TCRP SYNTHESIS 110

TRANSIT COOPERATIVE RESEARCH PROGRAM

Commonsense Approaches for Improving Transit Bus Speeds

Sponsored by the Federal Transit Administration

A Synthesis of Transit Practice

TRANSPORTATION RESEARCH BOARD
OF THE NATIONAL ACADEMIES

TRANSIT COOPERATIVE RESEARCH PROGRAM

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Commonsense Approaches for Improving Transit Bus Speeds

A Synthesis of Transit Practice

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SUBSCRIBER CATEGORIES
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TRANSPORTATION RESEARCH BOARD

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TRANSIT COOPERATIVE RESEARCH PROGRAM

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

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

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

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

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

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

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

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Cover figure: Off-set bus-only lane on First Avenue in Manhattan. *Photo credit*: New York City Department of Transportation.

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FOREWORD

Transit administrators, engineers, and researchers often face problems for which information already exists, either in documented form or as undocumented experience and practice. This information may be fragmented, scattered, and unevaluated. As a consequence, full knowledge of what has been learned about a problem may not be brought to bear on its solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem.

There is information on nearly every subject of concern to the transit industry. Much of it derives from research or from the work of practitioners faced with problems in their day-to-day work. To provide a systematic means for assembling and evaluating such useful information and to make it available to the entire transit community, the Transit Cooperative Research Program Oversight and Project Selection (TOPS) Committee authorized the Transportation Research Board to undertake a continuing study. This study, TCRP Project J-7, "Synthesis of Information Related to Transit Problems," searches out and synthesizes useful knowledge from all available sources and prepares concise, documented reports on specific topics. Reports from this endeavor constitute a TCRP report series, *Synthesis of Transit Practice*.

This synthesis series reports on current knowledge and practice, in a compact format, without the detailed directions usually found in handbooks or design manuals. Each report in the series provides a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems.

PREFACE

By Donna L. Vlasak
Senior Program Officer
Transportation Research Board

This report documents the common and perhaps not so commonsense approaches transit agencies have taken to realize gains in average bus speeds. A literature review, survey responses from 31 of 36 agencies (a response rate of 86%), and six case examples offer information with an emphasis on actions that transit agencies can take to improve service speeds, reliability, and attractiveness.

The synthesis identifies metrics pertaining to measures such as changes in travel speed and its components, operating cost, and ridership. It shows the results of each or a combination of approaches implemented. The results from this synthesis can benefit every transit agency that operates bus service.

Daniel K. Boyle, Dan Boyle & Associates, Inc., San Diego, California, collected and synthesized the information and wrote the report, under the guidance of a panel of experts in the subject area. The members of the topic panel are acknowledged on the preceding page. This synthesis is an immediately useful document that records the practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As progress in research and practice continues, new knowledge will be added to that now at hand.

CONTENTS

Note: Many of the photographs, figures, and tables in this report have been converted from color to grayscale for printing. The electronic version of the report (posted on the Web at www.trb.org) retains the color versions.

COMMONSENSE APPROACHES FOR IMPROVING TRANSIT BUS SPEEDS

SUMMARY

"Public transportation is too slow" is one of the common reasons given for not using transit. This is the case especially for buses, which typically travel in mixed traffic. Sources of delay include:

- Travel time in traffic, affected by congestion levels;
- Time stopped at traffic signals;
- Entry to and exit from bus stops;
- Dwell time at bus stops; and
- Inefficient routing, requiring many turn movements.

Transit agencies have implemented programs to speed buses through streamlined routes, increased stop spacing, all-door boarding and alighting, improved or judicious stop placement, fare payment policies, dedicated bus lanes, signal priority for buses, yield-to-bus laws, and traffic engineering methods to improve general traffic flow. The purpose of this synthesis is to document the commonsense (and perhaps not-so-common sense) approaches that transit agencies in North America have taken to realize gains in average bus speeds. The emphasis is on actions that transit agencies can take to improve service speeds, reliability, and attractiveness.

The survey of transit agencies was important in defining the current state of the practice of actions to improve bus speeds. Of a core sample of 36 transit agencies 31 surveys were returned, a response rate of 86%. An additional 28 agencies responded to an e-mail to APTA members about the synthesis, resulting in a total of 59 agencies in the final sample. Survey results include trends in local bus speeds; types of actions taken to improve bus speeds; assessments of the success of the actions, benefits, and drawbacks; desired changes; and lessons learned.

Major findings of the synthesis include:

Improving bus speeds is possible. The survey results and case examples reinforce that there are many valid ways to tinker with speeds and achieve some improvement. Success stories emphasize strong positive relationships with municipal agencies and stakeholders (elected officials, unions, and customers) and an internal agency commitment to the program, especially on the part of upper management.

Mitigating decreases in bus speeds resulting from other factors is important. The literature review and survey responses note external factors that contribute to declining bus speeds over time. Success for many agencies lies in the ability to mitigate decreases in bus speeds resulting from increased congestion or increased ridership.

Working with city traffic engineers to find ways to expedite the flow of transit vehicles is effective. External policy actions included signal priority, queue jump lanes, changes to signal timing, bus-only lanes on arterial streets, and yield-to-bus laws. The San Francisco case example found that signal priority had the biggest impact of any action. The New York City case example reported that off-board fare collection and increased stop spacing (combined

with transit signal priority, bus-only lanes, and all-door boarding) appeared to have the biggest impact on bus speeds.

Stop consolidation programs are effective if customer resistance can be overcome. Changes to stop spacing engender greater resistance than do other actions. Survey respondents lamented the inability to overcome opposition to stop spacing schemes, but case examples in Columbus, Ohio, and Spokane, Washington, show that stop consolidation programs can be implemented successfully. Open engagement with stakeholders, particularly those skeptical of the idea, support from upper management, and cooperation of municipal staff are characteristics associated with successful programs. Persistence is also useful because bus speed is rarely at the top of the list of agency priorities.

Other actions can also improve bus speeds. Stop consolidation and traffic engineering strategies received the greatest attention among survey respondents, but changes in fare policy, vehicles, and schedules have been successful and can be implemented independently by the transit agency. Experimentation with headway-based schedules, a strategy for frequent service in which buses are spaced a set number of minutes apart rather than arriving at time points at specific times, revealed segments where running times can be reduced. Locating stops at the far side of signalized intersections and the near side of intersections with stop signs is another example of a commonsense approach that works.

- Successful agencies emphasized good ideas above technology. Transit signal priority and other traffic engineering actions topped the “wish list” of responding agencies, but most successful actions could be implemented without new or added technology. A notable finding is that several agencies proceeded to implementation despite lacking the technology that would yield data for detailed analysis of results. These agencies did measure and report overall impacts, a critical step in establishing the success of the actions taken.
- Obstacles can be overcome with the support of upper management inside and outside the agency. The list of constraints can appear daunting: funding; lack of cooperation from outside agencies; competing goals and priorities; safety concerns; and opposition from customers, property owners, and businesses. With the support of upper management, successful actions can be implemented. The most salient factors appear to be defensible programs based on data; open, transparent, and consistent communication regarding benefits; flexibility in the face of legitimate and serious issues; and commitment to ongoing analysis and communication.

The six case examples provide additional details on innovative and successful practices, guidance in the form of lessons learned, and insights into overcoming obstacles to implementation. The following themes emerged from the case examples:

- Establish policy standards (e.g., for stop spacing) that are reasonable and defensible. Then work hard to adhere to the policy.
- Begin with the end in mind. The goal is faster, smoother, and safer operation that will improve the customer experience and enhance the image of transit in your city. The perception that increases in bus travel times are inevitable is not true.
- Ensure the support of upper management at the outset and throughout the project. Several successful efforts cited in the case examples began at the direction of the general manager or chief executive officer.
- Involve stakeholders early in the process, particularly those who can be expected to oppose the project. A strong relationship with city hall at all levels, from the general manager on down, is vital to success.
- Communicate early and often and by every means available. Post information at stops. Meet with stakeholders on a regular basis. Keep riders, the general public, and operators involved throughout the project. Update your website regularly. Promote actions taken and their effects inside and outside the transit agency.

- Be transparent in your analysis. Demonstrating positive impacts on bus speeds is very important for interagency and intraagency relationships. Display current data through global information system-generated maps to show results of the analysis of specific changes.
- Be reasonable for your community, and know what they will tolerate.
- Be flexible, but only when it makes sense to do so. You cannot design an entire transit system around the concerns of any single group.

Findings from this synthesis suggest seven areas of future study:

- *Analysis of the effectiveness of individual components of actions to improve bus speeds at the stop and route segment level*. Several agencies reported the need for more accurate and timely data to measure the impacts at the micro as well as the macro level. The need to understand what works in certain circumstances and not in others, and the reasons why, is clear. Stop spacing and signal timing optimization appear to be very effective in increasing bus speeds, but additional research is needed to confirm these findings. There will be increasing opportunities for cross-comparisons among agencies, which can also assess the transferability of results, and for more detailed analysis within agencies.
- *Customer response.* There was little quantitative data on customer ratings of the various actions taken. Case examples show that successful stop consolidation programs changed initial opposition into support, but many agencies have not been able to get to that point. How do transit customers rate actions to improve bus speeds, and do their ratings change as they become more familiar with an action as it is implemented? Do opinions really change, or is the observation that "Some people resent you for a long time" more accurate? Answers to these questions could provide tools for overcoming opposition mentioned by many agencies as a constraining factor.
- *Ways to encourage closer cooperation between transit agencies and traffic engineers.* City traffic signal engineers are not experts in bus transit, and transit analysts are not experts in traffic signal timing. A cooperative agreement between The Institute of Transportation Engineers and FTA to improve the integration of transit priority treatments on urban street networks produced a white paper citing a need for additional research and dissemination of findings in this area.
- *Specific traffic engineering concerns*. One agency reported that local jurisdictions are hesitant to implement extraordinary measures that are not "endorsed" by inclusion in the *Manual on Uniform Traffic Control Devices* (MUTCD). A review of MUTCD with regard to inclusion of actions that can improve bus speeds could be productive. An ongoing TCRP study (A-39, *Improving Transportation Network Efficiency Through Implementation of Transit-Supportive Roadway Strategies*) may address this concern.
- *An updated synthesis study on service standards. TCRP Synthesis Report 10* is the most recent (1995) review of service standards and guidelines in the transit industry. Revisiting this topic with particular attention to stop spacing, recovery times, and on-time performance guidelines and standards would broaden the findings of this study.
- *A synthesis study addressing bus speeds*. This synthesis includes quantitative data on bus speeds gathered from a select group of respondents able to provide hard numbers. However, the definition of average bus speed was not consistent across all cities. Systems with bus rapid transit (BRT) service have provided data on bus speeds before and after implementation, but survey results produced less hard data than anticipated. A study focused on bus speeds would provide a current baseline, expand on trend information reported in chapter one, and explore reasons for differences across and within cities.
- *Effect of bus operators on success.* Several agencies mentioned a disparity in the ability of operators to drive a route. This is a familiar concept in operations, but the effects are unclear. Do schedulers "schedule down" to the least common denominator or simply assume that some operators will be unable to keep to schedule? Are there training modules developed to address this issue, and how successful are they?

CHAPTER ONE

INTRODUCTION

PROJECT BACKGROUND AND OBJECTIVES

Most of the public transit buses operating in the United States and Canada do so in mixed traffic during congested peak travel periods. Many of these buses travel at an average speed of less than 10 mph (equivalent to 16 kph). Transit agencies have implemented programs to speed up buses using a variety of commonsense approaches, such as streamlined routes, increased stop spacing, all-door boarding and alighting, placement of stops at the far side of signalized intersections, and improved traffic flow in travel corridors. Even small increases in average travel speeds can mean reductions in operating costs to transit agencies while improving service to customers. Improved service to customers can translate into increased ridership and potential reductions in automobile use.

The purpose of this synthesis is to document the commonsense (and perhaps not-so-common) sense approaches that transit agencies have taken to realize gains in average bus speeds. The emphasis is on actions that transit agencies can take to improve service speeds, reliability, and attractiveness. The synthesis identifies metrics pertaining to measures such as changes in travel speed and its components, operating cost, and ridership. It shows the results of each or a combination of approaches implemented. The results from this synthesis can benefit every transit agency that operates bus service.

This synthesis focuses on changes in bus speeds as a result of actions taken. A section at the end of this chapter summarizes responses to a follow-up request for data on actual bus speeds, but the summary is based on a limited number of responses. A study that documents existing bus speeds in a variety of environments is one of the items noted for future study. Given its primary focus, this synthesis examines the following factors:

1. Existing trends in local bus speeds
2. Actions taken to improve speeds in the general areas of:
    a. Bus stops
    b. Vehicles
    c. Scheduling
    d. Route design
    e. Internal policies
    f. External policies
    g. Other
3. Metrics used to measure results
4. Results
5. Barriers to success
6. Actions considered but not implemented and the reasons
7. Benefits and drawbacks of actions taken
8. Lessons learned.

Survey results include transit agency assessments of the effectiveness of actions taken, desired changes, and lessons learned.

This report includes a review of the relevant literature in the field. An important element of this synthesis is the chapter documenting case examples, based on interviews with key personnel at selected agencies, to profile innovative and successful practices and explore ongoing issues. Findings from all these efforts are combined to summarize lessons learned, gaps in information and knowledge, and research needs.

TECHNICAL APPROACH

The approach to this synthesis included:

- A literature review. A Transportation Research Information Database (TRID) search using several different keywords was conducted to aid the literature review.
- A survey of transit agencies, described in the following paragraphs.
- Telephone interviews with six agencies selected as case examples.

The survey on actions taken to improve bus speeds was designed to solicit information on the reason for undertaking these actions, types of actions, results, barriers to success, and evaluation. Once finalized by the panel, the survey was posted and pretested. The pretest resulted in minor changes to the survey structure, logic, and flow.

The sampling plan involved a “core” sample of transit agencies, many of which were recommended by panel members and contacted in advance to ascertain interest. The core sample included 36 transit agencies. An e-mail with an attachment from the TCRP program manager explaining the importance of the survey and a link to the online survey site was sent to a known contact at each agency. Follow-up e-mails were sent approximately 3, 4, 6, 7, and 8 weeks after the original contact to encourage response.

To guard against missing agencies that have taken actions to improve bus speeds and ensure a broader sample, a similar

TABLE 1
TRANSIT AGENCIES BY SIZE

No. Vehicles Operated in Maximum Service	No. Agencies Responding	% Agencies Responding
Less than 250	36	61.0
250 to 999	16	27.1
1,000 or more	7	11.9
Total	59	100

Sources: National Transit Database 2011 data; survey results.

e-mail message was sent to APTA transit agency members inviting their participation in the survey.

Thirty-one completed surveys were received from the 36 agencies in the core sample, a response rate of 86%. An additional 28 agencies responded to an invitation to all APTA members to participate in the survey, resulting in a total of 59 agencies in the final sample. The 59 agencies range in size from 10 to more than 3,000 buses operating in peak periods.

Table 1 presents the distribution of responding agencies by size. More than 60% of all responding agencies operate fewer than 250 vehicles in peak service. Most of these smaller agencies had not been included in the core sample.

Table 2 shows the distribution of responding agencies by FTA region. Regions IX (Southwest), V (Great Lakes), and X (Northwest) led in terms of agencies responding. Figure 1 is a map of FTA regions.

Figure 2 presents the distribution of survey respondents across the United States and Canada. Case example locations are shown by a large dot.

ORGANIZATION OF THIS REPORT

Chapter two summarizes the findings of the literature review. Chapter three, the first of two chapters to present the results of the survey, examines trends in local bus speeds, types of actions taken to improve bus speeds, and the effects of these actions.

TABLE 2
TRANSIT AGENCIES BY FTA REGION

FTA Region	No. Agencies Responding	% Agencies Responding
I	1	1.7
II	2	3.4
III	3	5.1
IV	6	10.2
V	11	18.6
VI	7	11.9
VII	0	0.0
VIII	1	1.7
IX	13	22.0
X	10	16.9
Non–U.S. (Canada)	5	8.5
Total	59	100.0%

Sources: FTA; survey results.

FIGURE 1 Map of FTA regions. *Source:* FTA.

Chapter four discusses the responding agencies' assessment of actions taken. This chapter summarizes agency assessment of the success of actions taken, benefits and drawbacks, potential improvements, and lessons learned.

Chapter five reports detailed findings from each of the six case examples. The selection process for case examples had several criteria: (1) include transit agencies of various sizes in different parts of North America; (2) include agencies that have taken different types of actions; (3) include agencies that reported detailed and interesting observations in the survey; (4) include at least one agency that assessed its actions as less than somewhat successful to reflect the real difficulties involved in attempts to improve bus speeds.

Chapter six summarizes the findings, presents conclusions from this synthesis project, and offers items for future study. Findings from the surveys and particularly the case examples provide an assessment of strengths and weaknesses and likely future directions.

A NOTE ON ACTUAL BUS SPEEDS

The major purpose of this study is to document the actions taken to improve bus speeds and the effects of these actions. Respondents were contacted after completing the survey and asked to provide data on actual bus speeds.

Eighteen agencies provided data for 19 cities. The data vary in terms of how speed is measured. Many agencies used the ratio of revenue miles to revenue hours. Some agencies reported scheduled speed. Others used scheduled speed, excluding deadhead and recovery.

Table 3 summarizes current actual bus speeds by system size, as measured by number of peak buses operated. The results are somewhat counterintuitive in that midsize systems report the highest bus speeds.

A possible explanation of the results in Table 3 is that midsize systems are more likely to offer express service than are small systems, thus increasing their average system speed. Table 4 presents differences in average local bus speed and average system speed for the six agencies that reported both

FIGURE 2 Survey respondents and case examples. *Source:* Survey results and case examples.

speeds. Overall, the average local bus speed is 91% of the average system speed.

These summaries provide a sense of average bus speeds in 2012, with the caveats that they are based on only 17 cities and that the definition of "average bus" speed is not consistent across all cities.

Three agencies provided very detailed speed information. The Regional Transportation District (RTD) in Denver, Colorado, provided a breakdown of current speeds by service type and day of week, shown in Table 5. RTD measures "in-service speed," which excludes deadhead and recovery. Speeds generally are higher on weekends. Local bus service in Denver (Metro Local) averages 14.9 mph (24 kph). The downtown Denver Mall Shuttle operates at 5.1 mph (8.2 kph). Local service in Boulder, Colorado, and Longmont, Colorado, is somewhat faster.

The RTD also analyzed scheduled speed compared with actual speed and reported that actual speed is 2.3% less than scheduled speed.

Capital Metro in Austin, Texas, reported data on current average bus speeds by service type, as shown in Table 6.

TABLE 3
BUS SPEEDS REPORTED BY RESPONDENTS BY SYSTEM SIZE (MPH)

No. Vehicles Operated in Maximum Service	Average System Speed	Range of Reported Speeds	No. Cities
Less than 150	12.9	11.3 to 14.6	8
150 to 599	14.8	13.3 to 16.32	7
600 or more	11.7	8.1 to 16.0	4
All agencies	13.5		100.0%

Source: Follow-up survey request.

TABLE 4
AVERAGE LOCAL BUS SPEEDS VERSUS AVERAGE SYSTEM SPEEDS BY AGENCY (MPH)

Agency	Average Local Bus Speed	Average System Speed	Local Speed as % of System Speed
A	11.4	13.3	86
B	12.6	13.14	96
C	12.85	14.35	90
D	14.9	16.0	93
E	12.5	14.5	86
F	13.47	14.33	94
All agencies	12.95	14.27	91

Source: Follow-up survey request.

TABLE 5
RTD IN-SERVICE BUS SPEED BY SERVICE TYPE AND DAY OF WEEK (MPH)

Service Type	Weekday		Saturday		Sunday	
	Average Speed	Range	Average Speed	Range	Average Speed	Range
Metro local	14.9	8.7–25.9	15.7	11.8–26.6	15.9	11.8–26.6
Light rail	23.8	21.7–28.3	23.8	21.4–25.9	23.8	21.4–25.9
Mall shuttle	5.1		5.1		5.1	
Metro express	26.0	18.3–38.4	35.4	35.0–38.4	38.4	
Metro regional	28.7	23.5–34.2				
Skyride	32.8	25.9–39.5	35.2	26.6–42.1	35.1	26.5–41.9
Boulder local	16.0	9.9–19.4	18.4	14.1–22.2	18.1	14.1–21.4
BM/LM regional	26.4	19.4–30.7	28.1	21.7–31.2	28.2	23.2–30.9
Longmont	15.2	14.5–16.1	15.8	14.2–16.7		
“Call N Rides”	11.0	3.5–34.1	6.2	3.8–15.0		
All operations	16.0		17.2		17.8	

Source: RTD, R. 2016 SV Recap Summary Report—All Operations, August 19, 2012.
“Call N Rides” = personalized bus service that travels within select RTD service areas.

Capital Metro measures average speed as revenue time divided by revenue distance. Table 6 indicates that local buses have the lowest average speed.

Metro Transit in Minneapolis, Minneapolis, provided trends in bus speed by local route between 2005 and 2012 and reported local and system bus speeds. Metro Transit calculates speed as in-service miles divided by in-service hours. Table 7 displays trends in local and system speeds. Average system speeds are affected by the mix of local and express service, and average local bus speeds can be affected by the mix of city and suburban routes. The overall decline in bus speed was slightly higher for local bus than for the system. Since 2009, the average speed has been stable. This lends support to an observation by another respondent that the economic slowdown resulted in decreased congestion, which led to steady or even rising average bus speeds.

Table 8 summarizes trends in speed at the local route level. More than half of all local routes experienced a decrease of as much as 5% in bus speeds over the 7 years. Thirty percent showed a decrease of more than 5%, and 14% experienced an increase in average speed. The two routes with major increases in average speed were restructured with new schedules.

TABLE 6
CAPITAL METRO AVERAGE BUS SPEEDS BY SERVICE TYPE

Service Type	Average Speed (mph)
Local	12.5
Limited/Flyer	15.2
Feeder	21.2
Crosstown	15.2
Special services	16.2
Express	22.2
System average	14.5

Source: Unpublished Capital Metro data.

TABLE 7
METRO TRANSIT AVERAGE LOCAL AND SYSTEM BUS SPEEDS, 2005 TO 2012

Year	Average Local Bus Speed (mph)	Average System Speed (mph)
2005	13.39	14.79
2006	13.23	14.59
2007	13.07	14.33
2008	12.97	14.39
2009	12.93	14.38
2010	12.94	14.45
2011	12.86	14.36
2012	12.85	14.35
% change, 2005–2012	-4.0%	-3.0%

Source: Unpublished Metro Transit data.

TABLE 8
METRO TRANSIT CHANGE IN AVERAGE BUS SPEED FOR LOCAL ROUTES, 2005 TO 2012

Change in Average Bus Speed	No. Local Routes	% Local Routes
-8% or lower	6	16.7
-5% to -8%	5	13.9
-2% to -5%	11	30.6
-2% to 0%	9	25.0
0 to +2%	2	5.6
+2 to +5%	1	2.8
+5% to +8%	0	0.0
+8% or higher	2	5.6
% change, 2005–2012	36	100.0

Source: Unpublished Metro Transit data.

CHAPTER TWO

LITERATURE REVIEW

INTRODUCTION

This chapter summarizes findings from a literature review related to bus speeds. A Transportation Research Information Database (TRID) search was conducted to aid the literature review, using keywords such as “bus speed,” “transit speed,” “bus delay,” and “transit travel time.”

COMPARATIVE AND GENERAL STUDIES

Some of the most interesting work in the literature assessed the relative impacts of different actions to improve bus speeds. Levinson (*1*) conducted a detailed analysis of transit speeds, delays, and dwell times based on surveys conducted in a cross section of U.S. cities. Major conclusions from this analysis included:

- Reducing bus stops from eight to six per mile (five to 3.75 per kilometer) and dwell times from 20 to 15 s would reduce travel times from 6.0 to 4.3 min/mi (3.75 to 2.69 min/km), a time saving greater than that which could be achieved by eliminating traffic congestion. Transit performance can be improved by keeping the number of stopping places to a minimum.
- Fare collection policies and door configurations and widths are important in reducing dwell time, especially along high-density routes. Such time savings likely will exceed those achieved from providing bus priority measures or improving traffic flow.

St. Jacques and Levinson (*2*) analyzed the operation of buses along arterial street bus lanes and derived procedures for measuring the impacts of various factors on bus flow and speeds. In a follow-up study, St. Jacques and Levinson (*3*) conducted field tests in four cities to assess how well the procedures outlined in *TCRP Report 26* to estimate bus speeds in downtown matched observed speeds. Adjustments for default values for incremental traffic delay were suggested to reflect more accurately the range of conditions commonly encountered.

The *Transit Capacity and Quality of Service Manual* (TCQSM) lists factors influencing bus speeds and ways to improve speeds (*4*). Bus speeds can be improved in the following ways:

- Reduce dwell time,
- Implement transit preferential treatment,
- Enforce restrictions on use of bus lanes by other vehicles,
- Balance the number of stops with passenger convenience and demand,
- Consider supplementing local service with limited-stop service, and
- Implement skip-stop operation.

With a running speed of 50 mph (80 kph), actual speed on a busway or exclusive freeway high-occupancy vehicle (HOV) lane can vary based on stop distance and dwell time at stops, with a range from 46 (dwell time = 0, stop spacing = 2.5 mi/4 km) to 16 (dwell time = 60 s, stop spacing = 0.5 mi/0.8 km) mph (74 to 26 kph). TCQSM provides formulas for estimating speeds on arterial streets in bus lanes and in mixed traffic flow. With regard to bus rapid transit (BRT) service, TCQSM presents typical effects on speed of station spacing and dwell times. The only level of service ranking related to bus speed is the travel time difference between fixed-route transit and automobile, in which “A” is faster by transit and “F” is more than 60 min slower by transit.

A study conducted by the Finland Ministry of Transport and Communications (*5*) gathered examples, best practices, and experiences on speeding up public transport to evaluate the effects on competitiveness and transportation economics. The study reported that changes in travel time have a bigger effect on travel mode selection than do changes in ticket prices. Field tests were conducted to evaluate acceleration and door functions on different bus models. Acceleration on buses varies by 5% and door functions by 12% on an average bus line in Helsinki. Among the speed-related findings:

- Bus lanes increase speed and improve punctuality by 15% to 20%. In some cases, the bus-only streets show operation cost savings.
- Traffic signal priority reduces delays caused by traffic lights by 40% to 50%.
- If timetable and service frequency are included or integrated, punctuality and regularity improve even more.

Rutherford and Watkins (*6*) explored causes of travel time variability. Three questions were addressed: (1) What are the characteristics of route segments where travel times (as measured by runtime) are the least variable? (2) What are the characteristics of route segments where drivers are least likely to fall behind? (3) What are the characteristics of route segments where drivers are most likely to be able to catch up if they have fallen behind schedule? Results included:

- The characteristic with the highest impact on on-time status and additional runtime beyond scheduled is the presence of some kind of issue with service (e.g., detours, accidents) that would cause a service alert to be issued within the agency.
- The presence of high-floor buses increased delays by several seconds per trip segment.
- Through-routing, a practice in which a bus alternates trips between two routes throughout the day, had an even greater impact, adding almost a minute to the actual runtime beyond that scheduled.
- Standees on a bus had a similar negative impact on on-time status and overall runtime, indicating that agencies need to pay attention to their passenger loads to avoid delays.
- Interestingly, express buses and the percentage of exclusive lanes in the form of HOV lanes or business-access transit lanes had an inconsistent impact on reliability.

In speed and delay studies in the Jacksonville, Florida, region, Ryus and Bartee (*7*) found a linear relationship between bus and auto travel times (and speeds) across the range of sampled travel times, unlike the regional model structure, which uses three different linear functions for various ranges of auto speeds. Bus travel times were a consistent proportion of auto travel times during peak and off-peak periods, although absolute travel times were longer during peak periods. Finally, the current model structure was found to underestimate the maximum observed bus speeds in the field. These results are consistent with those of an earlier study conducted in the Tampa Bay, Florida, area.

Maloney and Boyle (*8*) analyzed components of running time on the Glendale (California) Beeline system. Results were reported by route for three local and two routes. The primary component of in-service time is actual travel time or time when the bus is moving, accounting for 59%. Recovery time (13%) and deadhead time (9%, inflated by extensive deadheading on one express route) ranked second and third, followed by time maneuvering in and out of traffic at bus stops (7%), dwell time (7%, higher on the local routes), signal delay (5%), and traffic delay (less than 1%).

TRAFFIC ENGINEERING ACTIONS

Studies cited in this section examined actual results from implementation of actions to improve bus speeds. Actions include signal priority, reserved bus lanes, and signal timing.

Pessaro and Van Nostrand (*9*) measured the effects of implementing transit signal priority (TSP) for the I-95 Express Bus Service in South Florida. The measures included before and after results for travel times, on-time performance, components of delay (e.g., dwell time, signal delay, turnout delay), as well as average signal delay per intersection. Results in the morning peak period showed a 12.1% reduction in bus travel times (from 33 to 29 min), a decrease in average signal delay from 24% to 20% of the total travel time, and an improvement in on-time performance from 66.7% to 75%. The results confirmed that nearly every intersection experienced less delay with the TSP activated. Results in the afternoon peak period were insignificant.

Albright and Figliozzi (*10*) analyzed the effectiveness of conditional transit priority, or the manipulation of traffic signal timing plans to reduce delay of late transit buses. The study involved a 5-mi corridor along SE Powell Boulevard with 14 signalized intersections, all TSP-equipped. TSP tends to be most effective at lower volume intersections, where queuing on the street of travel is less problematic. In addition, TSP effects are localized. The stop and intersection level analysis shows a TSP effectiveness that can be hidden or evened out when analyzing effectiveness at a route level. TSP is more effective for late buses, but other factors such as delays caused by lift usage can preclude schedule recovery.

Surprenant-Legault and El-Geneidy (*11*) evaluated the impact of adding a reserved bus lane on the running times and on-time performance of two parallel bus routes, one of them a limited-stop bus service and the other a regular bus service. The reserved bus lane yielded savings of 1.3% to 2.2% in total running time, and benefits were more noteworthy when congestion levels were high. The introduction of a reserved lane increased the odds of being on time by 65% for both routes. A decline in the variability of running time was noticed after implementation of the reserved lane, indicating that the reliability of the service being offered along the corridor had improved. Reserved lanes had a substantial effect on both service reliability and on-time performance, two key variables in customer satisfaction.

Schwartz et al. (*12*) evaluated the impacts of an exclusive dual-width bus lane, defined by pavement markings and overhead signs accompanied by intense enforcement, on Madison Avenue in midtown Manhattan. Results indicated that (a) peak hour bus speed was increased by 83%, (b) peak hour bus reliability was increased by 57%, (c) traffic speed on Madison Avenue was increased by 10% for all vehicles, and (d) average speed on eastbound cross streets was unchanged and on westbound cross streets was reduced by 6%.

Pangilinan and Carnarius (*13*) investigated traffic signal timing as a means of improving transit service specifically; they used the San Francisco Municipal Transportation Agency's signal timing project for the Inner Geary bus corridor as a case study in the development and evaluation of signal timing for transit progression. For most cases, traffic signal timing for a one-way street is a fairly simple exercise: automobile speeds and distances between intersections are measured to create a progression of vehicle platoons along a corridor. For transit, however, stop spacing and dwell time variability increase the complexity of this task. The main conclusion of the study by Pangilinan and Carnarius is that signal timing for transit is shown to improve transit travel time and reduce travel time variability. However, the strategy has limitations on where it can be applied.

BUS STOP ACTIONS

The Texas Transportation Institute (*14*) presented a composite of prevailing practices regarding bus stop spacing. Typical spacing was 600 ft (183 m) in the central business district (CBD), 750 ft (229 m) in urban areas, 1,000 ft (305 m) in suburban areas, and 1,250 ft (381 m) in rural areas. The study noted the essential trade-off in stop spacing between shorter walk distances and higher speeds but did not explore the effects of changes in stop spacing.

Cooper (*15*) evaluated a series of traffic and transit-related improvements in Victoria, British Columbia. Direct transit-related modifications, mainly involving bus stop reductions or adjustments, had the most marked and beneficial effect on bus operation. This net operational benefit, while not of a magnitude that would in itself lead directly to real cost savings, nevertheless derived from minor, low-cost traffic and transit improvements and resulted in demonstratively smoother bus operation. Service to the public, as represented by the number of available stops within the study area, was effectively unchanged.

Fitzpatrick et al. (*16*) studied the impacts of bus bulbs. A major advantage of bus bulbs is the creation of additional space at a bus stop for shelters, benches, and other bus patron improvements when the inclusion of these amenities would otherwise be limited without the additional space. Bus bulbs also eliminate the bus-weaving maneuver into and out of stops. An evaluation of pedestrian operations found that vehicle and bus speeds increased on the block and in the corridor. The nearside stops, which experienced higher delays to buses, saw a reduction in the average delay with the installation of the bus bulb.

Furth and SanClemente (*17*) analyzed delay associated with the bus stop location. The marginal impact of slope on stopping delay ranged from −4 to 11 s, depending on grade. Far-side stop placement causes a very small reduction in delay or has no effect. Near-side placement can reduce delay in a few cases, such as reserved bus lanes, but more often increases delay, sometimes considerably depending on factors such as traffic signal timing, the volume/capacity ratio, cycle length, and stop setback. Measures that reduce interference with the queue tend to reduce the net delay from a near-side location; these measures include increasing stop setback, shortening cycle length, and giving the bus a (near) exclusive lane.

Furth et al. (*18*) presented an analytical approach to bus stop location based on a parcel-level geographic database and a street network. Case studies in two cities demonstrated the practicality of this approach. Results show how stop consolidation plans can be adjusted to maximize the societal benefit.

King (*19*) summarized early experiences with yield-to-bus programs at a time when only four states and two provinces in North America had enacted yield-to-bus laws. This study reported greater agency satisfaction when a flashing light-emitting diode was used instead of a decal on the bus. Approximately one-third of survey respondents reported an increase in schedule adherence, but none was able to provide supporting data.

Fabregas et al. (*20*) examined the operational impacts of yield-to-bus electronic warning signs. The authors concluded that electronic warning signs lowered the reentry time from pullout bays, thus increasing overall bus speed.

Estrada-Romeu et al. (*21*) and Alonso et al. (*22*) both examined the impact of multiple loading areas at bus stops in Spanish cities. Estrada-Romeu et al. (*21*) found that in Barcelona, a capacity gain of 30% to 70% can be achieved, with a greater gain if buses spend more time at the stop and the variability in dwell time is low, and suggested a revision of the TCQSM by which the “effective number of berths” concept should be considered a variable (instead of a constant) that depends on the dwell time characteristics. Alonso et al. (*22*) reported that arrivals at stops can be better staggered if bus stops are divided into more than one berth. In the city of Santander, Spain, the quantified benefits of an optimal route-stop assignment show increases of 10% in average bus speed.

BUS RAPID TRANSIT IMPACTS

Bus rapid transit implementation has spawned several studies looking at impacts on bus speeds. Levinson et al. (*23*) noted operating speeds for BRT on arterial streets ranged between 8 and 19 mph (13 to 31 kph), with 14 mph (23 kph) reported as typical. The study reported that bus speeds in Los Angeles had declined by 12% in recent years and that two-thirds of the increases in bus speeds brought about by BRT in Los Angeles were the result of fewer stops, whereas one-third were the result of signal priority. This study also reported a wide range of BRT travel time savings in minutes per mile, with higher estimates for busways and lower estimates for arterial BRT service.

Volume 2 of study by Levinson et al. cited several factors affecting BRT bus speeds, including stop distance, dwell time, and the volume/capacity ratio at bus stops. The report documents afternoon peak period bus speeds in selected cities with bus lanes, ranging from 2.6 to 12.8 mph (4.2 to 20.6 kph). The authors address the impact of the fare collection method on dwell time and discuss how bus speed affects operating cost and fare box recovery.

Kittelson & Associates et al. (*24*) report travel time savings per mile associated with busways and arterial bus lanes.

Evidence from arterial lanes indicates that speed increases of 1.5 to 2.0 mph (2.4 to 3.2 kph) can be expected, representing percentage changes between 22% and 47%. Examples show the impact of increased bus speeds on the number of vehicles required (keeping headway constant) and on headway (keeping number of vehicles constant). Peak hour travel time rates for various stop spacings, dwell times, and operating environments are presented; these suggest that the number of stops has a greater impact on speed than does dwell time at stops. The study provides a variety of ways to estimate BRT travel time savings and concludes with a detailed analysis of six BRT scenarios.

Callaghan and Vincent (*25*) assessed the Metro Orange Line of Los Angeles County, California, one of the first full-feature BRT systems in the United States, and compared the Orange Line with two recent transit investments in Los Angeles: the Gold Line light rail and Metro Rapid, a rapid bus service with limited BRT features. The study found that the Orange Line is performing better than the Gold Line, which costs considerably more yet carries fewer riders. Metro Rapid appears to have some cost-effectiveness advantages but lacks travel time consistency and a premium transit service image. Safety changes to the Orange Line operation, such as reduced bus speeds through intersections, reduced travel time savings.

Levinson (*26*) described the design, operations, and effectiveness of different types of BRT: mixed traffic, normal or contraflow curb bus lanes, and/or arterial median busways. The Levinson study identified the key issues and tradeoffs and showed that with proper design, BRT can improve bus speeds, reliability, and identity, while minimizing adverse impacts to street traffic, pedestrians, and property access.

Diaz (*27*) examined the impacts of TransMetro in Guatemala City, Guatemala, the first full BRT system in Central America. TransMetro's buses are able to achieve average speeds seven times greater than the previous average speeds (which were very low). These speeds are mostly because the system has five underpasses that allow buses to avoid intersections and only two traffic lights in the segregated infrastructure sections.

Two studies reported findings from the first two select bus service (SBS, New York's term for BRT) routes in New York City. Barr et al. (*28*) examined the Fordham Road SBS in the Bronx. Results showed a 20% reduction in travel time along the corridor and an 11.5% increase in ridership in the corridor. A total of 98% of bus customers surveyed described themselves as satisfied or very satisfied with the service. Beaton et al. (*29*) analyzed the First and Second Avenue SBS in Manhattan and reported a 15% to 18% improvement in travel time and a 10% increase in corridor ridership. In chapter five, the case examples include greater detail on changes in bus speed resulting from SBS implementation.

SIGNAL PRIORITY AND MODEL-BASED STUDIES

Many of the reports and articles in this literature review address traffic model results. These are clearly important as the industry continues to refine and expand its modeling capabilities but perhaps have less relevance to this study owing to their theoretical nature. Nonetheless, interesting and sometimes counterintuitive findings have been reported in the literature.

Foletta et al. (*30*) described a new methodology for solving the bus network design problem, covering both network design and frequency setting. The models were applied to the street network of Barcelona, Spain, and it was found that the new models produce bus networks with faster average travel speeds, smaller fleet size, fewer route kilometers, and fewer buses per link than did previous methodologies. Consideration of the variability of bus speeds and required route frequencies during route generation and frequency setting can appreciably improve the performance of a bus network.

Bekhor (*31*) proposed a methodology to estimate capacity and speed for bus lanes. The main difference between the TCQSM method and the proposed method is related to the estimation of bus speeds. Analysis of microsimulation results enabled the estimation and calibration of volume-delay functions for bus lanes. The initial validation results show a satisfactory match between modeled results and field observations.

Tranhuu et al. (*32*) addressed the implementation of bus lanes and median busways for Asian cities in which traffic is dominated by motorcycles, concentrating particularly on Hanoi, Vietnam. Model results show that the level of motorcycle violations has an important impact on the success of bus lane schemes: there is no major speed improvement on bus lanes if enforcement is weak. Busways can achieve much higher bus speeds than can bus lanes, but the potential extra delay caused by a poorly designed busway is greater than that resulting from a poorly designed bus lane.

Muzyka (*33*) conducted a simulation of traffic flow within a specified traffic system to predict the effect on bus service and general traffic performance of implementing candidate bus priority strategies. The model was calibrated to current peak hour traffic conditions within an urban street grid representative of the CBD of Minneapolis. Various bus priority strategies designed to increase bus speeds by providing bus-only lanes were evaluated. The important elements in bus travel time were shown to be frequency of station stops and red light signals.

