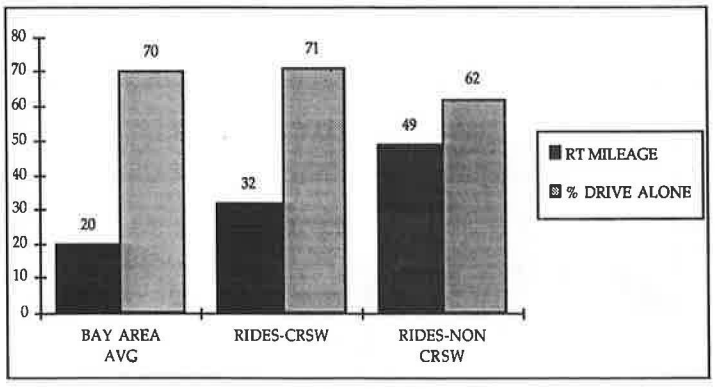

FIGURE 4 Round-trip mileage and prior drive-alone percentage (data for Bay Area average columns are from 1980 census).

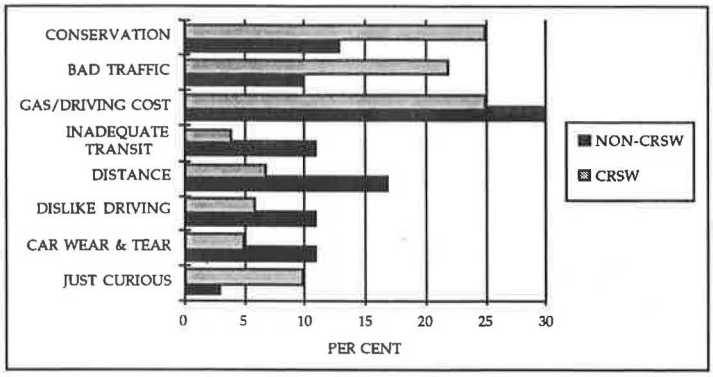

FIGURE 5 Motivation for matchlist request.

received a matchlist. Similarly, those who received the list but never used it to call other commuters have a lower rate of placement. It is also known that the chances that an applicant will be placed increase the longer the applicant remains in the data base, and that after an applicant has received a matchlist, subsequent contact with RIDES positively affects placement. The finding that commuters who request a matchlist from RIDES as a result of CRSW are more likely to be placed in a carpool than non-CRSW applicants is especially notable because the CRSW group's placement indicators were lower.

To control for the effect of the relatively short time CRSW applicants had been in the data base at the time the survey sample was drawn in October, CRSW applicants are compared with non-CRSW applicants who were entered during the CRSW campaign as well as all non-CRSW applicants in the RIDES data base. As Figure 7 shows, CRSW applicants were far less likely to have received the matchlist—one in five claimed not to have received one after applying—and less likely to have made calls from the list or to have had contact with RIDES after receiving a matchlist (even when compared with non-CRSW fall applicants) but more likely to have joined a carpool.

To underscore the divergent nature of the CRSW carpool placements, Table 4 shows that over a third (37 percent) of the CRSW applicants placed in carpools did not call anyone on their list compared with 12 percent of the non-CRSW carpool placements overall. All of the non-CRSW carpool placements who signed up during the promotion period used their matchlists. It is possible that the initiative of the non-CRSW applicants "carried" the CRSW applicants to their high placement rate or that the CRSW applicants entered the data base in such high numbers and in commute patterns that were concentrated enough that carpool formation took fewer phone calls. CRSW carpool placement was also assisted by the high percentage of applicants from the Bay Area's largest employers. Almost half (49.4 percent) worked at companies with more than 500 employees, thus increasing the possibility of common commute destinations.

Though a comparatively high percentage of CRSW applicants were placed in carpools after requesting a matchlist from RIDES, the finding that 20 percent of these applicants did not receive a matchlist is a disturbing indication that the quality of service received by applicants during a major promotion may be seriously compromised by the very success of the promotion. The source of this problem proved difficult to determine. Data entry error resulting from temporary staff hired during the campaign was ruled out, along with other traceable causes. Regardless of the cause, the problem highlights the need to ensure that the organization has the staff and computer capacity to handle the influx of applications attracted by a large, successful campaign. Promotion applicants present an agency with valuable exposure and word-of-mouth advertising opportunities; to maximize the benefits of a promotion, organizational resources and procedures should exist to cope with its results.

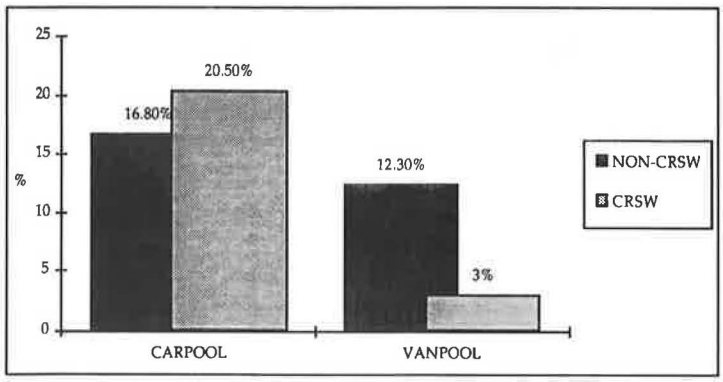

FIGURE 6 Carpool and vanpool placement.