Saberi et al. (*34*) assessed existing reliability measures proposed by the TCQSM and developed new reliability measures at the stop level. Three new reliability measures at the stop level are proposed: (1) an Earliness Index to measure the relative frequency of early buses; (2) a Width Index to measure the variability of headway deviations; and (3) a Second Order Stochastic Dominance Index to measure the distribution of delay and headway deviations.

Fernandez and Valencia (*35*) presented a macroscopic simulation model that represents the operation of a public transport corridor with enough detail to take into account all sources of delays, mainly running time, signal, and stop delays. The model has been validated against real data in a busway in Santiago, Chile. The authors found that bus speed can be improved between 9% and 20% if stops are optimally spaced. An additional 2% to 7% can be achieved if passing lanes are provided at stops. If traffic signals are set so that they take into account the bus progression, an additional 3% to 5% increase in commercial speed can be attained.

Furth et al. (*36*) explored signal control logic for reducing bus delay around a major bus terminal in Boston, Massachusetts, where the busiest intersections see almost four buses per signal cycle. A traffic microsimulation model evaluated a succession of signal priority tactics and found a reduction in bus delay of 22 s per intersection, with minor impact on general traffic. The general strategy was to provide buses with green waves, so that they are stopped at most once, coupled with strategies to minimize initial delay. The greatest delay reduction came from passive priority treatments: changing phase sequence, splits, and offsets to favor bus movements. Green extension and green insertion were found to be effective for reducing initial delay and providing dynamic coordination. Cycle-constrained free actuation, in which an intersection has a fixed cycle length within which two phases can alternate freely, provided flexibility for effective application of early green and green extension at one intersection with excess capacity. Emphasis was given to the approach of providing aggressive priority with compensation for interrupted phases.

Li et al. (*37*) described the development and implementation of adaptive TSP on an actuated dual-ring traffic signal control system. Adaptive TSP is responsive to transit priority requests in real time in the context of current traffic conditions. At a congested intersection, it is found that the average bus delay was reduced by 43%, and the average traffic delay along the bus movement direction was reduced by 16%. The average delay of cross-street traffic was increased by about 12%.

Winters and Abbas (*38*) sought to determine the benefits of TSP in Blacksburg, Virginia, a college town of 50,000. The road modeled for this analysis runs on the north side of campus, and three intersections were included in the analysis. A total of 56 buses per hour move through the network. Maximum transit extension times varied from zero to 45 s in 5-s intervals. Based on statistical analysis, it was recommended that the signals be reprogrammed to allow 20 s of transit green extension. This would decrease bus delay by 15%, decrease bus stops by 6%, and increase car delay by 5% while having no impact on car stops and heavy vehicles.

Zhou and Gan (*39*) evaluated the performance of queue jump lanes under different TSP strategies, traffic volumes, bus volumes, dwell times, and bus stop and detector locations. Four TSP strategies were considered: green extension, red truncation, phase skip, and phase insertion. Queue jump lanes without TSP were ineffective in reducing bus delay. Queue jump lanes with TSP strategies that included a phase insertion were found to be more effective in reducing bus delay while also improving general vehicle operations than were strategies that did not include this treatment. Near-side bus stops were preferred for queue jump TSP over far-side bus stops. Through vehicles on the bus approach were found to have only a slight impact on bus delay when the volume/capacity (v/c) ratio was below 0.9, but bus delay increased quickly when v/c exceeded 0.9. Right-turn volumes were found to have a very small impact on average bus delay, and an optimal detector location that minimizes bus delay under local conditions was shown to exist.

Pye and Bode (*40*) reported on bus priority measures implemented in London, United Kingdom, to improve bus speed and reliability. Using a range of microsimulation models on a section of Route 149, Kingsland Road, Hackney, the authors found that traffic signal timings had the most impact on journey times and that bus lanes provided the most benefits under congested conditions. These priority measures were introduced onto Bus Route 149 progressively from 2000, and the effects of the different measures were monitored. It was shown that a successful approach would seek to include improvements at traffic signal junctions, provision of bus lanes, and control of curbside activity.

Rouphail (*41*) evaluated the impact of the use of two bus priority techniques on the operation of bus and nonbus traffic in a simulated environment. The strategies studied were (1) contraflow bus lane on a downtown street and (2) signal settings based on minimizing passenger, rather than vehicle, delays. The operational setting reflected actual observations on a Chicago downtown street. It was found that predicted bus operation improved considerably as a result of dedicating an exclusive lane to bus traffic. However, the degree of bus operation improvement was dependent on whether the buses operated in mixed traffic or on exclusive lanes. A limited field study was conducted to test bus performance indices predicted by the model. The observed and simulated overall bus travel speeds were found to compare favorably at the 5% significance level.

Horn and Widstrand (*42*) evaluated several improvements, including adding dedicated bus lanes along the length of the corridor and completing individual intersection projects to the NE 85th Street and Redmond Way arterial corridor in Kirkland and Redmond, Washington. The improvements were evaluated by conventional intersection measures of performance, such as average delay and queue length. Benefit-to-cost ratios were used to determine the return on investment by the transit agency of each enhancement alternative. The bus travel time benefits realized from corridorwide and combinations of relatively small intersection improvements were comparable and noteworthy. In addition, the benefit-to-cost ratio for the intersection improvements was comparable and outweighed those of the corridorwide improvements. The study showed that in this suburban setting, getting buses moving means getting all of the traffic moving.

Koonce (*43*) authored a white paper summarizing barriers associated with the implementation and maintenance of TSP systems. The white paper also described partnerships between transit and traffic engineering professionals that have helped to identify and overcome technical and policy-related limitations to implementation. Conclusions focused on next steps for advancing the integration of transit into transportation engineering projects.

HISTORICAL SPEED DATA

Blake and Jackson (*44*) summarized streetcar speeds in various cities in the early 1920s. Average speed ranged from 9.4 to 10.9 mph (15.1 to 17.5 kph) in 12 large cities and from 7.7 to 10.8 mph (12.4 to 17.4 kph) in 20 medium cities.

Levinson (*45*) analyzed peak hour bus travel times in a number of cities. Peak hour travel times (measured in minutes per mile) were greatest in CBDs, averaging 11.5 min/mi (7.1 min/km) compared with 6.0 min/mi (4.4 min/km) in cities exclusive of CBDs and 4.2 min/mi (2.6 min/km) in the suburbs. The percentage of time the bus was in motion (as opposed to stopped in traffic or at bus stops) was less than 50% in the CBD, 65% in other areas of the city, and 71% in the suburbs. The ratio of automobile-to-bus speeds in the afternoon peak hour ranged from 1.4 to 1.6.

SUMMARY

The literature review reveals several local analyses of the impacts of actions to improve bus speeds but few comparisons of which actions are most effective. Stop spacing and traffic engineering actions, such as TSP and reserved lanes, have been shown to work, although some actions such as TSP produce localized results that may not be apparent at the route level. Fare policies also have an impact. BRT has received considerable attention, and analysis of BRT implementations highlights the difficulty of separating and specifying the outcomes of individual actions. The literature includes a wealth of modeling efforts that have the practical effect of identifying actions with a high payoff in terms of speed. These reports provide a good starting point for this study.

The literature review has informed the survey instrument used to gather input from transit agencies. Survey results and case example findings have been checked against findings in the literature for consistency. Chapter six reflects the literature review as well as the survey and case examples. Additional research needs have been developed based on unclear or conflicting information.

Chapters three and four present the results of a survey of transit agencies regarding approaches to improving bus speeds. Survey results provide a snapshot of the state of the practice as it exists today with regard to approaches to improving bus speeds.

CHAPTER THREE

SURVEY RESULTS

INTRODUCTION

This is the first of two chapters presenting the results of a survey of transit agencies regarding approaches for improving transit bus speeds. The survey was designed to elicit information on trends in average bus speeds over the past 5 years, actions implemented and their effects, actions considered but not implemented, barriers to success, metrics used in estimating and evaluating effects, assessment of the most successful actions, and lessons learned.

Thirty-one completed surveys were received from 36 agencies approved by the panel for inclusion in the sample, a response rate of 86%. In addition, 28 agencies responded to an invitation to all APTA members to participate in the survey, for a total of 59 transit agencies in the final sample. The transit agencies range in size from 10 to more than 3,000 fixed-route transit vehicles.

This chapter presents survey results regarding trends in local bus speeds, types of actions taken to improve bus speeds, and the effects of these actions. Chapter four discusses survey results related to the responding agencies' assessment of actions taken.

Throughout the rest of this chapter, increases and decreases of less than 5% in bus speeds are characterized as minor changes. Changes of 5% to 10% are characterized as moderate changes. Increases and decreases of more than 10% are characterized as major changes.

TRENDS IN LOCAL BUS SPEEDS

Table 9 summarizes survey responses regarding existing trends in local bus speeds. More than 75% of respondents reported that bus speeds have decreased across the board or results are mixed. Most (64%) agencies indicated that the trend has been identified quantitatively, tracked by means of performance measures. The others indicated anecdotal information as the source of speed trends.

Agencies that indicated a change in bus speeds were asked more specifically about the trend. Table 10 summarizes responses from these agencies. Nearly half of all respondents noted a minor decrease in bus speeds, whereas 15% reported that bus speeds increased. The survey did not ask agencies to quantify overall bus speed increases because there is no problem if bus speeds increased. "Other" responses included slower local service but increased speed on BRT routes and mixed results by route or by area served.

As noted in chapter one, respondents were contacted after completing the survey and asked to provide data on actual bus speeds. Table 11 shows trends in bus speeds based on data from nine cities. The overall annual rate of change was –0.45%.

One interesting difference of opinion was related to the impact of the economic downturn. One respondent observed that the economic downturn combined with increases in gas prices had reduced traffic congestion and resulted in increased speeds and improved on-time performance. Another participant theorized that the economic downturn limited funds available for agencies to implement actions to improve bus speeds.

ACTIONS TAKEN TO IMPROVE BUS SPEEDS

Respondents reported actions taken to increase or mitigate decreases in bus speeds. Table 12 lists seven broad categories of actions taken. Each category is discussed in greater detail in the following sections.

At least two-thirds of all responding agencies took actions in the areas of schedule and route adjustments. Bus stop location, design, and placement, policy changes, and vehicle-related actions were also fairly common. Only one agency did not take any action intended to improve bus speeds.

Schedule Adjustments

Table 13 shows schedule-related actions. Such actions offer the potential to increase bus speed by reducing the need to hold for time at stops if the bus is ahead of schedule or by balancing service time and recovery time more appropriately. By far the most common action reported was to adjust running times. Changes in recovery time policy and changing to headway-based schedules (a strategy for frequent service in which buses are spaced a set number of minutes apart rather than arriving at stops at specific times) were implemented less often. Eleven agencies reported "other" actions, which are described here.

TABLE 9
TRENDS IN LOCAL BUS SPEEDS OVER PAST 5 YEARS

Trend	No. Agencies Responding	% Agencies Responding
Results are mixed	23	39.0
Bus speeds have decreased	23	39.0
No change in bus speeds	7	11.9
Bus speeds have increased	6	10.2
Total responding agencies	59	100

Source: Survey results.
Note: Percentages do not add to 100% because of rounding.

TABLE 10
CHANGES IN BUS SPEEDS OVER PAST 5 YEARS

Change	No. Agencies Responding	% Agencies Responding
Decreased by 0% to 5%	23	42.3
Decreased by 5% to 10%	9	17.6
Decreased by more than 10%	0	0.0
Increased	7	15.4
Other	12	23.1
Total responding agencies	51	100

Source: Survey results.
Note: Percentages do not add to 100% because of rounding.

Running time adjustments are rarely made for the purpose of improving bus speeds. These actions are routine at many agencies and are intended to improve the accuracy of the schedules and thus on-time performance. On average, respondents reported running time adjustments on approximately 44% of their routes, with a median percentage of 30%.

Eleven agencies measured the specific impact of running time adjustments on bus speeds. Eight (73%) reported a decrease in speeds, two (18%) reported a minor increase in speeds, and one (9%) reported no impact. The running time adjustments decreased scheduled speeds but may not have had an effect on actual bus speeds, which presumably were lower than the original scheduled speed.

TABLE 12
TYPES OF ACTIONS TAKEN TO IMPROVE BUS SPEEDS

Action Category	No. Agencies Responding	% Agencies Responding
1, Schedule adjustments	51	86.4
2, Route adjustments	44	74.6
3, Stop-related	38	64.4
4, Vehicle-related	37	62.7
5, External policies (typically traffic-related)	32	54.2
6, Internal policies	29	49.2
7, Other	11	18.6
No actions	1	1.7
Total responding agencies	59	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

TABLE 13
SCHEDULE-RELATED ACTIONS

Action	No. Agencies Responding	% Agencies Responding
Adjust running time	49	98.0
Change recovery time policy	8	16.0
Headway-based instead of time point-based schedules	4	8.0
Other	11	22.0
Total responding agencies	50	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

The eight agencies that changed *recovery time policies* took a variety of approaches. Two agencies added recovery time on specific routes (one on routes with high variability in running times during peak hours). One agency reduced recovery time by 25% to improve efficiency. Others reported specific formal

TABLE 11
TRENDS IN BUS SPEEDS REPORTED BY NINE CITIES

City	Overall % Change	No. Years over Which Change Occurred	Compound Annual Rate of Change
A	-11.0	14	-0.75%
B	-8.6	13	-0.64%
C	-1.5	10	-0.15%
D	-0.9	10	-0.09%
E system	-2.6	4	-0.64%
E frequent routes	-4.2	4	-1.03%
F system	-3.0	7	-0.42%
F local routes	-4.0	7	-0.56%
G	-2.0	5	-0.40%
H	-0.7	2	-0.35%
I	+0.2	4	+0.05%
Average			-0.45%

Source: Follow-up survey request.

or informal policies. Only two agencies quantified the effect on bus speeds. One agency set recovery time at 5 min for all trips and reported a slight increase in speed. The other agency allowed 10 to 15 min of recovery time based on delays identified and reported a decrease in bus speed.

Four agencies reported changing to *headway-based schedules*. Unlike conventional time point–based schedules, headway-based schedules do not list specific times points. Instead, customers are told that buses arrive at set intervals (every X minutes). Headway-based schedules are more common on BRT routes, and two agencies indicated that they are used only on BRT routes. Two other agencies reported that selected local routes use headway-based schedules. No agency measured the effect of this action alone on bus speeds.

Other schedule-related actions included lessening hold time (i.e., the time that buses sit or "hold for time" after arriving early at a time point) by adjusting segment-level running times or by increasing the use of estimated time points that do not require an early bus to hold for time; moving operator reliefs to the end of the line; moving time points; changing running times by time of day; using automated vehicle location (AVL) systems to track schedule adherence in real time or to use average actual running time to set schedules; considering variability in running times when setting layover time; and reconsidering the mix of local, limited-stop, and express routes. One agency that adjusted segment-level running times specifically to reduce hold times reported a minor increase in bus speeds.

Improving bus speeds can be a collateral benefit of certain schedule-related actions, but the primary purpose of these actions is to improve schedule adherence and reliability. Moving operator reliefs to the end of a route keeps customers from experiencing the delays incurred by midroute reliefs (which normally take 3 to 5 min). Running time adjustments affect scheduled bus speeds and can affect actual bus speeds through their effects on hold times at time points. An advantage of headway-based schedules is that hold time is not required at time points (because there are no time points), but supervisors may hold buses to ensure even headways.

Route Adjustments

Three-quarters of responding agencies reported route-related actions to improve bus speeds. Route adjustments offer the potential to increase bus speed by keeping the bus on a major corridor, thereby reducing the number of deviations and turns, or by reducing the number of stops. Table 14 summarizes actions taken.

TABLE 14
ROUTE-RELATED ACTIONS

Action	No. Agencies Responding	% Agencies Responding
Streamline routes	39	90.7
Introduce limited-stop service	18	41.9
Introduce BRT service	10	23.3
Other	10	23.3
Total responding agencies	43	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

The most common action was to *streamline routes* (i.e., keep buses on major corridors and reduce the number of turns). On average, respondents reported streamlining approximately 19% of their routes, with a median percentage of 15%. One respondent stated that obvious streamlining opportunities are rare. Several agencies noted that restructuring occurred episodically, most often in conjunction with major system studies or with implementation of new rail lines. Only six agencies measured the specific impact of route streamlining on bus speeds. Three (50%) reported a minor increase in speeds; one (17%) reported a moderate increase in speeds; one (17%) reported a decrease in speeds; and one (17%) noted that the streamlining was too complex to report an overall trend because route segments were transferred among routes.

Approximately 42% of agencies reporting route-related changes introduced *limited-stop service*. Half of these responses involved only one new limited-stop route, with a few agencies reporting four new or restructured limited-stop routes within the last 5 years. Four agencies measured the specific impact of limited-stop service on bus speeds. Two (50%) reported a minor increase in speeds, and two (50%) reported a moderate increase in speeds.

Ten agencies (23% of those reporting route-related changes) introduced or added *BRT service*. BRT elements common to at least half of the responding agencies include signal priority, all-door boarding, branding (in some cases special buses), bus lanes or other dedicated right-of-way, real-time passenger information, and upgraded bus stops and shelters. A few agencies mentioned queue jump lanes and level boarding. Six agencies measured the specific impact of BRT service on bus speeds. Five (83%) reported a major increase in speeds, and one (17%) reported a minor increase in speeds.

Other route-related actions included streamlining routes on arterials; removing unnecessary route deviations; creating a multiroute trunk line to improve speed and provide needed capacity; eliminating duplicative routes; restructuring routes and route segments to serve light rail or allow time to extend another route; and shortening or consolidating routes. Other actions for nonlocal routes included using shoulder lanes on highways and building new direct-access ramps for HOVs. The two agencies that reported the impact of "other" changes on bus speeds saw no effect.

Limited-stop and BRT services clearly improve bus speeds. Streamlining bus routes can also improve bus speeds to a lesser extent.

Stop-Related Actions

Almost two-thirds (64%) of responding agencies reported stop-related actions to improve bus speeds. Stop-related actions offer the potential to increase bus speed by reducing the number of stops, making it easier to get into and out of bus stops, or reducing dwell time at stops. Table 15 summarizes actions taken.

The most common action was to change bus stop spacing, with 79% of responding agencies taking this action (all increased stop spacing). Many agencies increased stop spacing on a limited number of routes or frequent corridors, on a case-by-case basis, or in specific areas, such as downtown. Some focused on underused stops or eliminated flag stops entirely. One agency reported implementing consistent stop spacing on new and adjusted routes. Another initiated a pilot project that first increased spacing on two routes; the agency will analyze the effects on bus speeds on these routes before deciding whether to implement similar changes systemwide.

Several agencies reported policy-based changes regarding stops. One guideline called for fewer than eight stops per mile (five stops per kilometer) in urban areas, fewer than six stops per mile (3.7 per kilometer) in suburban areas, and fewer than four stops per mile (2.5 per kilometer) in rural areas. One agency changed its policy from nine stops per mile (5.6 per kilometer) to six or seven (3.7 to 4.3 per kilometer). Another reported a gradual conversion of urban stop spacing from every two to three blocks (500 to 700 ft or 152 to 213 m) to every three to four blocks (800 to 1,000 ft or 244 to 305 m) where possible. In a specific downtown example, stops were changed from every block to every other block.

Seventy-two percent of agencies reporting changes to stop spacing noted that their service standards address stop spacing. Three agencies reported a determined effort to apply the (unchanged) existing stop spacing policy.

Two policies were very detailed:

- A density-based bus stop spacing standard: high-density, CBD, or shopping (greater than 20 persons per acre), 500 to 700 ft or 152 to 213 m; fully developed residential area (10 to 20 persons per acre), 700 to 850 ft or 213 to 259 m; low-density residential (three to 10 persons per acre), 850 to 1,200 ft or 259 to 366 m; rural or express bus service (0 to three persons per acre), 1,200+ ft or 366+ m.
- A change from stops every 600 ft (183 m) to every 800 to 1,500 ft (244 to 457 m) with a targeted average of 1,200 ft (366 m). This agency has implemented the new policy on 80% of its routes, resulting in 24% fewer bus stops systemwide.

TABLE 15
STOP-RELATED ACTIONS

Action	No. Agencies Responding	% Agencies Responding
Change stop spacing	30	78.9
Change bus stop location	18	47.4
Change bus stop design or length	13	34.2
Level boarding at transit centers	8	21.1
Other	5	13.2
Total responding agencies	38	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

Only two agencies measured the specific impact of changes in stop spacing on bus speeds. One reported an increase from 5.5 to 6.1 mph (8.8 to 9.8 kph) on a mile-long corridor segment. Another indicated that a reduction in downtown stops on express routes reduced travel time circulating through downtown by about 5 min.

Forty-seven percent of agencies reporting stop-related changes changed the *location of bus stops.* The most common change was moving to a far-side location, especially at signalized intersections. Several agencies reported a preference for near-side locations at stop signs. A few agencies noted that safety, convenience, accessibility of stops, and property issues are the major factors, not improving speed, in changing stop locations. Only one agency measured the specific impact of changing stop locations. This agency reported a minor increase in speeds with the location of stops at far-side locations wherever feasible.

Slightly more than one-third of all agencies reporting bus stop changes changed *bus stop design or length.* A variety of changes were reported, including updated design standards, a new stop classification system that specifies thresholds (based on ridership and land use) for additional amenities and larger paved waiting areas, increased number of bus bulbs, extended curb lengths to improve stop capacity and accommodate longer vehicles, lengthened approach to the stop, and use of any bay at major downtown stops for buses that are only dropping off passengers. No agency measured the specific impact of changing bus stop design or length.

Relatively few agencies (21%) introduced *level boarding at transit centers* or other major stops. One-quarter of these respondents indicated that they had increased the number of low-floor buses in the fleet, as opposed to actually building level boarding platforms or pads. No agency measured the specific impact of level boarding.

Other stop-related actions included elimination of flag stops, elimination of parking adjacent to stops, elimination of bike rack usage at key downtown stops, and construction of bus bulbs for BRT stops. Only one agency measured the specific impact of “other” stop-related actions. This agency reported a moderate increase in speeds with the elimination of flag stops.

Overall, there are not enough reported evaluations to assess the effect of all bus stop changes on bus speeds. Stop spacing is the most successful stop-related strategy for increasing bus speeds.

Vehicle-Related Actions

Almost two-thirds (65%) of responding agencies reported vehicle-related actions to improve bus speeds. Most vehicle-related actions offer the potential to increase bus speed through a reduction in dwell time at stops, although one action is intended to improve acceleration. Table 16 summarizes actions taken.

The most common action was to introduce or increase the use of *low-floor buses*, with 89% of responding agencies taking this action. Low-floor buses account for an average of 74% of the local bus fleet among responding agencies, with a median figure of 79%. The effect on bus speeds from low-floor buses results from reduced dwell time. Only one agency measured the specific impact of low floor buses. This agency reported a reduction in dwell time of 1 s per passenger boarding.

More than three-quarters (78%) of agencies reporting vehicle-related changes switched from lifts to *ramps for wheelchair access* through the introduction or expanded use of low-floor buses. Only one agency measured the specific impact of replacing lifts with ramps. This agency reported a minor increase in bus speeds.

Approximately 60% of all agencies reporting vehicle-related changes introduced or increased the use of *vehicles of different size.* The changes went in all directions. Three primary themes were articulated buses for the busiest routes; smaller vehicles for low-productivity routes; and 40-foot buses, instead of 35-foot buses, as the standard for local service. No agency measured the specific impact of different vehicle sizes. One agency noted that use of articulated buses has increased running time owing to longer dwell times at stops but that this trend has been partially mitigated by use of low-floor articulated buses. Another reported a switch to smaller vehicles with greater acceleration and maneuverability. A third agency noted that increasingly worse traffic overwhelmed any changes resulting from bus size.

Slightly less than half of all agencies reporting vehicle-related changes introduced *vehicles with better performance.* Half of these respondents indicated that the new vehicles were hybrid buses. Several agencies commented that the engines in new buses offered much better performance, especially in terms of acceleration and hill-climbing ability. One agency replaced its cutaways (a bus body attached to a truck or van chassis) with “real transit buses.” Only one agency measured the specific impact of vehicles with better performance on bus speeds, noting a minor increase.

About 20% of all agencies reporting vehicle-related changes changed the *seating configuration* inside the bus. Reported changes include perimeter seating throughout the vehicle or in the rear; removal of a row of seats behind the wheelchair space to provide room for strollers/walkers; a 2-1 seating configuration by the rear door to improve interior circulation and reduce congestion. No agency measured the specific impact of seating configuration changes.

Almost 20% of all agencies reporting vehicle-related changes allowed *bicycle storage inside the bus.* No agency measured the specific impact of this action.

Eleven percent of all agencies reporting vehicle-related changes changed the *door configuration.* Half of these respondents changed the door configuration on BRT buses only, either with doors on both sides of the bus or a third door. The other agencies reported that all articulated buses in their fleet now had three doors. No agency measured the specific impact of door configuration changes.

TABLE 16
VEHICLE-RELATED ACTIONS

Action	No. Agencies Responding	% Agencies Responding
Introduce/increase use of low-floor buses	33	89.2
Switch from lifts to ramps for wheelchair access	29	78.4
Introduce/increase use of different-size vehicles	22	59.5
Introduce vehicles with better performance	17	45.9
Change seating configuration	8	21.6
Allow bicycle storage inside the bus	7	18.9
Change door configuration	4	10.8
Other	3	8.1
Total responding agencies	37	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

Other vehicle-related actions included taking the local climate into account when preparing bus specifications to ensure good performance. No agency measured the specific impact of “other” vehicle-related actions.

Overall, there are not enough reported evaluations to assess the effect of vehicle-related changes on bus speeds.

External Policy Changes

More than half (53%) of responding agencies reported changes in external policies (typically municipal traffic-related policies) to improve bus speeds. Most external policy changes offer the potential to increase bus speed through providing priority for transit vehicles or minimizing conflicts with automobiles. Table 17 summarizes actions taken.

The most common action was to implement *signal priority or queue jump lanes*, with two-thirds of responding agencies reporting this action (some of these are close to installation). Typically these actions are implemented on select corridors (often in conjunction with BRT) and at specific intersections. Two agencies noted extensive use of signal priority (one stated that 20% of its routes benefit from signal priority, and the other reported 300 intersections with signal priority and 10 queue jump locations). In some cases, priority is granted only if the bus is behind schedule by more than a specified period of time. Eight agencies (seven with signal priority only, one with both signal priority and queue jump lanes) measured the specific impact of these actions. Five (62.5%) reported a minor increase in bus speeds, two (25%) reported a moderate increase, and one (12.5%) reported a major increase with the caveat that the increase applied to bus speeds in the immediate vicinity of the intersection. One agency commented that signal priority works most effectively in conjunction with a dedicated lane.

Close to half (44%) of agencies reporting external policy changes benefitted from *signal timing changes.* Many cities have implemented signal synchronization on major arterials, and optimization is a continual process. One city adapted the signal progression to favor transit on major transit corridors. Three agencies described a formal process through which they can raise a signal timing problem with the municipality that owns the signal. All three agencies indicated that a change does not always occur, but in general revised timing plans are implemented where feasible.

TABLE 17
EXTERNAL POLICY CHANGES

Action	No. Agencies Responding	% Agencies Responding
Signal priority or queue-jump lanes	22	68.8
Signal timing	14	43.8
Bus-only lanes on arterial streets	13	40.6
Yield-to-bus laws	13	40.6
Turn restrictions	9	28.1
Parking restrictions	8	25.0
Other	6	18.8
Total responding agencies	32	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

One agency reported that its major city added “intelligence” to its signal system so that the signals now detect if there is a vehicle on the side streets waiting for a green light rather than having a set signal cycle. This change is reported to have had a more positive effect on running time than has TSP.

Seven agencies measured the specific impact of signal timing changes. Three (43%) reported minor increases in bus speeds; three (43%) reported moderate increases; and one (14%) reported a decrease in bus speeds. The decrease in bus speeds was a result of a city changing its signal timing cycle from 75 to 90 s within downtown.

Forty-one percent of all agencies reporting external policy changes saw the introduction of *bus-only lanes on arterial streets.* The bus-only lane was usually a curb lane; the lane was fully separated from other traffic in only two cities (one featured a contraflow lane). The number of routes using a bus-only lane varied widely, from “just our rapid service” to “about half of routes” to “most routes are on a bus lane somewhere.” Three agencies focused on freeway bus-only lanes. One indicated that existing HOV lanes on two corridors were being converted to bus-only lanes. Only one agency measured the specific impact of bus-only lanes; this agency noted a moderate increase in bus speeds.

Forty-one percent of all agencies reporting external policy changes indicated implementation or prior existence of yield-to-bus laws. In most cases, this is a state or provincial law. Buses have been equipped with decals, illuminated signs, or blinking signs. One agency reported that the law has resulted in faster, smoother merging back into traffic as well as increased driver awareness. No agency measured the specific impact of yield-to-bus laws on bus speeds. One agency noted that very few, if any, law enforcement agencies actually enforce the law.

Twenty-eight percent of all agencies reporting external policy changes described turn restrictions for nontransit vehicles. Restrictions include both left turns and right turns; in one case, through traffic is restricted except for buses. These restrictions may apply throughout downtown or during certain hours. No agency measured the specific impact of turn restrictions for nontransit vehicles.

One-quarter of all agencies reporting external policy changes described parking restrictions. These restrictions are at or near bus stops, on narrow segments of corridors, at locations with tight turning radii, or along major corridors during peak periods. No agency measured the specific impact of parking restrictions.

FIGURE 3 Sharrow lane markings.

Nineteen percent of all agencies reporting external policy changes cited other changes affecting bus speeds, including geometric changes to intersections, protected-permissive left turns triggered by means of a setback vehicle detector loop, a statewide “don’t block the box” law (with low enforcement priority), and tolls on major bridges. One agency noted that service reductions resulting from the economic downturn have slowed buses because of increased crowding. Another agency reported that several communities within its service area are adding or are considering sharrows, which are used to indicate travel lanes shared by bicyclists and motorists (see Figure 3). The agency’s concern is that shared lanes will result in lower bus speeds.

An agency in a large city noted many locations where the city has introduced pedestrian plazas and refuges, traffic calming measures, bike share stations, and bike lanes. In some cases this has slowed bus service, but such measures sometimes are helpful to service because they make accessing bus stops easier and safer for customers. Two agencies measured the specific impact of other external policy changes in isolation from other changes. One agency (with tolls implemented on a major bridge and a bus bypass lane) reported a moderate increase in bus speeds, whereas the other (with numerous traffic-calming measures) reported a decline in bus speeds.

One agency noted a key difficulty in cooperating with other agencies: City traffic signal engineers are not experts in bus transit, and transit analysts are not experts in traffic signal timing. Regarding TSP, the transit agency controls only the emitters and not the receivers or the programming of the controllers and does not have staff to monitor and make sure the controllers are all still working. Anecdotally, bus operators think that signal priority helps at some intersections and actually hurts at others.

External, often traffic-related, policies can have a major effect on bus speeds. The magnitude of the effect depends on the specific policy and the location where it is applied and can be affected by other factors, such as enforcement.

Internal Policy Changes

Almost half (48%) of responding agencies reported changes in internal policies to improve bus speeds. Unlike external policy changes, these changes are under the control of the transit agency. These actions offer the potential to increase bus speed by reducing dwell time through faster boardings or other means or by changing hold policies at transit centers. Table 18 summarizes actions taken.

The most common action was pricing to encourage the use of *prepaid fare media*, with 75% of responding agencies reporting this policy. The most common actions were offering a large discount or increasing the discount for prepaid media. Some agencies added discounted fare media (day pass, family pass), whereas others reduced fare media in favor of a smart card. A higher price for onboard fare collection was mentioned by two agencies. One agency simplified its zone system, and one changed to exact fare. Only one agency measured the specific impact of prepaid fare media, indicating that an increased discount on prepaid media resulted in a minor increase in bus speeds.

TABLE 18
INTERNAL POLICY CHANGES

Action	No. Agencies Responding	% Agencies Responding
Pricing to encourage use of prepaid fare media	22	75.9
Off-board fare collection	8	27.6
All-door boarding	7	24.1
Changes in hold policies at transit centers	7	24.1
Free fares or introduction/discontinuation of fare-free zones	6	20.7
Changes in bus door practices	3	10.3
Other	3	10.3
Total responding agencies	29	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

Almost 30% of all agencies reporting internal policy changes allowed or required *off-board fare collection*. There was some overlap with prepaid fare media (generally purchased off board). Two agencies indicated off-board fare collection was required only on its BRT routes. One agency reported a demonstration project using a phone-based payment system that is being considered for full deployment on all routes. Only one agency measured the specific impact of off-board fare collection, noting that this action in conjunction with all-door boarding decreased running times by 9%.

One-quarter of all agencies reporting internal policy changes allowed *all-door boarding*. Three of the seven agencies allow this only on BRT routes, one only on two very busy college routes, one only in downtown on pay-as-you-exit express routes, and one only on double-decker buses with a conductor on board. San Francisco Municipal Transit Agency is the only agency that allows all-door boardings on all routes (except cable cars), a policy that began in July 2012. Two agencies measured the specific impact of all-door boarding. As noted in the previous paragraph, one agency reported a decrease of 9% in running times from a combination of all-door boarding and off-board payment. The second agency, which allowed all-door boarding on its pay-as-you-exit express routes, reported a reduction in boarding time of 3 to 4 s per passenger.

One-quarter of all agencies reporting internal policy changes described changes to *hold policies at transit centers*. Two agencies have a maximum hold time of 5 min and one other has a maximum of 10% of the headway. Hold times are allowed to exceed the maximum for the last trip of the day. One agency reported a change to a slightly longer hold time. Two others reported that supervisors can decide not to hold buses if only one bus is late or for long-distance buses in off-peak times. No agency measured the specific impact of changes to hold policies.

More than one-fifth (21%) of all agencies reporting internal policy changes introduced or eliminated free-fare zones or routes. Two agencies discontinued downtown free-fare zones. Two others eliminated zones or raised prices across all zones. One agency introduced a free-fare route. One agency allows free boardings within the downtown area on two routes that end in downtown. This agency indicated that ridership has increased, and as a result the routes are slower through downtown. No agency measured the specific impact of changing free-fare zones.

Eleven percent of all agencies reporting internal policy changes noted a change in bus door policies. Two agencies restrict multiple door opening at stops; one has a policy that the operator cannot open stop and open the door again once the bus has pulled away from a stop even if a passenger is running to the bus; the other instructs operators to avoid multiple stops at busy downtown stops where buses line up unless the second stop is for a passenger with disabilities. Another agency noted that bus operators open all doors routinely on BRT routes. No agency measured the specific impact of bus door policies.

Other internal policy changes include offering electronic fare cards; allowing strollers and walkers to remain open on the bus; and banning the use of the radio to ask other buses to wait for transferring passengers. The agency offering electronic fare cards noted that these cards are popular with express bus riders and have reduced the dwell time at some park-and-ride lots. Electronic fare cards are used less on local routes, except among college students. Bus speeds have not increased on routes serving colleges, but electronic pass cards accommodate heavy loading without a need to add time to the schedule. One agency measured the specific impact of other internal policy changes, noting a small increase in bus speeds as a result of electronic fare card use on express buses.

Internal policies can affect bus speeds. The magnitude of the effect appears to be greater with a combination of all-door boardings and off-board fare collection. There is less evidence of actual impacts for other internal policies.

Other Actions

Eleven agencies (19% of all responding) reported other actions to improve bus speeds. Several agencies took the opportunity to mention actions that will be implemented soon. Actions that have already been taken include the use of pedestrian bridges to separate pedestrians and buses at key locations; land use designs that limit off-street movements within developments; bus bulbs; boarding islands to remove transit from right-turn queues; redesign of roadways that allows transit to avoid traffic congestion wherever possible; proactive implementation of bus transit priority measures; techniques to monitor individual operators and address behavior issues affecting bus speed; and a downtown mobility study addressing transit, bicycles, and pedestrians.

One agency measured the specific impact of other changes. This agency reported a minor increase in bus speeds as a result of roadway redesign.

METRICS USED TO MEASURE THE OVERALL IMPACT OF CHANGES

Many agencies indicated that individual changes were evaluated as part of a total package of improvements. Table 19 presents the metrics used to measure the overall impacts. Metrics of greatest concern for this study (change in average bus speed and analysis of components of travel time) were cited by 35% and 33%, respectively, of respondents. The most common metrics reported were on-time performance and ridership. Table 19 confirms observations elsewhere in the survey that many actions were taken for reasons other than increasing bus

TABLE 19
METRICS USED TO MEASURE OVERALL IMPACT OF ALL CHANGES IMPLEMENTED

Metric	No. Agencies Responding	% Agencies Responding
Schedule adherence	51	92.7
Ridership	29	52.7
Change in average bus speed	19	34.5
Analysis of components of travel speed (dwell time at stops, time stuck in traffic, etc.)	18	32.7
Operating cost	17	30.9
Qualitative measures from passenger surveys	14	25.5
Other	9	16.4
Total responding agencies	55	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

speeds. "Other" metrics included person-minutes of delay (to determine the need for roadway improvements); travel times on specific route segments; change in travel time; other forms of passenger comments; discussions with bus operators; time and delay studies; and analysis of AVL data on specific routes.

Forty (73%) of the 55 agencies described overall results (Table 19). It should be noted that many of the responses were qualitative in nature. Table 20 summarizes the reported results. Only six agencies (of 20 that reported impacts on bus speeds) experienced increases in bus speeds. Four others stated that the actions taken mitigated decreases in bus speeds as a result of other factors; one commented that changes enabled the agency to maintain the average speed on local bus routes through a period of major growth in ridership. This highlights the difficulty of achieving increases in bus speeds in the face of external factors that can slow speeds. A few agencies also noted that bus speeds were negatively affected by actions taken for other purposes, such as adding running time to improve on-time performance.

An interesting "other" measure was variability in running time. Two agencies reported a decrease in variability. In one case, this decrease resulted from operation on an exclusive right-of-way for a BRT line. The other agency said that implementation of signal priority led to a decrease in travel time variability.

Examples of quantitative or comparative results reported by respondents include:

- Bus speeds on BRT routes are approximately 10% to 15% faster than on comparable regular service routes;
- Improving traffic signals through TSP and signal timing to aid the flow of transit vehicles had the greatest impact on bus speeds;

TABLE 20
OVERALL IMPACT OF ALL CHANGES IMPLEMENTED

<table>
<tr><th>Element</th><th>No. Agencies Responding</th><th>% Agencies Responding</th><th>Direction of Change</th><th>No. Agencies</th></tr>
<tr><td rowspan="5">Speed</td><td rowspan="5">20</td><td rowspan="5">50.0</td><td>Increase</td><td>6</td></tr>
<tr><td>Decrease</td><td>7</td></tr>
<tr><td>Decrease mitigated</td><td>4</td></tr>
<tr><td>No change</td><td>2</td></tr>
<tr><td>BRT increase</td><td>3</td></tr>
<tr><td rowspan="3">On-time performance</td><td rowspan="3">19</td><td rowspan="3">47.5</td><td>Increase</td><td>16</td></tr>
<tr><td>Decrease</td><td>1</td></tr>
<tr><td>No change</td><td>2</td></tr>
<tr><td rowspan="2">Ridership</td><td rowspan="2">7</td><td rowspan="2">17.5</td><td>Increase</td><td>6</td></tr>
<tr><td>No change</td><td>1</td></tr>
<tr><td>Other measures</td><td>11</td><td>27.5</td><td rowspan="2" colspan="2"></td></tr>
<tr><td>Total agencies responding</td><td>40</td><td>100</td></tr>
</table>

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

- HOV direct access ramps or freeway stations had the most notable impact on bus speeds and travel time;
- Specific routes have seen a ridership increase of 65% over the past 5 years, and on-time performance on some routes has increased by 25%;
- Overall scheduled speed for local routes decreased by less than 2% over the past 5 years, and local ridership increased by 17%;
- Schedule adherence improved by 35%;
- On-time performance improved to 86% in recent years;
- On-time performance is now 94%; and
- On-time performance on the primary route improved from one of the worst in the system (83%) to one of the best (92%).

ACTIONS CONTEMPLATED BUT NOT IMPLEMENTED

Transit agencies have a wide variety of options from which to choose. The survey asked about actions that were considered but not implemented. More than half (56%) of the agencies that answered this question indicated that certain actions were considered but never taken. Table 21 lists actions mentioned by at least 15% of responding agencies and notes the primary reasons for not taking each action.

It is possible to glean from Table 21 the primary reasons for not implementing desired actions:

1. Rider opposition—for actions that would require a longer walk to a bus stop or otherwise affect convenience. Americans with Disabilities Act (ADA) concerns also apply to such actions.
2. Lack of cooperation from municipalities—for traffic engineering actions such as dedicated lanes and signal priority for buses.
3. Community opposition—from businesses for dedicated lanes and from homeowners for stop relocation.
4. Costs and funding—a general concern.

The case examples presented in chapter five have been chosen in part to demonstrate how some agencies overcame these concerns.

TABLE 21
ACTIONS CONTEMPLATED BUT NOT IMPLEMENTED AND PRIMARY REASONS

Action	No. Agencies Responding	% Agencies Responding	Primary Reasons
BRT service	13	44.8	Cost; plans for future rail; envisioned as wholly apart from current system
Signal priority for buses	13	44.8	Community/city opposition; logistics of coordinating; funding
Increased stop spacing	12	41.4	Customer convenience; no alternative service; ADA accessibility
Bus-only lanes on arterial streets	11	39.3	Opposition from businesses in the corridor and others; under city control; plans for future rail
Off-board fare collection	9	31.0	Enforcement/other costs; no reliable technology; transit center not designed for this
Changes in stop location	8	27.6	Changed agency priorities; opposition from locals and property owners; lack of political will
Limited-stop service	8	27.6	Cost; ADA accessibility
Queue-jump lanes	8	27.6	Opposition by traffic engineers/others; under city control; limited opportunities
All-door boarding	6	20.7	Enforcement cost; capital/maintenance cost
Signal timing	6	20.7	Lack of willingness by city
Level boarding at major stops	5	17.2	Cost; community opposition
Changes to vehicle size/performance	5	17.2	Inability to store/maintain; cost; community opposition
Streamlined route design	5	17.2	Customer opposition; backlash about added transfers; ADA concerns
Other	23	79.3	Variety of actions/reasons
Total agencies responding	29	100	

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

TABLE 22
RATINGS OF POTENTIAL CONSTRAINTS

Potential Constraint	Major Constraint	Minor Constraint	Not a Constraint	No. Agencies Responding
Inability to identify a funding source	54%	24%	22%	54
Lack of cooperation from outside agencies	33%	41%	26%	54
Competing goals viewed as more important	32%	44%	24%	54
Safety concerns from operations department	32%	37%	32%	54
Passenger complaints	26%	48%	26%	54
Lack of support from upper management	19%	25%	57%	53
General reluctance to change	13%	42%	45%	53
Operator complaints	11%	51%	38%	53
Other	25%	75%	0%	12

Source: Survey results.
Note: Percentages do not necessarily add to 100% across rows because of rounding.

CONSTRAINTS

The discussion of actions contemplated but not implemented is a good lead-in to a broader examination of constraints affecting the ability to take actions to improve bus speeds. Survey respondents described various elements in terms of the extent to which they were constraining factors. Table 22 summarizes the results. The inability to identify a funding source is the only element characterized as a major constraint by a majority of respondents. Lack of cooperation from outside agencies, competing goals, and safety concerns were identified as major constraints by at least 30% of respondents. "Other" issues noted as major constraints include lack of support from municipal staff and the time it takes to make changes (often affected by staffing levels). Additional issues were ADA accessibility, neighborhood opposition regarding the removal of four-way traffic stop signs, safety concerns over operators driving too fast, business or property owner opposition to parking removal, bus-only lanes, high-volume bus stops, budget limitations, lack of vehicles (a result of budget limitations), lethargy, the inability to marshal internal resources, difficulty in dealing with a larger bureaucracy (such as a state department of transportation with different priorities), and politics. One respondent noted that the goal of improved bus speeds is deemed laudable but is not accorded high priority.

Respondents also answered an open-ended question to describe the major constraint affecting a given program. Examples of specific responses are shown here. Table 23 summarizes the responses.

> Time, we are doing what we can in the time that we have to do it. We could argue that we don't have enough staff or money, but that would be a false claim. We are doing what we can with the resources that we have available to us and we have seen significant improvement in a number of areas. The thing that we cannot control is the number of vehicles that share the road with us, nor can we control the timing cycles at intersections

TABLE 23
MAJOR CONSTRAINTS FACING IMPLEMENTATION OF ACTIONS TO IMPROVE BUS SPEEDS

Constraint	No. Agencies Responding	% Agencies Responding
Funding	19	44.2
Competing priorities	14	32.6
Lack of support from external agencies	9	20.9
Customer opposition	8	18.6
Existing traffic/factors beyond our control	6	14.0
Community opposition	3	7.0
Staff time	3	7.0
Other	5	11.6
Total responding agencies	43	100

Source: Survey results.
Note: Percentages do not add to 100.0% because of rounding.

> (although our work with the State and the Counties related to our TSP program is bearing some fruit on those routes—we are seeing signal optimizations that are improving our speeds in a limited way). We still have not been able to overcome the on-street parking in some communities.
>
> Some stops were placed back due to passenger complaints. Operator complaints of running too fast and not enough layover. Operations holding buses too long at transit centers for transfers and not managing late buses coming in. Transfers taking priority over releasing buses. City not wanting to invest in signal prioritization due to costs. No funding if fares eliminated. Wanting to reduce costs on demand response by offering free fixed route rides causing more ramp usage and slowing speeds.
>
> In issues previously described, speed was perceived as less important than customer convenience. Streamlining routes thru the CBD would have forced more transfers. In addition, efforts to give bus priority at traffic signals have continually been stymied in this community by the City Fire Department, which controls the signal system. Significant political pressure will have to be brought to bear to change that.
>
> Increasing traffic and ridership make it difficult to improve bus speed. Just holding speed constant is a major challenge. Coordinated transfer route design limits the ability to add a small amount of time to a route to improve on-time performance.
>
> There is a lack of understanding among some members of our staff as to the extent to which internal policies such as fare pricing and collection, stop spacing, and inefficient routes with unnecessary turning movements impact bus travel speeds. Implementing other elements such as signal priority and dedicated lanes has proved difficult to get support for and coordinate with multiple local agencies. It has historically also been very difficult from a public relations standpoint to remove bus stops.

SUMMARY

A total of 59 agencies reported on approaches for improving transit bus speeds. The need for such actions is reflected in current trends. More than 75% of respondents reported that bus speeds have either across the board or in certain areas or for certain types of service.

At least two-thirds of all responding agencies took actions in the areas of schedule and route adjustments. Bus stop location, design, and placement, internal and external policy changes, and vehicle-related actions were also fairly common. Only one agency did not take any action intended to improve bus speeds.

The survey results reinforce that there are many valid ways to tinker with speeds and get some improvement. The greatest benefit typically can come from working with city traffic engineers to find ways to expedite the flow of transit vehicles. The most common external policy action was to implement signal priority or queue jump lanes, followed by changes to signal timing, bus-only lanes on arterial streets, and yield-to-bus laws. External policies can have a major effect on bus speeds. The magnitude of the effect depends on the specific policy and the location where it is applied; it also can be affected by other factors, such as enforcement.

Schedule-related actions offer the potential to increase bus speed by reducing the need for the bus to hold at stops if it is ahead of schedule or by balancing service time and recovery time more appropriately. Improving bus speeds can be a collateral benefit of certain schedule-related actions, but the primary purpose of these actions is to improve schedule adherence and reliability. By far the most common action reported was to adjust running times, an action that usually decreases scheduled bus speed.

Route adjustments offer the potential to increase bus speed by keeping the bus on a major corridor, thereby reducing the number of deviations and turns, or by introducing new services that stop less often. The most common action was to streamline routes. On average, respondents reported streamlining approximately 19% of their routes, with a median percentage of 15%. Limited-stop and BRT services were also common actions, and these services clearly improve bus speeds. Streamlining bus routes can also improve bus speeds to a lesser extent.

Stop-related actions offer the potential to increase bus speed by reducing the number of stops, making it easier to get into and out of bus stops, or by reducing dwell time at stops. The most common action was to increase bus stop spacing, followed by changing the location of stops. There are not enough reported evaluations to assess the effect of all bus stop changes on bus speeds. Stop spacing is the most successful stop-related strategy to increase bus speeds.

Vehicle-related actions offer the potential to increase bus speed, reducing dwell time at stops or improving acceleration. The most common action was to introduce or increase the use of low-floor buses with ramps instead of lifts, followed by use of different-size vehicles, and introduction of vehicles with better performance. There are not enough reported evaluations to assess the effect of vehicle-related changes on bus speeds.

Internal policy changes are under the control of the transit agency. These actions offer the potential to increase bus speed by reducing dwell time through faster boardings or other means or by changing hold policies at transit centers. The most common action was pricing to encourage use of prepaid fare media. Some agencies also reported experience with all-door boarding and off-board fare collection. The magnitude of the effect of these policies appears to be greatest with a combination of all-door boarding and off-board fare collection. There is less evidence of actual effects for other internal policies.

Many agencies indicated that individual changes were evaluated as part of a total package of improvements. Among metrics reported to measure the overall effects, those of greatest concern for this study (change in average bus speed and analysis of components of travel time) were cited by 35%

and 33%, respectively, of respondents. The most common metrics reported were on-time performance and ridership. Many actions were taken for reasons other than increasing bus speeds.

Only six agencies (of the 20 that reported changes in bus speeds) experienced increases in bus speeds. Four others stated that the actions taken mitigated decreases in bus speeds owing to other factors; one commented that changes enabled the agency to maintain the average speed on local bus routes through a period of major growth in ridership. This highlights the difficulty of achieving increases in bus speeds in the face of external factors that can slow speeds. A few agencies also noted that bus speeds were negatively affected by actions taken for other purposes, such as adding running time to improve on-time performance.

The survey asked about actions that were considered but not implemented. More than half of respondents indicated that certain actions were considered but never taken. The primary reasons for not taking actions included costs and funding, customer or community opposition, and lack of cooperation from external agencies. Broader survey findings suggest that many successful actions rely on building relationships with external agencies, particularly city traffic engineers.

Respondents also described various constraining factors and the extent to which they affected the ability to take action. Inability to identify a funding source is the only element characterized as a major constraint by a majority of respondents. Lack of cooperation from outside agencies, competing priorities, and safety concerns were identified as major constraints by at least 30% of respondents.

CHAPTER FOUR

AGENCY ASSESSMENT OF ACTIONS TO IMPROVE BUS SPEEDS

INTRODUCTION

The previous chapter addressed survey results related to trends in local bus speeds, types of actions taken to improve bus speeds, and the effects of these actions. This chapter's focus is on agencies' evaluations of their program of actions. Specific topics include agency assessment of the success of actions taken, benefits and drawbacks, potential improvements, and lessons learned.

RATINGS OF ACTIONS TAKEN TO IMPROVE BUS SPEEDS

Table 24 shows transit agencies' ratings of actions taken to improve bus speeds. Most respondents (54%) rated their actions as somewhat successful. One-third reported a neutral outcome. Only 8% of respondents reported an unsuccessful rating. All "very successful" ratings were for actions to improve schedule adherence only.

Table 25 presents the primary benefits of these actions. These are responses to an open-ended question. The most frequently cited benefit was improved on-time performance and reliability, with almost half of all respondents citing this outcome. Next was the ability to mitigate factors slowing bus speeds (such as increased congestion, increased ridership, increased mobility-impaired ridership, and new operator learning curves), followed by an improved customer experience, and increased bus speeds. Two of the eight agencies reporting improved bus speeds noted only modest increases, and two others stated that the speed improvement applied only to new BRT service.

"Other" benefits included a renewed sense of cooperation with the city; reduced schedule variability; reduced reports of operators speeding; faster loading times and less confusion among customers; improved transfer connections; and a more rational transit network.

Table 26 summarizes drawbacks of actions taken to improve bus speeds, based on responses to an open-ended question. The most frequently cited problems involve customer complaints over stop relocations and reduced level or quality of service. Reduced level of service arises from longer headways (a result of changes to running times), route truncations or changes to one-way loops at ends of routes, and limited service in low-density areas. Quality of service is seen in overcrowding (a result of less seating capacity in low-floor buses) and transfer-related issues (greater need to transfer as a result of route truncations or rerouting or more frequent missed connections because of changes in hold-time policy).

Several agencies noted that improvements to bus speeds are being overwhelmed by continuing increases in traffic congestion and transit ridership. This phenomenon affects agency credibility and contributes to customer resentment. Cost and funding availability are also issues, primarily on the capital side but operationally in terms of continued local service on limited-stop and BRT corridors. Two agencies noted that the actions taken were not comprehensive, resulting in minor improvements perceived as "good enough." Fifteen percent of all respondents reported no drawbacks.

Other issues mentioned by fewer than 5% of respondents are grouped in the "other" category in Table 26. These included community complaints, stakeholder education, complaints regarding unsafe driving by operators, the tension between improving on-time performance and improving bus speeds, the unpopularity of headway-based schedules among operations supervisors, and capacity constraints of park-and-ride lots as a limiting factor in rerouting routes by means of HOV freeway lanes.

Table 27 reports the most successful (as defined by the respondents) actions taken. There is no consensus regarding the most effective single action to improve speeds. Consolidating stops was most frequently mentioned, but only 20% of responding agencies cited this action. Respondents gave multiple responses despite the phrasing of the question; some indicated that it was difficult to separate the impacts of actions taken together.

Although not definitive, Table 27 suggests an ordering of actions by effectiveness. The most effective among non–BRT-related actions include stop consolidation, route restructure, fare policy or fare payment (off-board fare collection usually is associated with BRT, but there are other actions in this category), vehicle size or configuration, and limited-stop service. One agency reported that eliminating paper transfers was the biggest single factor in improving bus speeds. TSP and reserved bus lanes or guideways were called out as effective components of BRT service, although these actions have also been implemented for non-BRT service.

TABLE 24
AGENCY RATING OF ACTIONS TAKEN TO IMPROVE BUS SPEEDS

Rating	No. Agencies Responding	% Agencies Responding
Very successful	3	5.8
Somewhat successful	28	53.8
Neutral	17	32.7
Somewhat unsuccessful	4	7.7
Very unsuccessful	0	0.0
Total responding agencies	52	100

Source: Survey results.

Among agencies focused on schedule adherence, revising schedules and monitoring running time at the route segment level were important. The response that reduced bus speeds were the most effective action was from an agency whose primary goal was to improve on-time performance. One agency cited headway-based schedules in the peak periods as yielding the greatest time savings and noted that "testing" a route with headway-based schedules can uncover running time savings.

Respondents were asked, "If you could change ONE aspect in the process of designing and implementing actions to improve bus speeds, what would you change?" Table 28 summarizes the results.

Traffic engineering measures, particularly signal priority for buses and dedicated bus lanes on arterials, would receive more attention from almost one-quarter of agencies responding. Taking a more systematic, data-driven approach was suggested by 20% of respondents. Outreach, explaining the importance of improved bus speeds to cities and the general public, ranked third. Multiple agencies also mentioned stop consolidation, raising the internal priority of improving bus speeds, and the need for additional funding.

One interesting suggestion was to incorporate the transit priority guidelines in the *Manual on Uniform Traffic Control*

TABLE 25
PRIMARY BENEFITS OF ACTIONS TAKEN TO IMPROVE BUS SPEEDS

Benefit	No. Agencies Responding	% Agencies Responding
Improved on-time performance/reliability	20	47.6
Able to mitigate factors slowing bus speeds	10	23.8
Improved customer experience	9	21.4
Increased bus speeds	8	19.0
Increased ridership	6	14.3
Reduced/constant operating costs	5	11.9
Improved efficiency	3	7.1
Improved operator satisfaction	2	4.8
Reduced accidents	2	4.8
Other	6	14.3
Total responding agencies	42	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

TABLE 26
DRAWBACKS OF ACTIONS TO IMPROVE BUS SPEEDS

Drawback	No. Agencies Responding	% Agencies Responding
Passenger complaints about stop relocation	12	29.3
Reduced level of service or reduced comfort/reliability	12	29.3
None	6	14.6
Benefits overwhelmed by continuing traffic and ridership increases	5	12.2
Increased cost/limited funding	5	12.2
Improvements are not comprehensive enough	2	4.9
Reduced credibility/customer resentment	2	4.9
Other	6	14.6
Total responding agencies	41	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

TABLE 27
MOST SUCCESSFUL ACTIONS TAKEN

Action	No. Agencies Responding	% Agencies Responding
Consolidating stops	8	19.5
Restructuring/streamlining routes	6	14.6
Transit signal priority	6	14.6
Fare policy/fare payment	5	12.2
BRT	5	12.2
Vehicle-related (low-floor buses, smaller buses)	4	9.8
Limited-stop service	4	9.8
Reserved bus lanes/guideways	4	9.8
Schedule-related (adjusting running times/ increasing recovery time/headway-based schedules)	4	9.8
Monitoring on-time performance on all route segments	3	7.3
Improving signal timing	2	4.9
Express service on freeways	2	4.9
Reduced bus speeds	1	2.4
Total responding agencies	41	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

Devices for Streets and Highways (MUTCD) (*46*). The respondent noted that local jurisdictions are hesitant to implement extraordinary measures that are not "endorsed" by inclusion in the MUTCD. An ongoing TCRP study (A-39, *Improving Transportation Network Efficiency Through Implementation of Transit-Supportive Roadway Strategies*) includes potential changes to MUTCD among its objectives and may address this concern. Those citing internal processes and priorities stressed the need for all departments within the transit agency to understand the benefits accruing from improved bus speeds. "Other" responses included all-door boarding at heavy stops, off-board fare collection, a streamlined public process, greater decision-making power for scheduling and operations staff, and not requiring a traffic model run for every change.

TABLE 28
ONE CHANGE TO DESIGNING AND IMPLEMENTING ACTIONS TO IMPROVE BUS SPEEDS

Action	No. Agencies Responding	% Agencies Responding
Add traffic engineering measures (TSP, dedicated lanes, bus bulbs)	9	22.5
Take a more systematic, data-driven approach	8	20.0
Educate cities/general public about benefits of improved bus speeds	6	15.0
No change/not sure	6	15.0
Emphasize stop consolidation	5	12.5
Achieve a higher internal priority for speed improvements	4	10.0
Increase funding	3	7.5
Other	5	12.5
Total responding agencies	40	100

Source: Survey results.

LESSONS LEARNED

Survey respondents shared lessons learned that would benefit other agencies considering implementation of similar actions to improve bus speeds. The lessons learned were grouped into nine broad categories, as shown in Table 29. Lessons regarding outreach to external stakeholders led the list of topic areas, followed by process/analysis, internal consensus, and persistence.

Responses are presented by category here. All comments are reported verbatim as expressed by agency respondents.

Outreach to External Stakeholders

- Selling decision makers on "hours saved" that can be reinvested back in the service.

TABLE 29
LESSONS LEARNED

Lessons Learned Category	No. Agencies Responding	% Agencies Responding
Outreach to external stakeholders	10	30.3
Process/Analysis	9	27.3
Internal consensus	6	18.2
Persistence	6	18.2
Fare payment	3	9.1
Transit speed versus traffic speed	3	9.1
Schedules/on-time performance	3	9.1
Vehicles	2	6.1
Limits of technology	2	6.1
Total responding agencies	33	100

Source: Survey results.
Note: Multiple responses allowed; percentages do not add to 100%.

- Extremely important to have high level support at the local municipality for actions related to external policies (e.g., TSP and physical transit priority measures).
- Listen to the public.
- More outreach at earlier stages of project development is better but doesn't guarantee success.
- It's important to keep the public involved and consider both public and bus operator feedback. Then taking their points into consideration, revise the changes to bus stops, but only where it makes sense. Often this is not a popular stance with passengers using a particular stop, but overall in the long run it makes for a better ride.
- Know your community and adhere to their desired expectations of the service they wish to have. This will provide a level of support for any improvements, changes, and enhancements planned.
- Good working relationship and partnership with local jurisdiction.
- Start with educating the stakeholders.
- Bus stop consolidation is not easy from a public relations stand-point.
- Ensure that you are kept in the loop on any construction projects rather than finding out the hard way or when it occurs.

Process/Analysis

- Start with the biggest bang (Phase I of stop consolidation included all routes with 15-minute frequencies).
- Having solid data and making a compelling case for why the changes are needed and how they provide broad benefits to customers and the overall mobility for the area are critical.
- Don't get so focused on trying to improve the on-time performance metrics that you lose track of trends in bus system speeds.
- Have the resources to measure and evaluate the impact on continuous basis.
- Attention needs to be paid to passenger origin and destination.
- Don't be afraid to make recommendations that did not originate from the public. Often the public will look at just adjusting the existing model rather than thinking "outside the box" for new and innovative ways to deliver service.
- Pay attention to left turns, eliminate them when you can, the queuing at intersections takes valuable minutes out of your schedule. Stay out of campuses (shopping centers, corporate campuses, college campuses), they really slow you down and expose you to accidents (which *really* slow you down).
- Plan routes to operate as directly as possible to major destinations. Limit stops—customers will walk farther to access good service. Provide a range of access options at major stops—coordinated local bus connections, sidewalks/bike trails to multi-family areas, in addition to park-and-ride.
- The other item to be wary of is the actual physical removal of the bus stops. If there is not proper communication and follow through, stops that should be removed are still standing, or maybe the transit agency bus stop has been removed but the city regulatory signs are still standing. Not having the proper communication and follow through on this front causes much confusion for both operators and passengers. So make sure it's clearly communicated to the folks doing the work which stops are to be removed—both the transit agency staff, and the respective municipality staff, and then have someone double check their work.

Internal Consensus

- Keep communication of goals and plan open to all (union and management) and invite input.
- Decreases in travel speeds need to be recognized as not simply an inevitable consequence of increased traffic and passenger loads, but as something that the agency has the power to affect through their own actions (or inaction). It is critical for staff at all levels of management to understand this concept.
- It's important to consider bus operator feedback.
- Extremely important to have high level support within the transit agency.
- Fully engage and involve all components of your organization in design of BRT system.
- Training operators to operate safely at higher speeds.

Persistence

- It takes on-going analysis and attention to detail. A crisis can create similar actions but making changes to routes tends to be incremental. You have to have a clear objective in mind and work toward that goal.
- Bus operators who initially oppose stop consolidation may become your biggest champions. Riders, too, will begin to push for stop consolidation as they see the benefits to their own commutes. Don't be thrown off by media attention or the initial complaints.
- On the bus stop spacing issue, you need to adopt a policy, and then work hard to adhere to it. It takes time to review passenger activity at all bus stops and then make recommendations.
- Make sure you have the resources to implement and operate the actions/systems you put in place.
- Just keep at it.
- Be prepared to receive complaints about queue-jumps from less-observant car drivers.

Fare Payment

- Have customers purchase fares before boarding the vehicle and or limit fare types.
- Off-board fare collection in tandem with all-door boarding is highly successful.
- The single factor that improved and smoothed operations the most is one I do not recall seeing asked/discussed in this survey: the elimination of paper transfers. Transfers are still permitted, but only through smart cards. That has increased the use of smart cards, both speeding the passenger's transaction time as well as driver time spent on such transactions. Cumulatively, this is our single biggest factor.

Transit Speed Versus Traffic Speed

- Our experiment to reduce bus stops along a route in a dense residential area with stops every block was unsuccessful because of the number of four-way stop signs at each intersection. Not only did we save little time, but because the bus stopped at every other block without picking up or dropping off passengers we were criticized by the riding public.
- Consider transit speed in relation to traffic speeds to determine if transit is a competitive mode of travel in the corridor.
- Design express bus service to be competitive with driving alone and attract choice riders who are not transit-dependent. Develop HOV or bus-only lanes to increase speed and improve dependability and on-time performance.

Schedules/On-time Performance

- Lessons learned that incremental time point and dwell time adjustments are not long-term fixes to the problem of schedule adherence.
- Schedule development with proper layover is important. Squeezing cycle time to reduce costs can impact the quality of your service. You have to be careful about it.
- Design your own report from the AVL system to represent how you schedule vehicles and that match your traffic patterns. Also, increase your speed from the 1st to the 2nd time point to allow for faster operators or light traffic days. This prevents operators from hanging back at the beginning of the trip or having to wait at the 2nd time point to avoid leaving early.

Vehicles

- Some issues with ramps and slope, particularly in rural areas. With larger and heavier wheelchairs, ramps sometimes present problems. Check out these issues prior to purchasing.
- Smaller vehicles are quicker than a larger vehicle.

Limits of Technology

- If you are thinking about Transit Signal Priority, it's much harder to design something that works than you think. You can't just install it, turn it on and tinker with the programming. It can help at individual intersections that are problematic, but before spending money on a whole corridor, hire yourself an expert traffic engineer to do computer modeling of the entire corridor first.
- Signal priority is more likely to affect travel time variability than to reduce wholesale travel time; that is, it may be unrealistic to expect to save enough travel time to reduce the number of buses deployed on a route with signal priority.

SUMMARY

This chapter has described agency assessments of actions taken to improve bus speeds. Findings include:

- Results regarding the success of actions taken are neutral to positive. Only 6% of survey respondents rated the actions as very successful. More than half rated their actions as somewhat successful, and one-third reported a neutral outcome.
- The primary benefit of these actions is improved on-time performance and reliability, cited by almost half of all respondents. Other benefits include the ability to mitigate negative trends in bus speeds, an improved customer experience and increased bus speeds, particularly on BRT or limited-stop service.
- The major drawbacks of these actions are customer complaints about stop relocations and reduced level or quality of service. Quality of service issues involve overcrowding (shifting to use of low-floor buses with fewer seats reduces capacity) and tradeoffs between improving bus speed and improving on-time performance. Several agencies noted that improvements to bus speeds are being overwhelmed by continuing increases in traffic congestion and transit ridership. Two agencies noted that the actions taken were not comprehensive, resulting in minor improvements perceived as "good enough." Fifteen percent of survey respondents reported no drawbacks.
- Consolidating stops was most frequently mentioned as the most successful action, but only 20% of responding agencies cited this action. Respondents indicated that it was difficult to separate the impacts of actions taken together. There is no consensus regarding the most effective single action to take to improve speeds. Responses suggest that stop consolidation, route restructuring, fare

policy/fare payment, vehicle size/configuration, TSP, and limited-stop service are the most effective non-BRT actions.

- Traffic engineering measures, particularly signal priority for buses and dedicated bus lanes on arterials, led all responses to the question: "If you could change ONE aspect in the process of designing and implementing actions to improve bus speeds, what would you change?" Respondents also mentioned a more systematic, data-driven approach and added outreach to cities and the general public explaining why these actions are important among desired improvements.
- Survey respondents shared lessons learned that would benefit other agencies considering implementation of similar actions to improve bus speeds. Lessons learned were grouped into nine broad categories. Lessons regarding outreach to external stakeholders led the list of topic areas, followed by process/analysis, internal consensus, and persistence. A total of 44 responses are provided within these nine categories.

CHAPTER FIVE

CASE EXAMPLES

INTRODUCTION

Synthesis survey results provide an overview of the actions taken to improve bus speeds. Following a review of these results, six agencies were chosen as case example sites. Personnel directly involved with these programs agreed to be interviewed by telephone. In all cases, more than one person at an agency either participated in the interviews or reviewed the draft summary of the case example. The case examples provide additional details on innovative and successful practices, guidance in the form of lessons learned, and insights into overcoming obstacles to implementation.

The selection process for case examples had several criteria: (1) include transit agencies of various sizes in different parts of the country; (2) include agencies that have taken different types of actions; (3) include agencies that reported detailed and interesting observations in the survey; and (4) include at least one agency that assessed its actions as less than somewhat successful to reflect real difficulties facing attempts to improve bus speeds. More than 60% of responding agencies offered to serve as a case example. The six agencies chosen provide an overview of the current state of strategies for improving bus speeds.

Figure 2 in chapter one shows the location of the case example cities. The six case example cities and agencies are:

- Columbus, Ohio: Central Ohio Transit Authority
- Gainesville, Florida: Gainesville Regional Transit System
- Nashville, Tennessee: Metropolitan Transit Authority
- New York City: MTA–New York City Transit
- San Francisco, California: San Francisco Municipal Transportation Agency
- Spokane, Washington: Spokane Transit Authority

The case examples summarize survey responses and interview observations from each agency. The introduction to each case example includes a basic description of the system, with data provided by the agency or taken from fiscal year 2011 National Transit Database reports. The interviews explored issues raised by the survey responses in greater depth.

CENTRAL OHIO TRANSIT AUTHORITY (COLUMBUS, OHIO)

Central Ohio Transit Authority (COTA) is the public transportation operator in the Columbus, Ohio, metropolitan area. COTA serves portions of five counties, with a service area population of 1.11 million. COTA operates 258 peak buses directly. Annual bus ridership was 18.8 million in 2011.

Actions Taken to Increase Bus Speeds

COTA reported a minor downward trend in bus speeds over the past 5 years. The major action taken was the multiyear Bus Stop Service Improvement Project (BSSIP) to review bus stop spacing on all routes. The chief executive officer (CEO) of the agency rode the system regularly and came to the conclusion that stops were too close. He directed the staff to develop a policy on bus stop spacing.

COTA staff first reviewed policies developed by other agencies. COTA analyzed a local route, a crosstown route, and an express route to explore potential strategies, and concluded that between 25% and 35% of bus stops could be removed.

COTA convened a stakeholder group composed of metropolitan planning organization members and riders, including two riders with disabilities, and presented preliminary ideas on stop spacing. Stakeholders were initially not entirely pleased with the concept. At the end of the meeting, COTA invited all stakeholders to board a bus waiting outside the building and ride along on one of the busiest routes, stopping at every bus stop. This experience in the field convinced stakeholders that a real problem existed and that a new policy was needed.

The stop spacing standard was supported by the stakeholders and adopted in 2010. The policy called for varied stop spacing, based on land use and density:

- High-density residential areas (20+ persons per acre), CBD, and shopping areas: 500 to 700 ft (152 to 213 m);
- Fully developed residential areas (10 to 20 persons per acre): 700 to 850 ft (213 to 259 m);

- Low-density residential areas (three to 10 persons per acre): 850 to 1,200 ft (259 to 366 m);
- Rural (zero to three persons per acre) or express bus service areas: 1,200+ ft (366+ m).

Mindful that the research had shown that large-scale efforts across an entire system engendered extensive resistance, the agency began implementation with express routes, followed by crosstown routes, smaller local routes, and finally major local routes. COTA focused on stop removal as opposed to stop repositioning to avoid the need to move stop signage, pads, shelters, and benches.

COTA prepared geographic information system (GIS) maps showing density, land use, and boardings per stop (using automatic passenger counter or APC data) and used these to identify stops that did not meet the spacing standard. GIS maps that showed 0.25-mi (0.4-km) buffers around each stop demonstrated that there was very little loss of coverage. The process can be summarized as:

1. Analyze the stops on a given set of routes and identify stops for removal.
2. Post commuter bulletins at all affected stops for at least 3 weeks to solicit comments.
3. Post the information and solicit comments on the COTA website as well as at public meetings.

Figure 4 shows a map of a segment of Line 2 East Main showing all stops. Stops to be removed are marked by red circles with a text balloon noting stop number and location. This type of information was posted on the COTA website, first as proposed changes and then (revised as necessary) as final changes.

COTA reevaluated certain stops based on public input and operator comments. Input regarding ADA customer use and other arguments (e.g., inadequate queuing space at the nearest stop) influenced decisions to retain a given stop. After final decisions were made, new notices were placed at all stops that were changing several weeks in advance of the changes. Customer Service telephone personnel were fully informed throughout the project regarding the plan's purpose as well as specific proposals.

The CEO strongly supported the program throughout the process, allowing staff to stand up to political pressure. One example involved a stop outside a private school. The APC data showed four boardings per day, but parents protested and claimed that the nearest stop was too far away. COTA prepared maps showing that the walking distance from the school entrance to the nearest stop was only 50 ft (15 m) more than to the stop being removed and distributed these maps to all involved. The stop was ultimately removed.

There were also humorous moments. Staff recalled the complaint regarding pigeon droppings at the stop closest to a stop proposed for removal. The complaint proved to be unfounded.

Operator reaction was very positive. At the end of a monthly meeting with operators to discuss scheduling issues, an operator volunteered that changes to a major bus line allowed her to operate more smoothly, not to begin slowing down for the next stop when still accelerating from the last stop. The other operators immediately agreed. Recently, operators who drive affected routes have been invited to the meetings to provide input on candidate stops for removal.

COTA has long had a very positive relationship with the city of Columbus. The city understands the agency's reasoning and sees benefits in terms of parking management (additional spaces become available), financial impacts (fewer concrete pads), and impacts to traffic flow.

The Columbus Dispatch carried an article on the bus stop service improvement project. COTA shared the methodology used to decide the fate of individual stops, and the article discussed the rational approach underlying the entire project. Shortly thereafter, the paper published an editorial in support of the BSSIP.

The agency noted that it is extremely difficult to isolate individual components affecting bus speeds. Along with changes to bus stop spacing, COTA took other actions, such as purchasing low-floor buses, adjusting running times, and streamlining routes. Low-floor buses decrease dwell times at stops, but fewer seats on these buses result in more standees. Operators protested that the back doors on the first low-floor buses placed into service operated so slowly that it lengthened dwell times and caused them to fall behind schedule. In addition, operators select their work every 4 months, and the impact of operators with different driving styles is real, even if difficult to quantify.

During the past 5 years, scheduled speed for local service decreased by less than 2% (see Table 30) while local ridership increased by 17%. COTA credits the bus stop spacing standard and its implementation with allowing speeds to be maintained during a period of major ridership growth.

COTA cited staffing as the only major constraint. Limited staff availability supported the decision to follow an incremental process instead of changing everything at once. At the outset of the project, COTA set a goal to review routes with a total of 400 to 500 bus stops each 4-month service period. One staff person conducted the analysis, although other persons reviewed comments before making the final decision. The process of actually removing a stop is labor intensive and involves City as well as agency staff.

Benefits and Drawbacks

The primary benefit of actions to improve bus speeds came through the BSSIP: the ability to maintain existing local bus

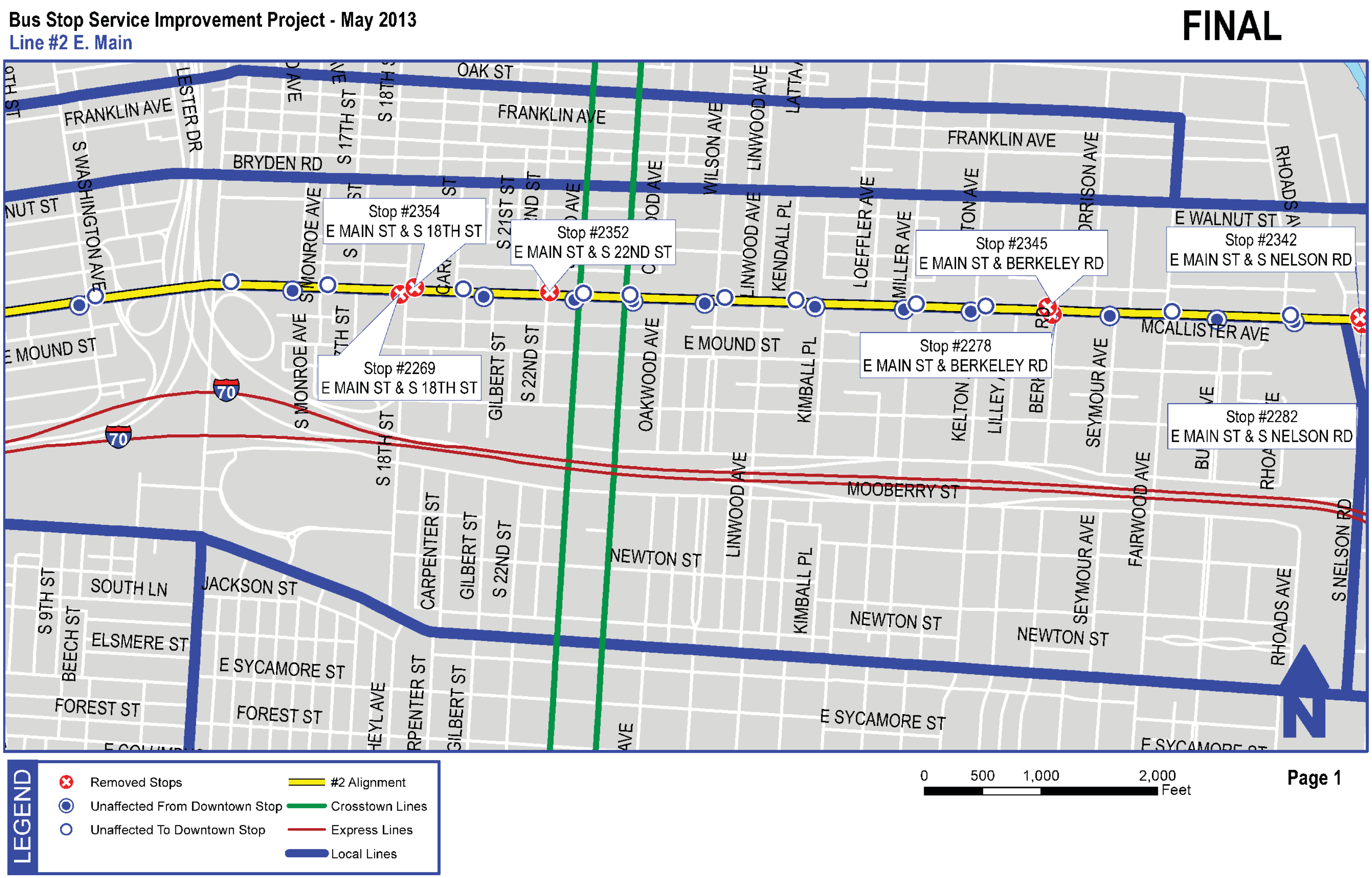

FIGURE 4 BSSIP map for Line #2 East Main.

TABLE 30
SCHEDULED SPEED FOR COTA LOCAL BUS SERVICE, 2007 TO 2012

Year	Average Speed (mph)
2007	13.66
2008	13.52
2009	13.45
2010	13.55
2011	13.53
2012	13.39
% change, 2007–2012	–2.0%

Source: Unpublished COTA data.

speeds during a period of major ridership growth. The primary drawback was disgruntled passengers who did not want their stops removed, although this was mitigated by establishing a reasonable and defensible process based on data and open to public input. COTA answered every complaint with an explanation of the purpose of the project and a direct response to the specific argument. Through this process, even unhappy passengers felt as though their complaints had been heard and acknowledged. As noted, COTA did reevaluate stops when there was a legitimate reason to do so but did not promise to do so at every challenge in the absence of compelling evidence. COTA was flexible in its dealings with major trip generators, such as Ohio State University; the number of campus stops was reduced, but compromises were struck over specific locations.

The most successful actions were the establishment of new bus stop spacing standards and the BSSIP. The impact of not having to stop so often is hard to measure, given ongoing construction projects and the different driving patterns of different operators. COTA sees a future benefit in addition to its current ability to maintain speeds in a period of growing ridership: new riders will accept the new stop locations as a given. COTA also uses the spacing standards to respond to requests to add, relocate, or remove stops.

Changes/Lessons Learned

If COTA could change one aspect of actions to improve bus speeds, it would have been more aggressive in increasing stop spacing. At the outset, staff believed that a reduction of 25% to 35% in the number of stops would be the maximum politically feasible change. The BSSIP has generated broad support and encountered minimal negative reaction.