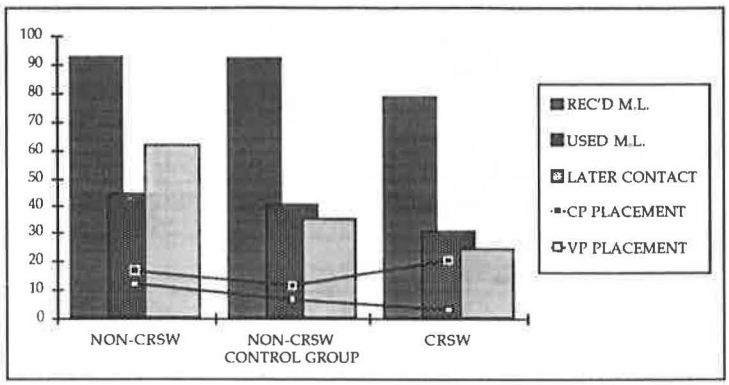

FIGURE 7 Matchlist response and placement.

One aspect of the CRSW campaign's emphasis on trying ridesharing for just one day is the possibility that commute changes will not be as long lasting as will the placement of typical RIDES applicants. However, at the time of the survey 80 percent of the CRSW carpool placements were still carpooling, in contrast to 64 percent of the non-CRSW applicants whom RIDES placed in carpools during the campaign. Why CRSW placements exhibit a longer duration is not apparent. It may be that some combination of their commute characteristics or motivation contributes to stronger carpool groups. A comparison of changes in commute mode of CRSW applicants with changes reported by applicants who have requested ridematching services in response to a transportation emergency indicates that the promotion may have a more long-lasting effect. Table 5 shows the before-and-after commute modes of CRSW ridematching applicants and of applicants who requested service in response to two notable Bay Area transportation emergencies, the Loma Prieta earthquake in October 1989 and a strike by bus drivers at a subregional transportation agency in January 1988.

CONCLUSION

Public resources committed to CRSW result in a campaign that raises public awareness of commute alternatives and convinces tens of thousands of commuters to change their habitual behavior for one day. Long-term shifting of commute mode away from single-occupant vehicles is slight but evident among promotion participants who try an alternative method of commuting. Among participants who request ridematching assistance, survey findings suggest a long-term shift of 10 percent away from usage of single-occupant vehicles. There are indications that commuters who are introduced to the services of the local ridesharing agency through CRSW would not otherwise have requested such service. The successful placement of CRSW ridematching applicants is evidence of the complementary nature of the promotion and program services. Despite commute characteristics and behavior that would indicate the opposite, CRSW ridematching applicants are more likely to be placed in carpools than typical applicants. However, few CRSW applicants are placed in vanpools, because the availability of vanpool seats does not increase to accommodate sudden high demand.

The promotion's effect on local ridesharing agencies is significant. The large number of promotion-related applicants received can result in a decline in the quality of service the agency provides by lowering average the staff time and resources available. Because of incentives to rideshare, such as higher bridge tolls and the development of more HOV facilities, there is reason to believe that the response to CRSW will become even greater in the coming years as traffic congestion increases. In addition, all urban regions of California are implementing or are in the process of formulating air quality plans. These plans have focused attention and discussion on transportation alternatives. The momentum created by the earlier successes of CRSW combined with present circum-

TABLE 4 CARPOOL PLACEMENTS' USE OF THE MATCHLIST

	Source and Time of Application of Clients Placed in Carpools by Extent of Matchlist Use		
	All Non-CRSW Carpoolers	Non-CRSW Carpoolers From Promotion Period	CRSW Carpoolers
Called one person	76.3%	90.9%	52.6%
Called several people	11.9%	9.1%	10.5%
Didn't call anyone	11.9%	0	36.8%
Total	100.1%	100.0%	99.9%

TABLE 5 COMMUTE MODE CHANGES: TRANSIT EMERGENCY AND CRSW APPLICANTS

	Commute Mode (%) of Applicant Groups Before and After Receiving Ridematching Services				
	Drive Alone	Carpool	Vanpool	Transit	Other
CRSW apps					
Before	69.7%	15.3%	0.8%	11.1%	3.1%
After	52.1%	23.8%	3.1%	18.4%	2.6%
Earthquake[a]					
Before	72.3%	12.0%	4.2%	8.7%	2.7%
After	58.5%	18.3%	5.5%	13.8%	3.9%
Strike[b]					
Before	36.4%	3.8%	1.4%	57.4%	1.0%
After	35.4%	5.3%	1.9%	53.8%	1.0%

[a] D. Burch, RIDES' 1990 Database Survey, RIDES for Bay Area Commuters, Inc., 1990
[b] S. Beroldo, *Effects of Golden Gate Transit Strike on Highway 101 Corridor*, Transportation Quarterly, Eno Foundation for Transportation, April 1989.

stances in California indicate that the continuation of this promotion will result in the use of commute alternatives among increasing numbers of Californians with the associated economic and environmental benefits.

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Publication of this paper sponsored by Committee on Ridesharing.