COTA offers several lessons learned through its implementation of the BSSIP:

- Establish a policy standard that is reasonable and defensible. Analysis of different types of service at the outset of this process helped to ground the process in common sense.
- Be transparent in your analysis. Use GIS-generated maps to show the results of the analysis of specific routes.
- Involve your stakeholders early in the process, particularly those who can be expected to be opposed to the project. In retrospect, staging a bus to take stakeholders on a trip along a major bus route right after the initial meeting was crucial in convincing the skeptics in the group, including members of the disabled community, that the proposed actions were necessary. The broad support among stakeholders minimized negative reaction.
- Be reasonable for your community, and know what they will tolerate. There is a general unwillingness to walk in Columbus, as in many American communities. The standards were set with this in mind.
- Use feedback from bus operators to improve bus speeds.
- Ensure support of upper management at the outset. In COTA's case, the CEO was the driving force behind the policy and its implementation, and his support was vital in overcoming obstacles, especially in the early stages of the project.

COTA's advice to another agency trying to replicate its program is to adopt a policy then work hard to adhere to it. Keep the public and bus operators involved. Be flexible, but only when it makes sense. Follow through on stop removal to ensure that everything is done correctly.

RTS GAINESVILLE REGIONAL TRANSIT SYSTEM (GAINESVILLE, FLORIDA)

The Regional Transit System (RTS) is the public transportation operator in Gainesville, Florida, the home of the University of Florida. RTS serves a service area population of 188,000. RTS operates 93 peak buses directly. Annual bus ridership is 10 million.

Actions Taken to Increase Bus Speeds

RTS reported a minor downward trend in bus speeds over the past 5 years. The agency took actions regarding stops, vehicles, and schedules to address this decline. The primary efforts to improve bus speeds relied on stop-related actions. Actions are described in the following paragraphs.

Stop-Related Actions

RTS set a guideline for bus stop spacing as part of its Bus Service Improvement Program (BSIP) in three categories: urban (eight stops per mile: every 660 ft or 200 m); suburban (six stops per mile; every 880 ft or 268 m); rural (four stops per mile; every 1,320 ft or 402 m). Urban stops were often tied to redevelopment or infill efforts. The BSIP also created a stop classification system that bases stop amenities on ridership and transit-supportive land use. The new stop classification system supports improved design layout and includes thresholds for bus stop amenities and increases to paved waiting areas. This guideline was not officially adopted but served to guide stops and amenities toward arterials on the premise that removing stops is more acceptable if nearby stops are upgraded.

RTS applies the new spacing guideline to new or extended routes and has made inroads in stop removal. RTS posted notices at affected stops and took calls and comments for a 2-week period. Stops were restored if there were compelling reasons, such as ADA access. RTS identified 72 stops for removal, all with very low ridership activity, and actually removed or consolidated 67 stops. Securing funds for the local match was a challenge in obtaining federal funding for enhanced stops.

Public reaction was generally supportive because only stops with very low ridership activity were affected. Bus operators also were supportive. Motorists were happy because they were less likely to get stuck behind a stopped bus. Opposition came from the maintenance person who had been responsible for stop oversight for several years and was passionate about passenger access to the system.

RTS is preparing a stop maintenance plan intended to improve the appearance and maintain the cleanliness of bus stops. The plan will specify when structures are obsolete and need to be replaced and a maintenance schedule. Staffing is an issue in plan implementation.

Other Actions

Low-floor vehicles comprise 57% of the RTS fleet. RTS has moved to a perimeter seating configuration on most buses to increase capacity, especially on routes serving the University of Florida campus, where full loads are a chronic problem.

Approximately 10% of all routes have had recent running time adjustments that decrease scheduled bus speeds.

RTS uses schedule adherence and ridership in evaluating the success of various strategies. Funding is the major constraint. It is difficult to remove or consolidate bus stops without improving nearby arterial bus stops to support higher bus speeds. If there is a lack of funding to improve bus stops with shelters and other key amenities, how can you convince riders of the importance of removing other more conveniently located stops?

The overall response to these changes is neutral. The actions related to stop spacing have helped to mitigate the declining trend in bus speeds. RTS attributes this to increased boardings, especially passengers in wheelchairs and other mobility devices. RTS policy is that ADA-certified passengers can ride fixed-route buses for free.

Benefits and Drawbacks

The primary benefit of actions to improve bus speeds is maintaining existing frequencies and high ridership without increasing operating costs. The primary drawback is less convenient access to bus stops.

The most successful action was consolidating and removing bus stops. Along with improving bus speeds, this action has a fiscal impact in terms of bus stop maintenance costs. In addition, bus stops can be maintained to a higher quality when there are fewer stops.

Changes/Lessons Learned

If RTS could change one aspect of actions to improve bus speeds, it would have established a Bus Stop Review Committee at the outset. This could have increased awareness of the importance of bus stops and created greater buy-in among stakeholders, including the city and the county. Bringing those in charge of right-of-way at the city and the county to the table through such a committee could foster meaningful discussions.

RTS offers the following lessons learned through its bus stop consolidation efforts:

- Post information at stops. This cannot receive too much emphasis when stops are being changed or removed.
- Meet with neighborhood associations on a regular basis and partner with them in selling bus stop changes to the community.

METROPOLITAN TRANSIT AUTHORITY (NASHVILLE, TENNESSEE)

The Metropolitan Transit Authority (MTA) is the public transportation operator in the Nashville, Tennessee, metropolitan area. MTA's service area population is 627,000. MTA operates 137 peak buses directly. Total ridership for all services MTA operates or manages exceeded 10 million in 2012.

Actions Taken to Increase Bus Speeds

MTA reported a minor downward trend in bus speeds over the past 5 years. The major action taken was the introduction of limited-stop routes on two major corridors with traffic signal priority. The first corridor with "BRT lite" service, as it is called locally, was Gallatin Pike. The second corridor, as of April 2013, was Murfreesboro Pike. The MTA website describes BRT lite as follows: "Designed to move bus riders along the city's busiest corridors, this service offers more frequent service, fewer stops, and a greener attitude."

Gallatin Pike is characterized as a mixed-use, medium- to high-density corridor served by one of the highest ridership routes. The existing route had bus stops every other block, typical of most of the MTA network. Limited-stop service has 15 bus stops in each direction, compared with 100 over the 12-mi (19-km) corridor for local service. The average spacing for the limited stops is approximately 0.75 mi (1.2 km). Signal priority is provided at all signalized intersections outside of downtown. A bus will be given an additional 8 to 10 s of green time if it is at least 1 min behind schedule. The traffic controllers are old, so it takes several cycles before priority is granted to another bus.

Before BRT lite came into use on Gallatin Pike, local service operated every 20 min throughout the day and every 40 min in the evening and on weekends. BRT lite service is provided every 15 min on weekdays before 6 p.m. and every 30 min in the evening and on Saturday. Local bus service is provided every 40 min on weekdays before 6 p.m. and every 60 min in the evening and on Saturday. No BRT lite service is operated on Sunday; local service is provided every 40 min. The same model is being used for Murfreesboro Pike.

MTA learned the importance of shelter location at the stops and how to address conflicts with utilities during the Gallatin Pike implementation. MTA also learned the most effective way to do a comprehensive analysis of where to place the stops. The first step was to analyze manual ride checks, limited APC data, and fare box data to identify the busiest stops. Next, representatives from Metro, MTA Planning, MTA Operations, and the city's Public Works Department took a bus out on the corridor to identify the specific location of proposed stops.

The operations department supported limited-stop service. On-time performance has improved, and operators can take their full recovery time. MTA has not aggressively reduced running times on routes other than the limited-stop routes.

The city's Public Works Department has been supportive for the most part, although it can be difficult to obtain a firm commitment regarding new strategies. There have been more serious conversations about a true BRT east-west line in the past few months. The ongoing relationship with the city is aided by the current mayor, a very strong transit advocate. Public Works also sees that cooperation can yield benefits, such as an opportunity to obtain new traffic control hardware. Lack of sidewalks and pedestrian amenities hampers the ability of residents in many neighborhoods to access a bus stop, but this reflects the availability of funds and not a lack of desire to improve.

MTA cited passenger complaints and competing goals as major constraints. It has historically been very difficult from a public relations standpoint to remove bus stops or streamline a route with numerous turns. There can be a lack of understanding in other departments of the importance of maintaining or increasing bus speeds and the extent to which fare collection, stop spacing, inefficient routing, and other seemingly minor actions add up to a notable impact on speed of service.

Recent efforts are beginning to overcome some of these constraints. MTA recently developed stop and amenity placement and stop spacing guidelines, balancing reasonable stop distances against the availability of pedestrian amenities. MTA is conducting a comprehensive bus stop survey, working on one route each week. An interdisciplinary group goes out into the field with GIS maps that include a passenger boarding overlay by stop to update the stop database and to identify locations where stops could be eliminated or added. The new guidelines help; to date, a handful of stops have been eliminated.

Fare policy actions, such as replacing transfers with day passes; issuing EasyRide smart cards to local government employees, college students, and some private-sector employees; and eliminating fare zones, have reduced dwell times. Minimizing the number of coins required to pay the cash fare and encouraging prepaid media through discounted pricing are other actions that can lower boarding times. Although there will always be competing goals, successful implementation of limited-stop service has demonstrated the appeal of faster service for riders.

Benefits and Drawbacks

New BRT lite service on the Gallatin Pike has increased ridership in the corridor by 15%. MTA is looking forward to a new AVL system to analyze running times and bus speeds at a highly detailed level. From a monthly data sample, on-time performance has improved in the corridor. Running times decreased with limited-stop service. Anecdotal evidence suggests that new shelters dedicated for limited-stop and local passengers at the major stops are appreciated by both groups of riders.

The primary drawback was the cost of adding service because local service still operates with the limited-stop service in the corridor. The support of the mayor, who made the new service one of his top priorities and promised to obtain funding for it, was invaluable in making implementation possible.

The most successful action was the introduction of limited-stop service, for the reasons cited earlier.

Changes/Lessons Learned

If MTA staff could change one aspect of actions to improve bus speeds, it would allow the scheduling and operations staff more decision-making power in the management of bus stops and route structure. The standard answer to decreased bus speeds in the past has been to add resources or, if resources are not available, to reduce service. Scheduling and operations staff are analyzing data and observing operations on the street and are thus developing better, more nuanced, answers.

MTA offers several lessons learned through its implementation of limited-stop service and other actions to improve bus speeds:

- The perception that increases in travel times are inevitable is not true. Identify actions that can be taken proactively to stem the decline in, if not increase, bus speeds.
- Promote these actions and their effects within and outside the transit agency. The actions may not save a bus, but they can avoid the need to add a bus in the near future, or at least put off the need for a few years.

MTA's advice to another agency trying to replicate its program is:

- Examine the busiest corridors stop by stop, and assess what constitutes a reasonable distance between stops. Use current boarding/alighting data to flag low-usage stops.
- A strong relationship with city hall at all levels, from the CEO on down, is vital to the success of the program.
- Being able to demonstrate the effect these changes can have on bus speeds is very important for interagency and intraagency relationships. Other departments and agencies will have different priorities and will not immediately understand the importance of what you propose to do.
- Upper management allowed MTA staff to fix the things that needed to be fixed, but it is necessary to bring these issues constantly to their attention. Bus speed is never an emergency. Other "fires" tend to take precedence, unless transit staff keep bus speed on the radar of upper management.

MTA–NEW YORK CITY TRANSIT (NEW YORK CITY, NEW YORK)

MTA–New York City Transit (NYCT) is the public transportation operator in the city of New York. NYCT serves a service area population of 8.0 million. NYCT operates 3,727 peak buses directly. Annual bus ridership is 800 million.

Actions Taken to Increase Bus Speeds

NYCT reported a minor downward trend in bus speeds over the past 5 years. The agency took a variety of actions regarding stops, vehicles, schedules, routes, internal policies, and external policies to arrest this decline. Many of the actions centered on the introduction of BRT service (known locally as Select Bus Service or SBS). Actions are described in the following paragraphs.

Stop-Related Actions

NYCT has increased bus stop spacing for local routes in a few instances when there was an opportunity to do so. The typical opportunity is a rebuilding of a street by the City, which would pour and pay for new concrete pads. Bus stops might also be removed when articulated buses began service on a route; lengthened stops would sometimes be practically adjacent to each other.

After experimenting with various designs, NYCT and the city installed three bus bulbs in 2012 and are planning to install 30 this year. These are primarily along SBS routes (see Figure 5), but the city has also installed bus bulbs as part of a sidewalk widening project and at bus stops underneath elevated trains, where the stop historically is at the pillar (between the travel lane and the parking lane (Figure 6) and not at the curb.

NYCT is also experimenting with level boarding at stops. The low-floor bus entrance is 13 in. above the street. Where conditions permit, the city is installing 10-in. curbs at stops. When the bus kneels, the floor of the bus is at the same level as the curb.

Vehicle-Related Actions

Sixty percent of the NYCT local bus fleet consists of low-floor buses. NYCT is increasing the use of articulated buses. Three-door articulated buses were introduced in 2010.

FIGURE 5 Bus bulb in Manhattan.

FIGURE 6 Stop under the elevated station at Freeman Street (*left*) before and (*right*) after.

Schedule-Related Actions

NYCT adjusts schedules on all routes within a 3-year cycle. The primary schedule-related action has been headway-based schedules for SBS and some limited-stop routes. This action has been a bone of contention internally. The NYCT Department of Buses has concerns regarding headway-based scheduling because it makes road supervision more difficult at the same time as dispatcher positions are being eliminated. The bus operator unions also oppose this action, although anecdotal information suggests that the bus operators themselves do like headway-based schedules. NYCT has made some adjustments, such as adding a few more time points along certain routes. The agency is awaiting the full implementation of Bus Time, an AVL program that tracks bus location in real time, to address the issues surrounding headway-based schedules with real data.

Route-Related Actions

The primary change in recent years has been the introduction of four SBS routes since 2008. All feature bus lanes, low-floor buses, and wide stop spacing. Three routes use articulated buses, three have off-board fare collection, two routes have traffic signal priority, and bus bulbs are being built on two of the corridors in operation and on one of the corridors scheduled for 2013 implementation.

SBS has increased speeds, compared in most cases to previous limited-stop routes in the same corridors. Table 31 shows before and after speeds for the first three SBS routes.

NYCT has made changes to specific routes, but there has been no overall policy change. Forty limited-stop routes have been introduced incrementally since 1975, including four or five new routes in the past several years.

Internal Policy Changes

All-door boarding, off-board fare collection, and changes to bus door practices have all been introduced on three of the four SBS services. Fare machines that issue proof-of-payment receipts have been installed at all SBS stops. Prepayment allows all-door boarding, and bus operators open all three doors at all stops. The combination of off-board fare collection and all-door boarding has resulted in a 9% reduction in running time on the three SBS routes.

MetroCard fare discounts, including free transfers between bus and subway, were introduced in 1998 and resulted in

TABLE 31
BEFORE AND AFTER SPEEDS FOR SBS ROUTES IN NEW YORK

Route	Average Speed Before SBS	Average Speed After SBS
Fordham Road, the Bronx (Bx12 limited)	9 mph, 14 kph	12 mph, 19 kph
First/Second Avenues, Manhattan (M15 limited)	6.75 mph, 10.86 kph	8 mph, 13 kph
Hylan Boulevard, Staten Island (S79 local)	10 mph, 16 kph	13 mph, 21 kph

Source: Unpublished MTA–NYCT data.

notable ridership increases. More boardings affected bus speeds negatively. Swiping, or more precisely "dipping," the MetroCard takes longer than depositing a token in the fare box. The MetroCard has had many benefits for NYCT, but increased bus speed is not among them. NYCT is considering contactless fare cards, but this remains an elusive technology for the agency.

External Policy Changes

New York City has had bus-only lanes for many years, but the implementation of SBS has expanded the number of bus lanes. Currently there are 70 mi (113 km) of bus lanes on arterials and 10 mi (16 km) of physically separated lanes on expressways. Most arterial bus lanes are curb lanes, but approximately 10 mi (16 km) are offset lanes (see Figure 7). Offset lanes are becoming the standard for new SBS routes because they leave the curb lane available for deliveries and parking. Offset lanes work even better with bus bulbs. New York City expected to open an additional 20 lane-miles (32 lane-kilometers) of offset bus lanes during 2013.

Between 10 and 15 routes operate on corridors with TSP. NYCT reports a minor increase in bus speeds associated with signal priority, but it is difficult to quantify because each intersection is different. Signal priority in tandem with bus lanes is very effective.

Many streets have peak hour no-standing zones to increase traffic flow. Signal progression has been in place for a long time on several arterials, and the City continues to optimize the timing. Turn restrictions are also common.

In recent years, New York City has introduced pedestrian plazas (Figure 8), pedestrian refuges, curb neckdowns (Figure 9), bicycle lanes, and other general traffic calming measures. The purpose of these measures is to slow all traffic.

FIGURE 7 Offset bus-only lane on First Avenue in Manhattan.

FIGURE 8 Pedestrian plaza at Putnam Plaza.

Decreased general traffic speeds are good for a city with so many pedestrians but are not so good for bus speeds. However, these measures are sometimes helpful to bus service in terms of making access to bus stops easier and safer for customers.

NYCT uses a variety of metrics to measure impacts. Among these are analysis of components of travel speed, time and delay studies, changes in average bus speeds, schedule adherence, operating cost, ridership, and qualitative measures from passenger outreach in evaluating the success of various strategies.

NYCT cited passenger complaints, union concerns, concerns from operations, competing goals, funding, general

FIGURE 9 Curb neck-down.

reluctance to change, and not in my backyard (NIMBY) attitudes as major constraints. Stop removal is certain to generate passenger complaints, although SBS service on First and Second Avenues in Manhattan (a major improvement in frequency and speed) has received more complaints upon implementation than any other recent action. One possible explanation is that trips may be shorter in these corridors. Union complaints arise from a general mistrust of management and a sense that faster service might somehow be used to reduce the labor force.

The NYCT Department of Buses is very concerned about headway-based scheduling, which increases the workload for road supervisors at a time when the number of these positions is being reduced. Each division within operations is held to a strict on-time performance goal, so minor operational modifications, such as stop removals, are common. Safety has not been raised as an issue.

Competing goals (speed versus convenience; traffic calming versus bus speeds) are difficult to resolve. The customer perception is very different depending on whether the customer is waiting at a local-only stop watching a limited-stop bus go by or whether the customer is on the limited-stop bus. Reluctance to change is a human condition. This is magnified in New York, where a majority of the population rides public transit.

NYCT works within all these constraints by consistently stressing the benefits to be gained. NYCT uses phased implementation, partnerships with the city, particularly the NYC Department of Transportation, and reliance on data to support the actions. NYCT received many fewer complaints than expected for its most recent SBS implementation on Hylan Boulevard in Staten Island. The local newspaper, not known as a supporter of NYCT, published several favorable articles.

By aggressively employing a wide variety of actions, NYCT was able to mitigate the decrease in speed on some bus routes, reversing a longtime trend. Overall, SBS service has increased speeds in a noteworthy manner on the corridors that have been converted to SBS.

Benefits and Drawbacks

The primary benefits of actions to improve bus speeds are increased ridership and additional service at the same cost. NYCT has reinvested the savings generated by much faster operation on SBS service into improved headways or extended span of service. Drawbacks include expense (e.g., off-board fare collection), added work for road supervisors because of headway-based scheduling at a time of decreasing supervisory resources, and a lack of robust data at the stop and route segment levels. NYCT has worked around these drawbacks by opting not to deploy off-board fare collection on the Hylan Boulevard SBS route with few high-boarding stops, by thorough analysis of all available data, and by moving forward with Bus Time (AVL) implementation.

The most successful action was the combination of transit signal priority, bus-only lanes, off-board fare collection, all-door boarding, and increased stop spacing for SBS service.

Changes/Lessons Learned

If NYCT could change one aspect of actions to improve bus speeds, it would obtain better, more accurate, and more timely data. The implementation of Bus Time is expected to meet many of these data needs. NYCT would not have delayed the SBS implementation to wait for Bus Time, but the data would have helped greatly in day-to-day road supervision and service optimization.

NYCT offers the following lessons learned through its implementation of changes to improve bus speeds and advice to other agencies:

- Keep at it. Off-board fare collection in tandem with all-door boarding is highly successful.
- It is very easy to be influenced by the concerns of specific groups. You cannot design an entire transit system around the concerns of any single group.

SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY (SAN FRANCISCO, CALIFORNIA)

San Francisco Municipal Transportation Agency (SFMTA; also known as Muni) is the public transportation operator in the city of San Francisco, California. SFMTA serves San Francisco, with a service area population of 805,000. SFMTA directly operates 375 peak buses, 210 peak trolleybuses, 115 light rail vehicles, 25 historic streetcars, and 30 cable cars. Annual ridership is 95.6 million on bus, 67.5 million on trolleybus, and 59 million on combined rail modes.

Actions Taken to Increase Bus Speeds

SFMTA reported a minor downward trend in bus speeds over the past 5 years. The agency took a variety of actions regarding stops, vehicles, schedules, routes, internal policies, and external policies to arrest this decline. These are described in the following paragraphs.

Stop-Related Actions

SFMTA set bus stop spacing guidelines for each type of service and removed some stops that were too closely spaced.

The guidelines call for stops every two to three blocks on local routes, depending on block lengths. The Transit Effectiveness Project (TEP) developed proposals to modify stop locations based on these guidelines, and stop modification has been one of the most controversial actions for bus riders. The TEP team is conducting a second round of extensive public outreach. Customers are concerned about route accessibility.

The agency is also increasing stop lengths to accommodate more and larger vehicles at stops. Bus bulbs are being planned and have been installed at key stops in corridors with very heavy traffic or in locations where buses have difficulty pulling back into the travel lane. SFMTA is also optimizing transit stop placement by establishing near-side stops at intersections with stop signs and far-side stops at intersections with traffic signals.

Vehicle-Related Actions

The primary vehicle-related action is the purchase of low-floor buses. Low-floor buses currently comprise 10% of the bus fleet, and plans call for a fleet of 100% low-floor buses in the future. Light rail vehicles will continue to be high floor because of platform infrastructure and subway expansion currently under construction. SFMTA has not found any real differences in bus speeds as a result of low-floor buses, but the existing low-floor buses are scattered throughout the system, and there are not enough to make a difference on any one line. The lower seating capacity of low-floor buses is a major concern, given the crowded conditions on the buses. All low-floor buses use wheelchair ramps instead of lifts.

Schedule-Related Actions

SFMTA is implementing a program to adjust schedules on approximately 30% of its routes each year. As part of this process, SFMTA constantly reevaluates the mix of local and limited-stop routes to maximize efficiency. The limited-stop buses have become more popular and are frequently overcrowded, severely so during peak periods, whereas local buses have seated loads. After analyzing loads, SFMTA will consider changing the mix as part of ongoing schedule adjustments.

Route-Related Actions

The agency has streamlined about 10% of its routes to reduce the number of unnecessary deviations and turns and to minimize route redundancy. These changes were implemented as part of major service modifications for budgetary reasons in 2009. Recently, a new limited-stop route was added (Route 9L). The TEP proposes additional route realignments to streamline service.

All-Door Boarding

All-door boarding has been the major internal policy change, taking effect in July 2012, on all services except cable car (light rail had all-door boarding before July 2012). SFMTA released an update on all-door boarding after 6 months, in February 2013. An informal policy previously had permitted boarding through the rear doors. Use of the rear doors has increased to 51% at stops with 10 or more boardings per trip, and dwell times at these stops have decreased by 3 to 4 s per stop. Passengers continue to board primarily through the front door at less busy stops, with no measurable impact on dwell times.

Eleven fare inspectors were added in July 2012. Fare evasion has declined from 4.6% to 3.5%. Perception of fare evasion has gone up among riders, which may be the result of an unclear policy regarding when a rider needs to tag his/her card on the Clipper device (prepaid electronic fare instrument) at the rear doors. Monthly pass holders do not always tag.

The most dramatic impact of all-door boarding can be seen in the afternoon on outbound express buses in downtown San Francisco, where queues of 40 people are not uncommon. The boarding process is much faster, but some express riders have complained that even if they arrive early at the stop, they can no longer get “their” seat because passengers entering through other doors take it.

SFMTA is conducting a comprehensive overview that will include a running time analysis for selected routes. Anecdotally, the primary impact appears to be helping buses to keep to schedule.

External Policies

Bus-only lanes have been in effect for many years in the downtown core on major corridors such as Mission Street and Geary Street. Approximately 15 mi (24 km) of bus lanes are currently in place. The city and SFMTA are focusing on expanding transit-only lanes. The newest pilot project (Spring 2013) is on a three-block congested segment of Church Street. At this location, the city has painted the bus lanes red (“red-carpet lanes”) in an attempt to make the lanes self-enforcing (Figure 10). A May 2013 press release reported a 5% reduction in travel time and an increase of 20% in travel time reliability on Route 22-Fillmore as a result of the transit-only lane on Church Street. Future expansions are planned for 8X Bayshore Express (on Third Street) and the N-Judah light rail line by Spring 2014. Bus-only lanes will be part of the Van Ness Bus Rapid Transit project, and the TEP proposes expansion to other major corridors.

TSP has been expanded to 200 intersections affecting 20% of all SFMTA routes. The Mission corridor and Third Street corridors have TSP, and the Geary corridor is next on

FIGURE 10 Bus-only lanes on Church Street in San Francisco.

the list. TSP has the biggest impact of any actions taken to improve bus speeds. SFMTA reports an increase of between 5% and 10% in bus speeds associated with signal priority.

The city has made changes in signal timing progression to favor transit on the Geary and O'Farrell corridors. The impact of these changes is lessened by the number of bus stops, but SFMTA has seen a minor (less than 5%) increase in bus speeds as a result of signal timing.

San Francisco has had restrictions on left turns and parking during peak hours for some time, making it difficult to assess their impact. Recently, the city has installed right-hand turn pockets at congested intersections to separate vehicles making a right turn from through buses. These are created by prohibiting parking on the near side of the intersection, creating a lane for right-turning vehicles. Turn pockets serve a similar purpose as queue jumps, which are not prevalent in San Francisco. The city and SFMTA are looking to expand the use of boarding islands (already on Market Street) to other corridors with sufficient width. Boarding islands also separate buses from right-turn queues.

SFMTA uses a variety of metrics to measure impacts. The availability of segment-level and stop-to-stop travel times by means of APCs has created an insatiable appetite for data to analyze components of travel speed. Only a portion of the fleet is equipped with APCs, but SFMTA will evaluate the pilot bus lane on Church Street through close analysis of travel times and dwell times at stops on and adjacent to this three-block segment. SFMTA also uses changes in average bus speeds, schedule adherence, operating cost, ridership, and qualitative measures from passenger outreach in evaluating the success of various strategies.

SFMTA cited passenger complaints, safety concerns from operations, funding, and neighborhood opposition as major constraints to implementation. Passenger complaints focused primarily on bus stop removal. Neighborhood opposition arose when stop signs were proposed for removal to improve travel speed; neighborhoods generally prefer slower traffic for safety reasons. Concerns from operations include operational flexibility, safety, and operator quality-of-driving-experience issues. Funding concerns were shared by the city for traffic engineering measures and by SFMTA for expanded service. The constraints have delayed the bus stop consolidation program, but SFMTA and the city have been able to implement other actions.

Benefits and Drawbacks

The primary benefits of actions to improve bus speeds included an improved customer experience and more consistent running times. Bus bunching is a major frustration for customers. Signal priority and bus lanes have not solved the problem, but bunching occurs less frequently. Passenger response to limited-stop service is positive, and SFMTA is seeking ways to expand limited service.

Drawbacks vary by type of improvement. Stop removal is the most controversial policy for SFMTA because it reduces access to the system in the eyes of many customers. Increasing use of bus bulbs and right-turn pockets reduces the amount of on-street parking.

The most successful action was TSP. It increased bus speeds and reduced variability in running times with minimal impacts.

Changes/Lessons Learned

If SFMTA could change one aspect of actions to improve bus speeds, it would streamline the public process. This change concerns the internal processes of the agency, which manages all transportation in San Francisco, not just transit. In such a large agency, multiple projects have an effect on other projects. At times, SFMTA has gone out to the public multiple times about the same street or corridor. Packaging changes across the agency before going out to the public (which would require extensive coordination in the planning phase and greater flexibility in implementation) would be valuable.

The primary lesson learned at SFMTA through its implementation of changes to improve bus speeds is that more outreach at earlier stages of project development is better, but it still does not guarantee success.

SFMTA's advice to another agency trying to replicate its program is:

- Know your community, what it will and will not tolerate.
- Know your stakeholders and get buy-in at an early stage.
- Be prepared for a lot of planning work on the back end of the project, to ensure that the actions work as planned.

SPOKANE TRANSIT AUTHORITY (SPOKANE, WASHINGTON)

Spokane Transit Authority (STA) is the public transportation operator in Spokane, Washington. STA serves a service area population of 394,000. STA operates 112 peak buses directly. Annual fixed-route bus ridership is 11.0 million.

Actions Taken to Increase Bus Speeds

STA reported a mixed trend in bus speeds over the past 5 years. Anecdotal information suggests that overall speeds are roughly the same. The agency took actions regarding stops, schedules, and routes to improve bus speeds. The primary effort to improve bus speeds was the Stop Consolidation Plan (SCP).

The Stop Consolidation Plan began in 2010 and is now in its fourth and final phase. The impetus for the program was new service design guidelines that called for maximizing ridership while being cost-effective and energy efficient. General stop spacing had been every two blocks on average, or 600 ft (183 m), with many stops closer. The new standard, prepared in 2009 in conjunction with new service guidelines and approved by the STA Board as part of the 2010 Comprehensive Plan, is 800 to 1,500 ft (244 to 457 m), with a targeted average of 1,200 ft (366 km).

STA submitted Phase 1 of the SCP to the Board as an information item following adoption of the standard. STA made the decision to start on the six routes with 15-min headways, the busiest routes in the system, because changes to these routes would yield the greatest improvements.

STA encountered opposition from riders and to a lesser extent from a limited number of bus operators. The news media ran three features telling the stories of riders opposed to the changes. STA provided information at affected bus stops and on its website. A single point of contact was established at STA to ensure that all input was received and all the information provided was consistent and correct.

The initial information signs at affected bus stops were orange (Figure 11) and included a brief summary of the program, notice that the agency was proposing to remove this stop, the location of the two closest stops, and STA's website address for customers to obtain additional information and comment on the plan. When a final decision was made, a red sign (Figure 12) was posted for 2 weeks, indicating that the stop would be removed and giving an approximate date for removal.

In each phase of the project, STA decided to keep a limited number of stops, usually after receiving overwhelming public input with compelling arguments for keeping the stop. In several cases, STA removed an adjacent stop when putting back a stop. Retained stops received a green sign (Figure 13).

The decision to phase in the SCP is worth noting. As stated, the most frequent routes were included in Phase 1 in 2010 to achieve the greatest benefits for the greatest number of riders. Phase 2 occurred in 2011, when the agency implemented a major service reduction (7% reduction in revenue hours of service and a system restructuring that was preceded by a 3% service reduction in 2010 for a cumulative total

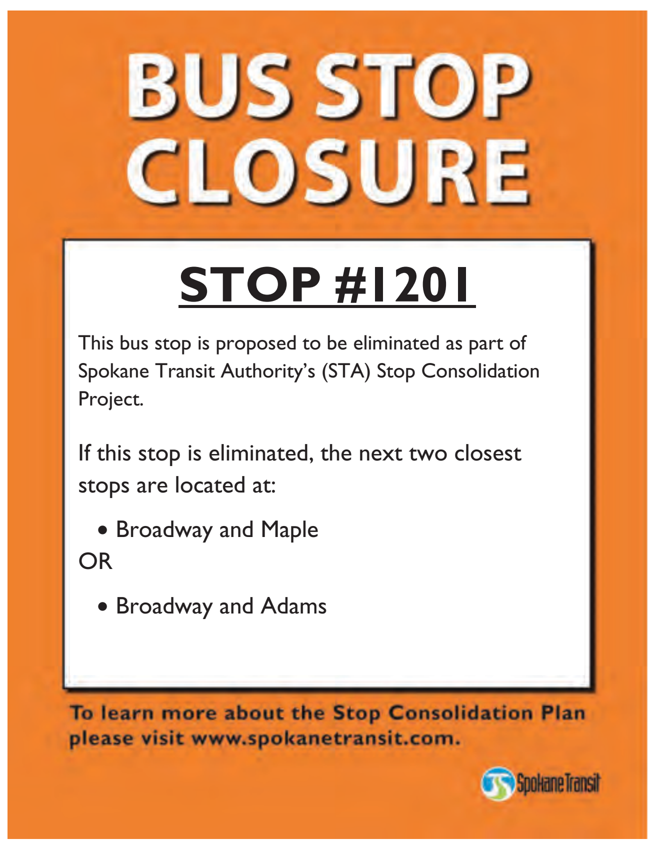

FIGURE 11 Stop closure sign.

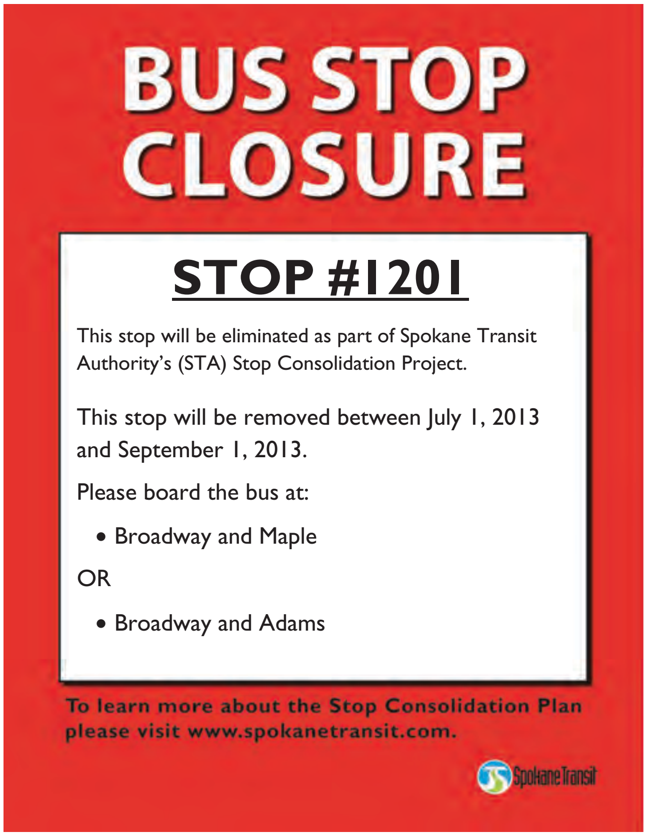

FIGURE 12 Stop removal sign.

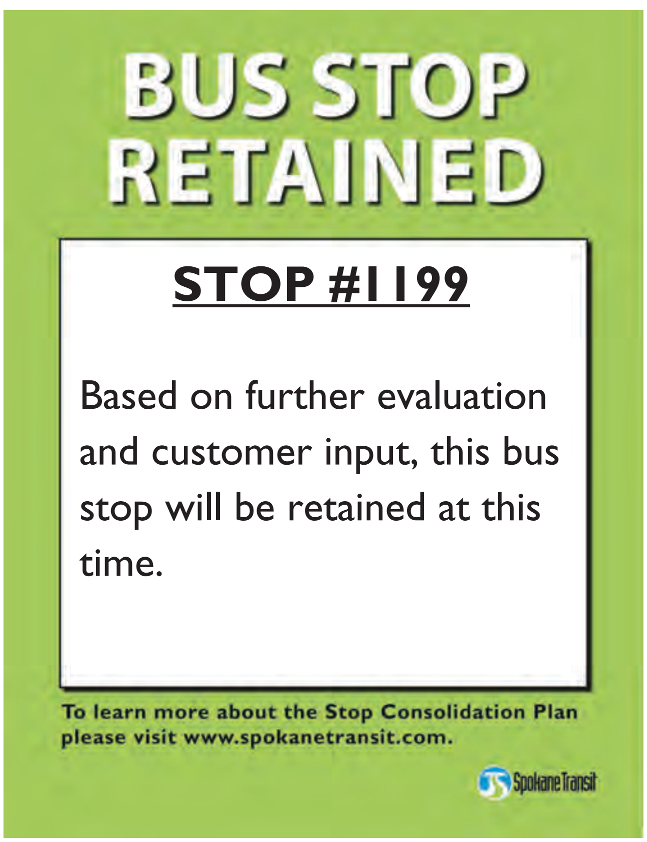

FIGURE 13 Stop retained sign.

of 10%). Phase 2 originally was envisioned to include all remaining stops within the city of Spokane but was adjusted to include only routes with major changes. This change was primarily to ensure schedule adherence on restructured routes.

In 2012, Phase 3 included higher-ridership routes with 30-min headways. Phase 4, now under way, included all other routes. STA has also implemented two bus bulb stops in cooperation with the city, and a third was planned for 2013.

The SCP is approximately 80% complete. To date, there are approximately 24% fewer stops systemwide than in 2009. This percentage will increase to approximately 35% when Phase 4 is completed.

STA has changed running times and streamlined several routes, but the SCP is the primary action taken to improve bus speeds. Owing to limited staff, a number of major road reconstruction projects happening concurrent with stop spacing changes and the lack of computer-aided dispatch or AVL data, STA has not conducted a systemwide analysis to measure detailed effects of stop spacing and route streamlining efforts. The 10% reduction in service resulted in a 1% ridership increase in the first year, as the streamlined routes attracted additional ridership. Some routes experienced greater ridership increases that negatively affected travel times. Overall, STA is better off than if these actions had not been taken.

STA uses ridership and discussions with operators in evaluating the success of the SCP program. Ridership impacts have already been noted. Operators with concerns have come to communicate stop-specific issues rather than take issue with the program as a whole. This has contributed to a positive working relationship between operators and service planners.

Funding is the major constraint. STA did not ask for additional local funding in 2011, choosing instead to live within its resources even in difficult financial times. The SCP served as a demonstration that STA is sensitive to the need for cost-efficient operation and provides good stewardship of public funds.

If there is not a major new revenue stream (i.e., increase in tax rate by vote of the citizens), STA will be cutting service. The agency does not have extra revenue to make major capital investments otherwise. The long-range plan calls for high-performance transit (HPT), using BRT concepts while avoiding the polemic around what exactly "BRT" means. HPT encompasses several types of service:

- Blue Line service, with freeway-type service with dedicated lanes, frequent peak service, and 30-min midday service;
- Red Line service, with signal priority, frequency and spacing typical of BRT, which may or may not have dedicated lanes;

- Green Line service, with signal priority and three- to five-block stop spacing and very frequent service.

STA is focusing on a program of HPT in five to six corridors that can be brought to a vote to increase funding. The planned HPT service has provided a guiding framework for the SCP, and the SCP helps to advance the argument that STA has been a good steward of public funds. Cost-effectiveness is a very big political argument, and STA has delivered on its promise to be more cost-effective. Productivity in terms of boardings per hour has risen from 22 in 2002 to 27 in 2009 and 29 in 2012. Operating costs are deployed efficiently with cost per revenue hour running nearly 20% below the average for large urban transit systems in Washington State.

STA assesses the actions to improve bus speeds as somewhat successful. The most common complaint now is overcrowded buses.

Benefits and Drawbacks

The primary benefit of actions to improve bus speeds is more rational stop spacing. STA also has relied on its warrants to add amenities to stops with confidence that it is a long-term investment. Future riders will accept the new stop spacing as a given. STA's relationship with its bus operators has improved as a result of the SCP implementation. Ridership has increased even in the face of service cuts. Anecdotal data indicate that on-time performance has increased slightly.

The primary drawback is resentment from some riders whose stops were removed. Complaints are magnified in winter weather. STA conducts a community perception survey; recent results indicate that 1% to 2% of respondents do not ride the buses because the nearest stop is too far away. Coverage issues and not the SCP are likely the cause, but the SCP may have contributed somewhat to this response.

The most successful action was stop consolidation, especially on the busiest routes. The operation of these routes is more consistent and is favored by operators and most riders. On some routes, STA removed 40% or more of all stops.

Changes/Lessons Learned

If STA could change one aspect of actions to improve bus speeds, it would have had the ability to track prechange to postchange data in greater detail by means of an AVL system or some other means. STA also notes that it is difficult to communicate changes to all riders. Posted notices were torn down at some stops, often the most controversial ones. Despite extensive efforts by the agency to provide information, some riders complained that they were not informed of the prospective changes.

STA offers the following lessons learned through its stop consolidation efforts:

- Begin with the end in mind. The SCP was not only about bus stops.
- Start with routes that will yield the biggest improvements. Phase 1 of the SCP targeted all routes with 15-min frequencies.
- Do not be discouraged by media attention or initial complaints from riders and operators. Bus operators who initially oppose stop consolidation may become your biggest champions. Riders, too, will begin to push for stop consolidation as they see the benefits to their own commutes.

CHAPTER SIX

CONCLUSIONS

INTRODUCTION

This chapter summarizes key findings, presents conclusions from this synthesis project, and offers areas for future study. Findings from the literature review, survey responses, and particularly the case examples identify and assess the factors contributing to the success of actions to increase bus speeds. The chapter is organized in five sections:

- Approaches to Improving Bus Speeds
- Agency Assessments
- Lessons Learned—Survey Respondents
- Lessons Learned—Case Examples
- Conclusions and Suggestions for Future Study

The further research needs offered here would address a greater detail of analysis regarding impacts of actions, customer response, traffic engineering concerns, effects of bus operators on success, and transferability of results.

APPROACHES TO IMPROVING BUS SPEEDS

- The need for actions to improve bus speeds is reflected in current trends. More than 75% of respondents reported that bus speeds have decreased across the board or in certain areas or for certain types of service. Nine respondents supplied detailed data on bus speed changes, showing an average annual rate of change of –0.45%. One agency observed that the economic downturn combined with increases in gas prices reduced traffic congestion and resulted in improved on-time performance.
- There are many valid ways to tinker with speeds and get some improvement. The greatest benefit typically can come from working with city traffic engineers to find ways to expedite the flow of transit vehicles. The most common external policy action was to implement signal priority or queue jump lanes, followed by changes to signal timing, bus-only lanes on arterial streets, and yield-to-bus laws. The magnitude of the effect of these actions varies with the specific policy and the location where it is applied and can be affected by other factors such as enforcement.
- Stop-related actions increase bus speeds by reducing the number of stops, making it easier to get into and out of bus stops, or by reducing dwell time at stops. Increased bus stop spacing and optimized stop placement are common actions. Two of the case examples reported successful stop spacing programs. Findings and the literature review suggest that this can be very effective. Increased stop spacing is also a key element of bus rapid transit (BRT) applications.
- Route adjustments increase bus speeds by keeping the bus on a major corridor, thereby reducing the number of deviations and turns, or by introducing new services that stop less often. Limited-stop and BRT services are examples of the latter approach and clearly improve bus speeds. Streamlining bus routes improves bus speeds to a lesser extent.
- Vehicle-related actions increase bus speeds through a reduction in dwell times or through improved acceleration. Low-floor buses with ramps instead of lifts for wheelchair access, different-size vehicles, and vehicles with better performance are typical actions.
- Internal policy changes increase bus speeds by reducing dwell time by means of faster boardings or other means or by changing hold policies at transit centers. Pricing that encourages use of prepaid media is one common action. One agency reported that eliminating paper transfers was its single most effective action. One case example reported experience with all-door boarding. Off-vehicle fare collection is a component of many BRT projects. Combinations of these policies appear to result in the greatest magnitude of change.
- Schedule-related actions can increase bus speeds by reducing the need for a bus to hold at stops if it is ahead of schedule or by balancing service time and recovery time more appropriately. Improving bus speeds is sometimes a collateral benefit of certain schedule-related actions, but the primary purpose of these actions is to improve schedule adherence and reliability. Typically, scheduled bus speeds decrease when running times are adjusted. One agency reported that experimenting with headway-based schedules has revealed previously undetected opportunities to reduce running times.
- Individual changes are difficult to isolate when implementation involves a package of improvements. Among metrics reported to measure the overall impacts, those of greatest concern for this study (change in average bus speed and analysis of components of travel time) were cited by 35% and 33%, respectively, of respondents. A common concern, reflected in the case examples, was the inability to analyze impacts at the desired level of detail. Continued widespread adoption of automated vehicle location (AVL) and automatic passenger counter (APC) technologies will mitigate this concern.

- Regarding technology, it is interesting to note that several successful strategies were implemented without the ability to analyze results in detail. Agencies taking this course of action recognized that overall improvements, particularly from combinations of strategies, would be too valuable to wait until new technologies were in place. In other words, many agencies did not wait for all desired technologies to be in place before implementing successful strategies.
- Only six agencies (of 20 that reported impacts on bus speeds) experienced increases in bus speeds. Four others stated that the actions taken mitigated decreases in bus speeds owing to other factors; one commented that changes enabled the agency to maintain the average speed on local bus routes through a period of major growth in ridership. This highlights the difficulty of achieving increases in bus speeds in the face of external factors that can slow speeds. A few agencies also noted that bus speeds were negatively affected by actions taken for other purposes, such as adding running time to improve schedule adherence.
- The survey asked about actions that were considered but not implemented and constraining factors that affected the ability to take action. More than half of respondents indicated that certain actions were considered but never taken. Primary reasons for not taking actions included an inability to identify a funding source, the only element characterized as a major constraint by a majority of respondents. Lack of cooperation from outside agencies, competing priorities, and safety concerns were identified as major constraints by at least 30% of respondents. Broader survey findings suggest that many successful actions rely on building relationships with external agencies, particularly city traffic engineers.

AGENCY ASSESSMENT OF ACTIONS TO IMPROVE BUS SPEEDS

- Results regarding the success of actions taken are neutral to positive. Only 6% of survey respondents rated the actions as very successful. More than half rated their actions as somewhat successful, and one-third reported a neutral outcome.
- The primary benefit of these actions is improved on-time performance and reliability, cited by almost half of all respondents.
- The ability to mitigate negative trends in bus speeds is another key benefit, along with an improved customer experience and increased bus speeds, particularly on BRT or limited-stop service.
- The major drawbacks of these actions are customer complaints over stop relocations and reduced level or quality of service. Quality of service issues involve overcrowding (low-floor buses have fewer seats) and tradeoffs between improving bus speed and improving on-time performance. Improvements to bus speeds are being overwhelmed at several agencies by continuing increases in traffic congestion and transit ridership. There is also a desire for more comprehensive programs of action that can result in notable improvements. Fifteen percent of survey respondents reported no drawbacks.
- A variety of responses were given with regard to the most successful action. This reflects the differing actions taken by the 59 agencies. Although there is no consensus regarding the single most effective action to take to improve speeds, stop consolidation ranks highest among effective non-BRT actions.
- Traffic engineering measures, particularly signal priority for buses and dedicated bus lanes on arterials, led all responses to the question: "If you could change ONE aspect in the process of designing and implementing actions to improve bus speeds, what would you change?" A more systematic, data-driven approach and added outreach to cities and the general public explaining why these actions are important also ranked highly among desired improvements.

LESSONS LEARNED—SURVEY RESPONDENTS

Survey respondents shared lessons learned from implementation of actions to improve bus speeds. Lessons regarding outreach to external stakeholders led the list of topic areas, followed by process/analysis, internal consensus, and persistence.

- Outreach to external stakeholders involves education as well as feedback. It is a mistake to assume that the benefits of improving bus speeds are obvious, particularly if customer or community reaction is negative. Positive impacts, such as reliability and savings, that can be reallocated back into improved service need to be emphasized. Good working relationships and partnerships with local jurisdictions are essential, especially for external actions, such as signal priority and dedicated lanes. Encouraging input, making changes to proposals where they make sense, and clearly communicating the reasons other changes are not being included are all vital steps.
- Making a compelling case based on solid data for why changes are needed and how they provide broad benefits to customers and for overall mobility is critical. Public response is often limited by an inability to envision new (for your city) concepts or to believe that they will actually work. Internally, a focus on a single metric, such as on-time performance, can result in losing track of trends in bus speeds. Keep an eye on the big picture of what you are trying to achieve but also pay close attention to the details. Agencies that have overcome opposition cite the importance of flexibility and a rational and defensible process based on data and open to public input as key to achieving implementation. Devote resources to measuring and evaluating the impacts, even if the technology to analyze detailed

levels of data is not yet available, and communicate these impacts to stakeholders.

- Agencies that implemented successful stop consolidation programs differed in their approach, as noted in the case examples. One began with the busiest routes, and the other began with less busy routes. Both approaches led to successful implementation, suggesting that the phasing of stop consolidation can be determined by local priorities.
- High-level support within the transit agency is extremely important. Fully involving all departments of the agency pays dividends, as does bringing bus operators and union representatives into the discussion. Open communication of goals and openness to input are also cited as factors contributing to success. As one agency stated, decreases in travel speeds need to be recognized as not simply an inevitable consequence of increased traffic and passenger loads, but as something that the agency has the power to affect through its own actions (or inaction).
- The long haul will look different from the short haul. Be prepared for complaints; stakeholders who initially oppose certain actions may become your biggest allies. Have a clear objective in mind, communicate it consistently, and work toward that goal. Make sure you have the resources to implement and operate the actions and systems you put in place.

LESSONS LEARNED—CASE EXAMPLES

- COTA, in Columbus, Ohio, implemented a multiyear Bus Stop Service Improvement Project (BSSIP) to review bus stop spacing on all routes. The stop spacing standard was adopted in 2010 and supported by stakeholders after they were invited on a trip along a major bus route to see the problem firsthand. The policy called for varied stop spacing, based on land use and density. The chief executive officer (CEO) was the driving force behind the policy and its implementation, and his support was vital in overcoming obstacles, especially in the early stages of the project. COTA began implementation with express routes, followed by crosstown routes, smaller local routes, and finally major local routes. Scheduled speed for local service decreased by less than 2% while local ridership increased by 17%. COTA credits the bus stop spacing standard and the BSSIP with allowing speeds to be maintained during a period of major ridership growth. COTA's advice to other agencies is to adopt a policy, then work hard to adhere to it. Keep the public and bus operators involved. Be flexible, but only where it makes sense. Follow through on stop removal to ensure that everything is done correctly.
- Gainesville Regional Transit System (RTS) set a guideline for bus stop spacing as part of its Bus Service Improvement Program (BSIP) in urban, suburban, and rural settings. This guideline served to guide stops and amenities toward arterials on the premise that removing stops is more acceptable if nearby stops are upgraded. RTS applies the new spacing guideline to new or extended routes and has removed or consolidated 67 stops. Local match is a challenge in obtaining funding for enhancing nearby stops. Public reaction was generally supportive because only stops with very low ridership activity were affected. Stop consolidation improved bus speeds, reduced stop maintenance costs, and allowed remaining stops to be maintained to a higher quality. RTS emphasizes the importance of communicating with riders and stakeholders, including city and county staff responsible for right-of-way issues.
- Metropolitan Transit Authority (MTA) Nashville introduced limited-stop ("BRT lite") routes on two major corridors with traffic signal priority. The average spacing for the limited stops is approximately 0.75 mi (1.2 km). Signal priority is provided at all signalized intersections outside of downtown. A bus will be given an additional 8 to 10 s of green time if it is at least 1 min behind schedule. The first new BRT lite service increased ridership in the corridor by 15% and also improved on-time performance. The support of the mayor, who made the new service one of his top priorities and promised to obtain funding for it, was invaluable in making implementation possible. MTA's advice to another agency trying to replicate its program is begin with a detailed examination of the busiest corridors; build and maintain a strong relationship with the city; understand that other departments and agencies have different priorities and will not immediately understand the importance of what you propose to do; and keep attention focused on the benefits of improved bus speeds.
- Metropolitan Transportation Authority (MTA)–New York City Transit (NYCT) centered many of its actions to improve bus speeds on the introduction of BRT service (known locally as Select Bus Service or SBS). Four SBS routes have been implemented since 2008. All feature bus lanes, low-floor buses, and wide stop spacing. Three routes use articulated buses, three have off-board fare collection, two routes have traffic signal priority, and bus bulbs are being built on two of the corridors in operation and on one of the corridors scheduled for 2013 implementation. SBS has increased speeds when compared with previous limited-stop routes in the same corridors. Speed increases from 9 to 12 mph (14 to 19 kph) occurred in the Bronx, from 6.75 to 8 mph (10.86 to 13 kph) in Manhattan, and from 10 (for the local route) to 13 mph (16 to 21 kph) in Staten Island. NYCT addresses competing goals (speed versus convenience, traffic calming versus bus speeds) by consistently stressing the benefits to be gained. NYCT uses phased implementation, partnerships with the city, particularly New York City Department of Transportation, and reliance on data to support the actions. NYCT emphasized the need for persistence, and noted that it is very easy to be influenced by the concerns of specific groups. A transit system cannot be designed or redesigned around the concerns of any single group.

- San Francisco Municipal Transit Agency (SFMTA) took a variety of actions to improve bus speeds. Transit signal priority (TSP) has been expanded to 200 intersections affecting 20% of all SFMTA routes. TSP is reported to have had the biggest impact, with bus speed increases of between 5% and 10%. All-door boarding, the major internal policy change, has reduced dwell times at stops with 10 or more boardings by 3 to 4 s per stop. SFMTA set bus stop spacing guidelines for each type of service and has removed some stops, but passenger complaints have delayed the bus stop consolidation program. Bus bulbs have been installed at key stops. The city and SFMTA are focusing on expanding transit-only lanes. Signal timing and turn restrictions have also helped. Passenger response to limited-stop service is positive, and SFMTA is seeking ways to expand limited service. SFMTA's advice to other agencies is to know your community, work with stakeholders to get buy-in at an early stage, and be prepared for a lot of planning work on the back end to ensure that the actions work as planned.
- Spokane Transit Authority (STA) designed a phased Stop Consolidation Plan (SCP). The SCP was the means to implement a new stop standard approved by the STA Board as part of the 2010 Comprehensive Plan. The standard calls for a targeted average stop spacing of 1,200 ft (366 m). STA included its most frequent routes in Phase 1 because changes to these routes yielded the greatest improvements. Phase 2 occurred in 2011, in conjunction with a major service reduction and system restructuring. Phase 3 included higher-ridership routes with 30-min headways, and the current Phase 4 includes all other routes. To date, there are 24% fewer stops systemwide than in 2009. This percentage will increase to 35% with the completion of Phase 4. Ridership has increased even in the face of service cuts. Anecdotal data indicate that on-time performance has increased slightly. STA's advice to other agencies is to begin with the end in mind, start with routes that will yield the biggest improvements, and do not be discouraged by media attention or initial complaints from riders and operators. In STA's case, both operators and riders have become supporters of the program as they see the benefits to their own situations.

CONCLUSIONS AND AREAS OF FUTURE STUDY

- Improving bus speeds is possible. The survey results and case examples reinforce that there are many valid ways to tinker with speeds and get some improvement. Success stories feature strong positive relationships with municipal agencies and stakeholders and an internal agency commitment to the program, especially on the part of upper management.
- Mitigating decreases in bus speeds as a result of other factors is an important goal. The literature review and survey responses note external factors that contribute to declining bus speeds over time. Success for many agencies lies in the ability to take actions that mitigate decreases in bus speeds resulting from increased congestion or increased ridership.

Working with city traffic engineers to find ways to expedite the flow of transit vehicles is very effective. The most common external policy action was to implement signal priority or queue jump lanes, followed by changes to signal timing, bus-only lanes on arterial streets, and yield-to-bus laws. The San Francisco case example found that signal priority had the biggest impact of any actions, resulting in an increase of between five percent and 10% in bus speeds. The New York City case example reported that off-board fare collection and increased stop spacing, in combination with TSP, bus-only lanes, and all-door boarding, resulted in notable improvements in bus speeds for its Select Bus Service routes.

- Stop consolidation programs are very effective if customer resistance can be overcome. Changes to stop spacing engender greater resistance than do other actions. Tension between speed on the system and access to the system is accentuated when increased stop spacing is proposed. Several survey respondents lamented the inability to overcome opposition to stop spacing schemes, but the case examples in Columbus and Spokane indicate that stop consolidation programs can be implemented successfully. Open engagement with stakeholders, particularly those skeptical of the idea, support from upper management, and cooperation of municipal staff are characteristics associated with successful programs. Persistence is also useful. As noted in one of the case examples, bus speed is never an emergency, and actions to improve speeds can slide down the list of agency priorities without constant reminders of the benefits.
- Other actions can also improve bus speeds. Bus stop consolidation and traffic engineering strategies received the greatest attention among survey respondents, but changes in fare policy, vehicles, and schedules have also been successful and can be done independently by the transit agency. Elimination of paper transfers, introduction of smaller or newer vehicles with better acceleration, and experimentation with headway-based schedules to reveal segments where running times can be reduced were among the less common but still successful actions. Changing stop location to the far side at signalized intersections and the near side at intersections with stop signs is another example of a commonsense approach to improving bus speeds.
- Successful agencies emphasized good ideas above technology. TSP and other traffic engineering actions topped the "wish list" of responding agencies, but most of the successful actions could be implemented without new or added technology. A notable finding is that several agencies proceeded to implementation despite lacking the technology that would yield data for detailed analysis of results. These agencies did measure and report overall impacts, a critical step in establishing the success of the actions taken.

- Obstacles can be overcome with the support of upper management inside and outside the agency. The list of constraints can appear daunting: funding; lack of cooperation from outside agencies; competing goals and priorities; safety concerns; and opposition from customers, property owners, or businesses. With the support of upper management, particularly within the agency, successful actions can be implemented. The most salient factors appear to be defensible programs based on data; open, transparent, and consistent communication regarding benefits; flexibility in the face of legitimate and serious issues; and commitment to ongoing analysis and communication.

Findings from this synthesis suggest eight areas of future study:

- *Analysis of the effectiveness of individual components of actions to improve bus speeds at the stop and route segment level*. Several agencies reported the need for better, more accurate, and more timely data to measure the impacts at the micro as well as the macro level. Future actions were prominently mentioned in the survey, suggesting that the overall impacts of actions to improve bus speeds are apparent. The need to understand more clearly what works in certain circumstances and not in others and the reasons why is clear. Stop spacing and signal timing optimization appear to be very effective in increasing bus speeds, but additional research is needed to confirm these findings. There will be increasing opportunities for cross-comparisons among agencies and for more detailed analysis within agencies.
- *Customer response.* Little quantitative data exist on customer ratings of the various actions taken. Many agencies measured customer response in terms of ridership, but no agency could say definitively how customers responded to individual actions. Case examples indicated that successful stop consolidation programs have changed initial opposition into support, but many agencies have not been able to get to that point. How do transit customers rate actions to improve bus speeds, and do their ratings change as they become more familiar with any given concept as it is implemented? Do opinions really change, or is the observation that “Some people resent you for a long time” more accurate? Answers to these questions could provide tools for overcoming opposition mentioned by so many agencies as a constraining factor.
- *Ways to encourage closer liaison or better working relationships between transit agencies and traffic engineers.* As noted by one agency, city traffic signal engineers are not experts in bus transit, and transit analysts are not experts in traffic signal timing. The Institute of Transportation Engineers has entered into a cooperative agreement with FTA to improve the integration of transit priority treatments on urban street networks. A white paper resulting from this agreement, cited in chapter two (Koonce, “Transit Priority Treatments White Paper”), noted a serious need for additional research and dissemination of findings in this area. Emerging technologies also would be addressed in this area.
- *Specific traffic engineering concerns.* One agency reported that local jurisdictions are hesitant to implement extraordinary measures that are not “endorsed” by inclusion in the *Manual on Uniform Traffic Control Devices* (MUTCD). This suggests that a review of MUTCD with regard to inclusion of actions that can improve bus speeds could be productive. If, as can reasonably be expected, some of the more successful actions are adopted by smaller agencies with less expertise available among limited staff, reliance on a source such as MUTCD could be instrumental in the ability to implement actions. An ongoing TCRP study (A-39, *Improving Transportation Network Efficiency Through Implementation of Transit-Supportive Roadway Strategies*) includes potential changes to MUTCD among its objectives and may address this concern.
- *An updated synthesis study on service standards. TCRP Synthesis Report 10* is the most recent review of service standards and guidelines in the transit industry, and it is almost 20 years old. Revisiting this topic with particular attention to stop spacing, recovery times, and on-time performance guidelines and standards would broaden the findings of this study.
- *A synthesis study addressing bus speeds.* The end of chapter one of this report includes quantitative data on bus speeds gathered from a select group of respondents able to provide hard numbers. However, this was a follow-up effort to the main survey, and the definition of average bus speed was not consistent across all cities. Research evaluating the implementation of BRT service has produced relatively current data on bus speeds before and after, but survey results produced less hard data than anticipated. A study focused on bus speeds would provide a current baseline, expand on trend information reported in chapter one, and explore reasons for differences across and within cities.
- *Effect of bus operators on success.* Several agencies mentioned the disparity in the ability of operators to drive a route. This is a familiar concept in operations, but the effects are unclear, and there is little information in the literature. Do schedulers “schedule down” to the least common denominator or simply assume that some operators will be unable to keep to schedule? Are there training modules developed to address this issue, and how successful are they? Does this phenomenon affect the success of actions to improve bus speeds?
- *Transferability*. Can the experience in one city or agency be applied with confidence elsewhere? Are there specific mitigating circumstances that affect the success of specific actions? How do these circumstances apply?

ACRONYMS

ADA	Americans with Disabilities Act
APC	Automatic passenger counters
AVL	Automatic vehicle location
BRT	Bus rapid transit
BSIP	Bus Service Improvement Program
BSSIP	Bus Stop Service Improvement Project
CAD	Computer-aided dispatch
CBD	Central business district
CEO	Chief executive officer
CNG	Compressed natural gas
COA	Comprehensive Operational Analysis
COTA	Central Ohio Transit Authority
DOT	Department of transportation
GIS	Geographic information system
GPS	Global Positioning System
HOV	High-occupancy vehicle
HPT	High-performance transit
MPO	Metropolitan planning organization
MTA	Metropolitan Transit Authority (Nashville) or Metropolitan Transportation Authority (New York)
MUTCD	Manual on Uniform Traffic Control Devices
NIMBY	Not in My Back Yard
NTD	National Transit Database
NYCT	MTA–New York City Transit
OTP	On time performance
RSA	Remote supervisor adaptor
RTD	Regional Transportation District
RTS	Regional Transit System
SBS	Select Bus Service
SCP	Stop Consolidation Plan
SFMTA	San Francisco Municipal Transit Agency
SR	State route
STA	Spokane Transit Authority
TCQSM	Transit Capacity and Quality of Service Manual
TEP	Transit Effectiveness Project
TOD	Transit-oriented development
TRID	Transportation Research Information Database
TSP	Transit signal priority

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APPENDIX A

LIST OF PARTICIPATING TRANSIT AGENCIES

Commonsense Approaches for Improving Transit Bus Speeds

1.	Albuquerque, NM	ABQ Ride
2.	Ann Arbor, MI	Ann Arbor Transportation Authority (The Ride)
3.	Antioch, CA	East Contra Costa Transit Authority/Tri Delta Transit
4.	Arlington, VA	ART–Arlington Transit
5.	Arlington Heights, IL	PACE Suburban Bus
6.	Atlanta, GA	Metropolitan Atlanta Rapid Transit Authority
7.	Austin, TX	Capital Metro
8.	Bremerton, WA	Kitsap Transit
9.	Charlotte, NC	Charlotte Area Transit System
10.	Cincinnati, OH	Southwest Ohio Regional Transit Authority
11.	Columbus, OH	Central Ohio Transit Authority
12.	Corpus Christi, TX	Regional Transportation Authority
13.	Davis, CA	Unitrans
14.	Dayton, OH	Greater Dayton Regional Transit Authority
15.	Denver, CO	Regional Transportation District
16	Eden Prairie, MN	SouthWest Transit
17.	El Paso, TX	Sun Metro
18.	Eugene, OR	Lane Transit District
19.	Flint, MI	Mass Transportation Authority
20.	Fort Worth, TX	Fort Worth Transportation Authority
21.	Gainesville, FL	Gainesville Regional Transit System
22.	Greensboro, NC	Greensboro Transit Authority
23.	Hartford, CT	Connecticut Transit
24.	Houston, TX	Metro
25.	La Crosse, WI	La Crosse Municipal Transit Utility
26.	Lansing, MI	Capital Area Transportation Authority
27.	Las Cruces, NM	City of Las Cruces RoadRUNNER Transit
28.	Minneapolis, MN	Metro Transit
29.	Mississauga, ON	Mississauga Transit
30.	Nashville, TN	Nashville Metropolitan Transportation Authority
31.	New York City, NY	MTA–New York City Transit
32.	Oceanside, CA	North County Transit District
33.	Olympia, WA	Intercity Transit
34.	Ottawa, ON	OC Transpo
35.	Philadelphia, PA	Southeastern Pennsylvania Transportation Authority
36.	Phoenix, AZ	Valley Metro
37.	Portland, OR	Tri-County Metropolitan Transit District of Oregon
38.	Reno, NV	Regional Transportation Commission of Washoe County
39.	Rio Vista, CA	City of Rio Vista
40.	Riverside, CA	Riverside Transit Agency
41.	Rockville, MD	Montgomery County Ride On
42.	Salem, OR	Salem Keizer Transit
43.	San Bernardino, CA	Omnitrans
44.	San Diego, CA	Metropolitan Transit System
45.	San Francisco, CA	San Francisco Municipal Transit Agency (Muni)
46.	San Jose, CA	Santa Clara Valley Transit Authority
47.	San Rafael, CA	Marin County Transit
48.	Santa Cruz, CA	Santa Cruz Metro
49.	Sarasota, FL	Sarasota County Area Transit
50.	Seattle, WA	King County Metro Transit
51.	Seattle, WA	Sound Transit
52.	Spokane, WA	Spokane Transit Authority
53.	St. Cloud, MN	St. Cloud Metro Bus
54.	Syracuse, NY	Centro
55.	Tacoma, WA	Pierce Transit
56.	Toronto, ON	Toronto Transit Commission
57.	Vancouver, BC	TransLink
58.	Victoria, BC	BC Transit
59.	Wenatchee, WA	Link Transit

APPENDIX B

Survey Questionnaire

1. WELCOME

This TCRP synthesis project will document the state of the practice in terms of approaches taken to improve bus speeds and their impacts. The survey contains questions about existing trends in bus speeds, actions taken (and considered but not taken), metrics used to measure results, impacts of various actions, barriers to success, reasons for success and failure, and lessons learned.

The survey questions try to address as many situations as possible, but given the variety of circumstances and transit systems, not all questions may be appropriate for all agencies. We encourage you to obtain input from others in your agency as needed. If any question does not apply to your system, simply answer "N/A."

We also ask for recommendations for other agencies to be included in our sample and for your willingness to participate in a telephone interview if your agency is selected for a more detailed case example.

The final report, to be published by the Transportation Research Board, will provide information on various approaches taken to improve bus speeds and their results. This report will be extremely useful to all transit agencies in deciding how to proceed when downtown circulators are being considered. All survey responses will be confidential.

Thank you for taking the time to participate.

2. Default Section

1. Today's Date

MM DD YYYY

MM/DD/YYYY [ ] / [ ] / [ ]

* 2. Please list your name, agency, and contact information

Name:

Company:

Title:

City/Town:

State/Province:

Email Address:

Phone Number:

3. EXISTING TRENDS

* 3. Describe the trend in local bus speeds at your agency over the past five years

- ◯ Bus speeds have increased
- ◯ Bus speeds have decreased
- ◯ Results are mixed
- ◯ No change in bus speeds

4. EXISTING TRENDS 2

* 4. How has this trend primarily been identified?

- ◯ Qualitatively – anecdotal information
- ◯ Quantitatively – tracked by performance measures

5. What is the trend in local bus speeds over the past five years?

- ◯ Decreased by 0 to 5%
- ◯ Decreased by 5 to 10%
- ◯ Decreased by more than 10%
- ◯ Increased
- ◯ Other (please specify)

5. ACTIONS TAKEN

This section first asks if your agency has taken any actions to affect bus speeds. Actions are grouped in six broad areas. Within each area, we ask if you have measured the impacts of specific changes. If you made a series of changes and did not measure the impacts of individual changes, there is a box to check, and you will be asked later about the overall impacts.

* 6. Has your agency taken any of the following actions to increase or to mitigate decreases in bus speeds?

- ☐ Bus stop spacing, design, length, or placement
- ☐ Vehicle size, seating or door configuration, performance, wheelchair boarding, or bicycle storage
- ☐ Schedule adjustments (running times, recovery time policy, headway-based vs. timepoint-based)
- ☐ Route adjustments (route streamlining, limited-stop service, BRT)
- ☐ Agency policies (off-board fare payment, pricing to encourage shifts to prepaid media, fare-free system or zones, all-door boarding, bus door practices, transfer policy, hold policy at transit centers)
- ☐ External policies (bus lanes, signal priority/queue-jump lanes, yield-to-bus laws, signal timing, turn restrictions, parking restrictions)
- ☐ Other
- ☐ No action taken

6. ACTIONS TAKEN - Bus stops

7. Did your agency take any of the following actions with regard to bus stops:

Increased distance between stops
Level boarding at major stops
Stop design or stop length
Stop location
Other actions related to bus stops

- ◯ Yes
- ◯ No

7. ACTION TAKEN - Bus stops 2

8. Did your transit agency change stop spacing?

- ◯ Yes
- ◯ No

8. ACTION TAKEN - Bus Stops 2A

9. Do your service standards address stop spacing?

- ◯ Yes
- ◯ No

10. Describe the change to stop spacing.

11. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

9. ACTIONS TAKEN - Bus Stops 2B

12. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

10. ACTIONS TAKEN - Bus stops 3

13. Did your transit agency introduce level boarding at transit centers or other major stops?

- ◯ Yes
- ◯ No

11. ACTIONS TAKEN - Bus Stops 3A

14. Describe this change.

15. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

12. ACTIONS TAKEN - Bus Stops 3B

16. What effect did this change have on bus speeds?

- ○ Increased by 0 to 5%
- ○ Increased by 5 to 10%
- ○ Increased by more than 10%
- ○ Decreased speeds
- ○ No impact

Other (please specify)

13. ACTIONS TAKEN - Bus stops 4

17. Did your transit agency change bus stop design or length?

- ○ Yes
- ○ No

14. ACTIONS TAKEN - Bus Stops 4A

18. Describe this change.

19. Did your transit agency measure the effect of this change on bus speeds?

- ○ Yes
- ○ Did not measure this separately; measured the effect of a package of changes
- ○ No

15. ACTIONS TAKEN - Bus Stops 4B

20. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

16. ACTIONS TAKEN - Bus stops 5

21. Did your transit agency change the location of bus stops (e.g., near-side, far-side, mid-block)?

- ◯ Yes
- ◯ No

17. ACTIONS TAKEN - Bus Stops 5A

22. Describe this change.

23. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

18. ACTIONS TAKEN - Bus Stops 5B

24. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

19. ACTIONS TAKEN - Bus stops 6

25. Did your transit agency make other stop-related changes to improve bus speeds?

- ◯ Yes
- ◯ No

20. ACTIONS TAKEN - Bus Stops 6A

26. Describe this change.

27. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

21. ACTIONS TAKEN - Bus Stops 6B

28. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

22. ACTIONS TAKEN - Vehicles

29. Did your agency take any of the following actions with regard to vehicles:

Introduce or increase use of low floor buses
Change size of vehicle
Introduce vehicle with better performance
Change interior seating (e.g., 2*1 seating instead of 2*2)
Change door configuration
Change from lifts to ramps for wheelchair access
Allow bicycle storage inside vehicles
Other actions related to vehicles

- ◯ Yes
- ◯ No

23. ACTIONS TAKEN - Vehicles 2

30. Did your transit agency introduce or increase use of low floor buses?

- ◯ Yes
- ◯ No

24. ACTIONS TAKEN - Vehicles 2A

31. Approximately what percentage of the fleet is comprised of low floor buses?

32. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

25. ACTIONS TAKEN - Vehicles 2B

33. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

26. ACTIONS TAKEN - Vehicles 3

34. Did your transit agency introduce or increase use of different-size vehicles

- Yes
- No

27. ACTIONS TAKEN - Vehicles 3A

35. Describe this change.

36. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

28. ACTIONS TAKEN - Vehicles 3B

37. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

29. ACTIONS TAKEN - Vehicles 4

38. Did your transit agency introduce vehicles with better performance?

- Yes
- No

30. ACTIONS TAKEN - Vehicles 4A

39. Describe this change.

40. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

31. ACTIONS TAKEN - Vehicles 4B

41. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

32. ACTIONS TAKEN - Vehicles 5

42. Did your transit agency change the seating configuration inside the bus (e.g., 2*1 seating instead of 2*2 or any other changes)?

- ◯ Yes
- ◯ No

33. ACTIONS TAKEN -Vehicles 5A

43. Describe this change.

44. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

34. ACTIONS TAKEN - Vehicles 5B

45. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

35. ACTIONS TAKEN - Vehicles 6

46. Did your transit agency change the door configuration on the bus?

- ◯ Yes
- ◯ No

36. ACTIONS TAKEN - Vehicles 6A

47. Describe this change.

48. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

37. ACTIONS TAKEN - Vehicles 6B

49. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

38. ACTIONS TAKEN - Vehicles 7

50. Did your transit agency switch from lifts to ramps for wheelchair access?

- ◯ Yes
- ◯ No

39. ACTIONS TAKEN - Vehicles 7A

51. What percentage of the fleet was affected?

52. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

40. ACTIONS TAKEN - Vehicles 7B

53. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

41. ACTIONS TAKEN - Vehicles 8

54. Did your transit agency allow bicycle storage inside the bus?

- ◯ Yes
- ◯ No

42. ACTIONS TAKEN - Vehicles 8A

55. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

43. ACTIONS TAKEN - Vehicles 8B

56. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

44. ACTIONS TAKEN - Vehicles 9

57. Did your transit agency make any other vehicle-related changes intended to improve bus speeds?

- Yes
- No

45. ACTIONS TAKEN - Vehicles 9A

58. Describe this change.

59. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

46. ACTIONS TAKEN - Vehicles 9B

60. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

47. ACTIONS TAKEN - Scheduling

61. Did your agency take any of the following actions with regard to bus schedules:

Adjust running time
Change recovery time policy (e.g., as % of running time)
Use headway-based instead of timepoint-based schedules
Other schedule-related actions to improve bus speeds

- ◯ Yes
- ◯ No

48. ACTIONS TAKEN - Scheduling 1

62. Did your transit agency adjust running time, either on specific routes or systemwide?

- ◯ Yes
- ◯ No

49. ACTIONS TAKEN - Scheduling 1A

63. Approximately what percentage of routes were affected?

64. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

50. ACTIONS TAKEN - Scheduling 1B

65. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

51. ACTIONS TAKEN - Scheduling 2

66. Did your transit agency change recovery time policy (e.g., as % of running time)?

- ◯ Yes
- ◯ No

52. ACTIONS TAKEN - Scheduling 2A

67. Describe the change

68. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

53. ACTIONS TAKEN - Scheduling 2B

69. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

54. ACTIONS TAKEN - Scheduling 3

70. Did your transit agency change to headway-based instead of timepoint-based schedules?

- ◯ Yes
- ◯ No

55. ACTIONS TAKEN - Scheduling 3A

71. Describe the change - how many routes were affected?

72. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

56. ACTIONS TAKEN - Scheduling 3B

73. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

57. ACTIONS TAKEN - Scheduling 4

74. Did your transit agency make any other scheduling-related changes to improve bus speeds?

- ◯ Yes
- ◯ No

58. ACTIONS TAKEN - Scheduling 4A

75. Describe the change.

76. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

59. ACTIONS TAKEN - Scheduling 4B

77. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

60. ACTIONS TAKEN - Route adjustments

78. Did your agency take any of the following actions with regard to route design:

Streamline routes
Implement limited-stop service
Implement BRT service
Other route changes to improve bus speeds

- ◯ Yes
- ◯ No

61. ACTIONS TAKEN - Route adjustments 1

79. Did your transit agency streamline any routes?

- ◯ Yes
- ◯ No

62. ACTIONS TAKEN - Route adjustments 1A

80. Approximately what percentage of routes were streamlined?

81. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

63. ACTIONS TAKEN - Route adjustments 1B

82. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

64. ACTIONS TAKEN - Route adjustments 2

83. Did your transit agency introduce limited-stop service on any routes?

- ◯ Yes
- ◯ No

65. ACTIONS TAKEN - Route adjustments 2A

84. Describe the change. How many limited-stop routes were implemented?

85. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

66. ACTIONS TAKEN - Route adjustments 2B

86. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

67. ACTIONS TAKEN - Route adjustments 3

87. Did your transit agency introduce or add BRT service?

- Yes
- No

68. ACTIONS TAKEN - Route adjustments 3A

88. Describe the change. How many BRT routes were implemented? What elements of BRT were included?

89. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

69. ACTIONS TAKEN - Route adjustments 3B

90. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

70. ACTIONS TAKEN - Route adjustments 4

91. Did your transit agency make any other route changes to improve bus speeds?

- Yes
- No

71. ACTIONS TAKEN - Route adjustments 4A

92. Describe the change.

93. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

72. ACTIONS TAKEN - Route adjustments 4B

94. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

73. ACTIONS TAKEN - Internal policies

95. Did your agency change any of the following internal policies:

Allow all-door boarding
Allow off-board fare payment
Change pricing to encourage shift to prepaid fare media
Introduce or discontinue fare-free zones or eliminate fares entirely
Change bus door practices (e.g., introduce passenger-actuated doors, change policies re operators re-opening doors after beginning to pull away from a stop)
Change transfer policies
Change hold policies at transit centers
Change other internal policies to improve bus speeds

- ◯ Yes
- ◯ No

74. ACTIONS TAKEN - Internal policies 1

96. Did your transit agency change boarding practices to allow all-door boarding?

- ◯ Yes
- ◯ No

75. ACTIONS TAKEN - Internal policies 1A

97. Describe the change. Does it apply to all routes or only to selected routes?

98. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

76. ACTIONS TAKEN - Internal policies 1B

99. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

77. ACTIONS TAKEN - Internal policies 2

100. Did your transit agency change fare payment practices to allow or require off-board fare payment?

- ◯ Yes
- ◯ No

78. ACTIONS TAKEN - Internal policies 2A

101. Describe the change. Does it apply to all routes, or only to selected routes?

102. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

79. ACTIONS TAKEN - Internal policies 2B

103. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

80. ACTIONS TAKEN - Internal policies 3

104. Did your transit agency change pricing to encourage use of prepaid fare media?

- ◯ Yes
- ◯ No

81. ACTIONS TAKEN - Internal policies 3A

105. Describe the change.

106. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

82. ACTIONS TAKEN - Internal policies 3B

107. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

83. ACTIONS TAKEN - Internal policies 4

108. Did your transit agency introduce or discontinue fare-free zones or eliminate fares entirely?

- Yes
- No

84. ACTIONS TAKEN - Internal policies 4A

109. Describe the change.

110. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

85. ACTIONS TAKEN - Internal policies 4B

111. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

86. ACTIONS TAKEN - Internal policies 5

112. Did your transit agency change bus door practices (e.g., introduce passenger-actuated doors, change policies re operators re-opening doors after beginning to pull away from a stop)?

- Yes
- No

87. ACTIONS TAKEN - Internal policies 5A

113. Describe the change.

114. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

88. ACTIONS TAKEN - Internal policies 5B

115. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

89. ACTIONS TAKEN - Internal policies 6

116. Did your transit agency change hold policies at transit centers?

- Yes
- No

90. ACTIONS TAKEN - Internal policies 6A

117. Describe the change.

118. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

91. ACTIONS TAKEN - Internal policies 6B

119. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

92. ACTIONS TAKEN - Internal policies 7

120. Did your transit agency change any other internal policies to improve bus speeds?

- Yes
- No

93. ACTIONS TAKEN - Internal policies 7A

121. Describe the change.

122. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

94. ACTIONS TAKEN - Internal policies 7B

123. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

95. ACTIONS TAKEN - External policies

124. Did your agency achieve changes in any of the following external policies:

Bus-only lanes on arterial streets
Signal priority/queue-jump lanes
Yield-to-bus laws
Signal timing
Turn restrictions
Parking restrictions
Other external policies affecting bus speeds

- ◯ Yes
- ◯ No

96. ACTIONS TAKEN - External policies 1

125. Did a municipality served by your transit agency implement bus-only lanes on arterial streets?

- ◯ Yes
- ◯ No

97. ACTIONS TAKEN - External policies 1A

126. What type of bus-only lane was added?

- ◯ Curb lane
- ◯ Median offset lane
- ◯ Fully separated lane

Other (please specify)

127. Describe the change. How many routes are affected?

128. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

98. ACTIONS TAKEN - External policies 1B

129. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

99. ACTIONS TAKEN - External policies 2

130. Did a municipality served by your transit agency implement signal priority or queue-jump lanes for buses?

- ◯ Yes
- ◯ No

100. ACTIONS TAKEN - External policies 2A

131. Describe the change. How many routes are affected?

132. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

101. ACTIONS TAKEN - External policies 2B

133. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

102. ACTIONS TAKEN - External policies 3

134. Did a municipality (or other entity) served by your transit agency introduce "yield-to-bus" laws?

- Yes
- No

103. ACTIONS TAKEN - External policies 3A

135. Describe the change.

136. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

104. ACTIONS TAKEN - External policies 3B

137. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

105. ACTIONS TAKEN - External policies 4

138. Did a municipality served by your transit agency introduce signal timing?

- ◯ Yes
- ◯ No

106. ACTIONS TAKEN - External policies 4A

139. Describe the change.

140. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

107. ACTIONS TAKEN - External policies 4B

141. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

108. ACTIONS TAKEN - External policies 5

142. Did a municipality served by your transit agency introduce turn restrictions for vehicles other than buses?

- ◯ Yes
- ◯ No

109. ACTIONS TAKEN - External policies 5A

143. Describe the change.

144. Did your transit agency measure the effect of this change on bus speeds?

- Yes
- Did not measure this separately; measured the effect of a package of changes
- No

110. ACTIONS TAKEN - External policies 5B

145. What effect did this change have on bus speeds?

- Increased by 0 to 5%
- Increased by 5 to 10%
- Increased by more than 10%
- Decreased speeds
- No impact

Other (please specify)

111. ACTIONS TAKEN - External policies 6

146. Did a municipality served by your transit agency introduce parking restrictions?

- Yes
- No

112. ACTIONS TAKEN - External policies 6A

147. Describe the change.

148. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

113. ACTIONS TAKEN - External policies 6B

149. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

114. ACTIONS TAKEN - External policies 7

150. Were there any other external policy changes that affected bus speeds?

- ◯ Yes
- ◯ No

115. ACTIONS TAKEN - External policies 7A

151. Describe the change.

152. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

116. ACTIONS TAKEN - External policies 7B

153. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

117. ACTIONS TAKEN - Other

154. Did your transit agency or any municipality served by your agency take any other actions to improve bus speeds?

- ◯ Yes
- ◯ No

118. ACTIONS TAKEN - Other A

155. Describe the change.

156. Did your transit agency measure the effect of this change on bus speeds?

- ◯ Yes
- ◯ Did not measure this separately; measured the effect of a package of changes
- ◯ No

119. ACTIONS TAKEN - Other B

157. What effect did this change have on bus speeds?

- ◯ Increased by 0 to 5%
- ◯ Increased by 5 to 10%
- ◯ Increased by more than 10%
- ◯ Decreased speeds
- ◯ No impact

Other (please specify)

120. METRICS USED TO MEASURE RESULTS

158. What metrics were used to measure the overall impacts of all changes implemented?

- [ ] Change in average bus speed
- [ ] Analysis of components of travel speed (dwell time at stops, time stuck in traffic, etc.)
- [ ] Schedule adherence
- [ ] Operating cost
- [ ] Ridership
- [ ] Qualitative measures from passenger surveys
- [ ] Other (please specify)

159. Please describe the overall results of all actions taken. If your agency only took one of the actions described here, note that here; you do not have to repeat your answer.

121. ACTIONS NOT IMPLEMENTED

160. Did your agency contemplate but not implement any actions to improve bus speeds?

- ○ Yes
- ○ No

122. ACTIONS NOT IMPLEMENTED 1

161. Please indicate all actions that were considered but not implemented.

- [ ] Increased bus stop spacing
- [ ] Level boarding at major stops
- [ ] Changes in stop design or length
- [ ] Changes in stop location
- [ ] Low floor buses
- [ ] Changes to vehicle size or performance
- [ ] Changes to interior seating configuration
- [ ] Changes to door configuration
- [ ] Use of ramps instead of lifts for wheelchair boardings
- [ ] Bicycle storage inside the bus
- [ ] Streamlined route design
- [ ] Limited-stop service
- [ ] BRT service
- [ ] Running time adjustments
- [ ] Changes to recovery time policy
- [ ] Use of headway-based instead of timepoint-based schedules
- [ ] All-door boarding
- [ ] Off-board fare payment
- [ ] Pricing to encourage shifts to prepaid fare media
- [ ] Introduce or discontinue fare-free zones
- [ ] Eliminate fares entirely
- [ ] Change bus door practices (passenger-activated or policies regarding bus operators re-opening doors for late-arriving passengers)
- [ ] Hold policies at transit centers
- [ ] Bus-only lanes on arterial streets
- [ ] Signal priority for buses
- [ ] Queue-jump lanes
- [ ] Yield-to-bus laws
- [ ] Signal timing
- [ ] Turn restrictions
- [ ] Parking restrictions

Other (please specify)

162. Please describe why the actions were not implemented.

123. BARRIERS, OBSTACLES, AND CONSTRAINTS

163. Please characterize the following elements as major constraints, minor constraints, or not a constraint in implementing actions to improve bus speeds.

	Major Constraint	Minor Constraint	Not a Constraint
Passenger complaints	○	○	○
Operator complaints	○	○	○
Safety concerns from operations department	○	○	○
Lack of support from upper management	○	○	○
Lack of cooperation from outside agencies	○	○	○
Competing goals viewed as more important	○	○	○
Inability to identify a funding source	○	○	○
General reluctance to change	○	○	○

Other (please specify)

164. Please describe the nature of the major constraint affecting the implementation of actions to improve bus speeds.

124. ASSESSMENT

165. How would your agency rate the actions taken to improve bus speeds?

- ◯ Very successful
- ◯ Somewhat successful
- ◯ Neutral
- ◯ Somewhat unsuccessful
- ◯ Very unsuccessful

166. What have been the primary benefits of these actions?

167. What have been the primary drawbacks of these actions?

168. What was the most successful action taken, and why?

169. If you could change ONE aspect in the process of designing and implementing actions to improve bus speeds, what would you change?

170. Please describe any "lessons learned" that would benefit other transit agencies that are considering implementation of similar actions to improve bus speeds.

125. CASE STUDY

171. Would you be willing to participate further as a case study, involving a telephone interview going into further detail on your agency's experience, if selected by the TCRP panel for this project?

- ◯ Yes
- ◯ No

126. ACTIONS CONSIDERED

172. Did your agency contemplate but not implement any actions to improve bus speeds?

- ◯ Yes
- ◯ No

127. ACTIONS CONSIDERED 2

173. Please indicate all actions that were considered but not implemented.

- [ ] Increased bus stop spacing
- [ ] Level boarding at major stops
- [ ] Changes in stop design or length
- [ ] Changes in stop location
- [ ] Low floor buses
- [ ] Changes to vehicle size or performance
- [ ] Changes to interior seating configuration
- [ ] Changes to door configuration
- [ ] Use of ramps instead of lifts for wheelchair boardings
- [ ] Bicycle storage inside the bus
- [ ] Streamlined route design
- [ ] Limited-stop service
- [ ] BRT service
- [ ] Running time adjustments
- [ ] Changes to recovery time policy
- [ ] Use of headway-based instead of timepoint-based schedules
- [ ] All-door boarding
- [ ] Off-board fare payment
- [ ] Pricing to encourage shifts to prepaid fare media
- [ ] Introduce or discontinue fare-free zones
- [ ] Eliminate fares entirely
- [ ] Change bus door practices (passenger-activated or policies regarding bus operators re-opening doors for late-arriving passengers)
- [ ] Hold policies at transit centers
- [ ] Bus-only lanes on arterial streets
- [ ] Signal priority for buses
- [ ] Queue-jump lanes
- [ ] Yield-to-bus laws
- [ ] Signal timing
- [ ] Turn restrictions
- [ ] Parking restrictions

Other (please specify)

174. Please describe why the actions were not implemented.

128. OTHER AGENCIES

175. Is there another agency (e.g., City Department of Transportation) that you suggest we contact for this synthesis project? If so, please provide a contact person and email address.

176. Is there another transit system that you suggest we contact for this synthesis project?

129. THANK YOU!

Thank you for participating! This survey is now complete. Please contact Dan Boyle at dan@danboyleandassociates.com or at 858-259-6515 if you would like any additional information about this study.

APPENDIX C

Summary of Survey Results

Commonsense Approaches for Improving Transit Bus Speeds

RESPONDENT INFORMATION

1. Date:

2. Contact Information

   Name of Respondent:

   Agency Name:

   Title of Respondent:

   Agency Address:

   Agency Size (note: this was entered after survey responses were received, based on FY 2011 NTD data)

Small (<250 peak buses)	37	62.7%
Medium (250–1,000 peak buses)	15	25.4%
Large (1,000+ peak buses)	7	11.9%

   Respondent e-mail address:

   Respondent Telephone Number:

EXISTING TRENDS

3. Describe the trend in bus speeds within your agency over the past five years.

Bus speeds have increased	10.2%	6
Bus speeds have decreased	39.0%	23
Results are mixed	39.0%	23
No change in bus speeds	11.9%	7

4. How has this trend primarily been identified?

Qualitative—anecdotal information	35.8%	19
Quantitative—tracked by performance measures	64.2%	34

5. What is the trend in bus speeds over the past five years?

Decreased by 0 to 5%	45.1%	23
Decreased by 5 to 10%	17.6%	9
Decreased by more than 10%	0.0%	0
Increased	13.7%	7
Other (please specify)	23.5%	12

   Other includes: (1) Results fluctuated over the years. (2) Not sure. (3) Decreased by 0 to 5% for local; increased on new limited stop/BRT routes. (4) About the same. (5) Decreased by 5–7% in regular system ~ increased where BRT service has been implemented. (6) We use on time performance as an indicator. (7) Please note that while we track average system speed, our overall goal is to reduce travel time. This is reflected in our responses that follow. Travel time can be reduced both through operational changes and by more direct routing. (8) Unchanged. (9) Mixed—depends on type of service and area served. This agency operates both in an urban as well as rural driving environment. (10) Some routes up some routes down depending on ridership and traffic patterns. (11) Depends on the route. In general speeds have slightly increased over the past 8 years. We have increased ridership. However, there are some routes where time performance is an issue and we have made schedule and routing adjustments to help improve on-time performance. (12) Addressed in service planning and schedule refinements.

ACTIONS TAKEN

This section first asks if your agency has taken any actions to affect bus speeds. Actions are grouped in five broad areas. Within each area, we ask if you have measured the impacts of specific changes. If you made a series of changes and did not measure the impacts of individual changes, there is a box to check, and you will be asked later about the overall impacts.

6. Has your agency taken any actions to increase or to mitigate decreases in bus speeds?

Bus stop spacing, design, length, or placement	64.4%	38
Vehicle size, seating or door configuration, performance, wheelchair boarding, or bicycle storage	62.7%	37
Schedule adjustments (running times, recovery time policy, or headway-based versus time point-based)	86.4%	51
Route adjustments (route streamlining, limited-stop service, BRT)	74.6%	44
Agency policies (off-board fare payment, pricing to encourage shifts to prepaid media, fare-free system or zones, all-door boarding, bus door practices, transfer policy, hold policy at transit centers)	49.2%	29
External policies (bus lanes, signal priority/queue-jump lanes, yield-to-bus laws, signal timing, turn restrictions, parking restrictions)	54.2%	32
Other	18.6%	11
No Action Taken	1.7%	1

Note: Numbers adjusted if agencies answered No but then reported actions in that category

ACTIONS TAKEN – STOPS

7. Did your agency take any of the following actions with regard to bus stops?
   - Increased distance between stops
   - Level boarding at major stops
   - Stop design or stop length
   - Stop location
   - Other actions related to bus stops

Yes	94.7%	36
No	5.3%	2

8. Did your transit agency change stop spacing?

Yes	83.3%	30
No	16.7%	6

9. Do your service standards address stop spacing?

Yes	72.4%	21
No	27.6%	8

10. Describe the change to stop spacing.

Responses summarized in Table 15, p. 45 of report. Verbatim responses are provided here.

In limited situations (primarily on one route) stop spacing was increased and/or stops on both sides of major intersections were consolidated into just one side, usually far side.

We eliminated some stops that were underutilized and we also combine stops that we considered too close together.

Eliminating flag stops and replacing with ¼ mile spacing

Took out approximately 600 stops that were too close to another stop.

Set a guideline to increase spacing under three conditions: urban (< 8 per mile), suburban (<6 per mile), rural (<4 per mile).

Set standards for each type of service. Removed stops that were too closely spaced

BRT has longer stop spacing ~ stops with distances less than 650 feet were removed whenever possible

Following our policy rather than just following up on public input. Policy is ¼ mile distance between stops.

Limited effort to remove a bus stop where bus stops are relatively close together.

We are working on a “pilot” program on 2 routes to determine if spacing will improve the speed.

When applicable, selected routes were chosen to improve bus stop spacing, every 0.25 miles

Gradual conversion of urban stop spacing from every 2–3 blocks (500'–700') to every 3–4 blocks (800'–1000') where possible.

A density-based bus stop spacing standard was adopted in 2010. High Density, CBD, Shopping (>20 persons/acre) 500–700 ft.; Fully developed residential area (10–20 persons/acre) 700–850 ft.; Low density residential (3–10 persons/acre) 850–1200 ft.; Rural (or Express Bus Service) (0–3 persons/acre) 1200+ ft.

Stop spacing was changed from 500–750 feet, to 0.2–0.3 miles between stops. The change generally impacts new stops, rather than the elimination/consolidation of old stops.

Combined stops where they had previously been to close due to block length.

Reduced number of stops in downtown area; created faster, more limited-stop versions of existing express routes.

We evaluated on a case-by-case basis where two bus stops could be consolidated into one.

In the past, in the urban environment, we had some stops placed at intervals of 1 block or more. This was done to accommodate ADA passengers that were transitioning to the fixed routed service. We have since been working on increasing our stop spacing to two blocks or more in the urban area, based mainly on traffic speed limits.

Culled stops that were close together on a limited number of bus routes

Stop consolidation to bring routes into alignment with service standards

We have not changed our overall standard for bus stop spacing. We adopted a standard of 8 stops/mile about 10+ years ago and continue to review stops to make sure we meet that standard. The most recent change in the last 3 years has been to go to every-other-block spacing of bus stops through the core of downtown.

Went to 6–7/mile from 9+

Reduced number of bus stops along a frequent transit corridor to align with service standards

Eliminated a few unnecessary stops on two high volume routes. However, stop spacing was not changed on a systemwide basis.

Stop consolidation in limited cases (1–2% of stops)

General stop spacing was every two blocks (600 feet) with many stops closer. New standard is 800'–1500' feet with a targeted average of 1200'. Project is about 80% complete and there are 24% fewer stops systemwide than in 2009

New or adjusted routes have more consistent stop spacing.

Increased between major stops on a corridor-specific basis

11. Did your transit agency measure the effect of this change on bus speeds?

Yes	6.9%	2
Did not measure this separately; measured the effect of a package of changes	58.6%	17
No	34.5%	10

12. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	33.3%	1
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	66.7%	2

Other includes: (1) Fewer downtown stops reduced travel time by about 5 minutes; more direct routing to downtown coupled with greater use of freeway HOV lanes reduced total route end-to-end travel time from 100 minutes to 81 minutes; did not track increase in speed. (2) To be fair, this was an increase in bus speed of about 10% on a corridor that was less than a mile long. We went from 5.5 mph to 6.1 mph and saved 1 minute of running time.

13. Did your agency introduce level boarding at transit centers or other major stops?

Yes	22.9%	8
No	77.1%	27

14. Describe this change.

Built Transit Center bays to be level boarding.

At-level boarding on all BRT stations

The fleet is now comprised entirely of low-floor transit buses.

Many of the bays at our newest transit center and Rapid bus stations along our busiest corridor were built for level boarding.

Downtown Seattle Transit Tunnel introduced level bus boarding in 2007.

Increased the number of low floor buses

Built "station level pads" at certain bus stops to minimize the need to lower the ramp for wheelchair access.

Just at one location to date, more planned

15. Did your transit agency measure the effect of this change on bus speeds?

Yes	12.5%	1
Did not measure this separately; measured the effect of a package of changes	37.5%	3
No	50.0%	4

16. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	100%	1

Other includes: (1) We did not measure the impact of level of boarding separately. The combination of level boarding, fewer stops, and TSP allow for a 20%–30% faster operating speed.

17. Did your transit agency change bus stop design or length?

Yes	37.1%	13
No	62.9%	22

18. Describe this change.

Moved to a far side stop strategy as part of TSP efforts

Created a stop classification that bases stop improvements on higher existing ridership and transit supportive land uses. The new classification supports improved design layout including thresholds for bus stop amenities and increasing paved waiting areas. Improvements are identified, but funds to make improvements are needed.

Increasing number of bus bulbs and stop lengths to accommodate larger and more vehicles.

BRT stations were designed differently

Platform length standardized to 15 m to accommodate all vehicle sizes.

We adopted standards for both design and spacing. However, we have not yet separately or in cooperation with the regional transit agency removed stops other than by construction projects

Extend curb length to improve bus stop capacity

Extend curb length to improve bus stop capacity

Updated our design standards manual to be fully consistent with ADA requirements.

Lengthened the approach to assure the unit is parallel to the curb

Stop procedures were changed in Downtown Transit Tunnel to reduce delays from drop-off only buses; these buses can drop off at any station bay rather than having to wait for certain ones to open up.

Some bus stops on new routes were redesigned with more customer information.

Increased length specifically to accommodate articulated buses

19. Did your transit agency measure the effect of this change on bus speeds?

Yes	0.0%	0
Did not measure this separately; measured the effect of a package of changes	50.0%	7
No	50.0%	7

20. What effect did this change have on bus speeds?

No answers

21. Did your transit agency change the location of bus stops (e.g., near-side, far-side, mid-block)?

Yes	51.4%	18
No	48.6%	17

22. Describe this change.

In limited locations we consolidated stops into just near-side or far-side, usually far-side.

We are practical, we tried to eliminate mid block stops to either near side or far side. This process is still undergoing. We decided to implement route by route rather than do a systemwide change all at once

TSP routes and any new fixed stop routes are far side where possible.

Mostly bus stops have been consolidated, but some stops have been moved to the far-side or near-side of intersections to improve access and minimize disruption to traffic.

Optimizing stop spacing by stop control.

Stops have been relocated, on a case-by-case basis, primarily for other reasons (i.e., not to increase bus speeds). For example, several existing stops which are not "accessible" (due to physical constraints) have been relocated to allow them to be designated "accessible."

We have moved a few stops from near-side to far-side in coordination with streetscape improvement projects.

Relocate to farside to facilitate transit signal priority or to location where it is safer for riders to cross

Made all bus stops at stop signs or farside intersections.

Preferred placement to far-side

More Mid blocks

When possible we are now putting bus stops at far side.

We are transitioning mainly to far side stops

Although we have not changed our policy on stop location, whenever a bus stop is placed, the location is considered. Speed is one factor in making the decision, although probably a minor one. Customer safety and convenience along with property issues are weighed more heavily.

1] Move to farside where signal phase favors the direction. 2] Move to near side where coincides with stop sign.

A limited case by case basis as the stop consolidation project has unfolded in 3 phases (with one to go)

Limited change due mainly to safety concerns.

Generally we have farside stops. There has been no policy change here. Continually trying to optimize bus stop location.

23. Did your transit agency measure the effect of this change on bus speeds?

Yes	5.6%	1
Did not measure this separately; measured the effect of a package of changes	27.8%	5
No	66.7%	12

24. What effect did this change have on bus speeds?

Increased by 0 to 5%	100%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

25. Did your transit agency make other stop-related changes?

Yes	14.3%	5
No	85.7%	30

26. Describe this change.

Eliminating flag stops

We are midway through a multi-year project to review bus stop spacing on all existing lines in an effort to space stops as suggested in our standards. This has required the elimination of some stops. Notices are placed on all stops slated for elimination and an open comment period is advertised. Stops slated for elimination that serve handicapped individuals who comment or sensitive land uses are sometimes retained. Most though, are pulled. During each 4-month service period approximately 400 to 500 stops are reviewed.

Eliminated stops

Dedicated lanes and eliminated parking

Eliminated bike rack usage at key stops downtown to save time.

For BRT services, we are building curb extensions (bus bulbs)

27. Did your transit agency measure the effect of this change on bus speeds?

Yes	20.0%	1
Did not measure this separately; measured the effect of a package of changes	60.0%	3
No	20.0%	1

28. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	100%	1
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

ACTIONS TAKEN – VEHICLES

29. Did your agency take any of the following actions with regard to vehicles?
    - Introduce or increase use of low floor buses
    - Change size of vehicle
    - Introduce vehicle with better performance
    - Change interior seating (e.g., 2*1 seating instead of 2*2)
    - Change door configuration
    - Change from lifts to ramps for wheelchair access
    - Allow bicycle storage inside vehicles
    - Other actions related to vehicles

Yes	88.1%	37
No	11.9%	5

30. Did your transit agency introduce or increase use of low floor buses?

Yes	89.2%	33
No	10.8%	4

31. Approximately what percentage of the fleet is comprised of low floor buses?

Low-floor buses account for an average of 74 percent of the local bus fleet among responding agencies, with a median figure of 79 percent.

75%

1%. It should be noted that all future bus procurement will be low floor buses

77%

100%

Approximately 57% of the fleet is low floor buses.

79%

10%

95%

100%

Feb 2008: 58% low floor; 15% lift-equipped, 27% high floor (non-accessible). Current: 87% low floor, 13% lift-equipped Note that the number of lift-equipped buses has remained steady (the percentage has decreased due to increasing total fleet size).

100% (achieved in 2012)

60 %

59% of over 1,400 fleets

89%

86%

As of today, 100%. In 2011 last of old style buses were retired.

100%

30%

75%

75%

80%

Approx. 65% (183 out of 281)

95%

85%

90%

58%

59.6%

30%

100% conventional service. Piloting a low floor community shuttle right now

Almost 100%.

90%

75%

About 60% excluding commuter fleet

32. Did your transit agency measure the effect of this change on bus speeds?

Yes	3.0%	1
Did not measure this separately; measured the effect of a package of changes	27.3%	9
No	69.7%	23

33. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	100%	1

Other includes: (1) Decreased boarding time by 1 second per passenger.

34. Did your transit agency introduce or increase use of different-size vehicles?

Yes	59.5%	22
No	40.5%	15

35. Describe this change.

Implemented 40 ft buses which will be the chosen method for all future bus procurements

Balanced fleet size based on route boardings by block

Increased articulated fleet from 10 to 15 buses. Introduced BRT fleet which has 11 additional articulated vehicles

We have recently added 12.8m long double-decker buses for use primarily on express routes.

Agency’s first 35'ers began service in August, 2007. Agency also has 31'ers and 28' narrow-body buses

We have acquired 5 60 foot articulated coaches and 4 30 foot coaches.

For our Rapid bus line, we have introduced articulated coaches

In 2008 we purchased 30' coaches to use on lines with lower max passenger counts.

Purchased 24 19-passenger cutaway buses to be utilized on lower productivity routes. Cost per revenue mile operated charged by service provider was lower for the smaller vehicle

Purchased small low floor buses with ramps

Introduced

Minivans and cutaways

Introduce Cut-aways for circulator to feed main routes.

Urban 40' Buses Rural 35' Buses Rural 27' Cutaways

The percentage of high capacity buses (57 seats) increased

We try to place vehicle size relative to demand. This allows for more seating capacity and, in turn, quicker deboarding.

In local service, we have been using articulated buses to accommodate larger loads without having to increase frequency. Usually, this has increased running time because of the longer times needed to make passenger stops. This has been mitigated somewhat by primarily using low-floor artics.

Replaced 35'ers with 40'ers. Used 29' heavy-duty transits to replace cutaways (which were actually longer, but had less capacity).

Changed the mix and deployment of 30', 40' and 60' buses.

Double decker vehicles as well as midsized community vehicle

Introduced a limited number of articulated buses in all divisions.

Significant increase in ridership over the past 8 years. We’ve replaced 35' with 40' coaches.

Increasing use of articulated buses

36. Did your transit agency measure the effect of this change on bus speeds?

Yes	0.0%	0
Did not measure this separately; measured the effect of a package of changes	42.9%	9
No	57.1%	12

37. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	100%	1

Other includes: (1) Can’t determine—traffic keeps getting worse

38. Did your transit agency introduce vehicles with better performance?

Yes	45.9%	17
No	54.1%	20

39. Describe this change.

Hybrids replaced old diesels with low power and old CNG’s with low power.

We implemented hybrid electric buses

Better engine performance

EMP and higher capacity AC units

472 of the 1,109 low-floor buses are hybrid vehicles (diesel-electric)

Better gas mileage in hybrid-electric buses

Replaced cut-a-way Fords with real transit buses

Trolley with battery backup

In 2010 we took delivery of 6 hybrid diesel/electric coaches. These are being compared to 6 diesel buses delivered at the same time to see if the hybrids are more cost effective in the long run. In 2013 30 CNG buses will be delivered.

Hybrid electric

Smaller vehicles with better acceleration and maneuverability that also get double the fuel mileage

Units were spec for our region (desert)

Compressed Natural Gas. Improved Transmission Retarder Performance. Engine Governance to 65 mph

Newer generation of articulated buses have better acceleration, hill climbing ability.

Deployed better performing inter-city buses on our long-distance, mountain routes.

Moving the fleet replacements with hybrid (diesel/electric) coaches

Some hybrid buses have been introduced, and others have been retrofitted to improve fuel economy.

40. Did your transit agency measure the effect of this change on bus speeds?

Yes	5.9%	1
Did not measure this separately; measured the effect of a package of changes	35.3%	6
No	58.8%	10

41. What effect did this change have on bus speeds?

Increased by 0 to 5%	100%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

42. Did your transit agency change the seating configuration inside the bus (e.g., 2*1 seating instead of 2*2 or any other changes)?

Yes	21.6%	8
No	78.4%	29

43. Describe this change.

Move to a perimeter seating configuration on most buses to increase capacity, especially on university campus bound routes where full buses is a chronic problem.

BRT buses had significant seating configuration changes

[Note that, starting with the 2007 bus deliveries, the configuration of the rear seats was changed to improve passenger utilization. Two double seats were replaced with three aisle-facing seats on each side. Although this resulted in two fewer seats, it encouraged more customers to move to the back of the bus.]

Another “pilot” program with the removal of a row of seats to accommodate strollers/walkers/etc. We had asked that these devices be folded which slowed down the process. We are now allowing them to be left open which we hope will speed access and egress.

One bench removed from curbside behind w/c space on some buses, to provide a larger area for carts and strollers, to ease loading and unloading.

We have been experimenting with one bus to see if a seating change will make a difference with interior circulation and congestion by the rear door. We have tried 2-1 seating by the rear door. Subjectively, it appears to make a difference and we will have a portion of our 2013 bus order with this configuration.

Configuration has changed, increased in size, to improve access for wheelchairs and reduced a number of seats in a low-floor coach

Newest buses (added to fleet 2nd half of 2012) have minor changes in seat configuration.

44. Did your transit agency measure the effect of this change on bus speeds?

Yes	0.0%	0
Did not measure this separately; measured the effect of a package of changes	25.0%	2
No	75.0%	6

45. What effect did this change have on bus speeds?

No answer

46. Did your transit agency change the door configuration on the bus?

Yes	10.8%	4
No	89.2%	33

47. Describe this change.

BRT buses had doors on both sides

Three door coaches for bus rapid transit

In 2008, all 2-door articulated buses replaced with 3-door articulated buses.

Introduced three-door articulated buses in 2010. No changes to standard buses

48. Did your transit agency measure the effect of this change on bus speeds?

Yes	0.0%	0
Did not measure this separately; measured the effect of a package of changes	100.0%	4
No	0.0%	0

49. What effect did this change have on bus speeds?

No answer

50. Did your transit agency switch from lifts to ramps for wheelchair access?

Yes	78.4%	29
No	21.6%	8

51. What percentage of the fleet was affected?

Average: 73.8%

Median: 80.0%

65% of fleet has a ramp

77%

100%

The percentage is 57%, same as low floor buses.

All vehicles purchased after 2000 were delivered with wheelchair ramps. All of the low-floor buses and articulated buses are equipped with wheelchair ramps.

10%

Went from approximately 65% of fleet being low-floor to 95%

[Prior to 1996, the regular fleet comprised only non-accessible buses. 237 lift-equipped buses were purchased in the 1996–1998 period. All buses purchased since 1998 have been low floor (ramp-equipped) buses. There are currently 1626 low floor buses, comprising 87% of the fleet. The 237 lift-equipped buses comprise the remaining 13% of the fleet.]

100%.

The low floor buses are all ramp buses. 60 % of fleet now has ramps instead of lifts.

59%

Gradual conversion of high-floor fleet to low-floor fleet. All fixed-route buses now low-floor except for cutaways on shuttle routes and over the road coaches on express routes.

Acquiring as we replace our fleet. Approximately 80% have ramps

100% as of 2011

Approx. twenty percent

50%

100%

90%

All low-floor buses equipped with ramps (65%). Others have lifts.

95%

All low buses have the ramps, so 85% of fleet

90%

58%—ramps come with low floor buses.

Small part of the change to low floor buses.

30%

See earlier answer re low-floor buses. Almost 100% of the fleet is now low-floor, except for over the road coaches used exclusively in commuter express service.

90%

All new buses are low-floor; high-floor buses will gradually be retired as new buses are introduced.

All low floor buses have ramps, about 60% of non-commuter bus fleet

52. Did your transit agency measure the effect of this change on bus speeds?

Yes	3.4%	1
Did not measure this separately; measured the effect of a package of changes	27.6%	8
No	69.0%	20

53. What effect did this change have on bus speeds?

Increased by 0 to 5%	100%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

54. Did your transit agency allow bicycle storage inside the bus?

Yes	18.9%	7
No	81.1%	30

55. Did your transit agency measure the effect of this change on bus speeds?

Yes	0.0%	0
Did not measure this separately; measured the effect of a package of changes	12.5%	1
No	87.5%	7

56. What effect did this change have on bus speeds?

No answer

57. Did your transit agency make any other vehicle-related changes intended to improve bus speed or reliability?

Yes	8.1%	3
No	91.9%	34

58. Describe this change.

See previous comment

Units were spec for our region (desert)

We're actually in the process . . . implementing Transit Signal Priority with local jurisdictions on two major corridors in our service district.

59. Did your transit agency measure the effect of this change on bus speeds?

Yes	33.3%	1
Did not measure this separately; measured the effect of a package of changes	33.3%	1
No	33.3%	1

60. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	100%	1

Other includes: (1) Again, the TSP feature will start to be implemented in 4th quarter 2013. We've created base line data with existing service schedules and route performance in order to compare it with TSP once it's implemented.

ACTIONS TAKEN – SCHEDULE ADJUSTMENTS

61. Did your agency take any of the following actions with regard to bus schedules?
    - Adjust running time
    - Change recovery time policy (e.g., as % of running time)
    - Use headway-based instead of time point-based schedules

Yes	94.3%	50
No	5.7%	3

62. Did your transit agency adjust running time, either on specific routes or systemwide?

Yes	98.0%	49
No	2.0%	1

63. Approximately what percentage of routes were affected?

Average: 44%

Median: 30%

Running time adjustments done based on the ad hoc requests—operator input predominantly. No follow up completed.

15%

In the past we made changes to 14 weekday/Saturday routes. We are in the process of updated all of the routes systemwide

15%

50%

5%

Approximately 10 percent of all routes have had recent running time adjustments.

All suburban transit routes and most city transit have been adjusted.

With each operator sign-up, reviewing and adjusting 10% of routes (~7 of 70 lines). Sign-ups 3x per year.

50%

5–10%

5%

11 of 13 routes

We monitor running times on an on-going basis using CAD/AVL data. Over the period of the last 5 years the running times on almost all schedules have been updated.

25%

10–15%

59%

All routes are monitored for on-time performance. Run time is added as a last resort as budget allows.

25%

We are adjusting travel times every service change on one line or another in order to improve overall on-time performance overall, not just to speed up buses. In the course of a year probably 1/3 or more of all lines are adjusted.

15

50%

Numerous routes running times have been adjusted in the past 12 months in effort to improve on-time performance. This is being done in conjunction with transition from manual observations to use of AVL data as the basis for on-time performance.

Five percent

10%

100%

100%

30%

Approx. 50%

We typically make schedule-based adjustments to routes during three service changes per year. The vast majority of our routes have at least been adjusted for better performance in the last five years.

20%

Over 50% of the routes were affected over the past 3 to 5 years.

20%

50%

25%

99%. We are constantly adjusting our schedules to make the scheduled running time match the reality on the street. Usually we add time.

Over the various pick cycles, will be 100% weekday, lesser on weekends.

80%

100%

75%

Running times are adjusted annually as part of annual service change.

We constantly monitor and adjust running time for specific routes/trips when there is a chronic on-time performance problem.

20

15%

10%

30

50%

100% in a three-year cycle

64. Did your transit agency measure the effect of this change on bus speeds?

Yes	31.3%	15
Did not measure this separately; measured the effect of a package of changes	39.6%	19
No	29.2%	14

65. What effect did this change have on bus speeds?

Increased by 0 to 5%	11.1%	2
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	44.4%	8
No impact	0.6%	1
Other (please specify)	38.9%	7

Other includes: (1) the adjusted schedules only made the schedules more realistic. It decreased the speeds (2) Except for our rapid bus line (3) Difficult to segregate impact on those adjustments made in last 12 months from broader changes to bus service network. There are fewer routes than 5 years ago, and more of the routes serve main arteries, with fewer community based circulator routes. (4) In some cases speeds were improved due to bus stop consolidation, in others the changes in schedules were to provide more time (slower speeds) in response to congestion. (5) Mixed bag. For the majority, it meant a reduction in scheduled speed to match increased traffic (vehicular & passenger). For others, it meant decreasing running time to match actual speeds (operators are not penalized for running ahead . . . system culture. Sigh.) (6) We add and remove running time at most sheet changes (for us sheet change is 4 times per year) In some cases speeds increase or decrease (7) There was no systematic change of bus speeds. WE altered most of our service and it had an impact on on-time performance which is what we measure.

66. Did your transit agency change recovery time policy (e.g., as % of running time)?

Yes	16.7%	8
No	83.3%	40

67. Describe the change.

Adjusted so that 90% of trips could depart next trip on time

To improve scheduling efficiency, layover was reduced by 25% (2010 to 2011)

5 minutes

Reduced accidents

Allowance for 10 to 15 minute recovery time depending on delays identified.

10% of Headway

We have not changed our policy on recovery time. We allow 7 minutes or 15% of the one-way running time, whichever is greater. However we have recognized that on some of our longer routes with high variability in running time, the policy recovery is not enough. On those few routes (about 3) we have "added a bus to the schedule." The improvement is in the on-time performance of the route—how well the scheduled running time matches the actual running time, rather than reducing running time and increasing speed. The main impact on schedule adherence is to make it more likely that a trip will start on time, one of the main factors of what the on-time performance of the trip will be.

We don't have a policy regarding recovery. We try to maintain 10% but for the most part our system-wide recovery is much higher than that. Some peak blocks may have lower than 10% recovery

Have introduced or increased recovery time on 2 selected routes

68. Did your transit agency measure the effect of this change on bus speeds?

Yes	22.2%	2
Did not measure this separately; measured the effect of a package of changes	78.8%	7
No	0.0%	0

69. What effect did this change have on bus speeds?

Increased by 0 to 5%	50.0%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	50.0%	1
No impact	0.0%	0
Other (please specify)	0.0%	0

70. Did your transit agency change to headway-based instead of time point-based schedules?

Yes	8.2%	4
No	91.8%	45

71. Describe the change; how many routes were affected?

Two city routes were changed from a time point based to a headway based service.

We did this only for our rapid bus line

15

Only for BRT and selected limited-stop routes

72. Did your transit agency measure the effect of this change on bus speeds?

Yes	22.2%	2
Did not measure this separately; measured the effect of a package of changes	78.8%	7
No	0.0%	0

73. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	100.0%	1

Other includes: (1) This was part of the rapid bus line design which included many elements of BRT; no element was measured individually.

74. Did your transit agency make any other scheduling-related changes to improve bus speeds?

Yes	22.4%	11
No	77.6%	38

75. Describe the change.

Constantly reevaluating mix of local, limited and express routes to maximize efficiency

On-board GPS system tracks schedule adherence in real time.

Moved the relief points to the end of the line for several routes.

We moved away from clock based headways, which effectively assumed the same running time throughout the day, to customize runtimes by trip or blocks of trips. This allowed us to elongate runtimes in high traffic periods, while reducing runtimes in lighter traffic periods.

Increased use of estimated timepoints (if bus arrives at timepoint early, can immediately proceed to next timepoint).

We adjusted time points to improve efficiency

We monitored interim run time speeds at time points and adjusted the schedule so that buses were not waiting at time points and were not running ahead of schedule

Introduced practice to develop layover based on running time volatility. (Did not change policy, as previous question asked, but changed practice)

Implementing BRT-light service on four major transit corridors

We added recovery in most cases but not by policy. We also adjusted run times to match AVL reported average travel time.

Measured timing between time points—route segments—to improve upon service schedule and on-time performance.

76. Did your transit agency measure the effect of this change on bus speeds?

Yes	36.4%	4
Did not measure this separately; measured the effect of a package of changes	36.4%	4
No	27.3%	3

77. What effect did this change have on bus speeds?

Increased by 0 to 5%	25.0%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	75.0%	3

Other includes: (1) Reliefs normally takes 3–5 minutes. Created running time charts before and after. (2) These will go into effect in 2014 and should improve operating speeds by 5–20% (3) Again, our measurement was on OTP, not speed.

ACTIONS TAKEN – ROUTE ADJUSTMENTS

78. Did your agency take any of the following actions with regard to route design?

- Streamline routes
- Implement new limited-stop service
- Implement BRT service

Yes	76.8%	43
No	23.2%	13

79. Did your transit agency streamline any routes?

Yes	90.7%	39
No	9.3%	4

80. Approximately what percentage of routes were streamlined?

Average:	19%
Median:	15%

5%

5%

10

30%

5%

40% of the suburban routes were affected by a route restructuring since 1999. A limited number of city routes were changed over the past 15 years.

10%

30%

15%

20%

Very few in the past. We are in the process of streamlining a large number of routes to integrate with three new rail lines.

Varies from time to time. In Fall 2010 ~20% of all routes

5%

20%

16%

5

5%

33%

Two percent

10%

75%

25%

Six of our 25 express bus routes (about 24%)

About 5%–10%

30%

8%

Less than 25%

3% of local routes (3 routes). Obvious streamlining opportunities are rare.

< 5%

75~80%

Converted two routes to express routes

10

4%

20%

15

15%

Route-specific changes, no overall policy changes

81. Did your transit agency measure the effect of this change on bus speeds?

Yes	15.8%	6
Did not measure this separately; measured the effect of a package of changes	47.4%	18
No	36.8%	14

82. What effect did this change have on bus speeds?

Increased by 0 to 5%	50.0%	3
Increased by 5 to 10%	16.7%	1
Increased by more than 10%	0%	0
Decreased	16.7%	1
No impact	0%	0
Other (please specify)	16.7%	1

Other includes: (1) In the last year, we redesigned several routes to increase efficiency, coverage, and speed. In some cases, route segments were transferred between routes.

83. Did your transit agency introduce limited-stop service on any routes?

Yes	42.9%	18
No	57.1%	24

84. Describe the change. How many new limited-stop routes were implemented?

6.40%

Some express service was introduced on 4 routes

2

Four routes were created as limited-stop routes (three city, one suburban).

Expansion of 1 additional line (9L)

"Four routes in the past five years: - 41E KEELE (express branch added to existing route), - 60E STEELES WEST (express branch added to existing route) - 145 DOWNTOWN/HUMBER BAY EXPRESS (new express route) - 199 FINCH ROCKET (revised express route)"

Just one route—the 45 was implemented as a limited stop route to enable three buses to provide 30 minute frequencies.

One limited stop service was implemented two years ago. Another limited stop service is proposed for implementation later this year (2013).

One limited stop BRT line

In 2012 one new limited stop line was added between downtown and the casino. Runs Friday & Saturday evenings between ~7:00 p and ~3:00 a.

1

4

One route (route to the airport)

We have implemented one new limited-stop route and on two other limited-stop routes we have increased service and coordinated them more explicitly with a local route.

1 in last 5 years, but have others.

One

Created 4 new limited stop routes

1

Approximately 40 limited-stop routes introduced incrementally since 1975. Four or Five routes in the last several years

85. Did your transit agency measure the effect of this change on bus speeds?

Yes	22.2%	4
Did not measure this separately; measured the effect of a package of changes	38.9%	7
No	38.9%	7

86. What effect did this change have on bus speeds?

Increased by 0 to 5%	40.0%	2
Increased by 5 to 10%	0%	0
Increased by more than 10%	40.0%	2
Decreased	0%	0
No impact	0%	0
Other (please specify)	20.0%	1

Other includes: (1) It wasn't really a change. This was a new line operating on a street that already had service, so times allotted because of the limited stops was less from day one by approximately 4.4%.

87. Did your transit agency introduce or add BRT service?

Yes	26.8%	11	NOTE: 1 not yet implemented; Table 14 on p. 43 reports 10
No	73.2%	30	

88. Describe the change. How many new BRT routes were implemented? What elements of BRT were included?

BRT will be introduced by October 2013. Two BRT routes will be introduced

2—Limited stops. These routes do not operate on a fixed guideway. Another limited BRT route will be added in 2015

Two BRT routes were implemented ~ pretty much all elements of BRT were included

Our BRT network has expanded over the years. It now includes 7 routes.

"York University Busway (196 YORK UNIVERSITY ROCKET): — Construction of a dedicated busway (in an electrical transmission corridor and on university lands) along part of the route — Conversion of existing HOV lanes to reserved bus lanes along other parts of the route — Construction of a new (more direct) access to the subway station bus terminal — Implementation of TSP at some traffic signals on the route — Limited stops — All-door loading and seamless subway-to-bus and bus-to-bus transfers at Downsview subway station (similar to previous service)"

One BRT line. Limited stop, peak service only every 15 minutes, branded, real time information at the stops. Upgraded shelters

4 BRT routes. Real-time signs, off-board fare transaction, transit signal priority, bus lanes, transit signal queue jumps, bus stop spacing, and route streamlining

Based on MAP-21, we have been told it does not meet the definition of BRT (<50% exclusive ROW). We do, however, have level boarding, TSP, limited stop, separate brand, and are weighing off-vehicle fare payment.

Route 350 was converted to Rapid bus service in June 2011. Low utilization stops were eliminated/consolidated. All but 2 stops were upgraded in terms of passenger amenities. Transit signal priority system was implemented. A short queue jump lane was implemented approaching Escondido Transit Center. Vehicles and stops were branded. Real time schedule displays installed at 8 locations.

Two routes covering four corridors. BRT elements include signal priority, premium 60' vehicles, upgraded stops, real-time passenger info, all-door boarding (with pass), limited stops, and dedicated lanes in the downtown area. To be implemented in 2014

2 routes with limited stops, queue jump lanes and signal priority

Four routes since 2008. All have bus lanes, low-floor buses and wide stop spacing. Three have articulated buses, three have off-board fare collection, two have TSP, and bus bulbs are being built on two corridors.

89. Did your transit agency measure the effect of this change on bus speeds?

Yes	46.2%	6
Did not measure this separately; measured the effect of a package of changes	30.8%	4
No	23.1%	3

90. What effect did this change have on bus speeds?

Increased by 0 to 5%	14.3%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	57.1%	4
Decreased	0%	0
No impact	0%	0
Other (please specify)	28.6%	2

Other includes: (1) Estimates only at this point. 5–20% reduction in travel time anticipated. (2) Varies from 15–23% depending on route, direction and time of day

91. Did your transit agency make any other route changes to improve bus speeds?

Yes	26.2%	11
No	73.8%	31

92. Describe the change.

We've installed emitters on all buses, installed transit signal priority receivers in one corridor and worked with the City to program existing receivers where possible.

Realigned routes to stay on major arterials, removed diversions from routes

Route optimization in 2011 eliminated duplication along some routes and replaced circuitous routings with more direct service. This increased some walking distances to access service, but decreased on-board travel time along certain routes.

Streamlined some routes

Rerouted one route to trunk with a 2nd to speed operation of both routes & also to provide additional capacity.

As part of its Mobility Plan (COA) changes, the agency has focused on making route deviations to traffic generators only when there is sufficient demand. Previously, routes for the most part operated the same alignment all the time.

Opened new HOV direct access ramps and freeway stations, allowing maximum use of freeway HOV system.

Changed primary operating corridor and received permission to utilize shoulder lanes on said corridor.

Truncated some routes to light rail stations, thus those routes don't operate in downtown area any more.

We transferred some segments to allow sufficient time to extend the length of one shuttle route.

Some routes were shortened, and others were consolidated with others (effective September 2012).

93. Did your transit agency measure the effect of this change on bus speeds?

Yes	18.2%	2
Did not measure this separately; measured the effect of a package of changes	36.4%	4
No	45.5%	5

94. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	33.3%	1
Other (please specify)	66.7%	2

Other includes: (1) Evaluated change in terms of decreased travel time rather than increase in speed. (2) We kept the same headways but added to the length of route. We also revised some routes within a larger jurisdiction and made those routes shorter to improve reliability and maintain desired headway along select segments.

ACTIONS TAKEN – INTERNAL POLICIES

95. Did your agency change any of the following internal policies?

- Allow all-door boarding
- Allow off-board fare payment
- Change pricing to encourage shift to prepaid fare media
- Introduce or discontinue fare-free zones or eliminate fares entirely
- Change bus door practices (e.g., introduce passenger-actuated doors, change policies re operators re-opening doors after beginning to pull away from a stop)
- Change transfer policies
- Change hold policies at transit centers

Yes	52.7%	29
No	47.3%	26

96. Did your transit agency change boarding practices to allow all-door boarding?

Yes	24.1%	7
No	75.9%	22

97. Describe the change.

All routes except for cable car. Started July 1, 2012.

Only applied to two super busy college based routes

Only on bus rapid transit

All-door boarding is used on modern double-decker buses which have conductor on board to monitor back door.

Only on the upcoming BRT routes

We allow all-door boarding at the downtown stops on pay-leave express routes. This has been in effect for 15+ years, so it is not a recent change.

Only on three BRT services

98. Did your transit agency measure the effect of this change on bus speeds?

Yes	28.6%	2
Did not measure this separately; measured the effect of a package of changes	28.6%	2
No	42.9%	3

99. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	33.3%	1
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	66.7%	2

Other includes: (1) This has reduced boarding time to 2 seconds per passenger, a savings of 3–4 seconds per downtown boarding. (2) off-board fare collection increased speeds by 9%.

100. Did your transit agency change fare payment practices to allow or require off-board fare payment?

Yes	27.6%	8
No	73.4%	21

101. Describe the change. Does it apply to all routes, or only to selected routes?

Implement a higher fare payment when purchased on the vehicle to encourage the purchase of fares at a ticket vending machine or outlets across the valley

Off-board fare payment no fare collection (fare inspectors only) on BRT service implemented

Prepaid media (smart card)

Simplified zone system applicable to all routes. Encourages use of weekly & monthly passes.

All routes

Demo project conducted using phone based payment system applied to all routes, being considered for full deployment

We instituted weekly and monthly passes as a fare option, along with a regional fare payment system on our big bus services.

Only for three BRT routes

102. Did your transit agency measure the effect of this change on bus speeds?

Yes	11.1%	1
Did not measure this separately; measured the effect of a package of changes	55.6%	5
No	33.3%	3

103. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	50.0%	1
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	50.0%	1

Other includes: (1) off-board fare collection and all-door boarding in tandem save 9% of running time.

104. Did your transit agency change pricing to encourage use of prepaid fare media?

Yes	75.9%	22
No	24.1%	7

105. Describe the change.

Price for the adult ticket and weekly pass have been increased

Added Family Pass, Day Pass.

Higher fares when purchased on the vehicle

Agency has been using pre-paid fare media since the 1990's. Beginning in 2014, agency will be introducing an open payment fare collection system using pre-paid fare cards, paying with credit/debit cards or cell phones.

A discount for tickets and smart cards over cash fares.

The price of our unlimited ride monthly pass, in relation to single fares, has been reduced, from a previous multiple of approximately 52 rides per month to approximately 46 rides per month. Also transit passes are eligible for a federal income tax rebate, which has effectively reduced the price of passes for customers with moderate and higher incomes.

Discontinued numerous fare media types and changed to cash and prepaid smart card

See previous.

We sell 24-hour passes off the bus for $4 vs. $5 on board;

We have and continue to provide a large discount on pre-paid media to encourage non-cash transactions. 72% of boardings are now non-cash boardings, up from 66% four years ago.

Monthly passes have been put on Regional Smart Card

Increased the discount by 15%

Reduce weekly, monthly pass

Smart Card, Magnetic Swipe, with 3, 7, 15, 31 day options. Value added Smart Cash Cards also available.

Starting selling Day Passes

Require exact fare. Previous to this our bus operators made change for customers.

Switching to the electronic fare cards as a stored value card gives a 10% bonus at the time of purchase.

Lowered fares for smart trip card holders relative to cash fares.

Changed fare structure to strongly encourage the use of a day-pass.

Use of daily (on board), weekly, and monthly passes and regional fare payment card

MetroCard fare discounts were introduced in 1998 and increased ridership, but this slowed buses down even more. No real changes since 1998

106. Did your transit agency measure the effect of this change on bus speeds?

Yes	4.5%	1
Did not measure this separately; measured the effect of a package of changes	27.3%	6
No	68.2%	15

107. What effect did this change have on bus speeds?

Increased by 0 to 5%	100.0%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

108. Did your transit agency introduce or discontinue fare-free zones or eliminate fares entirely?

Yes	20.7%	6
No	79.3%	23

109. Describe the change.

Increased base and zone fare. Day, monthly, and annual passes, and discontinued discounted media

Eliminate ride free area in downtown (Oct 2012)

New route introduced in 2011 is fare free.

We offer free rides in the downtown zone on two local routes that end downtown. This was done to increase ridership, which it has. The increased ridership has decreased bus speed.

Eliminated fare free zone in downtown core and changed to pay as you board standard. Before, outbound paid on exit.

Effective September 2012, zones were eliminated. Now two fare types only: 2 hour or all-day.

110. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	50.0%	3
No	50.0%	3

111. What effect did this change have on bus speeds?

No answers

112. Did your transit agency change bus door practices (e.g., introduce passenger-actuated doors, change policies re operators re-opening doors after beginning to pull away from a stop)?

Yes	10.3%	3
No	98.7%	26

113. Describe the change.

At some busy downtown stops where buses line up, bus operators are told to stop once and avoid multiple stops, unless it is for a disabled customer.

Buses once they pull away from the stop cannot reopen the doors.

On three BRT routes bus operators open all door routinely

114. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	66.7%	2
No	33.3%	1

115. What effect did this change have on bus speeds?

No answers

116. Did your transit agency change hold policies at transit centers?

Yes	24.1%	7
No	75.9%	22

117. Describe the change.

Slightly expanded span of time for allowable transfers at major downtown station

We operate a timed transfer system in off-peak & weekend periods. In those periods all routes have previously been schedule to meet. Longer suburban routes, had difficulty making the line-ups. System change involves more frequent service on core urban routes & not holding line-ups for the suburban routes.

Wait for transfers up to 5 minutes.

5 minutes beyond if coming from connecting intercity route only for last trip of the day.

Intersecting routes may communicate passenger desires and hold for those transferring passengers. Commuter Service will hold for arriving trains, or late night special events. Max of 5 minutes

Bus operators are not to hold longer than 10% of their headway times.

One route that gets seriously behind is not allowed to hold up other routes and get them seriously behind schedule to enable transfers. It inconveniences some riders, but at least fewer than before. The call is made on a case by case basis by a supervisor.

118. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	28.6%	2
No	71.4%	5

119. What effect did this change have on bus speeds?

Increased by 0 to 5%	100.0%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

Other includes: (1) off-board fare collection and all-door boarding in tandem save 9% of running time.

120. Did your transit agency make any other internal policy changes to improve bus speeds?

Yes	10.3%	3
No	89.7%	26

121. Describe the change.

Per previous comments. Allowed strollers, walkers etc. to remain open when boarding the bus.

No radio use to hold up other buses.

We have started to offer electronic fare cards. These are very popular with our express riders and we have been able to cut the scheduled boarding time at some park-and-ride lots because of them. We have not achieved as great penetration on our local routes. Exceptions are the local routes that serve the University campus. We have partnered with the U to let students have pass cards for a reduced fee. This has not allowed us to increase bus speeds, but it has allowed us to not reduce them. We can empty and refill a low-floor artic with a standing load in the amount of time it used to take for a high-floor 40' bus.

122. Did your transit agency measure the effect of this change on bus speeds?

Yes	33.3%	1
Did not measure this separately; measured the effect of a package of changes	0.0%	0
No	66.7%	2

123. What effect did this change have on bus speeds?

Increased by 0 to 5%	100.0%	1
Increased by 5 to 10%	0%	0
Increased by more than 10%	0%	0
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

EXTERNAL POLICY CHANGES

124. Did your agency achieve change in any of the following external policies?

- Bus-only lanes on arterial streets
- Signal priority/queue-jump lanes
- Yield-to-bus laws
- Signal timing
- Turn restrictions
- Parking restrictions
- Other external policies affecting bus speeds

Yes	59.3%	32
No	40.7%	22

125. Did a municipality served by your transit agency implement bus-only lanes on arterial streets?

Yes	38.2%	13
No	61.8%	21

126. What type of bus-only lane was implemented?

Curb lane	64.7%	11
Median offset lane	0.0%	0
Fully separated lane	5.9%	1
Other (please specify)	29.4%	5

Other includes: (1) Bus pass by shoulder lanes that were added on the Highway 403 segment (not arterial roadway). HOV Lanes on the Highway 403 exists with the special policy in place when to be used (Max Speed allowed is 60km/h; to be used only when the speed of the existing traffic on the highway is less than 60km/h). (2) Exclusive transit left-turn lane; counterflow transit only lane on one-way street. (3) Coming in 2014 for BRT routes and other routes over time. (4) Exclusive transit lanes in transit mall, plus limited curb shared right-turn-only/bus lanes in other areas. (5) There are 70 miles of bus lane in the city, approximately 10 miles are offset lanes and the remainder are curb lanes. There are about 10 miles of physically-separated lanes on expressways

127. Describe the change. How many routes are affected?

One

Bus lanes have been in effect for many years on downtown corridors such as Geary Street. Approximately 15 miles of lanes exist covering about half of routes.

Two BRT routes

Two frequent routes have benefited from reserved bus lanes recently added in the last year.

"York University Busway (196 YORK UNIVERSITY ROCKET; 4 other routes also travel all or part of the reserved bus lanes):— Conversion of existing HOV lanes to reserved bus lanes along Allen Road/Dufferin Street [Note that several HOV lanes (and some reserved bus lanes) were implemented several years ago benefitting many bus routes]"

Varies, depending on location. Downtown surface streets bus lane benefit more routes than suburban streets

Just our rapid service

8

Transit-only left turn lane provided access between arterial and exclusive busway; used by 3 agency routes, 8 partner agency routes. Counterflow lane used by 1 full-time agency route, 5 peak-only partner agency routes.

Two routes initially; many routes will use the corridor in the future

We have all three types of bus-only lanes, however most of them are curb lanes on freeways with a very few on arterials. Mostly they are for the benefit of express routes. Other benefits for express routes are dynamically priced/carpool lanes on two interstates, a downtown transit mall and a center crossover station on the one freeway. We had to severely curtail service to another freeway bus station to maintain our running time into downtown. To make a long story short on that, it doesn't work to combine median lanes and shoulder lane stops on the same section of freeway. The advantages for local routes are a contra-flow lane through downtown that currently benefits 4 routes and a bus-only transit mall for 5 local routes.

Approximately 50 routes affected by transit mall. Additional 2–5 routes affected.

Most routes are on a bus lane somewhere

128. Did your transit agency measure the effect of this change on bus speeds?

Yes	7.7%	1
Did not measure this separately; measured the effect of a package of changes	53.8%	7
No	38.5%	5

129. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	0%	0
Increased by more than 10%	100.0%	1
Decreased	0%	0
No impact	0%	0
Other (please specify)	0%	0

130. Did a municipality served by your transit agency institute signal priority or queue-jump lanes for buses?

Yes	66.7%	22
No	33.3%	11

131. Describe the change. How many routes are affected?

We have implemented The Spur, a pseudo-BRT. It has TSP, fewer stops (but not really limited stops), NextBus technology, stop-specific signage and articulated buses. However, you still pay fare onboard and it still travels in a regular traffic lane.

The queue jump bus lanes are being under construction at the moment

Expanded TSP to 200 intersections total affecting 20% of routes.

Two BRT routes with numerous signals and a few other routes had singular traffic signals changed

A few routes have benefitted from transit queue jumps and TSP in the past year.

"In the past five years, TSP has been installed at several isolated intersections where buses make left turns (benefitting buses on 15 routes). Two types of Left Turn TSP have been installed: 1. Buses may call and extend a leading left turn green arrow that is not callable by other traffic (i.e., if there are only autos in the queue, they only receive a green ball, allowing them to only turn 'permissively', whereas a bus is in the queue will call a leading 'protected' phase, and extended as necessary, to a maximum). 2. Buses may extend a leading left turn green arrow phase (which is callable by autos or buses) to a much greater extent (typically 16 seconds) than autos can extend the phase. An existing queue jump lane (westbound Finch at Finch Station) was lengthened, benefitting two routes. [Note that prior to 2008, TSP was installed: — At the majority of intersections along five bus routes (typically green extensions and red truncation) — At several isolated intersections where buses make left turns: Left Turn TSP was installed (typically as described above) benefitting buses on 25 routes]"

Only our main route—and two regional routes—are affected by the queue-jump. Works great. However, the impetus was Safety and driver concerns more than speed—the configuration of the intersection is less than optimal.

Signal priority and queue-jump at a couple of locations for the BRT line. Also implemented TSP (green light extension) on a large number of intersections

Improved reliability

Varies, depending on location

Just for our rapid route.

As part of an MPO-sponsored project, signals were upgraded with signal priority in one city for route 350.

We have had signal preemption for a number of years. System is being upgraded this year. Used only when bus is three minutes behind schedule

Currently in testing phase. Would affect up to three of our heavily-traveled routes through the City.

Corridor with 2nd highest ridership route was outfitted with signal priority. Operator hits button to obtain advantage at signal. He doesn't control signal, but he gains an advantage if he is running behind and hits button.

BRT routes initially, others over time

Many freeway on-ramps have queue-jump ramp meters for buses and carpools. Again, something that benefits express routes for the most part. We have traffic signal priority in one corridor, benefiting 3 routes. However, it is set so the bus must be late before it gets priority so it has reduced variability in running time more than it has reduced running time. However, in preparation for the TSP implementation, the city upgraded the signals to ones with more "intelligence". Specifically they now detect if there is anyone on the side streets that is waiting for a green light rather than having a set signal cycle. This seems to have had a more positive impact on running time than TSP itself.

Off

Same 2 BRT/limited stop routes

We are close to implementing TSP (starting later in 2013). It's taken 3 years to get to this point and has required cooperation between 5 local entities and 3 emergency service agencies. This will affect 4 routes (3 are trunk routes and 1 is a secondary (neighborhood route).

Currently, two

1

Approximately 50 routes affected. Signal priority on approximately 300 signalized intersections within core city. Approximately 10 queue-jump installations throughout service area.

10–15 routes are affected

132. Did your transit agency measure the effect of this change on bus speeds?

Yes	39.1%	9
Did not measure this separately; measured the effect of a package of changes	26.1%	6
No	34.8%	8

133. What effect did this change have on bus speeds?

Increased by 0 to 5%	45.5%	5
Increased by 5 to 10%	18.2%	2
Increased by more than 10%	9.1%	1
Decreased	0%	0
No impact	0%	0
Other (please specify)	27.3%	3

Other includes: (1) The speeds indicated above relate to the immediate vicinity of the intersection. (2) As I mentioned in a previous question, we've established current base line data for these routes and will be using that information to track results. (3) TSP in tandem with bus lanes works more effectively.

134. Did a municipality (or other entity) served by your transit agency introduce "yield-to-bus" laws?

Yes	38.2%	13
No	61.8%	21

135. Describe the change.

The yield to bus policy was implemented in 2004. Operation Section reported faster, smoother merging back to traffic in the adjacent lane. Driver population awareness improved as well.

Cars are supposed to yield to buses as they return to traffic lane from serving bus stop. Blinking yield signs installed on all buses

Drivers in Ontario must let buses back in traffic when a bus is departing from a bus, so long as it is safe to do so.

[Note that Yield-to-bus legislation enacted in Ontario in 2004; replaced local voluntary yield-to-bus program.]

State did. We purchased and installed signs several years ago.

Yield to Bus was presented to Police Jurisdictions and supported.

We have had a state law that buses have the right-of-way leaving a stop since 1993. We have had stickers on the bus informing motorists of this since 2006. So far, we haven't noticed any improvement.

Added yield to bus signs activated by door event and left turn signal.

Oregon allows transit districts to use "Yield to Bus" illuminated signs on buses for pulling away from stops. Even though it is a statutory law very few, if any, law enforcement agencies actually enforce the law.

Yield to bus is required when bus turns on signal to reenter traffic

This actually already exists in Washington State. I've simply noted it again since it has existed for many years.

All buses have red flashing "yield to bus" signs on the left rear of the bus. Installed since at least late 1990s.

State law

136. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	15.4%	2
No	84.6%	11

137. What effect did this change have on bus speeds?

No answers

138. Did a municipality served by your transit agency introduce signal timing?

Yes	41.2%	14
No	58.8%	20

139. Describe the change.

Bus timing priority at transit hub during off hours.

Progression changes on Geary and O'Farrell to favor transit.

Multiple jurisdictions on BRT routes introduced signal timing

Signal timing is routinely reviewed if delays to transit are reported. Revised timing plans are implemented when feasible.

Synchronized traffic signals, upgraded hardware, and changed signal cycle

We have had signal preemption for a number of years

Some signals now hold green for up to 30 seconds for approaching bus.

Improved on time performance

The city has embarked on a city-wide signal retiming effort to improve traffic flow in general. Transit has been identified as a key stakeholder. When we have a signal timing issue, we will bring it to the entity that owns the signal. Sometimes we point out something that has been mis-set and a correction is made very quickly. Sometimes, a resolution takes much longer. The most recent traffic signal retiming was on the express route transit mall.

Increased downtown cycle time from 75 to 90 seconds.

TSP implemented by various municipalities.

We work with 5 jurisdictions regarding signal timing. Much of it is basic tweaks over the years to accommodate bus service on local streets. It doesn't always occur but we do have a basis for asking for assistance when/where it's needed.

Signal timing was changed to accommodate signal priority (within the City). Other signal timing modifications may have impact on transit speeds.

Many arterial streets have signal progression. This is a continuous process of optimization

140. Did your transit agency measure the effect of this change on bus speeds?

Yes	50.0%	7
Did not measure this separately; measured the effect of a package of changes	43.7%	5
No	14.3%	2

141. What effect did this change have on bus speeds?

Increased by 0 to 5%	37.5%	3
Increased by 5 to 10%	37.5%	3
Increased by more than 10%	0%	0
Decreased	12.5%	1
No impact	0%	0
Other (please specify)	12.5%	1

Other includes: (1) Speeds are not measured, but rather delays to transit customers at intersections.

142. Did a municipality served by your transit agency introduce turn restrictions for vehicles other than buses?

Yes	26.5%	9
No	73.5%	25

143. Describe the change.

Left turn restrictions during peak hour throughout city.

Changes to improve BRT passage at conflict points

When needed and it is feasible, buses are exempted from certain turn/movement restrictions.

City recently changed traffic lanes on a major arterial and they restricted through traffic except for transit. All others must turn right.

Turns in urban areas that are shorter than normal are controlled by street striping controlling where cars are to stop on a red light allowing sufficient space for bus to turn and infringe in opposite lane.

Bus counterflow lane included general purpose traffic turn restrictions at intersections.

In the downtown core of the City, there are turn restrictions for vehicles between 7 am–7 pm that transit coaches are allowed to make.

General purpose traffic is subject to right turn restrictions on the transit mall.

At many locations left turns are banned and at some locations right turns are banned

144. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	33.3%	3
No	66.7%	6

145. What effect did this change have on bus speeds?

No answers

146. Did a municipality served by your transit agency introduce parking restrictions?

Yes	23.5%	8
No	76.5%	26

147. Describe the change.

Parking restrictions on busy corridors to accommodate bus lanes, parking restrictions at bus stops.

Parking spaces have been removed to facilitate bus turning movements.

The County intensively manages curb space and restricts parking by bus stops.

On-street parking restricted during the peak period to make room for curb bus lane

Installed No Parking on some segments that were narrow and caused buses to wait for on-coming traffic. This enabled the bus to continue without delay.

Parking restrictions to enable turning movements by buses and passenger stops are an on-going give and take between the transit agency and the municipalities. However, we have been working with the city to identify places where parking can be restricted during the peaks so that parking lanes can be converted to travel lanes. These would not be exclusive for buses however.

Peak period parking restrictions on major bus routes. AM and PM reverse directions

On many arterial streets there are peak hour no-standing zones to increase traffic flow and thus bus speed.

148. Did your transit agency measure the effect of this change on bus speeds?

Yes	0%	0
Did not measure this separately; measured the effect of a package of changes	25.0%	2
No	75.0%	6

149. What effect did this change have on bus speeds?

No answers

150. Were there any other external policy changes that affected bus speeds?

Yes	17.6%	6
No	82.4%	28

151. Describe the change.

Geometrics changes to intersections to reduce bus delays. Also, [Note that several years ago, before all buses were equipped with TSP transmitters, we'd made specific requests to add callable leading left turn green arrow phases for selected bus movements operating in mixed traffic, including at locations where the local "warrant" for a leading left turn phase was not met by traffic volumes alone. In these cases, a former "permissive-only" turn was changed to "protected-permissive," callable via a set-back vehicle detector loop (i.e., three or more cars, or a bus, in the queue would call the left turn green arrow). This resulted in significant decrease in average and maximum left-turn delay at these intersections, which increased speeds in the vicinity of these intersections.]

Downturn of the economy has resulted in reduction of service which has slowed bus trips due to increased ridership.

This hasn't occurred yet but several Coastal communities are adding or are considering adding sharrows in traffic lanes.

Tolls were introduced on the SR 520 bridge in Dec. 2011. This reduced bus travel time an average of 5 minutes during peak times.

The state passed a "don't block the box" law in the last two years modeled on the one in effect in New York City. So far it has been difficult to get the City police to make it a priority to enforce the law. They would like to do a public information campaign first and so far that has not been funded.

There are many locations where the City has introduced pedestrian plazas, pedestrian refuges, curb neck-downs, general traffic calming measures and bike lanes. Obviously these measures slow traffic as that is their purpose. In some cases this has slowed bus service. But it is sometimes helpful to bus service as it makes accessing bus stops easier and safer

152. Did your transit agency measure the effect of this change on bus speeds?

Yes	33.3%	2
Did not measure this separately; measured the effect of a package of changes	16.7%	1
No	50.0%	3

153. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	33.3%	1
Increased by more than 10%	0%	0
Decreased	33.3%	1
No impact	0%	0
Other (please specify)	33.3%	1

Other includes: (1) as discussed, good for the city as whole but possibly bad for bus speed.

154. Did your transit agency or any municipality served by your agency take any other actions to improve bus speeds?

Yes	19.6%	11
No	80.4%	45

155. Describe the change.

Communities worked with us to develop land use designs which limit off street movements within developments.

Expansion of bus bulbs, use of queue jumps, boarding islands to remove transit from right turn queues, use of real-time GPS tracking to deploy traffic management resources

When needed and as opportunities permit, roadways are redesigned to minimize transit delays due to traffic congestion.

Proactively implement bus transit priority measures

Bus speeds are predominately governed by the congestion of this community. Most routes run at moderately low speeds due to this congestion.

Developed ways to monitor individual operators and address behavior issues affecting speed.

The state passed a "don't block the box" law in the last two years modeled on the one in effect in New York City. So far in has been to get the City police to make it a priority to enforce the law.

Grade separation pedestrians/traffic at Euclid & Broadway. Table Mesa pedestrian overpass.

The City is conducting a downtown mobility study that includes the movement of transit vehicle, pedestrians, and bicyclists in the central business district.

Transit Signal Priority (as mentioned previously) is currently getting close to the implementation stage after 3 years of working through the issues/concerns.

Preparing to construct infrastructure improvements to increase route efficiency, speed, and pedestrian safety adjacent to two major highway interchanges. Completion planned within year.

The agency is deploying a new CAD/AVL system for buses that is expected to provide additional tools for bus dispatchers to manage bus headways and performance.

156. Did your transit agency measure the effect of this change on bus speeds?

Yes	25.0%	3
Did not measure this separately; measured the effect of a package of changes	33.3%	4
No	41.7%	5

157. What effect did this change have on bus speeds?

Increased by 0 to 5%	0%	0
Increased by 5 to 10%	33.3%	1
Increased by more than 10%	0%	0
Decreased	33.3%	1
No impact	0%	0
Other (please specify)	33.3%	1

Other includes: (1) We will monitor TSP results on a regular basis, which I expect will start up in earnest in 2014.

158. What metrics were used to measure the overall impacts of all changes implemented?

Change in average bus speed	34.5%	19
Analysis of components of travel speed (dwell time at stops, time stuck in traffic, etc.)	32.7%	18
Schedule adherence	92.7%	51
Operating cost	30.9%	17
Ridership	52.7%	29
Qualitative measures from passenger surveys	25.5%	14
Other – please specify	16.4%	9

Other includes: (1) The contractor who sold us on TSP tried to collect data to measure the results of TSP implementation, but the results were inconclusive at best and disappointing at worst. Anecdotally, the bus operators think it helps at some intersections and actually hurts at others. The problem is that the transit agency only controls the emitters and not the receivers or the programming of the controllers. City traffic signal engineers are not experts in bus transit and we're not experts in traffic signal timing. We don't even have the staff to monitor and make sure the controllers are all still working. We'd need to hire a consultant, an expert in the field but right now we have bigger fish to fry. (2) Internal staff rode routes that were experiencing low schedule adherence. Currently in the metropolitan area, we have many routes that are and or have been affected by long term construction. (3) Person-minutes are used instead vehicle delays to determine the need for road improvements. (4) Travel time on segment corridor (5) Change in travel time. This metric directly affects customer satisfaction and operating costs (service costs based on vehicle hours). (6) Other forms of passenger comments (7) Some modest review & analysis of customer comments (8) Discussions with operators. (9) We measure all this stuff. Also time and delay studies and analysis of AVL data on selected routes.

159. Please describe the overall results of all actions taken. If your agency only took one of the actions described here, note that here; you do not have to repeat your answer.

Table 20 on p. 60 summarizes results. Verbatim responses are included here.

Bus speeds are generally lower on affected routes.

Our on time performance has increased in a number of areas that we serve.

Actions have helped prevent significant decreases in bus speeds, but overall, bus speeds are dropping slightly and it seems mostly related to ridership increases including increases in ridership of persons with disabilities using wheelchairs and other mobility devices.

Since 1999, several route and schedule adjustments were initiated to reduce expenses, improve a route's operating ratio, reallocate resources and to generate additional passengers. In terms of schedule adjustments, the agency utilizes CARD-RSA and APC data to determine changes in running times between timepoints. Depending on the on-time performance of a particular route(s) follow up adjustments are made.

Bus speed on BRT route is approximately 10–15% faster than comparable regular service

When considering person-delay instead of vehicular delay, transit needs are given greater weight.

Generally, different actions targeted to specific routes or intersections, with little overlap, so answers not repeated. There was considerable overlap of actions for the York University busway, generally reported above: significantly reduced average travel time and variability in travel time; buses could be removed from service while maintaining (or improving) scheduled headway.

Schedule Adherence is improving. However, publishing a timetable reflecting reality occasionally has a depressing effect on ridership (wider headways).

We have seen a general increase in running times over the past several years. This appears to be due to several factors including new fare boxes, more frequent use of kneelers, operator turnover and an apparent increase in roadway construction.

Improving the traffic signals had the greatest impact

We have been forced to reduce our service and hence have seen reduced speeds due to increased PPH on most routes.

Line up system operating more efficiently. Chronically late bus lines no longer adversely affecting shorter, urban routes. Urban routes @ 20 min. headway frequent enough to shorten wait for late suburban passengers.

Prior to rapid bus service, we were looking at using additional buses and a longer cycle time to add bus bunching: 9 buses on a 90-minute cycle. We started with a 7 bus/70-minute cycle with a 3 bus/90-minute cycle for a local service as well. We have trimmed the 7/70 to 6/60 except for the busiest times of the day and are weighing if OVFP will save enough time to go to 6/60 all day.

It is extremely difficult to isolate individual components impacting bus speed. We have purchased low floor buses, adopted bus stop spacing standards and stretched distance between stops, adjusted travel times, and streamlined service. But often, when taking these actions, they're not in isolation—we're adjusting travel times, changing bus stop spacing, and sometimes removing small deviations all at the same time. Every four months operators can select their work, meaning different operators with different driving styles. When we purchased our first low-floor buses the back doors operated so slowly that operators didn't want to run those buses—it caused them to be late. Our overall scheduled speed (scheduled miles/scheduled revenue hours) for local lines decreased less than 2% 2007 through 2012, and during the same period ridership on local lines increased 17%. The overall ridership change 2007 to 2012 is an increase of 23.77%. The steps taken have enabled us to maintain our speed through major periods of growth rather than increase our speed.

Bus ridership has increased over past 2 years. On-time performance is gradually improving. There has been a slight increase in operating cost and a slight decrease in-service speeds system wide.

Bus speeds have decreased but more time is allowed so on-time performance has improved.

Improved on-time performance, Reduction in accidents, Greater customer satisfaction, increased ridership.

The overall effects encountered are that schedule adherence improved by 35% even with traffic and environmental factors that create delays. Bus speeds were improved to within 5% of posted limits.

Bus network was designed from the beginning to be long haul, limited stop express system. We have been careful not to add stops, and have closed low-ridership stops. Over past 5 years, have opened six freeway HOV direct access ramps and/or freeway stations; these facilities had the most significant impact on speed and travel time by making maximum use of freeway HOV system and avoiding congested arterials.

While OTP has decreased, mostly due to a large increase in ridership, we continue to make adjustments to improve performance.

We still have difficulty keeping routes on schedule, but overall routes are adhering to schedules more.

Incremental adjustments are being made to schedule timepoints and less frequently adjustments are being made to dwell time. These adjust have minimal long term affect on schedule adherence. Small adjustments have been made to certain routes and some removal of bus stops and changes in spacing. This transit system is ready to embark on a more rigorous route evaluation which could result in removal of bus stops and service areas and/or adjustments to headways to keep schedules on time.

On time performance of fixed route vehicles, measured at all time points, is currently averaging 94%

Some changes are fairly recent, such as shoulder lanes on a new operating corridor. So the total impact of such a change will not be fully known for a while.

OTP improved to 86% in recent years.

The overall result has been positive but some of the changes are still pending. This will be an area of increasing focus over time as congestion continues to impact bus speeds and service quality.

One of our primary measures of the quality of our service is our schedule adherence. Since we have been tracking it, it has mostly improved, especially on local service. We were initially surprised to realize that our schedule adherence was much better in the winter than the summer. When we looked closer we realized that during the winter, except during snow storms when nothing runs on time, we did pretty well. During the summer, there are so many events and detours that we never knew when a bus was going to get to where it was supposed to be. Unfortunately, most of the things we have done to improve our on-time performance has actually slowed our service down.

See above

Schedule adherence improved

Modest results.

Currently there has been very little change in bus speed (low of 12.57 / high of 12.86). A complete system redesign was conducted in 2009 with a goal of streamlining service to maximize service delivery on a restricted budget. This process started over with a blank slate and built the service from the ground up. Implementation took place over the Labor Day weekend in 2009.

On-time performance increased from 705 to currently over 7%.

We have not taken actions specifically to increase systemwide average bus speed. Introduction of low-floor and articulated buses was mainly for other reasons. Schedule adjustments are constantly made where there are chronic on-time performance problems.

Over time performance measures are used to analyze and, where possible, to improve upon existing service. Our overall intent has been to improve service speed and capacity along the major corridors served in our district. These are typically trunk routes and have the largest passenger loads and passengers per hour within our system. The results on specific routes has seen up to a 65% increase in ridership over the past 5 years (add more service frequency and larger buses) and a 25% increase in on-time performance on some routes.

On the principal route, on time performance on the primary route improved from one of the worst in the system (83%) to one of the best (92%). Other measures were combined with a service increase to reduce crowding. Efforts on other routes were less comprehensive, and have not produced results that can be attributed to the measures.

Due to limited staff, a number of major road reconstruction projects happening concurrent with stop spacing changes and the lack of CAD/AVL data, we have not taken up a system-wide approach to measuring the effect of stop-spacing and route streamlining efforts. However, research elsewhere indicated they were efforts that would positively impact speed and reliability so they were undertaken. The outgrowth of these actions have helped grow ridership which has in turn impact travel times on some routes But anecdotally they are much better of late than if these actions had not been taken.

Improved route design, coverage, and ridership

CBD bus speeds and schedule adherence increased or improved from before transit mall construction to after. Signal priority implementation appeared to result in reduced travel time variability.

By aggressively employing all these actions we were able to mitigate the decrease in speed on some bus routes, reversing the trend. On BRT routes we were able to increase speeds in a noteworthy manner

160. Did your agency contemplate but not implement any actions to improve bus speeds?

Yes	56.4%	31
No	43.6%	24

161. Please indicate all actions that were considered but not implemented.

Table 21 on p. 62 summarizes results.

Increased bus stop spacing	41.4%	12
Level boarding at major stops	17.2%	5
Changes in stop design or length	13.8%	4
Changes in stop location	27.6%	8
Low floor buses	3.4%	1
Changes to vehicle size or performance	17.2%	5
Changes to interior seating configuration	6.9%	2
Changes to door configuration	3.4%	1
Use of ramps instead of lifts for wheelchair boardings	3.4%	1
Bicycle storage inside the vehicle	10.3%	3
Streamlined route design	17.2%	5
Limited-stop service	27.6%	8
BRT service	44.8%	13
Running time adjustments	6.9%	2
Changes to recovery time policy	10.3%	3
Use of headway-based versus time point-based schedules	13.8%	4

All-door boarding	20.7%	6
Off-board fare payment	31.0%	9
Pricing to encourage shifts to prepaid media	10.3%	3
Introduce or discontinue fare-free zones	3.4%	1
Eliminate fares entirely	13.8%	4
Change bus door practices (passenger-activated or policies regarding bus operators re-opening doors for late-arriving passengers)	3.4%	1
Hold policies at transit centers	6.9%	2
Bus-only lanes on arterial streets	41.4%	12
Signal priority for buses	44.8%	13
Queue-jump lanes	27.6%	8
Yield-to-bus laws	6.9%	2
Signal timing	20.7%	6
Turn restrictions	6.9%	2
Parking restrictions	13.8%	4
Other	27.6%	8

Other includes: (1) we have a comprehensive approach for implementing a number of these items in the future, we have an aggressive BRT program that will allow us to take advantage of a number of the items listed here. We are also using our intelligent bus system data to analyze not only our schedules but our routings. We have low floor buses throughout our fleet with wide doors in front and rear. We will be introducing an account based electronic fare system that will have touch pass capability. (2) "Various actions: The agency developed the Transit City Bus Plan in 2009, which included: Implementing new express branches on many bus routes—Rapid, extensive expansion of the existing TSP program (1,150 new TSP intersections within 5 years)—Installation of queue jump lanes. The Transit City Bus Plan has not been implemented due to the lack of funding to provide additional transit services. In addition, the local municipality has indicated that it no longer has sufficient human resources to implement even a modest number of new TSP intersections, for which funding is available. Although there is funding available to begin the implementation of queue jump lanes, these lanes have not yet been approved by local municipal staff, due to competing municipal priorities (such as increasing public realm, tree planting, minimizing pedestrian crossing distances)." (3) Exclusive bus only lanes (4) Concerning bus stop spacing, need to clarify. We're looking to rationalize bus stop spacing based on utilization, not necessarily increase average spacing. (5) The transit system is evaluating—long-term—Bus Rapid Transit, Signal priority for buses, and Queue-jump lanes. These are not within the current 5-year CIP. (6) NOTE: Many of the features listed above will be implemented as part of the BRT project currently in construction. (7) Contactless cards remain an elusive technology for us.

162. Please describe why the actions were not implemented.

Table 21 on p. 62 summarizes results. Verbatim responses are included here.

Cost mostly. And the only problem with increased spacing or limited stops is ADA accessibility.

Budget constraints, property constraints

Change in agency priorities.

Timing, we have been working our way through the list and in conjunction with our sister agencies and our community partners.

No reliable technology for off board technology, transit center not designed for this. Needed the revenue from the fares and no replacement funding available.

Discontinuing bus stops would improve bus speeds; however, local politics and customer surveys do not support increased walking distances to the nearest bus stop. Relocating bus stops from near-side to far-side are not always acceptable to property owners. Agency staff examined acquiring additional articulated buses, but many of our garages do not have the ability to store or maintain vehicles without acquiring additional capital funds to reengineer these facilities. All-door boarding is not being considered under our New Payment Technologies program due to additional capital and maintenance costs. There are limited opportunities for queue-jump lanes, but also not being embraced by local traffic engineers. Establishing parking restrictions in the central city and the various suburban municipalities are difficult.

Customer service and convenience are often given more weight than operating speeds.

Vehicle size: Articulated buses were in operation many years ago, but were replaced by 40-foot buses when they were retired. Purchasing new artics had been considered for several years since then and was ruled out for various reasons until recently. The first new artics will be delivered in 2013. Parking restrictions: requests for parking prohibitions have not been supported by local politicians.

Most of the actions checked are still under consideration. All of the actions have budget or customer service implications. These implications are under review.

No support from impacted businesses along the corridor

All routes have circuitous routing thru CBD to cover as many activity nodes as possible. New Transit Hub facility opening presented opportunity to streamline CBD routing. Decision was ultimately made to leave CBD routing alone due to perceived backlash re additional transfers.

Initially, our board hesitated at possible cost associated with fare checkers; this is being evaluated again. We have looked at eliminating fares for the rapid service assuming most would still have to pay for connecting services but the perception of equity likely will keep this from moving forward.

We are in the process of implementing our first BRT. The items listed above have not been implemented yet, but will be implemented when our first BRT line opens in 2014.

Bus stop rationalization project will start this year. Limited stop service on local 303 route is a concept at this point.

Impact on revenue is a challenge. Still under consideration.

Community Opposition

In a few areas, we considered eliminating some low-use express bus stops but ST provided the only service so this created barriers to accessibility (no local service alternative). Our busiest bus corridors are being replaced by light rail, so it wasn't cost-effective to implement bus-only lanes or other expensive treatments if the benefits were realized for only a few years.

Usually lack of funds.

Logistics coordinating this and more importantly funding.

Significant changes have not yet been made to number and spacing of bus stops due to customer resistance. The agency has a policy to transition riders from the more expensive door-to-door service to the fixed route. Fewer bus stops and less frequent bus stop spacing make this goal more difficult to achieve. The above considerations are also why streamlined route design and limited stop service have been considered but not implemented. The agency has also considered adding resources (vehicles and operators) to routes to improve schedule adherence. Years of flat and/or declining budgets have not allowed these actions.

In a nutshell, lack of political will continuity.

BRT is envisioned as something new and wholly apart from the current system; its day will come. We just did start (last week) a select signal priority location (and results do not appear meaningful). For whatever reason, can't get yield-to-bus past the state legislature.

Some were due to a lack of funding to implement. Others are due to a lack of willingness on the part of the local municipality. Some are on schedule to be implemented but are waiting on further planning and development before implementation.

Municipality responsible for implementation. Change of policy (written but never implemented), capital cost

These actions are being planned, but have not yet been implemented.

This question is asked as if our efforts to improve speed and reliability have an end date in the past and any contemplation that was not acted on was an indication of inaction forever. Many of these items are still under consideration but rely on continue development of political trust, partnerships, revenue sources, staff capabilities, etc.

These actions are still being considered for future implementation. We are in the process of implementing a policy that will allow us to increase the average spacing between bus stops, and have future projects planned that will involve dedicated bus-only lanes and signal priority.

The agency is currently evaluating future BRT and electronic fare payment. Headway-based schedules are possible with the new CAD/AVL; once it is fully deployed, the agency may consider it.

163. Please characterize the following elements as major constraints, minor constraints, or not a constraint in implementing actions to improve bus speeds.

	Major constraint	Minor constraint	Not a constraint
Passenger complaints	26%	48%	26%
Operator complaints	11%	51%	38%
Safety concerns from operations department	32%	37%	32%
Lack of support from upper management	19%	25%	57%
Lack of cooperation from outside agencies	33%	41%	26%
Competing goals viewed as more important	32%	44%	24%
Inability to identify a funding source	54%	24%	22%
General reluctance to change	13%	42%	45%
Other	25%	75%	0%

Other includes: (1) ADA accessibility (2) Neighborhood opposition for example stop sign removal which can improve travel speed but neighborhoods feel they slow traffic and improve general street safety. (3) Lack of support from municipal staff—Major Constraint (4) Our focus is primarily on Safety and secondarily on Accuracy in On-Time Performance. Buses had to drive too fast to try and keep their schedule on some routes. (5) Staffing–major (6) Business/property owner opposition to parking removal, bus-only lanes, high-volume bus stops. (7) Lack of equipment (vehicles) (8) Lethargy and the in-ability to marshal resources, as we fight fires elsewhere. This (improved bus speeds) is deemed laudable but short of the expansive BRT proposals not deemed that high of a priority. (9) Budget limitations have had an impact on the amount of changes that could be implemented. (10) Note that we have to get approval from the State DOT for any changes associated with on ramps and off ramps. They have different goals and as a larger bureaucracy, feedback can be slow or subject to change. (11) Political more concerned with nimby issues than quality service.

164. Please describe the nature of the major constraint affecting the implementation of actions to improve bus speeds.

Responses summarized in Table 23, p. 66 of report. Verbatim responses are provided here.

Money is tight, what more need be said.

Major constraint is the impediment of bringing progress in a timely manner. Major constraint brings increase the cost of implementation

Time, we are doing what we can in the time that we have to do it. We could argue that we don't have enough staff or money, but that would be a false claim. We are doing what we can with the resources that we have available to us and we have seen significant improvement in a number of areas. The thing that we cannot control is the number of vehicles that share the road with us, nor can we control the timing cycles at intersections (although our work with the State and the Counties related to our TSP program is bearing some fruit on those routes—we are seeing signal optimizations that are improving our speeds in a limited way). Still have not been able to overcome the on-street parking in some communities.

Some stops were placed back due to passenger complaints. Operator complaints of running too fast and not enough layover. Operations holding buses too long at transit centers for transfers and not managing late buses coming in. Transfers taking priority over releasing buses. City not wanting to invest in signal prioritization due to costs. No funding if fares eliminated. Wanting to reduce costs on demand response by offering free fixed route rides causing more ramp usage and slowing speeds.

With all of the major road construction it is impossible at this time to increase speeds. At times routes are even on detour. The valley also has two light rail extension projects that will be taking place for the next 4–5 years. Lack of funding to add signal priority. We currently have a limited stop BRT and a local route servicing the same road and we are not seeing much of a savings in runtime between the two. In order for BRT to work they need to be on a fixed guideway.

Funding is the major constraint. It is difficult to remove/consolidate bus stops without improving key bus stops that have better locations to support higher bus speeds. If there is a lack funding to improve bus stops with shelters and other key amenities, then how do you convince riders of the importance of removing other more conveniently located stops?

Bus stop consolidation has been strongly opposed in past efforts to increase stop spacing and to improve bus speeds.

More controversial proposals such as bus stop removal can be a major constraint.

Our Transportation Master Plan has many competing objectives, with little direction on what priorities should be based on mode of travel. Consequently, transit priority projects are sometimes deferred due to other competing objectives, such as maintaining traffic capacity and providing enhanced cycling facilities.

Lack of support from municipal staff for improving transit service, due to: (i) lack of municipal staff resources to implement funded actions (e.g., TSP); and (ii) funded actions compete with other municipal priorities (e.g., queue jump lanes versus public realm)

Bus Stop Spacing—consolidation has to be addressed. The regional agency and our agency are gearing up in that effort. Public Engagement is a key concern.

The major concerns with increased stop spacing are customer complaints, especially elderly and disabled passengers, and the uncertain effect on ridership. The major concerns with traffic signal prioritization are funding and acceptance/cooperation from external agencies. The major concern with BRT service is funding.

Funding, availability of resources (manpower & time)

Individual jurisdictions demands to "get what they pay for" regarding transit service. Sales tax in the County has been declining for 5 years. Our agency derives 70% of revenue from sales tax and our incorporation does not allow us to tap any other sources of revenue.

Need to have a champion at local jurisdictions to implement bus priority treatments. Need political support in making transit mode a priority. Limited right-of-way with competing interest, bike lane vs. bus lane.

An issue previously described, speed was perceived as less important than customer convenience. Streamlining routes thru the CBD would have forced more transfers. In addition, efforts to give bus priority @ traffic signals have continually been stymied in this community by the City Fire Dept., which controls the Option signal system. Significant political pressure will have to be brought to bear to change that.

Overall, we have not had any issue other than complaints about stop spacing tied to the rapid service. While we still operate local service in our rapid service corridor, it runs only 30-minute headway compared to the 10-minute rapid service. We would look to offer more limited-stop services if additional funding was available.

The Bus Stop Service Improvement Project—changing spacing of bus stops—was always envisioned as a multi-year project. Given staff available a goal was set to review lines that have a total of 400 to 500 bus stops each four-month service period. Passenger activity at each stop is reviewed and then recommendations made to remove, combine, or move stops in an effort to adhere to the new spacing standards. Notices are placed on all affected stops and left up for an open comment period of three to four weeks. After final decisions are made, new notices are placed on all stops that are changing several weeks in advance of the change. This is labor intensive and so cannot be done all at once, but in smaller bits over a several-year period.

Currently there is a strong emphasis on the customer experience and service reliability, particularly with transfers between routes. Much of the running time adjustment over the past year has been focused on increasing on-time performance—to an extent this has lowered average local service in-service speeds. Service Planning is somewhat concerned regarding degradation of speeds, as this contradicts one of the Mobility Plan key goals. Service Planning is also concerned about possible impacts to fleet requirements. Other than Transit Signal Priority measures implemented on Route 350, many of the local jurisdictional policies, especially related to bike operation in general lanes, are potentially going to slow service further.

Done all we can short of completely restructuring the system. Difficult to get buy in for that much change at this time. Lack of adequate funding may force this change next year.

No fare boarding would be the most dramatic way to speed boarding but identifying a way to replace the fare revenue while sustaining existing revenue sources is a major challenge.

Funding source is the number once constraint preventing the introduction of new technologies to improve bus speeds.

The community values on-time performance, but does not wish bus speeds to be excessive to achieve. Community tolerates 10–15 minute delays from schedule time points. City jurisdictions will not agree to having BRT or designated high occupancy lanes nor do they wish to have limited stop service, with the exception of Commuter service that serves inter-county corridor. Leisure approach to travel from one end of the service area to the other is favored over tight scheduling. Intersecting route connections are preferred over expedience.

Actions that achieve the greatest increase in bus speed may have significant construction, economic and operational impacts on the community.

We have reached the limit to our annual budget

Mostly it is funding, because each route has only one bus on it causing the bus to stop more frequently for passengers at all times of the day. If we could afford to put additional buses on certain routes, at least at peak times, I feel that overall individual buses would not have to stop as frequently.

Safety, such as loading and tying down wheel chairs, is a major constraint in the implementation of actions to improve bus speeds. Inability to identify a funding source for expanding operations to add vehicles and operators to routes experiencing problems with schedule adherence is a major constraint. It is increasingly difficult to keep schedule adherence due to increased ridership and increased traffic on roads. The agency is considering seasonal time adjustments as one approach to this problem. This could mean that headways would be increased lowering levels of service, if additional funding is not available.

We have been battling with construction projects in our area. All major arterials are under some type of construction

State budgets have been tight, and our MPO, who also is the region's largest operator, has made it more difficult for Opt out/suburban providers to receive funding/support for measures that will increase bus speeds in suburban areas.

Safety is a big constraint. I think it is more important to design routes so drivers have time in the schedule without having to drive faster.

Funding is the biggest issue.

The biggest challenge is convincing municipalities of the need to give transit priority, whether it be through the dedicated ROW or other means. While there are good relations and an understanding of the need, the willingness to take a lane from general traffic or make significant investments in transit priority has been limited.

As I said in the last text box, one of our main measures of service quality is schedule adherence. The easiest way to achieve that schedule adherence is to add running time. If we try to maintain on-time performance while reducing running time, there are many competing interests that make that difficult. For example, we are currently trying to improve schedule adherence on a small 1-mile downtown corridor without increasing running time. We have identified many factors that contribute to the problem. A few of them we have some control over (operator behavior). Some of them the city has control over (signal timing), But most of the issues are either the behavior of car drivers, and getting the police to allocate more personnel to enforce those traffic laws has not been an easy sell, or the issues are related to the behavior of private businesses along the corridor and getting their cooperation has also not been easy. It seems for almost every measure that is proposed, there is a competing issue that may be as important to a municipality, a business or another department within the organization, which makes it difficult to enact.

Operational funding is very limited in the local area. This constraint limits opportunities for any operational innovations that would increase overall operational costs.

Budget issues

Cooperation and support to move forward. Competing interests and limited funds to do it all.

Other service planning considerations given higher priority than simply increasing average systemwide bus speed.

Limited local tax funding revenue, which we rely on for our transit system in terms of sustaining existing service. This is especially hard during these past few years due to the downturn of the local (and national) economy. We had been planning major capital facility projects/improvements, which will most likely be delayed or simply not completed. And we cannot meet current service demands without the expansion of our operating base to accommodate a larger fleet. With the new MAP 21 requirements placed on small transit systems we anticipate even harder times ahead. We will however, continue to look for service improvements and cost reductions in order to improve upon the sustainable service that we have developed for the communities we serve.

Increasing traffic and ridership make it difficult to improve bus speed. Just holding speed constant is a major challenge. Coordinated transfer route design limits the ability to add a small amount of time to a route to improve on-time performance.

If there is not a major new revenue stream (i.e. increase in tax rate by vote of the citizens) then we will be cutting service. We do not have extra revenue to make major capital investments otherwise.

There is a lack of understanding among some members of our staff as to the extent to which internal policies such as fare pricing and collection, stop spacing, and inefficient routes with unnecessary turning movements impact bus travel speeds. Implementing other elements such as signal priority and dedicated lanes has proved difficult to get support for and coordinate with multiple local agencies. It has historically also been very difficult from a public relations standpoint to remove bus stops.

Recent service reductions have postponed progress on improving travel times, streamlining routes, and re-spacing stops. Agency priority is on restoring service.

Too much traffic, too much double-parking, too many vehicles parked in bus stops and extreme difficulty in obtaining data to prove or disprove the value of any actions.

165. How would your agency rate the actions taken to improve bus speeds?

Very successful	5.8%	3
Somewhat successful	53.8%	28
Neutral	32.7%	17
Somewhat unsuccessful	7.7%	4
Very unsuccessful	0.0%	0

166. What have been the primary benefits of these actions?

Responses summarized in Table 25, p. 71 of report. Verbatim responses are provided here.

Reducing the time spent in traffic congestion. Improve operation. Make Bus service more attractive to population. Reduce cost of offering transit service.

Minor improvement (less degrade) in running times for one route with significant stop reduction. Better on-time performance on routes with re-timing, but not better speeds.

Improved on time performance and reliability

They have offset actions that have slowed bus speed such as increase in mobility impaired riders and bus maintenance issues of trolley routes and new operator learning curves.

Changing runtimes have helped with schedule adherence, but not necessarily reducing speeds

Maintaining existing frequencies and high ridership without increasing operating costs.

Improved reliability and a renewed sense of cooperation between the transit agency and the City to improve transit speeds. Suburban municipalities do not generally understand that improving transit speeds is a benefit to their communities.

Improved customer experience and more consistent running times for scheduling

Less cycle time for BRT service

Improved service reliability is achieved when transit travel speeds are normalized throughout the day. Reducing schedule variability is just as important as improvements to transit speeds along congested arterial corridors. While service continues to be delayed during peak periods due to high passenger demand, the impacts of traffic congestion on the road network can be greatly reduced.

Contrary to the general trend of decreasing bus speeds, on selected corridors and at selected intersections, speeds have increased, in some cases significantly. In some cases (e.g., TSP on a corridor, or BRT) operating costs have also been significantly reduced. Either (i) one or more buses have been removed from service while maintaining the headway, or (ii) additional capacity has been provided without additional buses.

The main strategies have to be: 1) bus stop consolidation; and 2) recruiting single-occupancy auto drivers to other modes. Primary benefits to date include better on-time performance and less speeding by operators

Improved service reliability, improved efficiency

Improve travel time reliability

More consistent line-ups have led to greater customer satisfaction. Our new Hub, with dedicated platforms for bus lines, has greatly decreased customer confusion & sped loading times.

Generally, where we have been able to streamline routes, we have been able to maintain operating speeds. Other routes have required more resources to combat the impact of congestion.

As noted above, we've been able to pretty much maintain speeds during a period of significant ridership growth. Bus operators who drive major bus lines already evaluated for bus stop spacing indicate it is easier for them to operate the bus smoothly. They indicate they are no longer still accelerating from one stop when beginning to slow down for the next. These comments were made at the end of one of our Service Delivery/Scheduling Committee meetings with absolutely no prompting from the management side. It was very rewarding to hear, even though it doesn't show in the actual speed numbers.

On some routes, we went from a "plain vanilla" route that always operated the same way all the time to tailoring operating route variants when they were warranted. The goal of this strategy was more to save revenue miles rather than to improve running times. The strategy has been effective in that it has offset service increases elsewhere in the system, such that local bus services have just had a modest increase in the past 18 months.

Schedule adherence and better customer service

Better on-time performance.

Improved on-time performance, Reduction in accidents, Greater customer satisfaction, increased ridership.

Improved service, satisfied community, acceptable customer service, cost efficiency, high ridership.

Transit travel times between major destinations in the region have been reduced significantly. Major corridors have travel times competitive with driving alone during peak times. Faster system has resulted in better productivity and cost-effectiveness. Most corridors have service all-day, 7 days a week, which has increased market penetration and resulted in a healthy mix of trip purposes.

OTP has not gone down as much as it might have, given the ridership increases.

At least the problem is not getting worse, even if it is still there.

Bus speeds have remained about the same over the past five years. Prior to that time, streamlining routes was a priority, and most of these changes have been achieved. The system has been improved as much as it can be improved without destroying levels of service (e.g. longer headways and/or reduced service areas).

Actual route performance closely mirrors printed schedule book.

Better on time performance

Improved quality of service.

Main benefit is faster travel times for customers. Reduced operating cost is also a major benefit.

In the last 5 years, out main focus has been on improving the on-time performance of our express routes and making sure that we have the capacity to grow that aspect of our service. These efforts have been fairly successful. The efforts directed at our local routes have been less focused and therefore less successful.

Reliability improvements

Modest results.

More customer convenience with quicker and more direct trips, fewer incidents due to driving on smaller streets, increased ridership on higher frequency corridor routes.

Improved on-time performance and schedule reliability

We are keeping up with the congestion, but not getting any better

Improved on-time performance. Improved transfer connections at a transit hub. Reduced driver stress as well as customer complaints/comments.

Maintaining speed of service with increasing ridership and traffic

A more rational stop spacing; more rationale route design; ridership has increased even as service was cut

On the corridor where we were able to implement limited stop service, running times were significantly decreased, and overall reliability was improved as a result of having fewer stops along the route.

More dependable service, better schedule adherence.

Increased ridership and more service possible at same cost

167. What have been the primary drawbacks of these actions?

Responses summarized in Table 26, p. 72 of report. Verbatim responses are provided here.

Educating the stakeholder about the change

Passenger complaints about stop consolidations.

We haven’t really experienced any drawbacks, some customer complaints initially about increased walking distance between stops but that went away

Construction

To a degree, the comfort and reliability of the service are compromised.

Customer complaints when stops are eliminated or consolidated. Community complaints over parking restrictions. Property owners complain when bus stops are relocated from near-side to far-side.

Drawbacks vary by improvement type. Stop removal reduces access and is the most controversial for our agency.

N/A

Capital funding to make infrastructure changes is limited.

No response

Too great an emphasis on speed results in complaints about unsafe driving. We’d rather avoid the complaints. Also, longer headways.

None

Reduction of service as a result of achieving on time performance and realistic bus speeds.

Suburban route riders sometimes miss connections. Our urban service is frequent, but no one's ever happy with a 20 minute wait.

For riders who have further to walk or longer wait times, there is obviously less satisfaction. For those that benefit from faster trip times, satisfaction has increased.

Disgruntled passengers who do not want their stops removed—although this has been held to a minimum given the process we are following. Also, low-floor buses have fewer seats, so the seating capacity of buses has decreased, causing more standees on crowded buses.

n/a

We have adjusted running times in the past 12 months to improve OTP, and are starting to see improvement in overall OTP as measured by the AVL system. The cost has been some reduction in average weekday in service speed.

Some stops have been dropped and routes shortened which has affected customers.

Service degradation: some areas have longer distance to access certain routes and some routes now have 1-way loops that require out of direction travel.

Haven't seen any yet

System is slow, time points are not met 100% of the time, high ridership that overwhelms certain routes.

Freeway-based system relies too heavily on park-and-rides; park-and-rides are full, limiting future system access; also, TOD potential is limited with a freeway-based system.

OTP is still decreasing.

They have been too little. Ridership and traffic is increasing and we will face the same problems again soon

Lack of on-time performance and reduced credibility to customers.

Some people have to walk a little further to access a bus stop

More cost

Less frequent stops for some routes.

Few drawbacks to date. Some customer concerns about stop consolidation, but relatively limited.

None that I can think of.

None

Customers have to walk further to a bus stop, limited coverage in lower density areas.

In some cases it has lengthened headways which has had a negative impact on our customers.

Our minor tweaks are seen as some as "good enough".

Had to relocate a number of bus stops. And in doing so had to invest additional funding to improve ADA accessibility at the new stop locations.

Not comprehensive enough

Some people resent you for a long time.

Adding limited stop service increased operational requirements, as we still run local service along the same corridor.

Increased walking distance for passengers (when stop spacing is increased), more transfers required (when routes are shortened or altered).

Some actions are expensive to implement, such as off-board fare collection. Headway-based schedules are highly unpopular with road supervision, despite obvious increases in speed. We are working against continually decreasing supervisory resources.

168. What was the most successful action taken, and why?

Responses summarized in Table 27, p. 74 of report. Verbatim responses are provided here.

Limited Stop Service. It has the immediate response—acceptance/complaint from transit patrons.

N/A

Creating the designated stops and eliminating the flag stop on most of the routes. But moving to far side stops as part of the designated stop program was really so intrinsic that we think of it as the same action

Low floor buses with ramps. Faster boarding and low maintenance.

Work with your contractors/operators to gain input on runtimes needed to improve schedules

Consolidating and removing bus stops. We could not afford to adequately improve and maintain more bus stops than we already have today.

The action which has yielded the most time savings has been headway based schedules during peak hours (City Transit Routes). Even "testing" a route with headway based schedules can uncover running time savings.

TSP, speeds vehicles and has minimal impacts

Signal priority & timing. No fare collection. At-level boarding. Backward-facing wheelchair without straps on BRT buses. Dedicated BRT guideways

Reserved bus lanes and dedicated transit corridors are the most successful in insulating the impacts of traffic congestion on transit service. By providing reserved space for transit on the roadway, transit customers are able to bypass traffic congestion and travel by transit becomes more competitive with automobile travel.

Most successful high-cost action: BRT – replaced highly variable and lengthy travel time, predominately in mixed traffic, with a much shorter, and much more consistent travel time (an electrical transmission corridor was available to bypass the most congested portion of the route and two left turn movements with extremely high delays). Most successful moderate-cost action: TSP on a corridor—very good speed improvement, given relatively high level of priority granted to buses. Most cost-effective action: Left Turn TSP—for a relatively low investment (i.e., given that selective detection equipment already existing on our buses), lengthy delays (and high variability in delay) at key intersections can be significantly reduced.

Making schedules match conditions

Improving traffic signals and TSP

Making it a larger program under bus rapid transit, it gains more support politically and likely to get better funding than other projects. Positive and consistent support from local jurisdiction on policy and implementation. Occasionally, one department set a policy and the other department doesn't embrace it.

Fare pricing policy has been designed to encourage weekly & monthly passes. Pass use speeds loading.

The changes on our major corridor that brought rapid service and local service. It was an overall increase in hours but addressed some long standing issues. The corridor has always been the most productive service but did not receive an equitable amount of resources. Bus bunching and overcrowding were common. The rapid service has almost eliminated bus bunching, larger articulated coaches have made it so that almost all passengers get a seat, the faster operating speed with less stops have made customers happier.

The bus stop improvement program. Makes for a smoother ride, and has the most potential to save time, although it's very difficult to measure.

Establishment of one Limited Stop Route. It seems to be working well.

The MPO-sponsored conversion of local route 350 to a rapid bus service. The installation of TSP and queue jump lane has resulted in a 0.5 mile/hour increase in weekday average in-service speed—about 6%.

Buying smaller equipment with ramps. More flexible, faster acceleration, better fuel mileage, no lift issues because they have ramps.

Nothing stands out. Some actions (route restructuring and stop elimination) have helped improve speeds but at some cost to passenger convenience. In some cases, the ridership impact was minimal, so these would be the most successful actions. We are still in the process of adding signal priority treatment at more signalized intersections, so we don't yet know if that will be more successful.

Combined stops where they had previously been to close due to block length. Bus does not have to stop as much. The Commuter Express service inter-county has been very successful in maintaining schedules, reliability, efficiency, cost effectiveness. Fare Recovery on this service has been 97%.

Development of planned capital program of freeway HOV lanes, HOV direct access ramps, freeway passenger stations and transit centers; commitment to provide the frequent service needed to make the system function as a network (when combined with local partner agency service).

N/A

The most successful action was the streamlining of routes in 2005 and 2006, and more recently, improving headways from 60 minutes to 30 minutes on four routes between 2005–2008. Ridership increased on these routes and some improvements to schedule adherence were achieved.

Monitoring on time performance on all route segments showed where deficiencies occurred.

Using on time (AVL) information to adjust the major offender routes

Reduced bus speeds. Safer and more reliable schedule adherence.

Signal priority, because it benefited the most riders in a high ridership corridor.

Signal priority for BRT routes, now under development, should be best action. The project will not only enable signal priority on the two BRT corridors, but make is possible at other locations citywide.

The two most successful actions we have taken are the move to electronic fare payment and the dedicated bus lanes that have been implemented.

The single factor that improved and smoothed operations the most is one I don't recall seeing asked/discussed in this survey. The elimination of paper transfers. Transfers are still permitted, but only through smart cards. That has significantly increased the use of smart card trips, both speeding the passenger's transaction time as well as driver time spent on such transactions. Cumulatively, this is our single biggest factor.

Focusing on providing primary service on major corridors. These locations have a higher number of trip destinations. By increasing frequency on these routes customers are able to have more flexibility in their trip purpose and can have more confidence in using the bus for day to day needs.

Implementing an AVL system with average travel time reporting between timepoints by trip. This data has allowed us to identify specific areas of concern and to verify customer and operator complaints. Streamlining routes to operate in a more direct routing, thereby reducing turns has also helped. We adjusted many "meandering" routes.

Express service. Customers love it. Easy to use and limited stops make service quicker

Simply eliminating bus stops on the heaviest routes means the bus stops less often.

We changed route patterns that allowed a reduction in trip times. Basically, cut out some redundancy along certain service corridors and created shorter routing between major transfer hubs.

Shortening route and increasing recovery time.

I believe stop consolidation on some of our busiest routes was very successful. While they are now seeing greater ridership strain that is causing delays, the operation of the route is more consistent and favored by the operators and riders (with exceptions of course). In some of those cases we took out closer to 40–50% of the stops.

Limited stop service, for the reasons mentioned above.

Transit mall implementation; increased bus speeds in CBD. Phase out of wheelchair lifts and replacement with ramps and low-floor buses also successful; improved schedule adherence.

Off-board fare collection and increased stop spacing

169. If you could change one aspect in the process of designing and implementing actions to improve bus speeds, what would you change?

Responses summarized in Table 28, p. 75 of report. Verbatim responses are provided here.

Transit Management—City departments awareness of the importance of actions (mainly listed) planned (implemented or not) on the Transit Bus Speeds

Agency has competing goals: minimizing walk distances vs. faster operating speeds. Improving operating speeds is not a current priority.

I would love to have a way to incorporate load data and dwell time into the run cutting and scheduling software. The ATP element of Hastus has proven to be very valuable to look at the best running time, what we will be looking at over the next year or so will be the data that we get from our intelligent bus system that shows how loading patterns impact the speed of the service

Easier/accurate way to monitor performance of change.

When creating express/rapids or limited stops have as few stops as possible from the beginning. Once stops have been in place it is difficult to remove them. Customers do not typically like change

The politics. We need to improve our communicative efforts to generally educate the public regarding the benefits of improving speeds to overcome potential opposition.

Streamlined public process

Somehow convince local jurisdictions to give us dedicated guideways more liberally & help us at major intersections with more bus-centric solutions

Establish transportation infrastructure priorities based on transit needs first instead of trying to fix problems after they develop.

No response

Rather than approaching bus stop consolidation on a route by route basis exclusively, the initial and periodic pitch should be system wide—build public awareness of the issue. In the ideal world, dedicated bus lanes

Commitment to keep the programs going. Running reliable transit service is a significant undertaking.

Find some way that we could get our 15 jurisdiction members to cooperate on a common plan for transit in the region not just in their jurisdiction.

Incorporate the transit priority guidelines in the MUTCD. Often local jurisdiction doesn't want to implement extra ordinary measures outside MUTCD even though they know it will benefit transit.

Need traffic signal priority for buses.

To dig deep into the causes for changes in bus speed takes time, and therefore staff. Having more staff available to devote to this cause would be helpful.

Use APC data to profile bus stops by route and relocate stops to match demand

Elevate the understanding internally within the agency regarding why it's important not to let bus speeds degrade, in terms of transit's attractiveness to the user, and why we should be trying to improve bus speeds.

Process and reluctance to consider changing routing structure.

More curb extensions so that buses can make stops without pulling out of traffic.

Have dedicated lanes

Dedicated bus lanes throughout the county.

Some portions of the express bus network use major arterials. Few improvements are planned for these arterials that will increase transit speed and improve transit reliability.

N/A

Increased capital and operating and capital funding to add vehicles to keep schedule adherence. In the future, bus lanes, signal priority, off board fare payment.

None

More distance between stops

Would like queue jumpers to be more accepted where we operate

Not sure.

All door boarding at heavy stops combined with TSP. As long as traffic is moving smoothly—even if heavy—buses will move smoothly, even in mixed traffic. But stops/stop activity can be killers. Reduce the stops, speed up boarding at heavy (not all) stops and facilitate moving in and out of free-flowing, albeit slow, traffic and you've not only sped up service, you've made it more reliable.

Need systematic approach to analysis.

Identify a funding source that would allow the successful service segments to be implemented throughout the entire service area.

n/a

The requirement to always conduct vehicle traffic modeling.

Bus stop location and spacing. Plus any technologies such as bus preference on major arterials.

We have a pretty good process in place. It can be frustrating at times since operating a public service needs to account for many different elements when initially identifying issues, reviewing and considering options, choosing a strategy, seeking and getting approval and then implementing a course of action. But one thing that is always a significant challenge is funding a project. During these hard economic times it seems it'll be getting worse before it gets better.

Not sure.

Allow the scheduling and operations staff more decision-making power in the management of bus stops and route structure.

Employ systematic stop spacing and consolidation.

Better, more accurate, more timely data

170. Please describe any "lessons learned" that would benefit other transit agencies that are considering implementation of similar actions.

Responses summarized in Table 29, p. 76 of report. Verbatim responses are provided here.

If you are thinking about Transit Signal Priority, it's much harder to design something that works than you think. You can't just install it, turn it on and tinker with the programming. It can help at individual intersections that are problematic, but before spending money on a whole corridor, hire yourself an expert traffic engineer to do computer modeling of the entire corridor first.

Plan the actions with Project Management process in mind, use the tools and start the actions with the Educating the Stakeholders chapter first.

Bus stop consolidation is not easy from a public relations stand-point.

Pay attention to left turns, eliminate them when you can, the queuing at intersections takes valuable minutes out of your schedule. Stay out of campuses (shopping centers, corporate campuses, college campuses) really slow you down and expose you to accidents (which really slow you down)

Ensure that you are kept in the loop on any construction projects rather than finding out the hard way or when it occurs. Have customers purchase fares before boarding the vehicle and or limit fare types. Add trips if possible. Smaller vehicles are quicker than a larger vehicle.

Our experiment to reduce bus stops along a route in a dense residential area with stops every block was unsuccessful due to the number of four-way stop signs at each intersection. Not only did we save little time, but because the bus stopped at every other block without picking up or dropping off passengers we were criticized by the riding public.

More outreach at earlier stages of project development is better but doesn't guarantee success

Fully engage & involve all components of your organization in design of BRT system

Consider transit speed in relation to traffic speeds to determine if transit is a competitive mode of travel in the corridor.

Extremely important to have high level support (within transit agency and local municipality) for actions related to external policies (e.g., TSP and physical transit priority measures)

Be prepared to receive complaints about queue-jumps from less-observant car drivers.

Make sure you have the resources to implement and operate the actions/systems you put in place. Have the resources to measure and evaluate the impact on continuous basis.

Good working relationship and partnership with local jurisdiction.

On the bus stop spacing issue, you need to adopt a policy, and then work hard to adhere to it. It takes time to review passenger activity at all bus stops and then make recommendations. It's important to keep the public involved and consider both public and bus operator feedback. Then taking their points into consideration, revise the changes to bus stops, but only where it makes sense. Often this is not a popular stance with passengers using a particular stop, but overall in the long run it makes for a better ride. The other item to be wary of is the actual physical removal of the bus stops. If there is not proper communication and follow through, stops that should be removed are still standing, or maybe the transit agency bus stop has been removed but the city regulatory signs are still standing. Not having the proper communication and follow through on this front causes much confusion for both operators and passengers. So make sure it's clearly communicated to the folks doing the work which stops are to be removed—both the transit agency staff, and the respective municipality staff, and then have someone double check their work.

Keep communication of goals and plan open to all (union and managements) and invite input.

Don't get so focused on trying to improve the on-time performance metrics that you lose track of trends in bus system speeds.

Some issues with ramps and slope, particularly in rural areas. With larger and heavier wheelchairs, ramps sometimes present problems. Check out these issues prior to purchasing.

Training to address the higher speeds

Know your community and adhere to their desired expectations of the service they wish to have. This will provide a level of support for any improvements, changes, and enhancements planned.

Design express bus service to be competitive with driving alone and attract choice riders who are not transit-dependent. Develop HOV or bus-only lanes to increase speed and improve dependability and on-time performance. Plan routes to operate as directly as possible to major destinations. Limit stops—customers will walk farther to access good service. Provide a range of access options at major stops—coordinated local bus connections, sidewalks/bike trails to multi-family areas, in addition to park-and-ride.

Lessons learned that incremental timepoint and dwell time adjustments are not long term fixes to the problem of schedule adherence.

Attention needs to be paid to passenger origin and destination.

Schedule development with proper layover is important. Squeezing cycle time to reduce costs can impact the quality of your service. You have to be careful about it.

Having solid data and making a compelling case for why the changes are needed and how they provide broad benefits to customers and the overall mobility for the area are critical.

Listen to the public, but also don't be afraid to make recommendations that did not originate from the public. Often the public will look at just adjusting the existing model rather than thinking "outside the box" for new and innovative ways to deliver service.

Design your own report from the AVL system to represent how you schedule vehicles and that match your traffic patterns. Also, increase your speed from the 1st to the 2nd timepoint to allow for faster operators or light traffic days. This prevents operators from hanging back at the end of the line or having to wait at the 2nd timepoint to avoid leaving early.

Selling decision makers on "hours saved" can be reinvested back in the service.

It takes on-going analysis and attention to detail. A crisis can create similar actions but making changes to routes tends to be incremental. You have to have a clear objective in mind and work toward that goal.

Bus operators who initially oppose stop consolidation may become your biggest champions. Riders, too, will begin to push for stop consolidation as they see the benefits to their own commutes. Don't be thrown off by media attention or the initial complaints. Start with the biggest bang (Phase I of stop consolidation were all the routes with 15-minute frequencies).

Decreases in travel speeds need to be recognized as not simply an inevitable consequence of increased traffic and passenger loads, but as something that the agency has the power to affect through their own actions (or inaction). It is critical for staff at all levels of management to understand this concept.

Signal priority is more likely to affect travel time variability than to reduce wholesale travel time; that is, it may be unrealistic to expect to save enough travel time to reduce the number of buses deployed on a route with signal priority.

Just keep at it. Off-board fare collection in tandem with all-door boarding is highly successful.

171. Would you be willing to participate further as a case study, involving a telephone interview going into further detail on your agency's experience, if selected by the TCRP panel for this project?

Yes	69.2%	36
No	30.8%	16

172. Is there another agency (e.g., City Department of Transportation) that you suggest we contact for this synthesis project? If so, please provide a contact person and an email address.

173. Is there another transit system that you suggest we contact for this synthesis project? If you know of a contact at that system, please list the name also.

Abbreviations used without definitions in TRB publications:

A4A	Airlines for America
AAAE	American Association of Airport Executives
AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ACI–NA	Airports Council International–North America
ACRP	Airport Cooperative Research Program
ADA	Americans with Disabilities Act
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
DOE	Department of Energy
EPA	Environmental Protection Agency
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
HMCRP	Hazardous Materials Cooperative Research Program
IEEE	Institute of Electrical and Electronics Engineers
ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
ITE	Institute of Transportation Engineers
MAP-21	Moving Ahead for Progress in the 21st Century Act (2012)
NASA	National Aeronautics and Space Administration
NASAO	National Association of State Aviation Officials
NCFRP	National Cooperative Freight Research Program
NCHRP	National Cooperative Highway Research Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
PHMSA	Pipeline and Hazardous Materials Safety Administration
RITA	Research and Innovative Technology Administration
SAE	Society of Automotive Engineers
SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (2005)
TCRP	Transit Cooperative Research Program
TEA-21	Transportation Equity Act for the 21st Century (1998)
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation