TCRP
REPORT 80

TRANSIT
COOPERATIVE
RESEARCH
PROGRAM

Sponsored by
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A Toolkit for Self-Service, Barrier-Free Fare Collection

TRANSPORTATION RESEARCH BOARD

NATIONAL RESEARCH COUNCIL

TRANSIT COOPERATIVE RESEARCH PROGRAM

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A Toolkit for Self-Service, Barrier-Free Fare Collection

MULTISYSTEMS, INC.
Cambridge, MA

with

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and

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SUBJECT AREAS
Public Transit

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TRANSPORTATION RESEARCH BOARD — NATIONAL RESEARCH COUNCIL

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TRANSIT COOPERATIVE RESEARCH PROGRAM

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

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions*, published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public 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 Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

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

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

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

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

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

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FOREWORD

By Gwen Chisholm
Staff Officer
Transportation Research Board

TCRP Report 80: A Toolkit for Self-Service, Barrier-Free Fare Collection addresses the full range of issues and parameters that an agency must consider in determining the applicability of self-service fare collection (SSFC) systems, including those related to policy and enforcement issues, operational issues, and capital and equipment issues. The Toolkit is designed for use by agencies at various points in the fare collection decision process. The types of situations in which transit agencies may wish to use the Toolkit include the following: agencies implementing a new service and seeking to choose between SSFC and another fare collection strategy, agencies trying to decide whether to switch to SSFC from another fare collection strategy, agencies currently using SSFC and trying to decide whether to switch to another fare collection strategy, and agencies looking for opportunities to improve an existing SSFC system. Each chapter of the Toolkit contains sections that address the key design parameters/decision areas associated with the types of situations discussed in the chapter. The report will be helpful to transit general managers, policy makers, planners, and operating managers, both in assessing SSFC as part of the overall fare collection decision and in designing and successfully implementing an SSFC system.

A significant number of rail transit operators are now or will be looking to adopt lower cost, less-infrastructure-intensive ways to carry out certain system functions such as fare collection. A key element of modern operational applications is the use of self-service, barrier-free fare collection systems (commonly referred to as proof-of-payment or POP.) Within rail system operations, a great deal has been learned by individual properties about the use of self-service, barrier-free fare collection that would be of value to transit practitioners, operating management staffs, planners, and policy makers. These experiences, captured in a comprehensive toolkit on self-service, barrier-free fare collection, will be valuable to existing operations already using or considering possible conversion to POP and to new operations.

Multisystems, Inc., in association with Mundle & Associates, Inc., and Parsons Transportation Group, Inc., identified and determined the usefulness of all literature related to U.S. and international use of SSFC systems; collected additional data on current use of SSFC in the United States and abroad through a survey; and developed a table of key parameters of SSFC systems related to policy, enforcement, operations, and capital and equipment issues. Based on the information gathered, the research team developed the Toolkit on SSFC design and usage.

This report is accompanied by a companion CD-ROM that duplicates the contents of the report.

CONTENTS

AUTHOR ACKNOWLEDGMENTS

The research for this Toolkit was performed under TCRP Project A-24 by Multisystems, Inc.; Mundle & Associates, Inc.; and Parsons Transportation Group, Inc. Multisystems served as the primary contractor for the study.

Daniel Fleishman of Multisystems was the Principal Investigator for the study and was responsible for the overall supervision of the research and the design of this Toolkit. Daniel Fleishman and Doug Parker of Multisystems are the primary authors of the Toolkit. Robert Berger of Multisystems assisted in the research and preparation of the Toolkit. George Pierlott of Mundle & Associates was responsible for the analysis of the results of the agency survey and the subsequent industry review. Other participants in the study included Subhash Mundle, Janet Kraus, Michael Schwartz, and Andrew Lynd of Mundle & Associates; and Karen Konecky, Richard Sheer, and Ashok Joshi of Parsons Transportation Group, Inc.

The guidance of Gwen Chisholm, the TCRP Program Officer for the project, and the Project Panel is also acknowledged.

Summary

Introduction

Self-service, barrier-free fare collection (SSFC) is used by most light rail transit (LRT) operators in North America, as well as by some commuter rail systems, and has long been used in Europe on both rail and bus systems. SSFC is based on a strategy of checking only a percentage of riders for proper fare payment and is thus, basically, an “honor system”; each rider is, therefore, responsible for buying and carrying a valid ticket or pass.

Given the growing use of SSFC as an alternative to installation of faregates or other “pay on entry” systems, there is now a considerable amount of experience related to the design, implementation, and operation of this type of fare collection system. As agencies plan and build new rail and bus rapid transit (BRT) lines—and continue to look for areas of improvement in existing systems—staff considering SSFC can clearly benefit from a compilation and distillation of the lessons learned regarding this approach.

The Study

The objective of TCRP Project A-24, *A Toolkit for Self-Service, Barrier-Free Fare Collection*, was to develop a set of guidelines for use by those transit agencies implementing or considering use of SSFC. The Toolkit has thus been designed to provide practical guidance to policy makers, planners, researchers, and operating managers, both in assessing SSFC as part of the overall fare collection decision and in designing and successfully implementing an SSFC system. The Toolkit addresses the full range of issues and parameters that an agency must consider in determining the applicability of SSFC; these issues fall into the following general categories:

- Policy and enforcement issues,
- Operational issues, and
- Capital and equipment issues.

The study included the following elements:

- A comprehensive literature review of research related to North American and international use of SSFC. An annotated bibliography was produced.

- Collection of additional data on the use of SSFC in the United States and abroad. A survey of transit agencies currently operating—or planning—SSFC was conducted; 40 agencies in North America and Europe were sent the survey, and responses were received from 26 of these.

- Development of a set of matrixes of key parameters (i.e., characteristics, principles, and techniques) of SSFC systems related to policy and enforcement, operations, and capital and equipment issues. These matrixes served as the framework for individual sections of the Toolkit.

- Development of a draft Toolkit and industry review. The draft document was submitted to agencies that had responded to the survey, as well as other agencies currently considering introducing SSFC. The final Toolkit addresses comments and suggestions of the industry reviewers.

Outline of the Toolkit

The Toolkit includes chapters addressing each of the key issue categories (i.e., policy and enforcement issues, operational issues, and capital and equipment issues), and each chapter covers the key design parameters and decision areas associated with that category. A stand-alone section is provided for each parameter and identifies the decisions that have to be made for the parameter in question, other sections related to this parameter, techniques and approaches that should be considered in relation to the parameter, key considerations in choosing a particular technique or approach, and industry practice in this area. Each section concludes with recommendations regarding the best techniques and approaches to consider.

Descriptions of the contents of the Toolkit's chapters follow.

Chapter 1: Introduction and Overview

This chapter presents a summary of SSFC systems currently in place and under development in North America and Europe and provides guidance on the use of the Toolkit.

Chapter 2: Fare Collection Strategies

This chapter discusses the relative advantages and disadvantages of SSFC in comparison with the other major types of fare collection: barrier, conductor-validated, and pay-on-boarding. The chapter also provides guidance in the estimation of capital and operating costs for introducing SSFC and reviews the results of analyses conducted by several U. S. transit agencies that have considered alternative strategies.

Chapter 3: Policy and Enforcement Issues

This chapter discusses the types of SSFC policy and enforcement issues an agency must address. The decision and issue areas discussed are as follows:

- **Legal Authorization for Enforcement**—How does an agency establish its legal authority governing inspection and enforcement?

- **Measuring the Evasion Rate**—How should an agency measure and estimate its fare evasion rate?

- **Inspection Strategy**—What general inspection strategy should be pursued? What pattern of inspection should be used?

- **Inspection Rate and Number of Personnel**—What is a reasonable inspection rate? What is the appropriate number of inspection personnel? What is a reasonable productivity for inspectors?

- **Type of Inspection Personnel**—What type of personnel should be used to perform inspections (i.e., police versus other staff or in-house versus contract)? What are the advantages of uniformed versus plainclothes inspection personnel?

- **Treatment of Fare Evaders**—What types of action can—and should—an inspector take when an evader is apprehended? What special circumstances, if any, will the inspector consider when apprehending an evader?

- **Fare Evasion Fine Structure**—What is an appropriate fine structure?

- **Fare Evasion Follow-up Program**—How can an agency track evaders who have been cited—and the outcomes of court cases?

Chapter 4: Operational Issues

This chapter discusses the types of operational SSFC decisions an agency must address. The decision and issue areas discussed are as follows:

- **Fare Structure**—What issues and challenges does SSFC present for different types of fare structures, including transfer policy and fare differentiation? How are zonal fares handled under SSFC?

- **Fare Media Distribution**—What types of distribution options are available for the sale of SSFC fare media? What is the appropriate mix of distribution channels in an SSFC system?

- **Use of Electronic Fare Media**—How can electronic farecards (i.e., magnetic or smart cards) best be used in an SSFC system? What are the trade-offs involved in the different approaches to decrementing value and checking validity of farecards? What types of equipment and procedures should be considered?

- **Station Monitoring and Security**—What are the advantages and disadvantages of alternative strategies for providing security and customer assistance at stations and stops? Under what circumstances does it make sense to monitor stations and stops remotely?

- **Marketing/Education**—What types of information must be communicated to passengers in an SSFC system? What types of techniques are useful in the marketing and education process?

Chapter 5: Capital and Equipment Issues

This chapter discusses the types of SSFC capital and equipment issues an agency must address. The decision and issue areas discussed are as follows:

- **Types of SSFC Equipment**—What types of ticket sale and validation equipment are available? What are the core equipment requirements?

- **Determining TVM Quantities**—How should the required number of ticket vending machines (TVMs) at each station be calculated?

- **Validation of Tickets**—What are the relative advantages of different validation approaches (e.g., at time of purchase, after purchase, and during boarding)?

- **SSFC at Stops/Stations without TVMs**—How can the agency provide for ticket sale and validation at stations without TVMs? Will there be attended and/or on-board sales options?

- **TVM Placement**—Where should TVMs be placed in stations (or on vehicles)? What customer amenities should be built into TVMs?

- **TVM Fare Media Options**—What are the advantages of different fare media options (e.g., multiple ticket stocks for different payment options)?

- **TVM Ticket Purchase Options**—What types of purchase options should be supported at TVMs (e.g., credit/debit or use of stored value)? Should all TVMs accept the same options? Will TVMs provide change?

- **TVM User Interface**—What design features should be considered in order to maximize the convenience of the TVM user interface for customers? How will passengers be informed about fare and purchase options—as well as TVM malfunctions?

Chapter 1: Introduction and Overview

Introduction: Self-Service, Barrier-Free Fare Collection

Self-service, barrier-free fare collection (SSFC)—also known as proof of payment (POP)—is the newest fare collection strategy to be adopted by transit agencies and has seen increasing use over the past 20 years. Beginning with the opening of the San Diego Trolley in 1981, most light rail transit (LRT) operators in the United States have implemented SSFC. Of the 18 existing North American LRT systems, 15 use the strategy—as do 9 commuter rail services. These commuter rail services tend to be the newer systems; the more established commuter rail systems serving the denser urban areas (e.g., New York, Chicago, Philadelphia, and Boston) use on-board fare collection, with conductors. The distinguishing characteristics of SSFC are the combination of (1) barrier-free platforms or entrances, (2) boarding without needing to take any payment-related action in view of a driver/conductor, (3) inspection for valid proof of payment, and (4) not being able to pay the fare to the inspector. Thus, a commuter rail "conductor-validated" system, which allows on-board fare payment, does not fall into this category.

SSFC actually began in Europe in the 1960s, with early applications in Germany and Switzerland. Till then, many European transit systems had relied on on-board fare collection, using conductors. In order to cope with growth in both labor costs and labor shortages, many transit operators began to convert to SSFC, which required fewer fare collection personnel. This approach was—and continues to be—based on a strategy of checking only a percentage of riders for proper fare payment. Thus, SSFC is largely an "honor system," requiring that the rider take responsibility for carrying a ticket or pass that is appropriate for the ride he or she is taking.

Each transit agency must decide on the most appropriate fare collection strategy whenever it introduces a new type of service. As suggested above, SSFC has become a common choice for LRT and commuter rail services. However, a handful of heavy rail and bus services have opted for SSFC as well and, as indicated above, not all LRT and commuter rail services use SSFC. The Los Angeles County Metropolitan Transportation Authority's (LACMTA's) Red

Line, for instance, is a subway service with a number of fully enclosed stations; however, the LACMTA chose to use SSFC on all of its new rail lines, including the Red Line. With regard to use on bus, the Tri-County Metropolitan Transportation District (Tri-Met) in Portland is the best known U. S. example. Tri-Met introduced SSFC on bus as part of a federal demonstration project in 1982. However, SSFC was deemed impractical for Tri-Met's buses, and bus fare collection was subsequently returned to the more conventional pay-on-boarding approach; Tri-Met continues to use SSFC for LRT. SSFC is widely used on bus service in Europe.

Now that SSFC has been widely used, the collective experience can be tapped to provide guidance to agencies now developing SSFC—or seeking ways to improve existing systems. New LRT systems are in development across the United States, and new lines are being added to existing systems. In addition, new commuter rail and bus rapid transit (BRT) lines are planned for various locations—and operators continue to look to improve existing systems. SSFC's applicability in a particular setting depends on the agency's specific requirements and constraints (e.g., station configurations and expected ridership).

This Toolkit represents a distillation of the lessons learned regarding the implementation and operation of SSFC. It has been designed to serve as a resource for decision makers, operators, and researchers in considering whether—or how best—to use this strategy. The Toolkit has been developed through TCRP Project A-24*, Toolkit for Self-Service, Barrier-Free Fare Collection*. The findings and guidelines provided were developed by the research team based on research on existing SSFC systems. Sources included (1) a review of literature on the topic, of both published reports and articles and unpublished project reports; (2) a survey of transit agencies in North America and Europe currently using—or planning to use—SSFC; and (3) discussions with operating personnel at many of these agencies. The remainder of this chapter contains the following sections:

- Summary of SSFC Systems in the United States and Canada,
- Outline of the Toolkit, and
- Using the Toolkit.

Summary of SSFC Systems in the United States and Canada

Light Rail

As mentioned above, most LRT services in the United States and Canada use SSFC. The newer systems (i.e., those established beginning in the 1980s) generally adopted SSFC from the start. Several older systems have converted to SSFC (e.g., New Jersey Transit's [NJ Transit's] Newark City Subway and San Francisco's Municipal Railway [Muni]), and some others are considering this conversion (e.g., the Port Authority of Allegheny County [PAT] in Pittsburgh and the Massachusetts Bay Transportation Authority [MBTA] in Boston). There are some instances, such as at Muni, where the SSFC operation is only partial—some stations are not equipped for ticket sales and riders can pay on board at the farebox by boarding the first car. The U. S. and Canadian systems currently using SSFC on their LRT lines are listed in Table 1-1. The details of the various aspects of agencies' SSFC systems are presented in the individual sections of the Toolkit.

Table 1-1: U. S. and Canadian Systems Using SSFC on Their LRT Lines

City/Agency (Line)	Comments	Recent/Pending Expansion
Baltimore, MD MTA		
Buffalo, NFTA	Downtown surface segment is a free-fare zone	
Calgary, C-Train	Downtown free-fare zone	Planning to extend both lines
Dallas, DART		Garland and Plano extensions under construction for 2002-2003; two additional lines under development
Denver, RTD	Higher price "express" ticket required for trips crossing fare zone boundary	Central Platte Valley and Southeast extensions under development
Edmonton	Operated for a brief time as a barrier-entry system when first opened Recently decided to discontinue the downtown LRT free-fare zone	Planning extension south, to Heritage Mall
Los Angeles, LACMTA (Blue, Green Lines)	TVMs accept (but do not vend) tokens.	Blue Line Pasadena extension under construction, scheduled to open 2003
New Jersey Transit (Hudson-Bergen Line and Newark City Subway)	TVMs accept cash, credit cards and debit cards. Newark City Subway is an existing service that converted from pay-on-entry operation. Most passengers transfer to/from other NJT services that have a separate fare—so the TVMs also sell (1) upgrade fares, (2) separate transfers and (3) ticket with transfer included.	Northward extension planned for Hudson-Bergen Line, incrementally northwards to Ridgefield. Planning to extend Newark City Subway to Elizabeth. NJT is also developing the South Jersey light rail system in the Philadelphia region, to connect Trenton and Camden.
Portland, Tri-Met	Some downtown stations are in the system's downtown "Fareless Square" 3-zone system; sell additional upgrade tickets to increase validity to "all-zone"	Airport MAX extension began operation September 2001. Interstate MAX to North Portland is scheduled to open September 2004
Sacramento, RTD	Some downtown stations are in the system's reduced fare "Central City" zone	Folsom/Amtrak and South Corridor extensions under construction
Salt Lake City, UTA	Some downtown stations are in the system's downtown free-fare zone. In addition to vending tickets directly, TVMs also vend tokens, which can then be used to purchase tickets.	East extension to University of Utah opened December 2001
San Diego Trolley	Fares depend on the number of stations from origin to destination, selected through the TVM	Mission Valley East extension to be constructed; Oceanside-Escondido line under development
San Francisco, Muni	Partial SSFC only; some platform stations have no TVMs and riders without prepaid fare media can pay on entry by boarding the first car.	Muni Metro Third Street extension scheduled to open in 2004; Central Subway under development
San Jose, Santa Clara Valley TA	Bulk purchase tokens are sold rather than multi-ride tickets, but tokens cannot yet be used with light rail	Tasman East and Capitol extensions under construction; Vasona line planned
St. Louis, BSDA/SCCTD	TVMs at Lambert Airport offer only a selection of the fare options available at other stations—and at higher prices. Noon period ride-free zone downtown.	St. Clair Co. extension opened in May 2001 (additional extension to Mid-America Airport planned); new Cross-County Line under development

Heavy Rail

Only two North American heavy rail services currently use SSFC: LACMTA (on its Red Line) and Vancouver (SkyTrain). Table 1-2 summarizes these two systems. The LACMTA Red Line subway has SSFC primarily for consistency with the SSFC on the Green and Blue LRT lines; however, LACMTA has given consideration to converting the Red Line—and possibly the Green and Blue Lines as well—to a barrier system. Vancouver uses SSFC to support a zonal fare system without requiring entry/exit faregates; however, it too has considered conversion to a barrier system for SkyTrain. Most heavy rail systems were initiated prior to the introduction of the SSFC concept into North America and, thus, did not even consider it as an option.

Table 1-2: North American Heavy Rail Services Using SSFC

City/Agency (Line)	Comments	Pending Expansion
LACMTA (Red Line)	TVMs accept (but do not vend) tokens	
Vancouver, SkyTrain/ SeaBus	Currently has three fare zones and the fare depends on the number of zones traversed. Entire service area operates under Zone 1 fares for evenings, weekends, and holidays. SeaBus ferry service to North Vancouver largely operates as a waterborne extension of SkyTrain service. Recently added a magnetic stripe to bulk prepaid "FareSaver" tickets and intermodal transfers	Millennium Line under construction

However, the strategy has been evaluated by at least one agency (the Metropolitan Atlanta Rapid Transit Authority [MARTA] in Atlanta) for its heavy rail lines and may be considered by others in the future. The advantages and disadvantages of the alternative fare collection strategies for different types of service are discussed in the next chapter.

Commuter Rail

Although they are generally barrier-free, allow the advance purchase of tickets, and involve inspection by conductors, the conductor-validated fare collection systems on most older commuter rail services are not considered proof of payment. Unlike the case with a true SSFC system, a conductor-validated approach allows the payment of the fare to the conductor on board the train. A conductor-validated approach also differs from SSFC in that the latter typically involves inspection of only a portion of passengers—although a few commuter rail systems, such as Virginia Railway Express (VRE), actually conduct 100% inspection, but are considered POP in that they do not accept on-board fare payment. As indicated earlier, several newer commuter rail systems have opted for SSFC fare collection (i.e., all riders must have a validated ticket or pass before boarding the train); in addition, one older system, GO Transit (Toronto), converted from conductor-validation to SSFC, and another system, Caltrain (Northern California), has begun such a conversion. The SSFC commuter rail systems are summarized in Table 1-3.

Bus/Bus Rapid Transit

SSFC is not typically used in North America for bus or streetcar-type services. The exceptions noted in Table 1-4 are cases where minimizing boarding time is critical because a multiple-unit streetcar or articulated bus is used. Even in these cases, however, SSFC is not the only fare collection strategy employed. Passholders can board through any door; riders without passes need to pay on board at the farebox and collect a proof-of-payment receipt from the operator. This is similar to the partial SSFC used on SF Muni's LRT. As explained earlier, Tri-Met in Portland experimented with SSFC on its buses, but discontinued it in favor of the traditional pay-on-boarding strategy. No other North American agencies are known to have used SSFC on regular bus service since then. (The strategy is being considered for some of the newly developing bus rapid transit (BRT) services.)

Light Rail. Numerous new LRT services (i.e., in addition to extensions under development to existing systems) are being developed; all are likely to use SSFC. The North American cities now developing plans for—or in the process of implementing—LRT lines include the following:

Table 1-3: North American Commuter Rail Systems Using SSFC

City/Agency (Line)	Comments	Recent/Pending Expansion*
Dallas-Fort Worth, DART (Trinity Railway Express)	Currently has two fare zones (this will increase to three with the next extension), and the fare depends on the number of zones traversed.	Expanded to connect with Dallas-Fort Worth Airport and westward to connect with Fort Worth
Los Angeles, SCRRA (Metrolink)	TVMs accept cash and credit/debit cards and vend all tickets and passes. System has 24 unique fare zones, although the maximum fare charges is for 7 zones. System includes 6 lines, and fares are not interchangeable between lines.	
Miami, Tri-Rail	System has 6 fare zones, and the fare depends on the number of zones traversed.	
Montreal, AMT	System switched to SSFC from more conventional commuter rail operation only recently. TVMs sell single-ride tickets only and require exact change. System has 5 fare zones, and the fare increases with the farthest (concentrically) zone in which any travel occurs.	
San Francisco (East Bay), Altamont Commuter Express	There are no TVMs (only validators for use with multi-ride tickets). Tickets are only available by mail, from station attendants and through retail outlets. System has 6 fare zones, and the fare depends on the number of zones traversed.	
Seattle, Sound Transit (Sounder)	TVMs accept cash, credit and debit cards, selling single-ride tickets and all types of passes. Upgrade tickets are also sold, for use in conjunction with transfers from buses. Recently introduced single ride “scratch tickets” (not available through TVMs). Essentially a flexible form of “capped pass,” as the number of trip tickets to be purchased for use in the next calendar month must be decided in advance. System has three fare zones, and the fare depends on the number of zones traversed.	The current Tacoma-Seattle service is to be supplemented with additional lines for Everett-Seattle (2002) and Lakewood-Tacoma (2003)
Toronto, GO Transit	Originally operated as a barrier-entry system; converted to SSFC in the 1980s. Multi-ride paper ticket cancelers optically sense marks from previous cancellations. A trial is in progress for the alternative use of smart card technology. Tickets purchased from station attendants, with cash, check, credit card, or debit card. Ticket price varies with the specific origin-destination station pair.	
Vancouver, West Coast Express	TVMs accept a stored-value smart card in addition to cash and credit and debit cards. Ticket price varies with the specific origin-destination station pair.	
Washington (DC), VRE	TVMs accept only credit/debit card payment (no cash); a planned upgrade is to add a “promise to pay” ticket as an alternative for those who would prefer to pay cash. Ticket price varies with the specific origin-destination station pair. TVMs may be equipped in the future to accept stored value from SmarTrip smart cards issued by the Washington Metropolitan Area Transit Authority.	

*Pending expansion does not include various double-tracking or station infill projects on existing lines.

Table 1-4: North American Bus/Bus Rapid Transit Systems Using SSFC

City/Agency (Line)	Comments
Ottawa, OC Transpo (Transitway and other articulated bus routes)	There are no TVMs at stops. Boarding riders without a pass must use the front door and receive a ticket in exchange for paying the fare with cash, token or transfer. Fare inspectors randomly board to check passes and tickets.
Toronto, TTC (Queen Street Streetcar)	Same as Ottawa

- Austin, TX
- Charlotte, NC
- Cincinnati, OH
- Columbus, OH
- Houston, TX
- Kansas City, MO
- Louisville, KY
- Memphis, TN
- Miami, FL
- Milwaukee, WI
- Minneapolis, MN
- Norfolk, VA
- Orange County, CA
- Ottawa, ON
- Phoenix, AZ
- Seattle, WA
- Spokane, WA
- Tampa, FL

Heavy Rail. No new heavy rail services are expected in North America for the foreseeable future, with the exception of extensions to existing service.

Commuter Rail. Numerous regions are planning or exploring commuter rail service—and many of these services could well decide to use SSFC.

Bus/BRT. Various cities have implemented measures to speed bus service in specific corridors. A consortium of agencies—with FTA support—is developing demonstrations for BRT service. In some cases, off-board fare collection will be employed to reduce boarding times. Types of off-board fare collection being considered include both SSFC and barrier strategies.

SSFC Services in Europe

As indicated earlier, SSFC fare collection was pioneered in Europe. As in North America, the strategy is used extensively for LRT and, to a lesser degree, for heavy or commuter rail services. The main difference lies in the extent to which SSFC is used for bus and streetcar operations. As explained at the beginning of this chapter, SSFC was inaugurated on buses in Europe largely to address labor shortages. Equipment for self-service ticket sales and validation was installed on board, and this was supported with random ticket inspection to replace the previous approach of using conductors to collect all fares. In some cases, bus operations have evolved along lines more similar to those in North America. For example, UK operators often do monitor fare collection—the driver receives fares and operates the on-board ticketing equipment.

In certain countries (e.g., Germany and Switzerland), SSFC is quite common on heavy rail services. To some degree, this is related to the use of SSFC for other transit services in these cities (i.e., when a new rail service was introduced, SSFC was adopted to retain consistency with established fare collection services for other modes).

Outline of the Toolkit

As suggested above, this Toolkit is intended to provide practical guidance to policy makers, planners, and operating managers in designing, implementing, and operating an SSFC system. The Toolkit has been designed to address the full range of issues and parameters that an agency must consider in developing an SSFC system; these issues fall into the following general categories:

- **Policy and Enforcement Issues** (e.g., legal authorization for enforcement, measuring the evasion rate, fare inspection rate and strategy, and fare evasion fine structure);

- **Operational Issues** (e.g., fare policy and structure, fare media distribution, use of electronic fare media, and educating passengers and station monitoring and security); and

- **Capital and Equipment Issues** (e.g., types of ticket sale/validation equipment/ technologies and system/station design considerations).

The Toolkit is divided into chapters that address each category; each chapter contains sections that address the key design parameters and decision areas associated with that category. Each section (1) identifies the issues that have to be addressed and/or decisions that have to be made for the parameter in question; (2) identifies the other sections that are closely related to this parameter; (3) presents the techniques or approaches that should be considered in relation to the parameter; (4) describes the key considerations involved in selecting the most appropriate technique/approach; (5) reviews industry practice in this area; (6) and presents a summary of the findings and recommendations as to the best—or most reasonable—technique or approach to employ.

Using the Toolkit

The Toolkit is designed for use by agencies at various points in the fare collection decision process. The types of situations in which transit agencies might wish to use the Toolkit include the following:

- Agencies implementing a new service (e.g., LRT or BRT) and seeking to choose between SSFC and another fare collection strategy,

- Agencies trying to decide whether to switch to SSFC from another fare collection strategy,

- Agencies currently using SSFC and trying to decide whether to switch to another fare collection strategy, and

- Agencies looking for opportunities to improve an existing SSFC system.

Figure 1-1 shows the use of the Toolkit for each of these paths. Essentially, each of the first three types of users should begin with the next chapter, Fare Collection Strategies. This chapter discusses the relative advantages and disadvantages of SSFC versus the other major fare collection strategies: barrier, conductor-validated, and pay-on-boarding. The chapter provides guidance in the estimation of costs for introducing SSFC and reviews the results of analyses conducted by U. S. transit agencies that have considered alternative strategies. Agencies simply looking to enhance or optimize their existing SSFC systems can skip that chapter and proceed to the chapters addressing the parameters and issues identified above. The document is designed to be modular in structure; as mentioned above, each of the key decision areas is addressed in a stand-alone section. Thus, the contents of the Toolkit are as follows:

Chapter 2. Fare Collection Strategies
Chapter 3. Policy and Enforcement Issues
Chapter 4. Operational Issues
Chapter 5. Capital and Equipment Issues
Appendixes: A. Glossary
B. Survey Effort and Results
C. Literature Review
D. Contact Information
E. Executive Summary

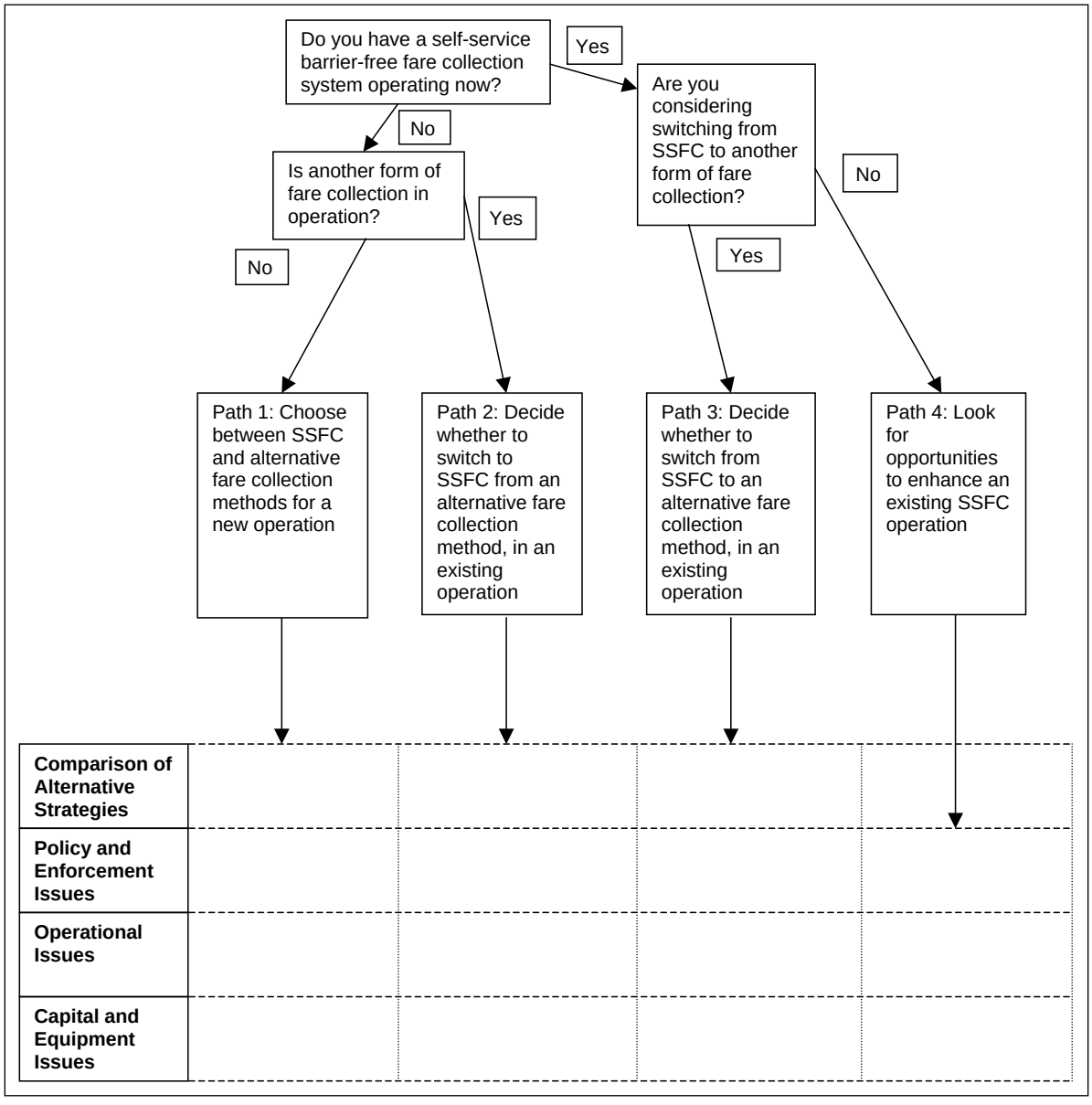


Figure 1-1: Guide to Use of the Toolkit

Chapter 2: Fare Collection Strategies

Introduction: Alternative Fare Collection Strategies

The type of fare collection an agency selects will depend to some extent on the type of service. In many cases, a particular strategy is clearly appropriate, given the mode, the infrastructure requirements and constraints, the demand volume, or other factors. In North America, most LRT systems use SSFC, heavy rail systems typically use barrier fare collection (i.e., payment at a faregate or to a ticket agent), and bus systems generally use pay on boarding (i.e., using a farebox or ticket processing unit). However, as noted in Chapter 1, there are exceptions. The strategies that have been applied to the different modes in North American systems are summarized Table 2-1.

Comparing the Fare Collection Strategies

Each strategy has advantages and disadvantages, and these may differ for a particular mode depending on various factors, as suggested above. Table 2-2 presents a comparison of the strategies with regard to several such factors. SSFC is compared with each of the other three strategies below.

SSFC Versus Barrier Fare Collection

These two strategies can be considered for LRT, heavy rail, and BRT systems. Although each strategy offers certain advantages over the others—as shown in Table 2-2—the most significant factors to consider are (1) the station or platform configuration and constraints and (2) the expected passenger volume. Basically, SSFC is usually more appropriate in an environment featuring open platforms, especially if any are at street level. In other words, if it is infeasible to install faregates and establish a clearly defined paid area, a barrier system will not be an option.

With regard to passenger volume, consistently high volumes (e.g., as would be experienced in a heavily used downtown rail station) suggest that a barrier system should be given serious consideration. The very nature of on-board inspection requires sufficient space for the inspector to walk through the car and check each rider, and very crowded cars will interfere with the ability to conduct effective fare inspections. (Of course, even an LRT service that typically receives only moderate use can occasionally become overcrowded; at such times, inspectors may have to conduct inspections on the platform, as passengers enter or exit the platform).

Passenger volume will also affect the costs associated with the two strategies. The typical trade-off between the costs of SSFC and barrier fare collection is higher labor costs (i.e., for the fare inspectors) for SSFC versus higher capital costs (i.e., for the faregates, as well as TVMs) for a barrier system. However, if the number of passengers necessitates a high enough number of TVMs, then the capital cost for SSFC can approach—or even exceed—the cost for a comparable barrier system. If the capital cost of SSFC is high enough, the total annual cost

Table 2-1: Potential Use of Fare Collection Strategies

Fare Collection Strategy	LRT	Heavy Rail	Commuter Rail	BRT	Bus
Self-Service Barrier-Free Fare Collection	✓	✓	✓	✓	✓
Barrier	✓	✓		✓	
Pay on boarding	✓			✓	✓
Conductor-validated			✓		

Table 2-2: Comparison of Fare Collection Strategies

Factor/Issue	Self-Service Barrier-Free Fare Collection	Barrier	Conductor-validated	Pay on boarding
Equipment needed	TVMs, validators, TOMS, hand-held readers*	Faregates, TVMs, add-fare machines	TVMs,* TOMS,* validators,* hand-held readers*	Fareboxes, ticket processing units*
Station or platform characteristics	Open (elevated) or on-street platform	Requires space for gates and TVMs and defined entry/exit	Open platform	NA
Handling large passenger volumes	Crowded cars can interfere with inspection. May require high no. of TVMs	Doesn't affect ability to collect fares	Crowded cars can interfere with inspection	Slows boarding
Fare evasion	Depends on inspection pattern, fine structure, level of crowding	Caused by faregate "jumping," short-swiping farecards	Minimal, since conductor inspects or collects fare from everyone; could be problem at congested times	Caused by using invalid pass or transfer. Also caused by crowding at boarding point
Handling Intermodal transfers	Transfer from bus can be used as SSFC on LRT; SSFC can include transfer to bus	Transfer from bus must be machine-readable; transfer to bus must be issued with rail ticket	Transfer from other mode can be shown to conductor	(see other strategies)
Handling zonal fares	More complicated (to use and to enforce); must include origin for validation	Requires exit gates and add-fare machines	Commuter rail lines invariably zoned	Rider tells driver destination (or zone), pays accordingly
Use of AFC	Use to buy SSFC ticket, or have to validate farecard—or have pass (inspectors need hand-held readers)	Faregates read farecard and deduct value—or indicate valid pass	Conductors need hand-held farecard readers / processing units	Need ticket processing units/card readers; ease of revaluing is issue
Security and customer service	Inspectors provide presence on vehicles and platforms. Added security needed at other times	If no ticket agents, security needed in stations and on trains	Conductors provide presence on all trains	Driver responsible for security and customer assistance on bus
Customer convenience	Needs validation of multi-ride or stored-value tickets; may be queues to buy or validate, but not to board	Depends on types of payment accepted in gates (easiest if cash accepted); may be queues	No need to prepay or validate, no need for exact change, and no queuing (to pay or board)	Needs either prepayment (pass or multi-ride option) or exact change;** may be queues
Capital costs	Lower than barrier, unless high vol. Requires many TVMs	Cost of faregates high, but requires fewer TVMs than for SSFC (validation at faregate)	Lower than SSFC; may be lowest (depending on no. of TVMs used)	Lowest costs: fareboxes, but no TVMs
Operating costs	Higher labor cost than barrier	Lower labor cost than SSFC	Highest labor cost	Lowest labor cost

*optional; may be required if AFC is used

**validating fareboxes will not require exact change, but change will be in form of stored-value card

(i.e., the annual operating cost plus the annualized capital cost) can well exceed the annual cost of a barrier system.

Examples of two such analyses (from San Juan and Atlanta) are shown in the boxes. In both cases, the estimated costs of SSFC were determined to be significantly higher than the costs associated with introducing or retaining barrier systems.

An analysis in **Atlanta** several years ago considered the possibility of converting from a gated to a barrier-free system and found that the SSFC option would have a significantly higher capital cost: roughly $14 million vs. an estimated $5 million for replacement or rehabilitation of the existing barrier system. When these costs were annualized and added to estimated annual operating costs, the overall annual costs were on the order of $7.2 million for SSFC and about $4.7 million for the barrier option. The most significant factor in this difference was the extensive TVM requirement that was assumed. MARTA decided not to switch to SSFC at that time—although the possibility has been subsequently raised again recently.

(Source: Metropolitan Atlanta Rapid Transit Authority, Proof of Payment Fare Collection Study: Report #4, Cost Comparison and Implementation Issues, June 1993.)

In **San Juan (PR)**, an analysis of the relative costs of using an SSFC vs. a barrier system for the new Tren Urbano rail system determined that the expected ridership (115,000 per weekday) was too high to allow a cost-effective SSFC system. The capital costs for the alternatives were estimated to be quite close: $10.3 million for SSFC, $10.6 million for a barrier system. However, the high number of inspection personnel needed resulted in a much higher annual operating cost for SSFC: $3.8 million vs. $1.3 million; the estimated overall annualized costs (i.e., annualized capital cost plus annual operating cost) were $4.6 million for SSFC vs. $2.2 million for a barrier system. A barrier option was selected.

(Source: DMJM, FR Harris, and Multisystems—for Tren Urbano GMAEC. Comparison of Alternative Fare Scenarios, July 1997.)

Thus, while there will always be exceptions arising from local circumstances, heavy rail systems—with their potentially high ridership and enclosed stations—are typically better suited to barrier fare collection, while LRT and BRT systems—typically featuring relatively small, open platforms—will usually be better off with SSFC.

Although introducing any new fare collection system results in a range of technical and operational requirements, SSFC has myriad institutional and management issues and requirements beyond those associated with barrier-type strategies. These relate in particular to the inspection and enforcement area. For instance, because the strategy relies on inspectors' ability to enforce fare payment by issuing citations for fare evasion, an agency must establish its legal authority to conduct fare inspection and enforcement and will have to establish a working relationship with the local court system. The agency will also have to address items such as devising an inspection strategy, setting the levels of fines, educating passengers in the requirements of SSFC, and designing easy-to-use TVM user interfaces. These and the other SSFC requirements are detailed in the remainder of the Toolkit.

SSFC Versus Conductor-Validated Fare Collection

This choice applies only to commuter rail operators. As suggested earlier, the two strategies are quite similar. In fact, from the agency's point of view, the only fundamental difference in the two strategies is whether or not the conductors/inspectors will collect cash (or other forms of payment) on board. If the agency elects to not accept on-board fare payment, then it can inspect a portion of riders, rather than all riders.

Reducing the number of inspectors will reduce operating costs, although this has to be weighed against the concomitant loss of revenue through fare evasion. As indicated in Table 2-2, there should be minimal fare evasion in a conductor-validated system—although it may not be possible to check all passengers in particularly heavily congested travel periods; 100% inspection (i.e., without collecting on-board payments) will clearly be much more effective at limiting evasion than will random inspection. Of course, the ability to receive all or at least a portion of the fine revenue collected will compensate for revenue loss from evasion to some extent.

An example of this type of comparison is shown in the box. As indicated, NJ Transit decided not to convert its commuter rail service to SSFC, although the agency did convert its Newark City Subway to SSFC and also installed SSFC on its new Hudson-Bergen light rail line. The lone example of a commuter rail service converting to SSFC is GO Transit in Toronto—although the original fare collection system used entry/exit barriers. The newer commuter rail systems have, by and large, opted for SSFC from the beginning.

NJ Transit analyzed the cost impacts of converting its commuter rail operations to random inspection SSFC as part of a system-wide fare collection study conducted in 1997. This study found that, given the increased risk of lost revenues—as well as the need for additional TVMs and other equipment—SSFC would not be cost-effective for NJ Transit's commuter rail services.

(Source: Booz-Allen & Hamilton, Ticketing and Fare Collection Alternatives: Technical Memorandum – Strategic Plan for Ticketing and Fare Collection, for New Jersey Transit, March 1997.)

SSFC Versus Pay-on-Boarding Fare Collection

These two strategies can be considered for LRT, BRT, and bus systems. However, as explained in Chapter 1, SSFC has not been found appropriate for typical bus operations (i.e., unless multiple-door boarding on articulated buses is a requirement). Thus, this choice will generally be limited to (1) those few LRT services (i.e., those in Pittsburgh, Boston,[1] and Philadelphia) or heavy rail services (i.e., in Cleveland) now using pay on boarding; and (2) new BRT services that have not yet selected a fare collection strategy.

The major advantages offered by SSFC over pay on boarding are as follows:

- Reduced boarding times—and therefore vehicle dwell times—by allowing boarding through all doors, rather than the single door used in the pay-on-boarding system. This gives the agency the potential to operate fewer vehicles and thus to reduce operating costs—or at a minimum, improve service reliability. Boarding through all doors is particularly important with higher capacity articulated buses. In the case of LRT, single-door boarding cannot support trains with two or more separate cars.

- Elimination of the requirement that the operator be responsible for fare collection and enforcement. Having this responsibility can detract from the operator's major responsibility—to operate the vehicle safely. Moreover, there is potential for high fare evasion at crowded stops—i.e., where the operator may have difficulty ensuring that every passenger pays the fare.

[1] The MBTA's Green Line actually has a combination of pay-on-boarding and barrier fare collection—depending on the stop/station. The subway portions of the line have enclosed stations, with faregates.

An agency must consider the cost implications of switching from pay on boarding to SSFC. Although there will be some savings related to eliminating the need for fareboxes on the vehicles, the need for on-street equipment (i.e., TVMs)—and possibly ticket office machines (TOMs) and hand-held readers—instead will likely offset any farebox-related savings. As suggested above, SSFC offers the potential for operational savings based on reduced dwell times; however, there are new costs involved, including hiring fare inspectors and making station and stop modifications necessary for installation of TVMs. Regarding the last point, some systems may have stops or stations that will not readily accommodate TVMs, and alternative ticket sales and validation approaches will be needed in those cases. As explained below, one option is to provide for on-board ticket sales and validation.

As indicated in the box, PAT in Pittsburgh plans to convert its LRT pay-on-boarding system to a strategy based on SSFC, but possibly also allowing on-board ticket sales. Two of the other agencies mentioned above (MBTA in Boston and the Greater Cleveland Regional Transit Authority [GCRTA]) have indicated that they plan to evaluate the possibility of switching to SSFC in the near future. Most of the agencies developing BRT services have not yet made decisions on fare collection. However, indications are that SSFC will certainly be given strong consideration in these cases.

PAT in **Pittsburgh** has evaluated the possible conversion of its pay on boarding LRT system to SSFC. In a study completed in 1998, PAT compared the continuation of pay on boarding with several SSFC scenarios. The overall costs for the existing system (pay on boarding) and three SSFC variations were found to be very close. The estimated capital costs were $2.5 million for pay on boarding, and $5.6 to $8.6 million for the SSFC alternatives. However, owing in part to assumed operating cost savings from reduced dwell times, the SSFC operating costs (roughly $0.7 million for all scenarios) were estimated to be lower than the cost associated with the existing strategy ($1.1 million). The overall annualized costs were calculated to be $1.3 million for pay on boarding versus $1.1 to 1.3 million for SSFC.

Although there was no clear favorite in terms of cost, SSFC (a scenario with on-board ticket sales and validation) was determined to be most advantageous to PAT—for allowing greater operating flexibility, offering the likelihood of reducing boarding/dwell times, and removing the operators from the fare collection/enforcement process. This scenario was envisioned as using either small TVMs or fareboxes with ticket-issuing capability; one of these units would be placed at each end of each vehicle, along with a validator next to each entrance (i.e., four per vehicle). People with tickets or passes could then board anywhere, while anyone lacking SSFC would have to board at one end of a vehicle or the other and buy a ticket. This scenario addresses the agency's concern that it is not physically feasible to place a TVM at every LRT stop. PAT plans to pursue an SSFC strategy, but had not yet begun implementation as of this writing.

(Source: Booz-Allen & Hamilton [for GAEC], Stage II Light Rail Transit Program — Fare Collection Review and Cost Analysis Update, for Port Authority of Allegheny County, December 1998.)

The next section presents guidelines on estimating costs for an SSFC system.

Developing SSFC Cost Estimates

To assist agencies in estimating the capital and operating costs of SSFC, this section illustrates a cost estimation methodology. Using a hypothetical SSFC example for an LRT line, guidelines are presented for estimating the basic cost elements. Of course, the specifics will differ for each real-world analysis. For details on typical alternatives for various elements

of the fare system (e.g., different types of equipment and inspectors), consult individual sections of the Toolkit.

Cost Components

Capital Costs. Introducing an SSFC system will typically require all—or most—of the following cost elements; some systems may not include TOMs and hand-held readers:

- TVMs (purchase and installation);
- Stand-alone validators (purchase and installation);
- TOMs;
- Hand-held card readers;
- Station controllers (purchase and installation);
- Central computer/data processing system (purchase and installation);
- Spare modules and test equipment;
- Training and manuals; and
- Contingency.

The extent of the individual cost items will depend mainly on infrastructure and installation requirements (e.g., structures, power supply, and communications), the unit costs for the various types of equipment needed, and the quantities of equipment being procured. Infrastructure and installation requirements tend to be very site-specific and can vary greatly, depending on the nature of the infrastructure already in place.

TVMs and other fare collection equipment are not manufactured as commercial “off-the-shelf” units; the equipment requires considerable customization, and orders are typically small. The unit cost for a particular type of equipment—and the lump-sum cost for engineering, development, and testing—can vary considerably based on factors such as the following:

- Equipment and software features (e.g., fare media types, user interface, and credit and debit card acceptance) and the degree of customization they require,
- Quantities,
- Options,
- Timing—and type—of procurement (including terms and conditions), and
- Business conditions in the marketplace.

Operating and Maintenance Costs. The primary component of the operating and maintenance cost in an SSFC system is labor. Staff categories often associated with an SSFC fare system include the following:

- Fare inspection,
- Revenue servicing and collection,
- Equipment maintenance,
- Data processing/clerical,[2]
- Security,
- Fare media sales, and
- Marketing and customer education.[3]

The key factors are the salary (including fringe benefits) of each staff category and the number of each type of staff. Depending on the organizational structure of the agency, staff in these categories might work for any of several divisions or departments. As such, they may have other duties, and each agency needs to decide on an appropriate percentage of the labor costs to allocate to the SSFC system. The costs of consumable items associated with fare systems operation (e.g., ticket stock and supplies) are also typically included in the operating cost.

A simplified cost estimate for a new SSFC system is presented below.

Hypothetical Scenario

An example of how to estimate costs is provided in the following scenario. An LRT line is being developed along an existing rail right-of-way. There will be 15 stations on the line, which runs from a suburb into the downtown; trains will load from platforms on either side of the tracks. Several bus routes will be reoriented to feed the LRT stations.

The average daily boarding volume is 13,000, with peak period boardings of 3,300 passengers per hour. The morning peak demand profile is as shown in Table 2-3 (the evening peak reverses this pattern).

Proof-of-payment options will include monthly passes, ten-ride tickets, single-ride tickets, and transfers from connecting buses. Passes and ten-ride tickets will be sold at attended locations in the downtown stations. Station TVMs will vend single-ride and ten-ride tickets; TVM payment options will be cash and credit and debit cards. Table 2-4 summarizes the

[2] This category includes resources for coordinating and interacting with the courts and the adjudication process.
[3] This category includes development of marketing materials and development/installation of signage in stations.

Table 2-3: Morning Peak Demand Profile for Hypothetical Scenario

Stations	Peak Boarding Rate (passengers per hour)	Peak Alighting Rate (passengers per hour)
Outermost 10	300	30
Innermost 5	60	600

Table 2-4: The Percentage Use of the Various Fare Media by Passengers Starting Their Trip at a Station, as well as Those Arriving on a Connecting Bus

	Fare Media		
Trip Begins on	**Monthly Pass**	**Ten-Ride Ticket**	**Cash**
Rail	16%	**4%**	**20%**
Connecting Bus	24%	**6%**	30%
Total	*40%*	*10%*	*50%*

Note: Figures representing passengers who need to use a TVM for at least some trips are shown in bold.

percentage use of the various fare media by passengers starting their trip at a station, as well as those arriving on a connecting bus.

The following sections outline the initial high-level cost estimation process. First, the equipment quantities and personnel requirements are estimated. These figures are then combined with unit cost information to develop a preliminary estimate of the capital and annual operating costs for an SSFC system.

Estimating Equipment Requirements and Capital Cost

Each platform direction will be equipped with a single cluster of TVMs, with the intent that there be enough to avoid excessive queuing during the peak period. TVMs would be used for purchasing ten-ride tickets (every 10th trip on average) and for purchasing single-ride paper tickets (every trip). There will also be stand-alone validators to allow the validation of previously purchased ten-ride tickets.

The quantity of TVMs required depends on the peak demand relative to the expected throughput of each TVM. The weighted average transaction time can be estimated as shown in Table 2-5, with a corresponding average throughput of about 145 passengers per hour for each TVM.

Table 2-5: Expected Use of TVMs

Transaction Type	% of Passengers	% of Boardings Using a TVM	Relative % of TVM Transactions	Average Transaction Time	Weighted Average Transaction Time
Single Ride Ticket	20%	20%	95%	25 seconds	**24.5 seconds**
Ten-Ride Ticket	10%	1%	5%	15 seconds*	

**Shorter transaction time assumes a mix of cash and credit/debit purchases.*

The peak boarding rate at the outer stations is estimated at 300 passengers per hour, of which 21%—or 63—are expected to use a TVM. The throughput of 145 passengers per hour suggests that a single TVM would be sufficient. On occasions when it is out of service, passengers could cross and use the TVM on the opposite platform. For the inner stations, the peak boarding rate is estimated at 600 passengers per hour (i.e., in the P.M. peak), with 21%—or 126—expected to use a TVM. This is close enough to the throughput limit that longer queues will occur more often—suggesting that two TVMs per platform would probably be a better choice.

Thus, the total estimated TVM quantity is 2 each for the 10 outer stations and 4 each for the 5 inner stations—for a total of 40. These TVMs require a communications network and a central computer system—for monitoring device alarms and enabling real-time credit and debit card authorization transactions. The estimated throughput for stand-alone validators would be about 1,200 passengers per hour, so no more than a single validator would be needed for each platform—for a total of 30 validators.

The estimated costs associated with these assumptions are shown in Table 2-6. As indicated, the total capital cost for the system is roughly $4.7 million, which translates into a cost of approximately $313,000 per station.

Estimating Personnel Requirements and Operating Cost

The number of fare inspectors required can be estimated on the basis of the expected daily ridership, because the intent typically is to inspect a planned percentage of the passengers. The results of the agency survey conducted as part of this project suggest that a typical fare inspector coverage ratio—for operations similar to this hypothetical example—would be on the order of 0.3 inspectors per 1,000 daily passengers. For the average daily boarding volume of 13,000, this suggests a total of four inspectors. Based on the survey results, the typical fully loaded labor cost for each fare inspector (i.e., salary plus fringe benefits) might be on the order of $50,000. (The actual cost varies considerably from agency to agency—depending on the details of local labor agreements, as well as the prevailing wage rates in each locale.)

With regard to maintenance personnel, a general rule of thumb is one maintainer per 25 TVMs, and one maintainer per 150 validators. This translates into a requirement for the example system of two full time–equivalent (FTE) positions; the example assumes an annual cost of $65,000 (salary + fringe benefits) for each maintenance person. The following additional FTE positions and annual cost are also assumed: five fare media sales ($35,000), two security ($40,000), two revenue service/collection ($40,000), and one data processing/clerical ($35,000). The estimated costs for these personnel, as well as for supplies (e.g., ticket stock for TVMs), are shown in Table 2-6. As indicated, the annual operating and maintenance cost for the hypothetical system is estimated to be roughly $1.2 million.

As suggested earlier, the actual costs for many of the above categories will vary depending on local conditions and other factors. This example was designed to show, in a simplified fashion, a possible methodology for estimating the order of magnitude costs for an SSFC system. The types of information needed to develop these costs are discussed further within the individual sections of the Toolkit.

Table 2-6: Example of an SSFC Cost Estimate

Item		Material		Costs							
No.	Description	Qty	U/M	Unit	Total	%	Engineering	%	Installation & Testing	Total
	Capital Costs									
1	**Ticket Vending Machines**	40	ea	$ 55,000	$ 2,200,000	30%	$ 660,000	5%	$ 110,000	$ 2,970,000
2	**Validators**	30	ea	$ 5,000	$ 150,000	30%	$ 45,000	5%	$ 7,500	$ 202,500
3	**Station Controller**	15	ea	$ 5,000	$ 75,000	30%	$ 22,500	5%	$ 3,750	$ 101,250
4	**Central Computer System**	1	ea	$ 250,000	$ 250,000	30%	$ 75,000	5%	$ 12,500	$ 337,500
5	**Spare Modules & Test Equipment**	1	lot	$ 267,500	$ 267,500	15%	$ 40,125	2%	$ 5,350	$ 312,975
6	**Training and Manuals**	1	lot	$ 133,750	$ 133,750					$ 133,750
	subtotal				*$ 3,076,250*		*$ 842,625*		*$ 139,100*	*$ 4,057,975*
7	**Capital Contingency @ 15%**				$ 461,438		$ 126,394		$ 20,865	$ 608,696
	Total				**$ 3,537,688**		**$ 969,019**		**$ 159,965**	**$ 4,666,671**
	Annual Operating & Maintenance Costs									
8	**Fare Inspectors**	4	ea	$ 50,000	$ 200,000					$ 200,000
9	**Equipment Maintainers**	4	ea	$ 65,000	$ 260,000					$ 260,000
10	**Revenue Servicing/Collectors**	4	ea	$ 40,000	$ 160,000					$ 160,000
11	**Security Staff**	4	ea	$ 40,000	$ 160,000					$ 160,000
12	**Data Processing/Clerical Staff**	4	ea	$ 35,000	$ 140,000					$ 140,000
13	**Fare Media Sales Staff**	4	ea	$ 35,000	$ 140,000					$ 140,000
14	**Supplies (e.g., ticket stock)**	1	lot	$ 15,000	$ 15,000					$ 15,000
	subtotal				*$ 1,075,000*					*$ 1,075,000*
15	**Operating Contingency @ 10%**				$ 107,500					$ 107,500
	Total				**$ 1,182,500**					**$ 1,182,500**
	Annualized Capital Cost				**$ 513,334**					**$ 513,334**
	Total Annualized Cost (Cap.+ O&M)				**$ 1,695,834**					**$ 1,695,834**
	Present Value of Operating Cost									**$ 14,555,595**
	Total Capital + PV Operating Cost									**$ 16,251,429**

NOTES:

Design is for 15 Light Rail stations, and average daily ridership of 13,000

TVMs include bills, coins, coin recirculation, escrow, credit/debit and provisions for smart cards

Equipment Costs (items 1-4) $ 2,675,000

Spare Modules and Shop Test Equipment, 10% of Equipment Cost $ 267,500

Training and Manuals, 5% of Equipment Cost $ 133,750

Labor costs are per annum (for Year 1)

Annualized capital cost based on 15-year economic life of system and 7% annual discount rate; annualization factor = 0.110

Present value of operating & maintenance cost assumes 2% labor cost escalation rate, 7% discount rate and 15-year system life

U/M = Unit of Measure

Annualized Cost per 1,000 Daily Passengers

$ 130,449

Annualized Cost per Station

$ 113,056

Estimating Total System Cost

The overall system cost (capital plus operating) can be expressed in two ways: (a) annualized total cost or (b) total capital plus present value of operating cost. The annualized total cost represents the annual operating cost plus the annualized capital cost (i.e., assuming a 15-year economic life of the system and a 7% annual "discount rate"[4]). As shown in Table 2-6, the total annualized cost for the suggested system is approximately $1.7 million. The average cost

[4] This is the discount rate required by the U.S. Office of Management and Budget for the evaluation of any project seeking federal funding. The discount rate is used with cost expressed in constant dollars and thus represents a rate of return net of inflation.

per 1,000 passengers would be on the order of $130,000, while the cost per station would be about $113,000.

The second method of depicting total costs is to add the total capital cost to the total operating cost over the life of the system. Present value is a common approach to dealing with a stream of future costs; it can be thought of in general terms as the funds that would need to be set aside and invested to cover the future costs. As indicated in Table 2-6, the total cost—capital cost plus the present value of operating costs over the assumed 15-year economic life of the system—is roughly $16 million.

Chapter 3: Policy and Enforcement Issues

This chapter discusses the types of SSFC policy and enforcement issues an agency must address. The major decision and issue areas are as follows:

- Legal Authorization for Enforcement—How does an agency establish its legal authority governing inspection and enforcement?
- Measuring the Evasion Rate—How should an agency measure and estimate its fare evasion rate?
- Inspection Strategy—What general inspection strategy should be pursued? What pattern of inspection should be used?
- Inspection Rate and Number of Personnel—What is a reasonable inspection rate? What is the appropriate number of inspection personnel? What is a reasonable productivity for inspectors?
- Type of Inspection Personnel—What type of personnel should be used to perform inspections (i.e., police versus other staff and in-house versus contract)? What are the advantages of uniformed versus plainclothes inspection personnel?
- Treatment of Fare Evaders—What types of action can—and should—an inspector take when an evader is apprehended? What special circumstances, if any, will the inspector consider when apprehending an evader?
- Fare Evasion Fine Structure—What is an appropriate fine structure?
- Fare Evasion Follow-up Program—How can an agency track evaders who have been cited—and the outcomes of court cases?

Individual Sections

Key considerations and techniques, approaches, and options for each area are shown in Table 3-1.

Table 3-1: Summary of Policy and Enforcement Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Legal Authorization for Enforcement	• Limitations in existing law • Relationships with state and local governments	• State enacts legislation • Local governments enact legislation • Governing board of agency authorizes
Measuring the Evasion Rate	• Enforcement data needs • Inspection strategy • Treatment of evaders • Consistency of enforcement	• Use regular inspection results, i.e., the totals reported by the inspectors from their normal inspection tours • Use the results of 100% inspection "sweeps" • Conduct special field audits and/or surveys on a periodic basis • Include only riders who are actually given citations • Include all riders found not to be carrying POP
Inspection Strategy	• Philosophy of deterrence • Treatment of evaders • Impact on number of inspection personnel needed • Tracking evasion patterns • Public safety • Labor issues	• Covering the whole system • Random inspections, at the discretion of inspection teams • Targeting peak periods (i.e., targeting the largest volumes of riders) • Targeting specific evasion problem areas • 100% "sweeps"
Inspection Rate and Number of Personnel	• Length and configuration of system • Daily passenger volumes • Inspection strategy • Type and cost of inspection personnel • Available budget • Ancillary duties • Use of inspection teams	• Consider industry experience: – Inspection rate – Number of inspectors/1000 riders – Productivity of inspectors – Relationship between inspection and evasion rates
Type of Inspection Personnel	• Effectiveness • Cost/budget • Role of inspection personnel • Liability if armed • Legal authority • Management control • Ability to conduct "sweeps" • Scheduling	• Agency police • Contract police • Agency staff (non-police) • Contract security
Treatment of Fare Evaders	• Impact on deterrence and ability to track repeat offenders • Image of agency • Inspection strategy • Level of conflict with evaders • Impact on productivity of inspection personnel	• Issuing citations to most evaders • Issuing warnings, rather than citations, to most evaders • Giving inspectors discretion as to whether to issue a citation or warning • Removing evaders from the vehicle (i.e., in addition to being cited/warned)
Fare Evasion Fine Structure	• Basic fine strategy • Treatment of evaders • Image of agency • Ease of implementation/ administration • Judicial environment • Prevailing fine structure for other violations • Receipt of fine revenue	• Assessing the same fine for all offenses • Assessing different fines for different types of offenses (i.e., based on the nature of the violation) • Assessing escalating fines for repeat offenses • Excluding passengers from the system for repeat offenses

Table 3-1: Summary of Policy and Enforcement Decision Areas (cont.)

Decision Area	Considerations	Techniques/Approaches/Options
Fare Evasion Follow-up Program	• Impact on deterrence • Cost • Court system procedures • Number of courts • Ability to track cases • Agency share of fine revenue	• Book citations • Track selected citations • Follow all citations through to resolution • Appeal procedure within the agency

Legal Authorization for Enforcement

Issues/Decisions

In implementing an SSFC/POP system, a transit agency must establish legal authorization for the inspection and enforcement programs. The basic operating assumptions of an SSFC system (i.e., that a passenger must pay a fare and carry proof of payment of the proper fare, that inspection personnel may approach passengers to request that they display their proof of payment; and that inspection personnel may issue citations if passengers do not present valid proof of payment) all must be established in law.

Related Sections

Inspection Strategy

Type of Inspection Personnel

Treatment of Fare Evaders

Fare Evasion Fine Structure

Fare Evasion Follow-up Program

There are certain challenges involved in getting appropriate state legislation or a local ordinance instituted, however. For instance, the enforcement power being granted to an agency is akin to police power, but the personnel involved will not necessarily have the training or experience of police officers. Moreover, the crime that most evaders will be accused of having committed represents “theft” of an amount typically around $1. Such a small amount may make the infraction seem insignificant—and potential penalties too large. There can also be complications in establishing legal authorization where a transit service operates in more than one county or state.

The basic issues an agency must address regarding establishing legal authorization for SSFC are as follows:

- What is the nature of existing laws that may pertain to SSFC inspection and enforcement issues, and are any directly applicable to the agency’s requirements?
- At which level of government will the system be authorized (i.e., state or local government, or perhaps the governing board of the agency)?

The approaches that can be employed in establishing legal authorization for the SSFC system, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the following sections.

Techniques/Approaches

Steps Needed

There are two basic approaches to establishing legal authority for an SSFC program:

- Utilizing existing legislation to authorize the agency’s inspection and enforcement program and

- Developing/enacting new legislation—or modifications to existing statutes—that will appropriately authorize the program.

Existing laws prohibiting "theft of service" or trespass may be the basis of a program of inspection and enforcement. However, as further explained below, there may be significant limitations in these laws, and the agency will, in many cases, be better off seeking new legislation. Thus, the first step will be to do a survey of all potentially applicable existing statutes. At this time, the agency should also review the details of the legislation and ordinances authorizing SSFC systems in other states.

Depending on its assessment of the viability of existing laws, the agency should next decide whether to try to (1) amend one of these laws or (2) draft new legislation specifically tailored to the requirements of the enforcement system. There are three basic alternatives in terms of the setting for legal authorization:

- Legislation passed at the state level,
- Local ordinance, and
- Authorization under the powers of the agency's governing board.

As is further discussed below, one consideration in identifying the appropriate entity is the nature of the transit agency's existing relationships with the different governmental units. These relationships may affect the agency's ability to get necessary legislation passed in a timely fashion. In short, the agency should identify the best vehicle available for securing the authorization it needs prior to the opening of the SSFC system.

Requirements of Legislation

The transit agency should ensure that the legislation authorizing SSFC includes language that does the following:

- Defines acceptable proof of payment;
- Allows the agency to define the "paid area" (e.g., whether on a vehicle or on a station platform);
- Specifies all the situations in which a passenger is expected to have POP;
- Establishes the authority of inspection personnel and defines their powers and its limits (e.g., will the inspection personnel have arrest authority?);
- Establishes that there will be a penalty for fare evasion, allows the transit agency to set the actual fine structure, and also allows the level of the fine to be increased for repeat offenses; and
- Allows the transit agency to receive at least a portion of the fine revenue.

Certain details (e.g., maximum fine) may be specifically spelled out in the legislation—or the legislation can effectively give the agency the authority to establish many of the operational details of the program; this level of flexibility will vary from one state or locality to the next.

Finally, an agency could seek to adjudicate evasion cases outside the criminal court system, through establishment of a separate entity. This option essentially requires that evasion be "decriminalized." This capability, which would have to be established as part of the legal authorization process, could be particularly useful in dealing with multiple jurisdictions.

Considerations

Establishing legal authorization for an SSFC system involves balancing several competing considerations. These considerations represent goals, constraints, and other factors influencing the agency's decisions in this area. Examples of such considerations include the following:

- **Limitations in Existing Laws.** State or local statutes that address theft of service or trespass or other applicable offenses can, in some cases, provide authorization for a program of SSFC inspection and enforcement. However, these laws often carry limitations that make them inappropriate for transit agency purposes (e.g., they may state that only police officers are authorized to enforce the particular law in question). Therefore, drafting new legislation specifically designed for an SSFC enforcement program may well be the preferred approach. In some cases, however, an existing law may be useful in the near-term, until the new legislation becomes effective.

- **Relationships with State and Local Governments.** Enactment of authorizing legislation is likely to require the close and continuing attention of the agency. The process will be no different from that of other bills—it will move slowly, and there may be surprises in the form of unexpected amendments. The danger, as always, is that even minor changes may alter essential provisions. As a consequence, there is likely to be an ongoing need to educate legislators about the workings of the SSFC system and about the significance of the specific language in the bill. Thus the strength of the agency's existing relationships with the state and with local governments can be an important factor in deciding where to seek authorization for the SSFC program. There also may be a need to coordinate authorization in more than one jurisdiction, if the agency's service crosses jurisdictional boundaries.

- **Relationships with the Court of Jurisdiction**. Evasion cases will be heard in courts of one or more jurisdictions (i.e., state, county, or municipality). The transit agency will have to establish a working relationship with the appropriate court(s) in order to ensure that fines are assessed as intended and to be able to track the outcomes of cases in general. (See the Fare Evasion Follow-up Program section.) The agency's existing relationships (if any) with a particular court may influence the decision as to where to seek legal authorization for inspection.

Industry Practice

Table 3-2 summarizes the legal authorization framework in place for many of the North American SSFC systems. As indicated, in most cases (85%), the legislation has been enacted by state or provincial legislatures. The statutes typically allow the agencies themselves to develop some of the details of the enforcement system. For example, a bill passed by the State of Washington provides regional transit authorities (e.g., Sound Transit) with the power ". . . to set a schedule of fines and penalties not to exceed those classified as Class 1 infractions under RCW 7.80.120 . . . [and] to issue citations for fare nonpayment or related activities. . . ." In this case, the state has allowed the transit authority to (1) develop its own fine structure, while placing certain limits on the fine structure; and (2) issue citations for evasion, while not involving itself in the procedural details (e.g., when it is more appropriate to issue a warning rather than a citation).

As shown in Table 3-2, all of these agencies have the power to issue citations for evasion. Regarding the Courts of Jurisdiction for evasion cases, the systems are distributed among the three types: state (or provincial), county, and municipal. One-half of the systems use the municipal courts, 8 of the 20 use the county courts, and 5 use state or provincial courts. Three agencies use more than one jurisdiction: municipal and county for Bi-State (St. Louis) and Lane Transit District (Eugene, OR), and municipal and state Superior Court for RTD (Sacramento).

Summary and Recommendations

In establishing legal authorization for an SSFC inspection/enforcement program, it is often necessary for a transit agency to initiate new legislation at the state or local level. Existing

Table 3-2: Legal Authorization Framework for SSFC Systems

Transit Agency	Legal Authority	Legal Instrument	Court of Jurisdiction
Bi-State (St. Louis)	State	Citation	Municipal; County
DART (Dallas)	State	Citation	County
GO Transit (Toronto)	Provincial	Citation	Provincial (changing to Municipal)
LACMTA (Los Angeles)	State	Citation	County
Lane Transit District (Eugene, OR)	State	Citation	Municipal; County
MTA (Baltimore)	State	Citation	State
Muni (San Francisco)	Municipal	Citation	State
NFTA (Buffalo)	State	Citation; Civil Penalty	Municipal
NJ Transit (New Jersey)	State	Citation	Municipal
OC Transpo (Ottawa)	Provincial	Citation; Fare Surcharge	Provincial
RTD (Denver)	State	Citation	County
RTD (Sacramento)	State	Citation	Municipal; Superior Court
San Diego Trolley	Local Ordinance	Citation	Superior Court
SCRRA (Los Angeles)	State	Citation	Municipal
SCVTA (San Jose)	State	Citation	Municipal
Sound Transit (Seattle)	State	Citation	County
Tri-Met (Portland)	State	Citation	County
Tri-Rail (Miami)	State	Citation; Civil Infraction	County
TTC (Toronto)	Municipal	Citation	Municipal
VRE (Washington)	State	Citation	Municipal

laws may enable some aspects of the program, but they often contain significant limitations with regard to SSFC requirements. In most cases, programs have been authorized by state governments, although it is more often municipal or county courts—rather than state courts—that deal with fare evasion cases.

A transit agency seeking to **establish legal authorization** for a new SSFC program should start by determining whether existing legislation can effectively provide the necessary legal framework. It is often preferable, although, to draft new legislation that specifically addresses the requirements of the SSFC system.

Measuring the Evasion Rate

Issues/Decisions

The procedure or methodology for gathering and reporting data on the number and percentage of riders not carrying valid proof of payment is referred to as "measuring the evasion rate." Measuring the evasion rate provides a necessary feedback loop for the enforcement effort, because it represents a key indicator of the effectiveness of inspection and enforcement. The overall evasion rate for the SSFC system will probably get the most attention from top agency officials and stakeholders (e.g., political leaders), but the details behind the overall rate are probably more important from the point of view of enforcement. These details include differences by day or time or by station or stop in the system. The details become particularly important as the agency seeks to make adjustments in the deployment of its inspection resources in order to try to maximize the impact of such resources.

Related Sections

Inspection Strategy

Treatment of Fare Evaders

Fare Evasion Follow-up Program

The basic issues an agency must address in deciding on a procedure for measuring the evasion rate are as follows:

- Defining "evasion rate" (i.e., include only those actually cited or include everyone given a warning) and
- Selecting procedures for collecting data and estimating evasion rate.

The techniques and approaches that can be employed regarding measuring the evasion rate, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the following sections.

Techniques/Approaches

The approaches that can be used in defining evasion rate are as follows:

- Include only riders who are actually given citations or
- Include all riders found not to be carrying POP (i.e., total of warnings and citations as percentage of total number of riders inspected).

The assumption behind using *cited offenders only* is that, because the offense did not warrant a citation, it should not be classified as evasion. There are numerous situations in which the passengers could be exempted from a citation (e.g., new to system, forgot pass, and long lines at TVMs). Thus the term "evaders" would be reserved for passengers who seem to have intended to evade and who had no extenuating circumstances. It can be argued that the

inadvertent evader is less a continuing enforcement problem than a one-time education problem. This approach results in a lower evasion rate than does the other.

The broader definition of evasion includes all riders who do not have valid POP and is the more common approach in the transit industry. The underlying assumption is that, no matter how blameless some violators may be, the agency is losing fare revenue because of them.

With regard to the procedures for collecting and measuring evasion rate, the basic approaches are as follows:

- Use regular inspection results (i.e., the totals reported by the inspectors from their normal inspection tours);
- Use the results of 100% inspection “sweeps”; and/or
- Conduct special field audits and/or surveys periodically.

The first approach requires that inspection personnel keep a count—at least periodically—of the results of the inspections they perform. The inspectors may be issued mechanical hand counters to facilitate the process. The second approach is possible only if the agency conducts inspection sweeps (see section on Inspection Strategy). Sweeps involve extra personnel, which makes it possible to secure the doors of the vehicle to ensure that evaders do not flee. This facilitates catching fare evaders who might otherwise be able to escape detection (e.g., by quickly disembarking the vehicle on observing an inspector boarding). Therefore, 100% sweeps produce more accurate (and usually higher) evasion rates—although how much more accurate is unknown.

Some agencies conduct special field audits or surveys to establish their “official” evasion rates—as well as to confirm the accuracy of the inspectors’ figures. Audits or surveys are done using agency personnel (e.g., internal audit) or outside contractors. This approach might involve, for example, auditors accompanying inspection personnel in checking for valid POP for a sample of riders at designated time periods over a 2- or 3-day period. Audits might be conducted annually or bi-annually; an agency might even conduct a special one-time audit (e.g., if it suspects that the reported evasion rate is highly inaccurate). The results of an audit can be used to identify particular problem areas (i.e., station locations and/or times of day that feature a higher-than-average evasion rate).

Considerations

Establishing an approach for measuring fare evasion involves balancing several types of considerations; these considerations include the following:

- **Enforcement Data Needs**. The types of data an agency needs to maximize the effectiveness and efficiency of its inspection and enforcement efforts influences the data collection approach. For instance, relying only on data collected during peak period sweeps will not provide fare evasion information for other times of day.

- **Inspection Strategy**. The type of inspection strategy an agency employs generally affects the approach to measuring evasion. In particular, only an agency using a "sweeps-based" inspection strategy can measure fare evasion based on 100% of specific trips.

- **Treatment of Fare Evaders**. An agency that issues many warnings—rather than citations—should use a fare evasion measure that accounts for all violators, not just those issued citations.

- **Consistency of Enforcement**. Regardless of the particular methodology used for measuring evasion, it is important to ensure uniformity in the procedures employed by different inspection personnel. This is especially important for historical comparisons; any effort to monitor the effectiveness of the enforcement program depends on developing a series of consistently created data. Consistency of approach is also necessary for making comparisons among different locations (or times of day). An agency experiencing significant variation among inspectors (e.g., in terms of citations issued over a several-month period) should opt for special audits to confirm the "real" evasion patterns.

Industry Practice

As shown in Table 3-3, most transit agencies with SSFC systems (60% of those included in the table) base their evasion rates on the normal inspection procedures, while the others conduct audits and/or surveys. With regard to the official definition of "evaders," a survey

Table 3-3: Evasion Rates and Measurement Procedures

Transit Agency	Evasion Rate	Procedure for Measuring Evasion Rate
ATC (Bologna)	6.0%	Fines
Bi-State (St. Louis)	2.0%	Inspectors
GO Transit (Toronto)	0.8%	Audits
HKL (Helsinki)	2.0%	No response
LACMTA (Los Angeles)	6.0%	Inspectors (cite + warn)*
MTA (Baltimore)	0.5%	No response
Muni (San Francisco)	1.0%	Inspectors
NFTA (Buffalo)	3.4%	Field audits
NJ Transit (New Jersey)	NCS: <1%; HBLR: 1%-2%	Inspectors (cite + warn)
OC Transpo (Ottawa)	2.0%	Inspectors
RTD (Denver)	2.0%	Surveys/audits
RTD (Sacramento)	2.0%	Inspectors
San Diego Trolley	6.0%	Surveys/audits
SCRRA (LA)	1.5%	Inspectors
SCVTA (San Jose)	1.8%	Inspectors
SEMICACS (Nice)	15.0%	Surveys
Sound Transit (Seattle)	0.3%	Field review
Tri-Rail (Miami)	2.0%	Statistical analysis
TTC (Toronto)	2.4%	Inspectors

* LACMTA conducted a special one-time survey in 2001 to check on the accuracy of the reported evasion rate; the audit revealed a rate of 6%, in contrast to the previously reported rate of 0.5%.

NCS = Newark City Subway
HBLR = Hudson-Bergen Light Rail

conducted by San Francisco's Muni (June 2000)[1] reported that all of the agencies contacted (10 agencies, including 9 of those shown in Table 3-3) base their evasion rates on total numbers of violators (i.e., warnings plus citations). Thus, the evasion rate typically represents "the total number of violators encountered as a percentage of the total number of passengers inspected." It is assumed that this figure represents a reasonable estimate of the percentage of evaders among all passengers (i.e., not just those inspected).

Table 3-3 indicates that most of these agencies report evasion rates in the range of 1% to 2%. Three of the agencies report rates under 1%, and six report rates greater than 2%. Only two North American agencies (LACMTA and San Diego Trolley) report evasion rates higher than 5%. Although there is no clear correlation between measurement approach (i.e., normal inspections versus audit and/or survey) and evasion rate, the North American agencies with the highest rates (i.e., LACMTA [6%], San Diego Trolley [6%], and NFTA [3.4%]) have all used surveys and/or audits; furthermore, four of the five agencies with the lowest reported evasion rates (i.e., 1% or less) use inspection results, rather than audits.

Summary and Recommendations

The measurement of fare evasion is important in that it provides an indication of the agency's overall effectiveness and efficiency in inspection and enforcement. Such measurement can also provide details on evasion differences by day or time or by station or stop in the system; these details can be used to adjust the deployment of inspection personnel. Based on a review of current industry practices, the following findings and recommendations can be made:

- About 40% of transit agencies use special field audits and/or surveys to identify their fare evasion rates; the others develop their evasion rates based on regular inspections. Audits generally result in the reporting of higher—and presumably more accurate—evasion rates than do reports based on routine inspections.

- Most, if not all, agencies base their evasion rates on total numbers of violators (warnings plus citations), rather than citations alone. This is an appropriate strategy, because it controls for variations in how inspectors treat evaders. Moreover, an agency that tends to issue a significant percentage of warnings, rather than citations, should measure all violators in order to provide a realistic picture of fare evasion.

- Regardless of the particular methodology used for measuring evasion, it is important to ensure uniformity in the procedures employed by different inspection personnel. Consistency is paramount to permit valid comparisons both over time and between different locations. An agency experiencing significant variation among inspectors (e.g., in terms of citations issued over a several-month period) should opt for special audits to confirm the "real" evasion patterns.

An agency can rely on regular inspections for day-to-day monitoring of **evasion rates**, but should strongly consider *augmenting these measurements with special field audits or surveys* to produce official evasion rates. These should be conducted at least once every 2 years. In addition, an agency should always include *both warnings and citations* in its evasion rate.

[1] *Muni Proof of Payment Program, Task 2—N Judah POP Evaluation*. Final Report, June 2000

Inspection Strategy

Issues/Decisions

The inspection strategy represents the agency's basic philosophy toward fare inspection and defines when and where inspection personnel are going to be deployed. Because SSFC generally involves checking less than 100% of passengers for valid fare payment, the inspection strategy is an important element of the overall system design.

The basic issues regarding the inspection strategy are as follows:

- Identifying a preferred basic approach,
- Developing inspection schedules, and
- Determining the number of inspection personnel.

Related Sections

Measuring the Evasion Rate

Inspection Rate & No. of Personnel

Treatment of Fare Evaders

Regarding the second point, some agencies follow explicit inspection schedules and assignments, while others give their inspection personnel considerable discretion regarding the details of the strategy (within a defined realm). (The third point is addressed in the section Inspection Rate and Number of Inspection Personnel, which follows this one.)

This section focuses on the basic fare inspection approaches. The strategies identified here are not mutually exclusive; certain combinations can be pursued simultaneously, depending on the available resources. Each strategy includes certain types of actions that an agency is likely going to want to take at some point. It is, therefore, important to understand the trade-offs among the different approaches. For example, the desire to conduct inspections across the system may have to be balanced against the desire to focus on particular problem areas (i.e., where high numbers of evaders have been identified or are anticipated).

The alternative approaches that can be employed in selecting the inspection strategy, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the sections that follow.

Techniques/Approaches

There are three basic approaches to conducting SSFC fare inspection:

- Covering the whole system;
- Random inspections, at the discretion of inspection teams; and

- Targeting peak periods (i.e., targeting the largest volumes of riders).

In addition, an agency may decide to include one—or perhaps both—of the following approaches as part of its inspection strategy:

- Targeting specific evasion problem areas and

- 100% sweeps.

As suggested above, given finite resources, a trade-off must be made between conducting inspections across the system and focussing on specific problem areas. The strategy of covering the whole system involves carrying out inspections according to a specific schedule that ensures inspections at all times of day and throughout the system—regardless of the passenger volumes at any particular time. Thus, under this strategy, a passenger boarding at the most remote stop late at night is just as likely to see an inspector as someone commuting to work during the peak period.

Instead of following the above scheduled approach, the agency can also pursue a strategy of random inspections, at the discretion of inspection teams. Under this strategy, inspection personnel are free to select a particular approach (within defined limits). For example, an agency may give an inspection team of two inspectors responsibility for a series of stations in a particular time period; the inspectors are then free to decide exactly how to conduct the inspections.

A strategy of targeting peak periods is efficient in that inspection personnel are able to approach many passengers in a relatively short amount of time. However, if trains are crowded, inspectors may have trouble moving through the vehicle, and inspection may actually become less efficient. It is sometimes necessary during periods of high ridership to inspect passengers on the platform before they board—or as they alight the vehicles.

Targeting evasion problem areas is a potential strategy when specific locations and/or times of higher-than-usual evasion have been identified during random inspections. Thus, this approach may be used to supplement more comprehensive strategies. Of course, doing this requires extra resources—or else diverting resources from regular assignments. For example, to target late-night evasion, inspection personnel could be moved from the day shift to the night shift—but that would be accomplished only at the cost of reducing enforcement during the day. The alternative would be to supplement the regular inspection staff with supervisors, agency security personnel, or contract staff.

Conducting periodic 100% sweeps at selected times of day can also be used to supplement one of the random inspection strategies. It has been found to be a useful strategy by many agencies, but it too requires extra personnel (on a temporary basis).

These strategies are reviewed within the context of several key considerations in Table 3-4; the considerations follow.

Table 3-4: Alternative Inspection Strategies

	Cover Whole System*	Target Peak Periods	Target Problem Areas	100% Sweeps
Philosophy of Deterrence	Deter by inspector visibility and passenger education	Deter by inspector visibility and passenger education	Deter by apprehending evaders	Deter by apprehending evaders
Treatment of Evaders	May be more appropriate for a policy of issuing warnings to most evaders	May be more appropriate for a policy of issuing warnings to most evaders	May be more appropriate for a policy of issuing citations to most evaders	May be more appropriate for a policy of issuing citations to most evaders
Impact on Number of Inspection Personnel Needed	Uses assigned personnel	If trains are crowded during peak periods, may be inefficient or require extra staff	Dealing with evaders is time-consuming. May require extra staff, particularly if done to supplement random strategy.	Dealing with evaders is time-consuming. May require extra staff, particularly if done to supplement random strategy.
Tracking Evasion Patterns	Not required	Not required	Required to identify problem areas	Not required
Public Safety	Can provide key security function, particularly at low usage times	Can supplement regular security staff	Can supplement regular security staff	Increase security at certain times/locations
Labor Issues	None	May be desirable to ask inspection personnel to work split shifts	May be desirable to ask inspection personnel to work split shifts (e.g., for evenings)	May require extra staff

***** This column also applies to Random Inspections.

Considerations

Developing an inspection strategy involves balancing several competing considerations. These considerations represent goals, constraints, and other factors influencing the agency's decisions in this area. Key considerations associated with the Inspection Strategy include the following:

- **Philosophy of Deterrence.** The purpose of inspection is not only to catch evaders but also to discourage further evasion from occurring. The basic elements of deterrence are thus: (1) maximizing the rate of catching evaders and (2) maximizing the visibility of the inspectors. There is thus a trade-off between targeting peak periods or problem areas, which is time-intensive, and covering as much of the system as possible, with the goal of maximizing the presence of inspection personnel. In making this choice, an agency has to decide on its basic philosophy regarding the most effective means of deterrence. A focus on maximum visibility should also include greater passenger education.

- **Treatment of Fare Evaders**. The appropriate policy toward evaders (e.g., issuing citations to all or most evaders versus issuing warnings to most; see the Treatment of Fare Evaders section) is related to some extent to the particular inspection strategy.

- **Impact on Number of Inspection Personnel Needed.** Strategies targeting particular periods or locations—including 100% sweeps—often require extra staff.

- **Tracking Evasion Patterns.** A strategy of targeting "evasion problem areas" assumes some means of—and a commitment to—tracking evasion patterns across the system. Inspections are the primary means for gathering data on evasion patterns. It is important to include racial data in tracking evasion patterns, so as to avoid what is essentially "racial profiling" in targeting "problem areas." Even if particular routes or locations are targeted, it is important to ensure consistent enforcement patterns across the system. One agency's analysis of evasion pattern is summarized in the box at right.

Anticipating likely evasion patterns could inform the selection of strategy. There is little documentation of evasion patterns. However, one analysis, conducted by Tri-Met (Portland), identified the following breakdown of evasion by time of day.

AM:	3.6%
Mid-day:	5.6%
PM:	4.6%
Eve. & early AM:	8.0%

Tri-Met's average daily evasion rate at that time was 5.4%.

Source: MARTA, Proof of Payment Fare Collection Study, Report 1—Experience of Other Transit Properties, 1993.

- **Public Safety.** Apart from their enforcement role, inspection personnel provide a sense of security to passengers. Although particular problem areas probably will have designated security personnel assigned, there may be places in the system where inspection personnel can supplement the security function. Inspection personnel can play major security role during low-demand times of day. Security concerns may influence the selection of an inspection strategy in some cases.

- **Labor Issues.** Scheduling constraints may influence the selection of an inspection strategy.

Industry Practice

As shown in Table 3-5, North American transit agencies pursue a range of inspection strategies, and more than one-third of these agencies combine two or more strategies (although not listed on this table, some of these agencies also conduct periodic 100% sweeps). More than one-half (55%) of the agencies allow inspection personnel to conduct random inspections, at their own discretion; 55% actively target evaders as part of their inspection program; and 36% perform inspections across the whole system.

Nearly two-thirds of these agencies (64%) report pursuing only a single inspection strategy, suggesting that finite resources may limit their ability to engage in multiple strategies. However, most of these (57%) allow inspection personnel to conduct random inspections at their own discretion. The flexibility of this strategy may allow an agency to respond more easily to local circumstances.

With regard to the relative impact of the type of strategy on fare evasion, the table shows evasion rates reported by these agencies. There is no apparent correlation between strategy and reported evasion rate—or between using multiple strategies and evasion rate—for these

Table 3-5: Inspection Strategy

Transit Agency	Inspection Strategy	Evasion Rate*
Bi-State (St. Louis)	Random, at inspection personnel discretion	2%
DART (Dallas)	Cover whole system	5%
LACMTA (Los Angeles)	Random, at inspection personnel discretion	6%
NJ Transit (New Jersey)	Target evaders	1.5%
NFTA (Buffalo)	Random, at inspection personnel discretion	3.4%
OC Transpo (Ottawa)	Cover whole system Random, at inspection personnel discretion Target evaders	2%
RTD (Sacramento)	Cover whole system Target evaders	2%
San Diego Trolley	Target evaders	6%
SCRRA (Los Angeles)	Cover whole system Target evaders	1.5%
Tri-Met (Portland)	Random, at inspection personnel discretion Targeted	4%
Tri-Rail (Miami)	Random, at inspection personnel discretion	2%

*****As explained in the previous section, the evasion rate, as reported by the agencies, represents the percentage of passengers inspected who do not have valid POP.

agencies. The relationship between evasion rate and factors such as number of inspectors and inspection rate is explored in the Number of Inspection Personnel section; the process of identifying the evasion rate itself is reviewed in the section Measuring the Evasion Rate.

Summary and Recommendations

Transit agencies use various inspection strategies on their SSFC systems, and some agencies use a combination of approaches. There is no apparent correlation between the strategy(ies) an agency employs and the resulting evasion rate. Thus, the decision on a particular strategy should be based on factors such as an agency's philosophy regarding the best way to deter fare evaders, the need to augment other security functions at certain locations and/or times, and constraints on resources available for inspections. Key points regarding the selection of an inspection strategy include the following:

- Given that an agency has finite resources for inspection purposes, a trade-off must be made between the desire to conduct systemwide inspections and the desire to focus on specific problem areas.

- Many agencies give inspection staff considerable discretion as to the specific inspection approach they use.

- Targeting the peak is the most efficient way to reach the largest number of potential evaders. Even if evasion rates are higher at other times, the absolute number of evaders is probably highest during the peak. However, crowded trains at times of high demand can complicate the inspection process, sometimes making it necessary to conduct inspections on platforms.

- Where feasible, regular inspections should be supplemented with at least occasional 100% sweeps at selected times. However, this often requires additional staff to assist the regular inspection personnel.

An agency should develop an **inspection strategy** based on its goals for deterring fare evasion, coupled with its resource constraints (i.e., the number of dedicated inspection personnel, as well as the potential for temporary additional staff when needed) and possibly anticipated evasion patterns. Where feasible, an agency should seek to supplement its normal inspection process with targeted 100% sweeps.

Inspection Rate and Number of Personnel

Issues/Decisions

The inspection rate is the percentage of the transit agency's passengers who are checked for proof of payment by fare inspectors. This rate is the fundamental measure of the level of an agency's inspection effort. This figure is related to the system's ridership, but the key determinant from the agency's point of view is the number of inspection personnel deployed. The basic issues an agency must address in this area are as follows:

- Identify the number of full-time (in-house and/or contract) fare inspection personnel to be used in the SSFC system,
- Identify the availability of supplementary personnel (e.g., to conduct special targeted inspection sweeps), and
- Identify the target inspection rate.

Related Sections

Measuring the Evasion Rate

Inspection Strategy

Types of Inspection Personnel

Fare Evasion Fine Structure

Fare Evasion Follow-up Program

The number of inspection personnel an agency uses depends on several factors, including the following:

- The size and configuration of the SSFC system, including number of stations and stops and number of lines and length of each;
- Daily system ridership;
- The agency's inspection strategy (e.g., systemwide/random, target the peak, target evasion problem areas, 100% sweeps—see Inspection Strategy section);
- Type—and cost—of personnel to be used (e.g., agency police, contract police, agency staff [non-police], or contract security—see Type of Inspection Personnel section); and
- The available inspection and enforcement budget.

Although ideally an agency would identify the personnel requirements and inspection rate on the basis of the inspection strategy, the size of the system, and the ridership, the reality is that the constraints of the available budget often represent the most important decision factor. A key question then arises: How important is the size of the inspection staff and the inspection rate in limiting fare evasion? This is addressed below, under Industry Practice.

The various considerations in establishing an inspection rate and determining the number of inspection personnel—along with a discussion of current agency practices and experiences in this area—are reviewed below.

Techniques/Approaches

As explained in the section on Industry Practice, there are no clear mathematical formulas that can be used in determining the appropriate inspection rate and number of personnel. As suggested above, these figures are typically based on a combination of factors and constraints unique to each agency. Although optimum levels are difficult to define, two basic principles typically apply to an SSFC system: (1) past some point, there appear to be diminishing returns associated with adding inspection personnel; and (2) if the inspection rate and number of inspection personnel do not meet certain minimum levels, the agency can open itself up to a devolutionary cycle under which increasing evasion overwhelms inspection, leading to still further evasion. The major considerations that come into play in identifying the inspection rate and personnel requirement are discussed the following sections.

Considerations

Determining the proper number of inspection personnel involves balancing several competing considerations. These considerations include the following:

- **Size and Configuration of System.** The size and operating characteristics of the SSFC system (e.g., overall length, number of stations and stops, number of cars in operation, and daily operating hours) have a significant impact on the number of personnel needed to achieve a certain inspection rate. Two systems with identical daily ridership may present very different logistical challenges for inspection because of size and operational differences.

- **Passenger Volumes.** Daily ridership—as well as variations by time of day—directly affects the number of personnel needed to achieve a certain inspection rate. Seasonal variations in ridership and variations for special events must also be considered, because they may have implications in terms of the need to redeploy inspection staff at certain times.

- **Inspection Strategy**. Individual strategies do not necessarily differ in their resulting personnel needs, although targeting peak periods is potentially more efficient, given the right circumstances (i.e., no crowding that would require extra personnel). However, pursuing multiple strategies simultaneously is likely to require extra personnel.

- **Type and Cost of Inspection Personnel**. The different types of personnel (police versus other staff, and in-house versus contract) have different cost implications and thus affect the number of inspection personnel an agency can use.

- **Available Budget**. The budget an agency has made available for inspection personnel is a major consideration and constraint on the inspection rate that can be achieved.

- **Ancillary Duties**. Any non-inspection responsibilities of inspection personnel may take away time from inspection and, ultimately, increase the number of inspection personnel necessary for effective enforcement.

- **Use of Inspection Teams**. Inspection personnel often work in teams, either at all times or in special circumstances (e.g., at night). This arrangement may reduce the efficiency of inspections.

Industry Practice

Information on inspection rates and numbers of inspectors, along with productivity and evasion rates, is presented for a number of SSFC systems in Table 3-6. Table 3-7 shows inspection costs reported by a subset of these agencies. These figures are compared below.

Number of Inspectors

As indicated in Table 3-6, the numbers of inspectors vary considerably, from a low of 3 at Sound Transit (Seattle) to a high of 169 at LACMTA. The average for all of these agencies is 34. As explained earlier, the number of inspectors is related, at least in part, to the ridership level. Thus, a more meaningful measure of level of inspection is the number of inspectors per 1,000 daily riders. Here too there is considerable variation, although Sound Transit, due to its currently low ridership (1,200 per day), has one of the higher rates, at 2.44. The highest rate is Tri-Rail's 4.38, while the lowest is HKL's (Helsinki) 0.09. The average for the group is just over 1.

Table 3-6: Inspection and Evasion Rates

Transit Agency	Average Daily Ridership	Number of Inspectors	Inspectors/ 1000 Daily Riders	Inspection Rate	Inspector Productivity (passengers/ inspector)	Evasion Rate
Bi-State (St. Louis)	42,000	15	0.36	20.0%	560	2.0%
Calgary Transit	187,700	NR	NA	42.0%	NR	1.7%
DART (Dallas)	42,800	45	1.05	30.0%	285	5.0%
GO Transit (Toronto)	136,000	NR	NA	4.0%	NR	0.8%
HKL (Helsinki)	637,300	55	0.09	1.0%	116	2.0%
LACMTA (Los Angeles)	211,000	169	0.80	20.0%	250	6.0%
MTA (Baltimore)	NR	40	NA	20.0%	NR	1.0%
Muni (San Francisco)	140,000	21	0.15	15.0%	1000	1.0%
NFTA (Buffalo)	25,000	7	0.28	11.5%	411	3.4%
NJ Transit (New Jersey)	9,000	22	2.44	40.0%	164	1.5%
RTD (Denver)	22,500	6	0.27	20.0%	750	2.0%
RTD (Sacramento)	28,500	6	0.21	10.0%	475	2.0%
San Diego Trolley	83,500	29	0.35	25.0%	720	6.0%
SCRRA (Los Angeles)	31,000	59	1.90	25.0%	131	1.5%
SCVTA (San Jose)	29,800	9	0.30	12.0%	397	1.8%
Sound Transit (Seattle)	1,200	3	2.44	100.0%	410	0.3%
TTC (Toronto)	269,600	NR	NA	5.0%	NR	2.4%
TPG (Geneva)	NR	NR	NA	0.7%	NR	2.0%
Tri-Met (Portland)	65,100	19	0.29	6.0%	206	4.0%
Tri-Rail (Miami)	8,000	35	4.38	75.0%	171	2.0%
Average	*109,444*	*34*	*1.02*	*26.0%*	*504*	*2.4%*
Minimum	*1,200*	*3*	*0.09*	*0.7%*	*116*	*0.3%*
Maximum	*637,300*	*169*	*4.38*	*100.0%*	*1000*	*6.0%*

NR = No response
NA = Not available

Table 3-7: Inspection Costs

Transit Agency	Number of Inspectors	Annual Cost of Inspectors*	Cost per Inspector*
Bi-State (St. Louis)	15	$414,000	$27,600
LACMTA (Los Angeles)	169	$19,435,000**	$114,967
MTA (Baltimore)	40	$1,400,000	$35,000
Muni (San Francisco)	21	$1,250,000	$59,524
NFTA (Buffalo)	7	$357,000	$51,000
NJ Transit (New Jersey)	22	$1,200,000	$54,545
RTD (Denver)	6	$265,000	$44,167
RTD (Sacramento)	6	$384,000	$64,000
San Diego Trolley	29	$1,116,000	$38,483
SCRRA (Los Angeles)	59	$3,900,000	$66,102
SCVTA (San Jose)	9	$700,000	$77,778
Tri-Met (Portland)	19	$1,300,000	$68,421
Average	*34*	*$2,643,000*	*$58,466*
Minimum	*6*	*$357,000*	*$23,636*
Maximum	*169*	*$19,435,000*	*$114,967*

***** These are "fully allocated" labor costs (i.e., including fringe benefits).

****** LACMTA reports a total cost for the overall police contract of $53 million (for 461 officers). However, only 169 officers are assigned to the rail lines and, thus, conduct fare inspections. The cost figure shown here is a pro-rated estimate for 169 police officers.

In general, the commuter rail services have higher inspection levels than do the LRT services; LACMTA includes both LRT and heavy rail. Except for NJ Transit (2.44) and DART (1.05), the U.S. LRT systems all fall within a range of 0.15 (SF Muni) and 0.36 (Bi-State in St. Louis). The average of this latter group of eight systems is 0.28; the average of the four commuter rail/heavy rail systems (i.e., including LACMTA) is 2.73. Thus, in terms of guidelines for new SSFC systems, the following would seem to be reasonable targets:

- LRT systems—0.2–0.3 inspectors per 1,000 daily riders and
- Commuter rail or heavy rail—2.0–3.0 inspectors per 1,000 daily riders.

Productivity of Inspection Personnel

The productivity of inspection personnel is defined as the average number of passengers an inspector checks each day. This rate is calculated as follows:

$$\text{inspection rate} \times \text{the daily ridership} / \text{the number of inspectors}$$

The agencies in Table 3-6 show a wide range of productivities: 116 (HKL) to 1,000 (SF Muni); the average is 504. Inspection productivity is affected several factors, including number of stations, vehicle headways, passenger volumes (i.e., per train), and inspection pattern (i.e., whether inspections are conducted on the train or the platform). As shown by the table, there is some relationship between the ratio of inspectors to passengers and the inspector productivity. In general, those agencies with the higher inspection levels have lower productivities. Thus, the LRT systems mentioned above (i.e. those with inspection levels under 0.4 inspectors per 1,000 daily riders) have the highest inspector productivities; most of these are over 400

inspections per day. The commuter rail/heavy rail group is mostly under 200; Sound Transit, which has 100% inspection, is an exception, with a rate of 410. Thus, in terms of guidelines for new SSFC systems, the following would seem to be reasonable targets:

- LRT systems—400–750 passengers per inspector per day and
- Commuter/heavy rail—100–200 passengers per inspector per day.

Inspection Rate

The inspection rate is the percentage of the transit agency's passengers checked for proof of payment by fare inspectors. As shown in Table 3-6, these rates vary considerably. The two European systems have the lowest rates: 0.7% for TPG (Geneva) and 1% for HKL (Helsinki). The highest rates are reported by two of the commuter rail systems: 100% at Sound Transit (Seattle) and 75% at Tri-Rail (Miami). A third commuter rail system, SCRRA (LA), has a rate more on the order of the LRT systems, at 25%; the final commuter rail system, GO Transit (Toronto), reports an inspection rate of only 4%.

Among the 13 North American LRT systems (including LACMTA) in the table, the range is 6% (Portland Tri-Met) to 42% (Calgary Transit). Most of these systems (7 of the 13) fall in the range of 15% to 30%. Two of the systems have rates higher than 30%, while four are below 15%. The average rate for all of the agencies in the table is just under 26%.[2]

Relationship Between Inspection Rate and Evasion Rate

The nature of the relationship between inspection rate and evasion rate typically arises in studies of SSFC systems: is there a clear correlation between the two measures? Does increasing the inspection rate inevitably result in reduction of the evasion rate? Table 3-6 shows the evasion rate. As can be seen in the table, the evasion rates are remarkably consistent; the range is 0.3% (Sound Transit) to 6% (LACMTA and San Diego Trolley), and the average for all of the systems is 2.4%. However, most of the agencies fall within the 1.5%-to-2.5% range; one-quarter report evasion rates above 2.5%, and one-fifth of the agencies are below 1.5%. Two-thirds of all these agencies report evasion rates between 1.0% and 3.0%.

Comparing the inspection rates with the evasion rates reveals no clear correlation between the two measures. Based on the rates reported by these agencies, there is no significant statistical relationship that can be derived. The one agency with 100% inspection, Sound Transit, does report the lowest evasion rate (0.3%), but it has, by far, the lowest ridership among these agencies. In some cases, agencies having lower inspection rates, as would be expected, are experiencing among the higher evasion rates: see Tri-Met and NFTA. However, two agencies (RTD in Sacramento and SCVTA in San Jose) with comparably low inspection rates report among the lower evasion rates. Meanwhile, the agencies with the

[2] Few of these agencies verify the accuracy of the inspection rates reported by their inspectors, relying solely on the number of inspections recorded by each inspector (e.g., on a daily basis). It may be useful to consider some type of periodic audit of the actual inspection rates. For instance, Metro North Commuter Railroad, although not a POP system, sends out an audit team once every 2 years to check that conductors are inspecting 100% of passengers, as is the policy.

highest evasion rates (LACMTA and San Diego Trolley) have inspection rates close to the overall average, and several agencies have lower evasion rates than do agencies with among the highest inspection rates.

Thus, although some level of inspection is required to minimize evasion, there is no clear evidence that a particularly high inspection rate will result in a particularly low evasion rate. Agencies introducing new SSFC systems might, therefore, consider inspection rates somewhere in the 15-to-25% range, and in so doing can reasonably expect, based on the reports of existing systems, to experience evasion rates on the order of 1.5 to 3%. Of course, fare inspection is only one element of the overall enforcement program. Factors such as the fine structure, the treatment of evaders, agency follow-up of citations issued (including working with the courts), and customer education are important as well.

Cost of Inspection Personnel

As indicated in Table 3-7, the average annual cost per inspector is roughly $58,500. There is a significant range, from a low of $27,600 (Bi-State) to a high of nearly $115,000 (LACMTA). This table presents the cost of the basic inspection staff (or contract personnel); a number of agencies have additional inspection costs for supplemental staff or contract personnel, as well as ancillary costs related to inspection.

Summary and Recommendations

Fare inspection is an important element of an SSFC enforcement program, and key inspection decisions include establishing an inspection rate and determining the number of inspection personnel to deploy. These decisions are affected by various factors, including the size of the system, daily ridership, and, perhaps, budgetary constraints. Key findings and recommendations based on the review of agency experience include the following:

- In general, commuter rail has higher inspection levels than does LRT. In terms of number of inspectors per 1,000 daily riders, there is considerable variation among the agencies—from 0.09 to 4.38. The overall average is 1.02. Most of the U.S. LRT systems fall within a range of 0.15 and 0.36, with an average 0.28; the average for commuter rail systems is 2.73.

- The average inspection productivity (i.e., number of riders checked by each inspector per day) is 504. In general, those agencies with higher inspection levels have lower productivities.

- Most LRT SSFC systems have inspection rates between 15% and 30%; the average is 26%. However, there is no clear correlation between inspection rate and evasion rate.

There is no specific formula for establishing a reasonable **inspection rate**. However, based on existing SSFC experience, agencies introducing new systems might consider inspection rates on the order of 15% to 25%, and in doing so, can expect to experience evasion rates on the order of 1.5 to 3%.

Type of Inspection Personnel

Issues/Decisions

The type of inspection personnel decision refers to the type (or types) of personnel the agency will use to perform fare inspection duties: agency police, contract police, agency staff (i.e., dedicated fare inspectors), or contract security.

The basic issues in selecting inspection personnel are as follows:

- Type of inspection personnel,
- Duties to be performed by inspection personnel, and
- Whether the inspectors should be uniformed or plainclothes.

Related Sections

Legal Authorization for Enforcement

Inspection Strategy

Inspection Rate & No. of Personnel

Treatment of Fare Evaders

The alternative techniques and approaches regarding inspection personnel, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the sections that follow.

Techniques/Approaches

There are four basic types of inspection personnel that transit agencies use to conduct fare inspections:

- Agency police,
- Contract police,
- Agency staff (non-police), and
- Contract security.

The first step for the agency is to define the role that it would like inspection personnel to play; the second step is to find the right personnel for these roles. The role of inspection personnel depends, in part, on the relationship that the agency is trying to create with its riders. The role also depends on local conditions (e.g., the security needs of the system). Besides fare inspection and enforcement, inspection personnel could conceivably be assigned any or all of the following duties: (1) customer service, (2) monitoring transit system operations, (3) security, and (4) responding to criminal acts. The proportion of time devoted to each of these duties will vary by agency; not all inspection personnel perform all these duties. For example, some agencies have dedicated security personnel. It is necessary to review the labor agreements in place—i.e., to determine the types of functions inspectors are allowed to perform.

Because different types of inspection personnel require different types of training and skills, clearly defining the role that inspection personnel will play at an agency is crucial. The experience of inspection personnel has consequences for both the work they are able to do and the cost of obtaining their services. In addition, the cost of inspection personnel may influence the size of the inspection team, which is itself a factor in its effectiveness. In some cases, inspection personnel may need additional training. Some agencies combine the types of personnel. Each approach has advantages and disadvantages; the alternatives are compared, within the context of key considerations discussed below, in Table 3-8.

A second decision regarding inspection personnel is whether they should be uniformed or plainclothes. Uniformed personnel typically have a greater deterrent value and add to the subjective sense of security of passengers. However, because they are more conspicuous, they more readily tip off fare evaders to their presence, thereby allowing evaders to alight a train if they see an inspector about to board. Plainclothes personnel are less conspicuous. Of course, this decision is dictated, in part, by the type of personnel being used; police inspectors, for instance, will typically be uniformed. (As explained below, most agencies use uniformed inspectors, although some use a combination of both uniform and plainclothes.)

Considerations

Selecting inspection personnel involves balancing several competing considerations. These considerations include the following:

- **Disadvantages.** Each type has certain potential disadvantages.

- **Cost/Budget**. The issue is the relative cost of these types of inspection personnel (e.g., using local police usually costs more than agency staff). There is likely to be a limited budget available.

- **Role of Inspection Personnel.** Some types of inspection personnel are better suited for some roles than others.

- **Safety/Security (of Inspectors and Passengers).** The safety of both inspectors and passengers is an issue. At least some fare evaders will have committed other types of offenses and may even be wanted on outstanding warrants; these or other individuals sometimes become unruly when inspected or cited. Armed police will be better equipped to deal with such situations than will unarmed inspectors.

- **Liability If Armed.** Insurance costs may vary significantly, probably in relation to training and experience.

- **Legal Authority**. The question here is whether any approaches are legally prohibited under the statutes authorizing the agency to conduct fare enforcement.

- **Management Control.** The contrast is sharpest here. Different personnel types may come to the job with different assumptions based on their professional backgrounds

Table 3-8: Alternative Inspection Personnel Techniques

Issue	Agency Police	Contract Police	Agency Staff	Contract Security
Disadvantages	Inspection may not be primary concern; may be diverted by security or other concerns.	Inspection may not be primary concern; may be diverted by security or other concerns.	Less able to deal with unruly evaders.	Maintaining professionalism (i.e., according to agency standards) is sometimes a problem.
Cost/Budget	Often most costly; fringe benefits and overhead can double hourly rate.	Relatively high. Local police often paid at overtime rates; however, no overhead.	Typically lower than using police, but fringe benefits and overhead can double hourly rate.	Usually least costly; no overhead.
Role of Inspection Personnel	Some agencies prefer police to be seen as "helpers," rather than in the negative light of issuing citations. Possible adversarial role; has resulted in lawsuits against agencies in some cases.	Since separate from transit police, "helper" role may be less important for contracted police. Possible adversarial role.	With adequate training, a professional and "helping" relationship can be established.	With adequate training and monitoring, a professional and "helping" relationship can be established.
Security (of Inspectors & Passengers)	Armed police better able to deal with unruly evaders.	Armed police better able to deal with unruly evaders.	Likely unarmed. May be at risk in some cases.	Likely unarmed. May be at risk in some cases.
Liability If Armed	Usually a feature of policies for agency police.	Must be negotiated with city/county—may require additional insurance coverage.	Cost can be substantial—requires aggressive risk management.	Agency must use risk transfer (insurance and indemnification) to be sure contractor is fully insured for any incident.
Legal Authority	Generally authorized.	Contracting sometimes prohibited.	May have to be part of police department.	Contracting sometimes prohibited.
Management Control	Police may see themselves as independent of operating management, which can be a problem.	Control can be a problem, especially if contract through another public agency; priorities may be mixed.	As employees, control of in-house inspectors should be excellent.	Control is established through contract performance requirements.
Ability to Conduct Intensive Inspections (100% Sweeps)	Possible if agency has large enough police force to provide pool of resources. Requires training of all police in inspections; quality control must be assured.	Requires a large pool of trained personnel to draw from. These personnel may not work frequently, which can become an administrative and quality control problem.	Availability of additional personnel will be limited. It may be possible to supplement staff with in-house security or police.	If contractor is large enough, there should be a pool of personnel to draw from. However, training and quality control must be assured.
Scheduling	May be a problem getting agency police to work split shifts, emphasizing peaks.	As part-time personnel, should be able to get short peak shifts. Availability may depend on other demands, however.	Work conditions must allow for split shifts and part-time work.	Contract must make personnel available during peak travel periods and as needed.

SOURCES: Booz-Allen & Hamilton, *Newark City Subway Proof of Payment System* (for New Jersey Transit, April 1997); and survey for TCRP Project A-24.

and also based on the arrangement under which they are retained (e.g., contract versus employee).

- **Ability to Conduct Intensive Inspections.** Intensive inspection (i.e., 100% sweeps), a useful strategy practiced by many agencies, often requires extra personnel (on a temporary basis) to implement.

- **Scheduling.** Not so much the type of personnel, but rather the arrangement under which they are typically hired, may affect their flexibility in terms of scheduling.

Industry Practice

As shown in Table 3-9, most SSFC systems use agency staff (i.e., non-police) to perform inspections (over 70% of those reported in the table). Agency police, contract police (or sheriff), and/or contract security are used, either by themselves or in conjunction with agency staff, at 9 of the 21 agencies. Overall, one-third of the agencies use contract personnel, but three of these agencies deploy contract personnel to supplement their in-house staff. Many inspection personnel perform other duties besides inspections as a regular part of their jobs. The most common duties are security and law enforcement, although these responsibilities, not unexpectedly, seem to be associated mostly with agencies that use police or contract security. The share of inspection personnel's time spent on security and law enforcement ranges from 10% to 50%.

Inspection personnel are usually complemented by other personnel. For example, where inspection personnel do not also perform an explicit security function, the agency typically employs security personnel for that purpose. Some agencies whose inspection personnel do perform a security function employ "ambassadors" to fill the customer service function. Finally, the inspection personnel of all North American SSFC systems wear uniforms, although some systems also have some plainclothes personnel.

Summary and Recommendations

Based on a review of the advantages and disadvantages of using different types of personnel to perform inspections—and related duties—the following findings and recommendations emerge:

- Most SSFC systems use uniformed agency staff to perform inspections, although a few supplement these with police (in-house or contract). Using agency staff typically costs less than using police; contract security is sometimes cheapest because of savings in fringe benefit costs and overhead. Using agency staff also appears to offer a greater level of control over the inspection process and more stability within the unit, which results in greater consistency in the treatment of passengers.

- Agencies should consider training at least some security staff in conducting inspections. This will enhance the flexibility of the enforcement team, including providing supplementary staff needed for 100% sweeps.

Table 3-9: Inspection Personnel Characteristics

Transit Agency	Inspection Personnel	Uniformed or Plainclothes	Other Duties	Other Staff
Bi-State (St. Louis)	Contract Security Contract Police	Uniformed	Security (10-15%)	Fixed post security, Police officers
Calgary Transit	Agency Staff	Both	NA	NA
DART (Dallas)	Agency Police	Uniformed	Security	Supervisors Agents Maintenance
GO Transit (Toronto)	Agency Police	Uniformed	Security and law enforcement (25%)	Ticket seller
HKL (Helsinki)	Agency Staff	Uniformed	Customer service (5%)	Security
LACMTA (Los Angeles)	City Police County Sheriff	Uniformed	Security and law enforcement	NA
MTA (Baltimore)	Agency Police	Uniformed	Security and law enforcement (50%)	NA
Muni (San Francisco)	Agency Staff	Uniformed	NA	Station agents Supervisors
NFTA (Buffalo)	Agency Staff	Uniformed	Cust. service (10%) Psgr counts (1%)	Maintenance staff
NJ Transit (New Jersey)	Agency Staff	Uniformed	Customer service	Operations Staff NJ Transit Police
OC Transpo (Ottawa)	Agency Staff	Uniformed	None	Security Transit supervisor
RTD (Denver)	Agency Staff	Uniformed	Passenger counts (~2%)	Contract security Supervisors Other staff
RTD (Sacramento)	Agency Staff Agency Police Local Police	Both	NA	Contract security
San Diego Trolley	Agency Staff	Uniformed	Monitor parking and cite violators	Station security and volunteer ambassadors
SCRRA (Los Angeles)	Agency Staff L.A. County Sheriff (contract)	Uniformed	Security (Sheriffs); Conductors inspect 10% of time	Ambassadors assigned stations on rotating basis
SCVTA (San Jose)	Agency Staff	Uniformed	None	Contract security
Sound Transit (Seattle)	Conductors (contract)	Uniformed	Operations and safety duties	Agency security
Tri-Met (Portland)	Agency Staff Contract Police	Uniformed	Security and law enforcement, with inspection (80%)	Private security at some stations; supervisors
Tri-Rail (Miami)	Contract Security	Uniformed	Security	Security zone patrols
TTC (Toronto)	Agency Staff	Uniformed	None	Station collector
VRE (Washington)	Conductors	Uniformed	NA	None

The most cost-effective **inspection personnel** approach is to use *uniformed agency staff* for conducting fare inspection, as well as assisting in performing general customer service duties. *Agency police* can also provide for effective inspection—and offer the advantage of being able to detain and arrest evaders, if necessary—but at a higher cost to the agency.

Treatment of Fare Evaders

Issues/Decisions

The treatment of fare evaders addresses the courses of action available to inspection personnel for dealing with the fare evaders they apprehend. Because the circumstances of evasion may vary from "honest mistakes" to willful flaunting of the law, inspection personnel usually have to exercise discretion for individual cases. However, word about how an agency typically treats evaders may spread informally among passengers. As a result, the treatment of individual cases eventually has a cumulative impact on perceptions about the agency and may, therefore, affect the extent of willful evasion. For example, an agency could develop a reputation as being either too lax or too harsh, and both of these extremes will affect evasion and enforcement. The basic issues an agency must address in establishing a policy on the treatment of evaders are as follows:

- Typical treatment of evaders,
- Independence and level of discretion given to inspection personnel, and
- "Special circumstances."

Related Sections

Inspection Strategy

Inspection Rate/No. of Personnel

Type of Inspection Personnel

Fare Evasion Fine Structure

Fare Evasion Follow-up Program

The techniques and approaches that can be employed regarding treatment of evaders, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the sections that follow.

Techniques/Approaches

The alternative basic approaches that can be used in the treatment of evaders are as follows:

- Issuing citations to most evaders (i.e., except for what the inspector considers to be "special circumstances");
- Issuing warnings, rather than citations, to most evaders (e.g., except for the most egregious violators, who would be cited and/or removed from the vehicle);
- Giving inspectors discretion as to whether to issue a citation or warning; and
- Removing evaders from the vehicle (i.e., in addition to being cited or warned).

An agency can decide to be very strict in its policy toward all evaders, or it can give its inspectors discretion as to how to treat evaders. This discretion can include (1) whether to issue a citation or a warning in general, as well as (2) whether to allow special treatment for certain mitigating circumstances. For instance, special treatment can be permitted (or even

encouraged) for such riders as tourists who are clearly unfamiliar with the fare requirements, seniors, riders with disabilities, or children.

In dealing with any type of special circumstance, the inspector has the choice of issuing a formal warning or simply explaining the SSFC process. As suggested above, an agency can also have a policy of issuing warnings to most evaders—perhaps to all first-time evaders (assuming the inspector has a means of immediately checking on prior offenses). Finally, the policy regarding treatment of evaders may also include removal of the evader from the vehicle; where this is done, it is typically in addition to issuance of a citation or warning.

Each approach has advantages and disadvantages. Regardless, if inspectors are given too much discretion, the result may be considerable variation in the treatment of evaders from one inspector to the next. It is thus useful for the agency to establish inspection performance guidelines for the inspectors; employee training is also important in instructing inspectors in treatment of evaders. The basic approaches of emphasizing citations versus emphasizing warnings are compared, within the context of key considerations discussed below, in Table 3-10.

Considerations

Establishing a policy for treatment of evaders involves balancing several competing considerations. These considerations include the following:

- **Impact on Deterrence and Ability to Track Repeat Offenders.** The financial penalty associated with a citation probably means that it has a stronger deterrent value for evasion and thus does better at discouraging repeat offenses. However, the inconvenience and embarrassment of being issued a warning—and/or being removed from the vehicle—should also act as a deterrent to future evasion. The downside of a warning is that it often provides no record of the offense—and thus prevents detection of repeat offenses.

Table 3-10: Alternative Techniques for Treatment of Evaders

	Citations to Most Evaders	Warnings to Most Evaders
Impact on Deterrence & Ability to Track Repeat Offenders	Financial penalty is probably stronger deterrent. Citation typically needed if agency wants to track repeat offenders.	Embarrassment and inconvenience should be sufficient deterrent in many cases. Warnings may provide no record of repeat offenses.
Image of Agency	Agency may be seen as unnecessarily punitive if applied inflexibly.	May complement an approach that favors customer education over deterrence.
Inspection Strategy	May be more appropriate for targeting evaders and 100% sweeps.	May be more appropriate for comprehensive coverage and targeting peak.
Level of Conflict with Evaders	Potential for conflict higher than with warnings.	Potential lower, but will be high if evader also removed from vehicle.
Impact on Productivity of Inspection Personnel	May result in less time for overall inspection and lower visibility of inspectors.	Should maximize overall coverage and general visibility of inspectors.

- **Image of Agency**. The policy on treatment of evaders will affect—and may be influenced by—the image that the agency projects to riders. For example, issuing citations to most evaders—with little discretion for special circumstances—may be seen as unnecessarily punitive by the riding public.

- **Inspection Strategy**. A policy that emphasizes citations—as opposed to warnings—is more appropriate for an inspection strategy that targets times and places with high evasion rates. This policy is also appropriate for 100% sweeps, because letting off most evaders (i.e., with warnings) would undermine the effort. Moreover, a citation ensures that an evader becomes known to the agency. A policy that allows warnings in most cases may be more appropriate for inspection strategies that involve more general comprehensive coverage or targeting the peak period, where the visibility of the inspection personnel may be considered the most important deterrence factor.

- **Level of Conflict with Evaders.** Issuing a citation may produce a greater level of conflict with an evader than will giving a warning. Attempting to remove the evader from the vehicle may result in further conflict. The inspector should be given discretion as to most appropriate treatment in such cases—i.e., so as to prevent possible physical harm to the inspector or disruption for the other riders.

- **Impact on Productivity of Inspection Personnel.** If issuing citations takes a significant amount of time, then the cumulative effect may be that inspection personnel have less time to conduct inspections. Therefore, the deterrent value of issuing citations must be balanced against a possible reduction in the overall coverage and visibility of inspection personnel.

Industry Practice

As shown in Table 3-11, there is a fairly even distribution among North American agencies as to treatment of evaders. “Officer discretion” is the most common policy, reported by 42% of these agencies. Similar numbers of agencies report that they issue citations (37%) or “cite or warn” (32%). Five of the these agencies (26%) remove evaders from the vehicle, most often in conjunction with citation or warning.

With regard to treatment of repeat offenders, the policies are more varied. Beyond the imposition of higher fines (see Fare Evasion Fine Structure section), some agencies remove—or even exclude from the system—repeat offenders, and, in a couple of cases, the person is subject to arrest.

A useful indication of agencies’ policies is the rate at which citations and warnings are issued to evaders. If riders perceive that citations are seldom written, the agency’s enforcement program can quickly lose its effectiveness. Table 3-12 presents information on citations and warnings issued by several agencies. As indicated, there is a considerable range in terms of agencies’ practices in this area. The range for number of annual citations issued is 2,844 (Baltimore) to 19,200 (LACMTA, on its Blue Line). The actual number issued translates into a citation rate (i.e., number of citations per 1,000 annual passengers) that ranges from Calgary’s 0.31 to Sacramento’s 2.08; the average for this group is 0.78.

Table 3-11: Transit Agency Treatment of Fare Evaders

Transit Agency	Basic Policy	Policy for Repeat Offenders
Bi-State (St. Louis)	Citation	Police called if 2 or more priors
DART (Dallas)	Removal from vehicle, citation	(same as basic policy)
GO Transit (Toronto)	Officer discretion	(same as basic policy)
LACMTA (Los Angeles)	Officer discretion, citation or warning	Repeat offenders' list
MTA (Baltimore)	Citation	(same as basic policy)
Muni (San Francisco)	Officer discretion	(same as basic policy)
NFTA (Buffalo)	Removal from vehicle, citation	Repeat offenders' list, possible arrest
NJ Transit (New Jersey)	Officer discretion, Citation, warning, or courtesy ticket	(same as basic policy)
OC Transpo (Ottawa)	Removal from vehicle, citation or summons	Summons to appear (second fine or higher)
RTD (Denver)	Check ID, citation	Removal from vehicle, citation
RTD (Sacramento)	Officer discretion	Removal and exclusion
San Diego Trolley	Removal from vehicle, citation or warning	Note on citation (to alert court)
SCRRA (LA)	Citation	(same as basic policy)
SCVTA (San Jose)	Removal from vehicle, citation or warning	(same as basic policy)
Sound Transit (Seattle)	Warning (will soon begin to issue citations)	(same as basic policy)
Tri-Met (Portland)	Officer discretion, citation or warning	Exclusion (depending on no. of priors); if violated may be arrested for trespassing
Tri-Rail (Miami)	Citation	Trespass warning or arrest
TTC (Toronto)	Officer discretion	Summons and court appearance
VRE (Washington)	Conductor discretion, citation or warning	(same as basic policy)

Table 3-12: Issuance of Citations and Warnings

Agency	Annual Citations Booked*	Citations per 1,000 Annual Passengers	Ratio of Daily Inspections to Citations	Ratio of Citations to Warnings
Bi-State (St. Louis)	4,000	0.50	614	NA
Calgary Transit	9,836	0.31	116	NA
LACMTA (Los Angeles)**	19,200 (5,800)	1.62	178	3.31
MTA (Baltimore)	2,844	0.47	366	NA
Muni (San Francisco)	3,339	0.36	210	NA
NFTA (Buffalo)	2,400	0.34	648	NA
RTD (Sacramento)	16,800 (200)	2.08	73	84.00
San Diego Trolley	11,196	0.68	298	NA
SCVTA (San Jose)	3,000 (11,400)	0.67	312	0.26

*annual warnings shown in parentheses; information on warnings not available for other agencies
**these figures are for the Blue Line only

SOURCE: *Muni Proof-of-Payment Program, Task 2 N-Judah POP Evaluation*, June 2000, pp.6-6, 6-7.

The ratio of daily fare inspections to citations issued is related to the inspection productivity (i.e., average number of riders checked per inspector per day—see Inspection Rate and Number of Personnel section). As shown, the agencies again vary widely in this measure. Finally, the ratio of citations to warnings issued is presented for a subset of these agencies. These three agencies exemplify the different types of philosophies regarding treatment of evaders: SCVTA issues considerably more warnings than citations, while Sacramento RTD takes the opposite approach, issuing relatively few warnings to evaders. LACMTA follows the

same basic approach as RTD, but the difference between citations and warnings is less extreme.

Summary and Recommendations

There does not appear to be a single optimal approach regarding treatment of evaders. Rather, an agency's treatment of evaders should reflect a combination of factors related to the agency's basic inspection strategy and philosophy toward deterring evasion—as well as how this is seen as affecting its public image. The level of independence given to the inspectors (e.g., in terms of discretion in treating special circumstances) is thus largely dictated by these factors. However, on the basis of review of current industry practices, the following findings and recommendations emerge regarding treatment of evaders:

- Each agency should develop guidelines for its inspectors regarding what constitutes a special circumstance. Special treatment can be permitted (or even encouraged) for riders such as tourists who are clearly unfamiliar with the fare payment requirements, seniors, riders with disabilities, or children. Training in this area should accompany these guidelines.

- An agency may wish to consider removing evaders from the vehicle, along with issuing a citation or warning. However, the agency must consider the extent to which its inspectors should have to deal with conflicts with evaders that may arise in such cases.

A reasonable policy for **treatment of fare evaders** for a new SSFC system would be to *give inspectors leeway in deciding whether to issue a citation or warning*, depending on the circumstances (e.g., honest mistake versus willful evasion): a warning would be issued where there are special mitigating circumstances; otherwise, a citation would be issued. However, the agency should provide clear guidelines as to what constitutes a *special circumstance* and training in how to deal with evaders.

Fare Evasion Fine Structure

Issues/Decisions

The fine structure defines the penalties for fare evasion (i.e., riding without a valid pass or ticket) under different circumstances. When caught, evaders are typically issued a citation similar to those issued for violators of traffic laws. Fines consist of a penalty and, in some cases, court fees as well. The primary purpose of the fine is to deter fare evasion; however, an agency may also benefit by receiving a portion of the fine revenue. The basic issues in establishing a fine structure are as follows:

- Base fine,
- Fines for second and later offenses,
- Highest fine, and
- Treatment of repeat offenders.

Related Sections

Inspection Strategy

Treatment of Fare Evaders

Fare Evasion Follow-up Program

The techniques and approaches that can be employed in establishing the fine structure, the key considerations, and a summary of current practice and recommendations in this area are reviewed the sections that follow.

Techniques/Approaches

Three alternative basic approaches can be used in a fine structure:

- Assessing the same fine for all offenses;
- Assessing different fines for different types of offenses (i.e., based on the nature of the violation); and
- Assessing escalating fines for repeat offenses.

In addition, an agency may decide to exclude passengers from the system for repeat offenses.

Each approach has advantages and disadvantages; the approaches are compared, within the context of key considerations discussed below, in Table 3-13.

Considerations

Developing an appropriate fine structure involves balancing several competing considerations. These considerations include the following:

Table 3-13: Alternative Fine Structure Techniques

	Same Fine for All Offenses	Different Fines for Different Circumstances	Escalating Fines for Repeat Offenses	Exclude Passenger from System for Repeat Offenses*
Basic Fine Strategy	A higher base fine may better to deter fare evasion than a low initial fine.	Allows a higher fine for intentional evasion (as opposed to lack of awareness of POP requirements).	Allows a more reasonable lower fine for first offense and higher fine for repeat offenses.	May ultimately be more effective deterrence than fine.
Treatment of Evaders	A low fine may increase likelihood that inspection personnel cite evaders.	Discretion as to seriousness/intent of violation may increase likelihood that inspection personnel cite evaders.	A low initial fine may increase likelihood that inspection personnel cite evaders.	Court/agency may be more likely to impose than high fine.
Image of Agency	A high fine for first offenses may make the agency seem unreasonably punitive.	Discretion as to seriousness/intent of violation will be viewed more positively.	Lower fine for first offense and higher fine for repeat offenders will be viewed more positively.	Image may be improved by exclusion of "problem" riders from system.
Ease of Implementation/ Administration	Simplest; does not require tracking of individual evaders.	Requires that inspector note special circumstances.	Requires that court track individual evaders.	Most complex; requires that court and agency track individual evaders.
Judicial Environment	Court may distinguish among different circumstances in assessing fine.	Court may distinguish among different circumstances in assessing fine.	Court may be reluctant to assess high fines for fare evasion.	Agency may be able to impose without judicial approval.

* This requires that (1) the agency maintain a list of repeat offenders and (2) inspectors have the ability to check this information—either by carrying an updated list or through use of some type of wireless communications device that allows checking a central database for prior citations for each fare evader encountered (see section on Types of SSFC Equipment).

- **Basic Fine Strategy.** The size of the fine, coupled with the expectation of possibly being caught, are the major deterrents to evading the fare. Given the limited inspection rates of most SSFC systems—meaning that they largely depend on self-policing for success—an individual offender may, in fact, evade numerous times before being apprehended. This suggests that the fine should be set with a goal of discouraging not only a single violation but really a series of violations. Therefore, it is tempting to maximize the fine—and thus its deterrent value. On the other hand, this must be balanced against the negative image impact of a high initial fine (see below), as well as possible inspector and/or court reluctance to assess high fines.

- **Treatment of Evaders**. Most SSFC systems give their inspection personnel significant leeway in the treatment of individual evaders. Most citations written (and thus most of the evaders apprehended) are for first-time offenders. Because the fare is usually around $1, the fine these evaders face is invariably a large multiple of the fare. An inspector may, therefore, be reluctant to issue a citation that carries a particularly high fine because of the lack of proportionality.

- **Image of Agency**. Because SSFC systems are largely self-policing, they depend not just on the fear of being fined, but also on the riders' good will, to function effectively. The perception that enforcement is fair and just is, therefore, an important ingredient in maintaining a positive public image. If the penalties assessed are seen as out of proportion to the crime committed, the agency could be perceived as unreasonably punitive.

- **Ease of Implementation and Administration**. This comprises two issues: (1) how simple (or complex) is the fine structure for inspection personnel to administer and for riders to understand and (2) how much record-keeping does the fine structure require of the agency.

- **Judicial Environment.** The unavoidable connection between the fine structure and the judicial environment is that penalties may be appealed and courts may negate or reduce them. Both the inspection personnel and judges are likely to distinguish among different circumstances, but they may have different standards. For instance, a judge may be reluctant to impose the fine called for in the fine structure because of the lack of proportionality. Requiring an evader to appear in court is itself (i.e., apart from the verdict) a form of punishment.

There are two other considerations related to the fine structure. Although these do not directly affect the selection of one of the above approaches (i.e., same fine for all offenses versus different fines) and thus are not included in Table 3-13, they should be considered in establishing the basic fine levels. The considerations are as follows:

- **Prevailing Fine Structure for Other Violations.** In some cases, the fine level is constrained by the prevailing fine structure for parking or other transportation-related violations.

- **Receipt of Fine Revenue**. The levels of the fines affect, to some extent, the amount of revenue that an agency might collect. However, the amount of fine revenue collected will also depend on the agency's ability to collect revenue from the courts; in some locations, all fine revenue stays with the municipality or county—or the courts, while in others, the transit agency does receive a portion of the revenue.

Industry Practice

Fine Structure

As shown in Table 3-14, many SSFC systems have base fines of $50 or less, but several have base fines of around $100 or more. Three agencies, all in the United States, charge $25 or less for a first offense. At most of the agencies shown, the fine escalates significantly for repeat offenders. The most common practice is to charge more or less twice the initial fine for repeat offenders. As indicated, GO Transit has the greatest difference between its first (CAN$90) and second (maximum of CAN$2,000) offense, and also between its first and highest (CAN$5,000) fines. Among those agencies that do have escalating fines, the average

Table 3-14: Transit Agency Fine Structures

Transit Agency	First Offense	Second Offense	Highest Fine	Ratio, Highest to First	Policy for Repeat Offenders
ATC (Bologna)	ITL 72,000 to 270,000			3.75	Liens on assets if not paid
Bi-State (St. Louis)	$25		$500	20	Judges discretion
Calgary Transit	$150	$150	$150	--	None
DART (Dallas)	$245	$545	$545	2.2	Higher fine
GO Transit (Toronto)	CAN$90	CAN$90-2K	CAN$5,000	56	None
HKL (Helsinki)	$42 (FIM 250)			--	None
LACMTA (Los Angeles)	$76 (plus bail amount)	$150 (plus bail amount)	$250 amount)	3.3	Bail amount increases $25, $50, $100, not to exceed $250; court discretion
LTD (Eugene, OR)			$250	--	Exclusion indefinitely
MTA (Baltimore)	$35	$35	$35	--	None
Muni (San Francisco)	$103	$157	$250	2.4	Incremental fine
NFTA (Buffalo)	$20	$40	$80	4	Entered on list
NJ Transit (New Jersey)			$50	--	Mandatory court appearance
OC Transpo (Ottawa)	CAN$80	CAN$500	CAN$2000	25	Given summons to appear (second fine or higher)
RTD (Denver)	$48	$78	$118	2.5	Can result in trespass and eventual exclusion
RTD (Sacramento)	$54		$250	4.6	Commissioner's discretion, increased fine
San Diego Trolley	$25	$50	$100 (Plus 170% penalty assess.)	11	Work with DA; 3rd offense considered Misdemeanor
SCRRA (LA)	court decides		$275	--	Tracked by database info forwarded to court
SCVTA (San Jose)	$145	Judge discretion	$325	2.2	None
SEMIACS (Nice)	F 30			--	Judicial procedure
Sound Transit (Seattle)	$50 (+ court cost)	$100 (+ court cost)	$250 (+ court cost)	5	Incremental fine
TTC (Toronto)	CAN$115		CAN$500	4.5	Summons and court appearance
TPG (Geneva)	$37.50			--	None
Tri-Met (Portland)	Warning	$75	$75	--	Exclusion from transit property (30 days then 60, then 90); if violated may be arrested for trespassing
Tri-Rail (Miami)	$50	$50	$50	--	Exclusion
VRE (Washington)			$150	--	Court discretion

ratio of highest fine to first offense fine is 11.5. A few agencies require a mandatory court appearance for repeat offenses. Some others use exclusion from use of the system, either for a finite or indefinite period of time, as their ultimate penalty.

Fine Revenue

As shown in Table 3-15, some transit agencies (37% of those reported in the table) do not receive a share of the fine revenue collected by the courts. Those that do typically receive between 50% and 100% of the revenue collected. It is worth noting, however, that the dollar amount these agencies receive is often relatively low (i.e., less than $50,000 annually for most of the North American agencies). The amounts received are considerably higher for the European agencies shown; each of these agencies receives 100% of fine revenues, and, in Nice and Bologna, the evasion rates are relatively high (15% and 6%, respectively). In those

Table 3-15: Distribution of Fine Revenue

Transit Agency	Evasion Rate	Fine Revenue to Transit Agency*	Share of Fine Revenue to Agency (%)	Recipient of Balance of Fine
ATC (Bologna)	6%	$1.2 m	100%	NR
Bi-State (St. Louis)	2%	$0	0%	Courts
Calgary Transit	NR	CAN$450,000	NR	NR
GO Transit (Toronto)	0.8%	$0	0%	Province
HKL (Helsinki)	2%	$1 m	100%	NR
LACMTA (Los Angeles)	0.5%	$402,000	NR	State, municipality, county
NFTA (Buffalo)	3.4%	$35,000	100%	NR
NJ Transit (New Jersey)	1.5%	$35,000 (to date)	50%	Municipal courts
OC Transpo (Ottawa)	2%	CAN$25,000	100%	NR
RTD (Denver)	2%	$0	0%	Courts
RTD (Sacramento)	2%	$0	0%	County
San Diego Trolley	6%	$50,000	12%	15% to courts; balance to state
SCRRA (LA)	1.5%	$0	0%	State, municipality, county
SCVTA (San Jose)	1.8%	$0	NR	County
SEMIACS (Nice)	15%	f 2.6 m	100%	NR
Sound Transit (Seattle)	1.5%	$0	0%	County
TPG (Geneva)	2%	$600,000	NR	NR
Tri-Met (Portland)	4%	miniscule	50%	Courts
Tri-Rail (Miami)	2%	$40,000	90%	Courts

*In some cases, these figures represent the revenue received from all types of violations (e.g., excessive noise) and not just fare evasion. The amounts specifically attributable to fare evasions were not identified by the agencies.

NR = No response

cases where the transit agency does not receive all of the fine revenue, the balance goes to the courts or the relevant political jurisdiction.

Summary and Recommendations

The fine structure is an important element of an SSFC enforcement strategy. Fines serve to deter would-be fare evaders and may generate revenue for the agency. Where the fine structure is not legally defined or constrained by the laws governing the agency's enforcement efforts, the agency must decide on the base fine and whether to escalate the fine for repeat offenders. Based on the review of current industry practices, the following findings and recommendations emerge regarding establishing (or modifying) a fine structure:

- The base fine should be high enough to represent a deterrent to fare evasion, but not so high that (1) the inspectors will be hesitant to issue citations in most cases, (2) the courts may decide in many cases that the fine is too high, and/or (3) the agency seems unreasonably punitive.

- There is a wide range of fine levels among existing systems ($20–$245 for 12 U.S. systems, with an average for these systems of $73). However, eight of these systems levy a first-time fine of $50 or less.

- Most agencies levy a higher fine for repeat offenders, generally at least twice the initial fine.

- More than one-third of agencies with SSFC receive none of the fine revenues ultimately collected by the courts. Among those agencies that do receive a portion, the typical

share is 50 to 100%. However, the amount of fine revenue received in any case tends to be very small (under $50,000 for most North American agencies.)

A reasonable **fine structure** for a new SSFC system (i.e., where existing laws do not dictate the fines) might thus include *a $50 fine for the first offense*, *$100 for the second offense*, and *$200 for a third or higher offense*. In addition, the agency should consider *excluding repeat offenders from the system altogether*. The agency should always seek to receive as much of the fine revenue it can (i.e., depending on the terms of the prevailing legislation), although, based on the experience of North American agencies, it should not expect this to amount to a significant total.

Fare Evasion Follow-up Program

Issues/Decisions

The fare evasion follow-up program defines procedures for (1) following individual fare evasion citations through to their resolution and (2) tracking the general outcomes of evasion cases. Agency follow-up usually involves working with the court system. Most transit agencies have a small staff, usually including an administrator and a clerk, designated to oversee this function. Citations are forwarded to the relevant court systems, and most agencies book citations (i.e., record them in a database). Almost all agencies also establish a liaison with the relevant court system; at a minimum, the liaison involves the coordination of the court appearances of inspection personnel. However, agencies differ in the amount of follow-up they do beyond these minimal tasks. The basic issues in establishing the follow-up program are as follows:

- Booking citations, specifically the level of detail of the records;
- Procedures for tracking individual citations; and
- Procedures for review of outcomes (citations, warrants, and fines).

Related Sections

Inspection Strategy

Treatment of Fare Evaders

Fare Evasion Fine Structure

As the follow-up procedure becomes more extensive, the required record-keeping become more detailed. For example, if the agency decides to track judicial outcomes, the citation record may need additional data fields, including court of jurisdiction, presiding judge, statutory and actual fines, and circumstances of citation.

The techniques and approaches that can be employed in establishing the follow-up program, the key considerations, and a summary of current practice and recommendations in this area are reviewed the sections that follow.

Techniques/Approaches

The techniques identified for the follow-up program represent a series of escalating steps, each building on the last, rather than mutually exclusive alternatives. Three basic approaches can be used in following up on evaders:

- Book citations,
- Track selected citations, and
- Follow all citations through to resolution.

In addition, the agency may decide to include an appeal procedure within the agency as part of its follow-up program.

If an agency has its own appeal procedure, citations are still ultimately turned over to the courts for processing, adjudication, and collection. The difference is that citations may be appealed to the agency, e.g., if the evader claims that there are mitigating circumstances. The agency then has can drop the citation; for example, if the rider presents a valid monthly pass within a couple of days of the citation, the agency may decide not to send the citation to the courts. Agencies that use this approach usually require a written appeal.

Considerations

Developing a follow-up program involves balancing several competing considerations. These considerations include the following:

- **Impact on Deterrence.** The primary purpose of the follow-up program is to ensure that evaders pay the penalty they have been assessed. It is likely that enforcement would be undermined if evaders could routinely avoid paying fines, though it is unclear to what degree. It is thus possible that would-be evaders would be emboldened if they found out that agency follow-up was limited. It is also possible that the morale of inspection personnel would suffer if they felt that there was little follow-up of the citations they issue.

- **Cost**. Each level of follow-up involves additional cost, most of it for staff time.

- **Court System Procedures.** Agency follow-up usually involves working with the follow-up apparatus of the court system. The court system itself may or may not have the means to do effective follow-up. Moreover, the mechanism could be in place, but not used. In this situation, the agency may be able to prompt the court system to take action.

- **Number of Courts.** If evasion cases are heard by courts in multiple jurisdictions, it will be more difficult for the agency to track of all of its citations.

- **Ability to Track Cases.** The number of evasion cases that most agencies process is going to require them to purchase a software database for the task. If the agency is going to track outcomes, staff may need to be trained to run somewhat sophisticated queries.

- **Agency Share of Fine Revenue.** If an agency does not receive a share of the fine revenue, it may be less inclined to engage in any level of follow-up. Some agencies keep most of their fine revenue, but others receive none (see Fare Evasion Fine Structure section).

Industry Practice

As shown in Table 3-16, roughly two-thirds of North American agencies have the ability to track citations using information supplied by the courts. In all instances, however, the courts are the key to this tracking, because agencies must rely on them for data. Most agencies take advantage of the available data, though it is unclear how often they do so. Once an agency has the data, its ability to make use of it is also often limited by the courts. For example, if

Table 3-16: Agency Tracking of Fare Evasion Court Cases and Adjudication/Appeal Mechanisms

Transit Agency	Able to Track Cases?	Appeal Available within Agency?
Bi-State (St. Louis)	No	No
GO Transit (Toronto)	Yes, monthly reports	No
LACMTA (Los Angeles)	No; but working toward access	No
Lane Transit District (Eugene, OR)	Yes, from District Attorney	Yes, to GM w/in 10 days of citation
MTA (Baltimore)	Yes, through courts	No response
Muni (San Francisco)	Yes, but do not (unreliable data)	No
NFTA (Buffalo)	Yes, but do not	Yes, hearing officers review transcripts
NJ Transit (New Jersey)	No	No
OC Transpo (Ottawa)	Yes, through courts	Yes
RTD (Denver)	On request to the court; plan to do so weekly	No
RTD (Sacramento)	Only if case goes to court	Yes, hearing by department manager for return of confiscated pass/ID card
San Diego Trolley	No	No
SCRRA (LA)	Some courts supply; others do not	Yes, Passenger Service Dept. reviews requests to dismiss
SCVTA (San Jose)	No	No
Sound Transit (Seattle)	Not yet	No
Tri-Met (Portland)	Yes, through courts in one county (serves three counties)	Yes, exclusions may be appealed to hearing officer
Tri-Rail (Miami)	Yes, but do not	Yes, to Safety/Security Administrator
TTC (Toronto)	Only if case goes to court	Yes, based on corporate policy petition for return of pass
VRE (Washington)	Yes, court dispositions	No

evaders ignore their citations, it is the courts that will collect—or fail to collect—the overdue fines. However, in some cases, the agency can prompt the court system to action.

Table 3-16 also indicates that eight North American agencies currently have in-house appeal procedures. However, four of these agencies use it for very specific purposes only (e.g., to appeal expulsion from the system).

Summary and Recommendations

The basic decision in establishing a fare evasion follow-up program is the extent to which the agency will track the citations it issues. The agency's ability to track the outcomes of cases depends largely on the nature of the court's own procedures. However, the extent of follow-up also depends on the agency's willingness to conduct the required record-keeping.

An agency's interest in tracking citations will depend to some extent on its ability to claim at least a portion of the fine revenue paid to the courts; in some cases, the agency receives none of the fine revenue. The actual revenue aside, the primary reason for tracking evasion cases is to ensure that evaders are made to pay the fine, as a deterrent to further evasion. The follow-up should therefore seek to determine, for instance, the following:

- What share of evaders are paying their fines?
- How many cases are being appealed to the courts?
- What is the typical outcome of appeals?

A key goal of tracking citations will thus be to ensure that the answers to such questions fall within appropriate ranges—and to work with the court to correct the situation should they not.

Since the success of an agency's follow-up program is largely dependent on the procedures—and effectiveness—of the courts, determining the most appropriate follow-up program for an agency will depend on its assessment of the local courts (i.e., based on informal conversations with judicial employees):

- In the optimal case, the local court will actively collect unpaid fines and will provide a reasonable share of the fine revenue to the agency; the court will also have an efficient citation tracking system of its own that allows it to share information with the transit agency regularly. Under these conditions, investing in a more thorough follow-up program that tracks all citations through to resolution should enhance the deterrence of evasion and support the agency's enforcement system in general.

- In the sub-optimal situation, tracking selected citations may be the best use of limited agency resources. The agency must still rely on the courts for data, but it is reasonable to assume that a modest request to receive data periodically (e.g., once a year) would meet with success. There may also be some benefit to the agency from observing court cases periodically.

- Finally, an agency may also wish to consider establishing its own appeal procedure, i.e., to give evaders an opportunity to appeal citations to the agency before they are sent to the courts.

Each agency should do at least a minimal level of **follow-up on the resolution of the citations** it issues to fare evaders. By tracking at least selected citations, the agency can seek to ensure that the court is collecting the fines levied and thereby support the deterrence value of its enforcement efforts.

Chapter 4: Operational Issues

This chapter discusses the types of operational SSFC decisions an agency must address. Major decision and issue areas are summarized below:

- **Fare Structure.** What issues and challenges does SSFC present for different types of fare structures, including transfer policy and fare differentiation? How are zonal fares handled under SSFC?

- **Fare Media Distribution.** What types of distribution options are available for the sale of SSFC fare media? What is the appropriate mix of distribution channels in an SSFC system?

- **Use of Electronic Fare Media.** How can electronic farecards (i.e., magnetic or smart cards) best be used in an SSFC system? What are the trade-offs involved in the different approaches to decrementing value and checking validity of farecards? What types of equipment and procedures should be considered?

- **Station Monitoring and Security.** What are the advantages and disadvantages of alternative strategies for providing security and customer assistance at stations and stops? Under what circumstances does it make sense to monitor stations and stops remotely?

- **Marketing/Educating Passengers.** What types of information must be communicated to passengers in an SSFC system? What types of techniques are useful in the marketing/education process?

Key considerations and techniques or approaches in each area are shown in Table 4-1.

Individual Sections

Table 4-1: Summary of Operational Issues/Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Fare Structure	• Existing fare structure • Impact on equity • Impact on revenue • Impact on ridership • Ease of use of system • Enforcement requirements • Feeder system design	Basic fare strategy: • Flat fare • Zonal or station-to-station fare • Peak/off-peak differential • Rail (or BRT) premium For zones: • Color-coding tickets • Printing zonal info. on tickets For transfers: • Free intermodal transfers • Small transfer charge • No transfer • Day pass (with no transfer)
Fare Media Distribution	• TVM queuing • Passenger convenience • Distribution costs	• TVMs • On-board vehicles • Attended sales outlets • Remote sales
Use of Electronic Fare Media	• Passenger convenience • Options for purchasing/revaluing farecards • Payment options supported • Consumer education • Capital cost • Maintenance requirements • Revenue accounting (in regional farecard system)	• Modify TVMs or install stand-alone unit: use stored value to buy ticket • Install processing unit: deduct fare from stored value (inspector carries hand-held unit) • Tag on/tag off reader at each door • With time-based pass, inspector checks with hand-held unit
Station Monitoring and Security	• Perceived passenger security • Support for customer assistance • Cost • Station design	• On-site monitoring using security personnel • On-site monitoring using agency (non-security) staff • On-site staff complemented or replaced by remote equipment • Selective use of on-site personnel or equipment
Marketing/Educating Passengers	• Complexity of fare structure and payment options • Ease of use of TVMs • Policy re treatment of evaders • Cost of producing signs/materials	• Post signs in stations and vehicles • Print rules on tickets • Print informational brochures • Prominently post customer info. no. • Train agency personnel • Use surveys/focus groups to identify issues and design materials

Fare Structure

Issues/Decisions

The fare structure defines the elements of the general fare payment strategy (e.g., flat versus zonal), the specific pricing levels of the various payment options (e.g., single ride, discounted multi-ride option, and monthly pass), and the transfer policy and pricing. An agency's overall fare structure is typically determined by its fare policy goals and objectives, although the pricing levels in particular may also be influenced by other factors, including the local political environment. The fare structure elements that are specifically relevant to an SSFC/POP setting are those related to fare strategy and transfer policy; thus an agency must address the following types of fare structure issues:

- Flat versus zonal fare;
- Other types of fare differentiation (e.g., peak period surcharge or LRT fare higher than bus fare); and
- Transfer pricing and policy.

Related Sections

Use of Electronic Fare Media

Fare Media Distribution

Marketing/Educating Passengers

Treatment of Fare Evaders

Validation of Tickets

The alternative fare structure approaches, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the sections that follow.

Techniques/Approaches

General Fare Strategy

In establishing a fare structure for an SSFC service, the basic approaches that might be considered are as follows:

- **Flat fare:** single fare regardless of distance traveled or time of day;
- **Zonal fares:** the line/service is divided into zones, and the fare is higher if more than one zone is crossed;
- **Peak/off-peak differential:** the fare is lower in off-peak hours than during the peak periods; and
- **Rail (or BRT) premium:** the fare on the rail or bus rapid transit service is higher than the local bus fare; this premium may be equivalent to the express bus premium.

The primary reasons agencies consider fare differentials such as these are (1) the argument that the higher operating costs associated with serving longer trips, providing peak service,

and operating “premium” (i.e., rail or express bus) service should be reflected in a higher fare; and (2) the users of these higher-cost services tend to display lower sensitivities to price than do those using local bus services, meaning that differentiated fares have a higher revenue-generating potential than do flat fares.

The major disadvantages to using fare differentiation relate to the complexity added to the system in terms both of understanding and usage by riders and of design, implementation, and administration by the agency. For instance, one of the chief rider complaints about zonal systems is that they can actually result in inequitable fares for riders making very short trips, but who happen to cross a zone boundary. One approach to addressing this issue is to institute overlapping zones. Another strategy is the use of station-to-station fares, in which the fare is based on the stations of origin and destination. The presence of zones also complicates the process of buying tickets for the rider unfamiliar with the system and the use of the ticket vending machines (TVMs).

Fare differentiation strategies are more complicated to administer than are flat fares in general, but the challenges are increased in an SSFC system. A zonal fare structure places the burden on the rider to buy a ticket (or pass) for the appropriate zone combination. However, the nature of the system makes it difficult to strictly enforce this; depending on the nature of the validation process, an inspector may not know from examining a rider’s ticket where he/she boarded—or how far he/she is riding. Techniques that can be used for improving inspectors’ ability to monitor zonal payments include the following:

- Color-coding tickets to correspond to different zone combinations; and
- Printing zonal information on tickets (i.e., as they are dispensed from the TVM or validated).

A station-to-station strategy can also be easier to administer and use than a straight zonal system. The purchase of tickets is simplified by clearly indicating on the TVM the fare for each destination station (i.e., from the station in which the person is standing), rather than forcing the passenger to figure out the proper fare and buy the appropriate ticket. Since the ticket indicates both the origin and destination stations, the inspector can readily determine if the passenger has an incorrect ticket.[1]

The advantages and disadvantages of the basic fare differentiation approaches are summarized in Table 4-2.

Transfer Pricing/Policy

Because most transit systems with light rail lines depend heavily on feeder bus routes to carry riders to and from the rail stations, the transfer pricing and policy is an important element of the fare structure. The basic approaches that can be considered include the following:

[1] Of course, none of these techniques prevents a passenger from buying a ticket covering a certain number of zones/stations and then riding beyond the designated destination (i.e., if the inspection occurs near a station that is covered by the ticket).

Table 4-2: Alternative Fare Structure Approaches

	Flat Fare	Zonal Fares	Peak/Off-peak Differential	Rail Premium
Impact on Equity	Considered less equitable than differential fares	Considered more equitable than flat fare structure	Considered more equitable than flat fare structure	Considered more equitable than flat fare structure
Impact on Ridership	More riders than zonal or rail premium	Fewer riders than flat fare	Highest ridership potential	Fewer riders than flat fare
Impact on Revenue	Less revenue than zonal or rail premium	Highest revenue potential	Least revenue	More revenue than flat fare
Ease of Use of System	Simplest to understand and use	Complex; most difficulty in use of TVM	Complex; potential for conflict with inspectors	Similar to flat fare in ease of use
Enforcement Requirements	Simplest to enforce	More difficult to enforce	More difficult to enforce	Similar to flat fare in ease of enforcement

- Free intermodal transfers;
- A small transfer charge;
- No transfer (i.e., full fare for boarding each vehicle); and
- A day pass instead of free or low-price transfers.

Most U.S. transit agencies offer either free or low-price ($0.10–$0.45) transfers between bus and rail services. In transferring from bus to rail, the paper transfer can serve as the POP ticket for the rail line. If a transfer from rail to bus is free, the rider simply uses the POP ticket as the transfer mechanism; if there is a transfer charge, the rider will have to buy a special POP ticket that includes a transfer. A small but growing number of agencies have begun to address transfers via day passes (typically sold on buses, as well as in TVMs), while eliminating free or low-price transfers. This is seen as avoiding the problems agencies often face with transfers, which include rider-inspector (or driver) conflicts over the validity of a transfer, as well as transfer abuse (e.g., riders obtaining low-price or free transfers and reselling them for a price lower than the normal full fare).

Considerations

Developing an appropriate SSFC fare structure involves balancing several competing considerations; these include the following:

- **Existing Fare Structure (on non-SSFC service).** Most of the details of the SSFC service fare structure will be dictated by the existing overall system fare structure. However, the SSFC service may have certain fare structure elements that differ from the rest of the system (e.g., perhaps station-to-station fares or a different zone structure or a higher base fare than for the bus system).

- **Impact on Equity.** One of the primary arguments for fare differentiation is equity. However, differentiation can produce inequities of it own, as with short trips that cross a zone boundary.

- **Impact on Revenue.** Another argument for zonal fares and service premiums is that they typically generate higher revenues than do flat fares.

- **Impact on Ridership.** Reducing the fare in the off-peak should generate increased ridership, but with lower revenue. Zonal fares and service premiums tend to produce lower ridership than do flat fares.

- **Ease of Use of System.**[2] This relates to riders' abilities to understand the fare structure and purchase the appropriate fare instrument. The complexity of the instructions and number of steps needed to purchase and validate a ticket will affect the length of time required for each purchase, which in turn affects queuing at TVMs, and can affect revenue (e.g., if riders end up buying tickets that do not represent the appropriate number of zones). Complexity can also conceivably deter people from using the transit system altogether.

- **Enforcement Requirements.** Enforcement of appropriate zonal fares becomes more problematic in an SSFC system than in a pay-on-entry/barrier system. Unless tickets are stamped or coded to indicate both boarding and destination points, an inspector may not know from examining a rider's ticket where he/she boarded and how far he/she plans to travel.

- **Feeder System Design.** A transit system that encourages transferring between bus and rail (i.e., through the design of the bus feeder system) must carefully consider its transfer policy and pricing.

Industry Practice

As shown in Table 4-3, the use of flat versus zonal fares is largely divided according to type of service: LRT versus commuter rail. All of the North American commuter rail systems shown have zones, in contrast with only three of the LRT systems (i.e., Denver RTD; Portland Tri-Met; and San Diego Trolley, which actually uses a station-to-station fare structure). NJ Transit uses an extensive zonal structure on its services throughout the state, but opted for a flat fare on its Hudson-Bergen Light Rail Line because of the problems it perceived in monitoring zonal fares. The Niagara Frontier Transportation Authority (NFTA) has long had zones on its bus system, but has maintained a flat fare on its LRT line.

[2] Note that promoting the use of time-based payment options (i.e., passes) rather than single-ride or even multi-ride tickets will improve passengers' ease of use of the system, in that they do not have to deal with TVMs or validators on each trip. Flash passes are also typically easier to inspect, since they are clearly marked by month or other valid period. On the other hand, electronic passes require that inspectors carry hand-held readers (see section on Use of Electronic Fare Media).

Table 4-3: Transit Agency Fare Structures

Transit Agency	Flat Fare	Zonal Fares	Pk/Off-pk Differential	Bus-Rail Transfer
ATC (Bologna)		✓		Free
Bi-State (St. Louis)	✓			$0.10
Calgary Transit	✓			Free
DART (Dallas)	✓			Free
GO Transit (Toronto)		✓		Free
HKL (Helsinki)	✓			Free
LACMTA (Los Angeles)	✓			$0.25
LTD (Eugene, OR)	✓			Free
MTA (Baltimore)	✓			Free
Muni (San Francisco)	✓			Free
New Jersey Transit	✓			$0.45
NFTA (Buffalo)	✓			Free
OC Transpo (Ottawa)	✓			Free
RTD (Denver)		✓	✓	Free
RTD (Sacramento)	✓			Free
San Diego Trolley		✓		Free
SCRRA (LA)		✓	✓	Free
SCVTA (San Jose)	✓			None (day pass)
SEMIACS (Nice)	✓			Free
Sound Transit (Seattle)		✓		Upgrade fare
TPG (Geneva)		✓		Free
Tri-Met (Portland)		✓		Free
Tri-Rail (Miami)*		✓		Free
TTC (Toronto)	✓			Free
VRE (Washington)		✓		Free

* Tri-Rail has a zonal structure on weekdays and a flat fare on weekends.

Only two of these agencies have peak/off-peak differentials (RTD and SCRRA), and RTD is considering eliminating this option (see box). In fact, according to the APTA Transit Fare Summary (2000), only 6% of North American transit systems use this strategy. Most of the LRT systems charge the same base fare as is charged for local bus service. San Diego Trolley's base fare ($1) is actually lower than the base fare for bus service in the area ($1.75). With regard to transfer pricing, most of these systems offer free bus-rail transfers. Only SCVTA does not offer low-price or free transfers, but it instead sells a 1-day pass that is good on both modes. Sound Transit charges an "upgrade fare," in which the rider pays the difference between the rail fare and the other mode's fare.

RTD (Denver) and Bi-State (St. Louis) offer contrasting approaches to fare structure design in an SSFC environment. RTD's fare structure has evolved over time to become quite complex. The system now features two zones (only on LRT; the second zone is equivalent to the express bus premium), as well as an off-peak discount. In addition, there is a confusing array of passes and multi-ride tickets with different pricing structures tied to different services. The agency is currently studying the fare structure and is considering at least some simplification in the near future.

Meanwhile, Bi-State simplified its fare structure several years ago and now features a single flat fare and a common pass pricing structure for all modes. The agency considered introducing a second zone with the opening of its new LRT line (May 2001), but decided to keep the fare structure simple for now; the issue may be revisited at some point, however, pending the planned expansion of the LRT system.

Summary and Recommendations

An agency must weigh essentially conflicting considerations in making fare structure decisions for an SSFC system. For instance, the basic trade-off in comparing a flat fare structure with a zonal structure is ease of use and administration, as well as the likelihood of higher ridership, with a flat fare versus a more equitable, but harder to use and administer approach with potential for higher revenue in a zonal fare structure. Of particular importance, the SSFC environment presents significant challenges associated with both purchase of tickets at a TVM and enforcement of payment of appropriate zonal fares. Based on the review of the advantages and disadvantages of the different approaches and current industry practices, the following findings and recommendations emerge:

- Commuter rail systems invariably have zonal fares because of the length of the lines and the often very long distances traveled. A single flat fare on such a service would have to be extremely high to permit any reasonable cost recovery.

- Zonal fares are relatively rare on LRT because most agencies have opted for the simplicity of flat fares on the service, even in some cases where zones are present on other modes.

- Peak/off-peak differentials are extremely rare in the transit industry because the potential of modest ridership gains are seldom considered worth the complexities they introduce for both riders and inspectors.

- In almost all cases, LRT fares are set equal to local bus fares, despite the widely held view that LRT is a “premium” service and could command a higher fare (e.g., equivalent to an express bus premium).

- Because most multimodal transit systems are designed to facilitate extensive transferring between bus and LRT, the vast majority of these agencies offer free or low-price transfers between the modes.

An agency designing a **fare structure** for an SSFC system on LRT should strongly consider the simplicity and ease of use of a *flat fare* structure, priced at the same base fare as is charged on the feeder bus routes serving the system. *Free or low-price ($0.25 or less) transfers* should be offered as well, although a widely available *day pass* good throughout the system should also be given strong consideration (i.e., in conjunction with the elimination of transfers). For commuter rail service, a *zonal fare* structure is generally appropriate, given the often very long distances traveled.

Fare Media Distribution

Issues/Decisions

Because SSFC requires that all passengers carry valid fare media while using the transit service, fare media distribution channels are an important operational element of the system. Relevant issues that must be addressed are as follows:

- What types of distribution options are available for the sale of proof-of-payment fare media?
- What is the appropriate mix of distribution channels?

The fare media distribution options that should be considered for an SSFC systems are discussed below.

Related Sections

Fare Structure

Use of Electronic Fare Media

Marketing/Educating Passengers

TVM Fare Media Options

Techniques/Approaches

The primary options for SSFC fare media distribution are as follows:

- TVMs;
- On-board vehicles (either on SSFC vehicles or on non-SSFC vehicles of connecting services);
- Attended sales outlets at transit stations or stops, at other transit-operated sales and customer service facilities, by other agencies in the region, or by third-party retailers; and
- Remote sales, where fare media are distributed by mail in response to orders received by telephone, fax, or the Internet.

The ideal distribution network will include some type of mix of these options. Table 4-4 reviews each strategy in the context of several key considerations, which are discussed below.

Considerations

TVM Queuing—As discussed in the Determining TVM Quantities section, exclusive reliance on TVMs can require a large quantity to avoid excessive queuing; the extent of queuing will also depend on the availability of multi-ride options and passes in general. Attended sales locations can reduce the use of TVMs, through the sale of higher value fare media such as passes. On-board sales can also reduce queuing at TVMs, but will, instead, slow down vehicle boarding speeds.

Passenger Convenience—TVMs, on-board sales, and attended sales at stations offer the convenience of supporting spontaneous or occasional use of transit. However, for regular

Table 4-4: Alternative Fare Media Distribution Channels

	TVMs	On-Board	Attended Sales	Remote Sales
TVM Queuing	Exclusive reliance on TVMs can lead to high quantities being needed, depending on how heavily single-ride tickets are used	On-board issuance can be used for transfers and perhaps other fare media High-value fare media sales require validating farebox	Can be used to help reduce queuing at TVMs from fare media with peaking demand such as some period passes	Phone, mail, and internet can be used for credit card payments to order passes and add to stored value
Passenger Convenience	Alternative to in-station attended sales for providing single-ride tickets at stations Some TVMs may not be able to support credit/debit cards	Essential for a service that cannot equip all stations or stops with TVMs Important if bus targeted as important initial sales point for certain fare media (e.g., day passes)	Attended sales outlets at retailers are a convenient way for customers to get prepaid fare media	Remote arrangements can provide convenient methods for ongoing pass or stored-value purchases (e.g., pass-by-mail)
Distribution Costs	TVMs help keep distribution costs down because they avoid labor costs; however, they still require revenue servicing and maintenance	Revenue servicing for on-board fare media sales can be integrated with current farebox procedures for bus, but on-board revenue servicing for rail would require new procedures	Can be relatively high, requiring labor costs for in-house sales and/or commissions for third-party sales	Centralized facilities can be set up, which helps to contain distribution costs

passengers, multi-ride tickets and passes offer the greater convenience of avoiding a fare purchase queue for each trip (passengers with multi-ride media will still have to stop at a validator, however). Developing ways for customers to obtain prepaid fare media conveniently, such as third-party sales outlets and remote sales channels, can provide additional convenience.

Distribution Costs—Several factors affect distribution costs. Extensive use of TVMs for the purchase of lower value tickets can result in higher cash handling costs. Providing a discount for bulk prepayment and ensuring that these alternatives are conveniently available can reduce the use of lower value tickets. For these higher value purchases, credit/debit card acceptance can be used to reduce the amount of cash collected, although the costs of transaction processing fees also need to be considered. Sale of fare media through third-party outlets avoids cash handling and credit/debit card transaction fees; however, there is a cost involved in distributing fare media to these points of sale on a regular basis (e.g., weekly or monthly). In addition, it may be necessary to pay third-party outlets a sales commission.

Industry Practice

SSFC agencies generally use a mix of several different fare media distribution channels, as shown in Table 4-5. The table also identifies the types of fare media sold through each channel. “Single” refers to full-price tickets, whether sold pre-validated for immediate use or as multiple tickets purchased in advance. “Multi-ride” refers to bulk discount fare media that can be used

Table 4-5: Fare Media Distribution Methods

Agency		Distribution Channel					
		TVMs	Ticket Office	Third Party Outlets	On-Board	Phone/Fax	Internet
ATC (Bologna)		SBMA	SBMA	SBMA			
Bi-State (St. Louis)		SRBD	BDWM	BWM			BWM
Calgary Transit		SD	SBDM	SBDM			
DART (Dallas)		SRBD		BM			M
Denver RTD		SR	DMA	M		MA	
GO Transit – rail (Toronto)			SRBDM	SRBDM			
HKL (Helsinki)		SB	MA	BM	S		
LACMTA (Los Angeles)		SR	W2M	W2M		W2M	
MTA (Baltimore)		SRDWM	DWM	WM		M	M
Muni (San Francisco)		S	BDWM	BDWM	S		M
NFTA (Buffalo)		SR	M	M		M	
NJ Transit (New Jersey)	Hudson-Bergen	SRBM				M	
	Newark Subway	SBM	M	M		M	
OC Transpo (Ottawa)			BDMA	BDMA	SD		
Sacramento RTD		SD	SDM	SDM		SM	
San Diego Trolley		SRD	DM	DM		M	
SCRRA MetroLink (Los Angeles)		SRBM	SRBM	BM		BM	
SCVTA (San Jose)		SD	MA	M			M
SEMIACS (Nice)			BDWM		SRD		
Sound Transit – rail (Seattle)		SBDW2M		BW2M		M	
TPG (Geneva)		SRD	BD WM		BD		
Tri-Met (Portland)		SRBDM	BDMA	BDMA	D	BDMA	BDMA
Tri-Rail (Miami)		SRBM	SRBM	M			
TTC – Queen streetcar (Toronto)			BDM	M	S	A	
VRE (Northern Virginia)		SBM		SBM		SBM	SBM

Key:
S – Single-ride ticket; R – Round-trip ticket; B – Bulk multi-trip ticket; D – Day pass; W – Weekly pass; 2 – 2-week pass; M – Monthly pass; A – Annual pass

directly as proof of purchase once validated—typically either a single decrementing ticket or a book of unvalidated single-ride tickets. Key points from the table include the following:

- Almost every SSFC agency with stations uses TVMs; GO Transit and the OC Transpo are exceptions. Use of attended sales locations is universal among the surveyed agencies, with most using both agency-operated ticket offices and third-party outlets.

- On-board distribution is used only on bus or streetcar services.

- Remote sales (i.e., via telephone or Internet) are used by 16 of the 25 agencies, primarily for monthly pass sales, with the actual distribution by mail. The most common mechanism is credit card orders received by phone or fax. Orders are increasingly also placed via the Internet.

In some cases, customers can register for the ongoing purchase of monthly passes on a discounted subscription basis—a form of annual pass. After initially providing credit card information or a bank account direct debit authorization by mail, the customer no longer needs to contact the agency each month.

Another form of ongoing “subscription” is an automatic revaluing arrangement for a stored-value farecard: the customer pre-authorizes the agency to complete a revaluing transaction of

a certain amount whenever the stored-value balance drops to a set threshold. The advanced fare system then updates the farecard balance when the card is next used; a subscription pass renewal could be similarly updated on a farecard. A disadvantage of credit cards in this role is that, because an on-line authorization cannot be completed with a card swipe, the credit card associations classify these as higher risk "card not present" transactions, for which fees are often 40% or more higher than normal on-line authorization credit transactions.[3]

Another increasingly important channel, although not included in the table, is distribution through employers or universities. In some cases, the actual fare media are distributed directly to the employees or students, and the cost is often subsidized by the employer or university. In other cases, vouchers are distributed that can be redeemed for fare media through regular agency distribution channels.

Summary and Recommendations

Based on the review of fare media distribution approaches, the following key points emerge:

- Most agencies use a mix of at least TVMs and attended sales locations for fare media distribution. The attended sales outlets usually include both agency-operated facilities and sales outlets operated by third parties. Agency sales outlets are often provided only at selected locations, rather than at every station. Third-party outlets include those operated by retailers, as well as those of other transit agencies in the region.

- A common form of on-board fare media distribution is the transfers provided on the non-SSFC bus services since these transfers can serve as proof of payment on connecting SSFC rail services. Other types of fare media (notably day passes) are sometimes sold on buses as well. In cases where an SSFC service has some stations or stops where tickets cannot be purchased, some passengers will need to pay or purchase their POP on board (i.e., from a driver-attended farebox or an on-board TVM).

- Remote sales are initiated through a request to the agency via mail, telephone, fax, or Internet to place a single order for tickets or a pass. In some cases, customers can place a standing "subscription" order to automatically purchase a pass each month or have their stored-value balance increased whenever it gets low. Payment is usually by credit card; higher fees often apply because the payment must be authorized as a "card not present" transaction.

Fare media distribution is a crucial element of any SSFC system, since all passengers need a valid ticket, farecard or pass, or transfer from a connecting service as their proof of payment. An agency should *use a mix of distribution methods*, so as to maximize passengers' purchase options. An agency should strive to maximize prepayment in particular, by *selling multi-ride tickets and passes through a combination of agency-operated, third-party-operated, and remote sales channels.* The greater the extent of prepayment, the fewer TVMs will be needed or the shorter the queues will be at the TVMs. If a TVM or attended sales outlet is not available at every stop, an SSFC service may need to sell some fare media *on board* as well; however, this will tend to slow down boarding speeds and means that fare sales and validation devices will be needed on each vehicle.

[3] Hoffman, K., "Credit Cards Face Online Challengers," *Card Technology*, May 2001.

Use of Electronic Fare Media

Issues/Decisions

Several regions are developing regional "universal card" systems, using smart card or a combination of smart card and magnetic-stripe technology. However, the use of either type of farecard in an SSFC system is not as straightforward as in a barrier or a pay-on-boarding fare system. Hence, programs such as TransLink in the San Francisco Bay area, the Seattle/Puget Sound Regional Fare Collection program, the Unified Fare System in Los Angeles County, and SmarTrip in the Washington, DC/Baltimore area have had to give special consideration to the use of electronic technologies on LRT and commuter rail.[4]

Related Sections

Inspection Strategy

Types of SSFC Equipment

Validation of Tickets

TVM Fare Media Options

TVM Ticket Purchase Options

Fare Media Distribution

Fare Structure

Marketing/Educating Passengers

The major challenge is that stored-value farecards (either magnetic stripe or smart card) cannot be *directly* used in a proof-of-payment environment, as SSFC requires the rider to display a validated ticket or a flash pass to an inspector. A faregate or farebox equipped to read electronic farecards automatically identifies the validity of the card and deducts the proper fare value (i.e., if the card is not an unlimited ride pass). This is infeasible with a TVM and visual fare inspection. Thus, use of farecards in an SSFC system requires special accommodations to allow the user to validate the card and the inspector to check the validity of the card; the potential approaches are discussed below.

The key questions that must be addressed in incorporating electronic fare media into an SSFC system are as follows:

- Which fare options will be provided using electronic fare media? If stored value is provided, how will the stored value balance be used?
- What types of electronic fare media will be used?
- Where will the electronic fare media be issued and revalued and, in a regional payment system, how will revenue be accounted for and allocated among the participating agencies?

[4] Note: This Toolkit does not address the differences between the electronic fare technologies. Because virtually all of the regional payment initiatives throughout the world are planning to use contactless or combined contact/contactless smart cards, the assumption here is that most SSFC systems will be seeking to incorporate smart cards, rather than magnetic media. However, the discussion in this section, by and large, applies to both technologies.

- How will the electronic fare media be validated and inspected?

The approaches that can be considered for using electronic media in an SSFC system, as well as the key considerations and industry experience, are discussed the sections that follow.

Techniques/Approaches

As suggested above, electronic farecards cannot be directly used as proof of payment in an SSFC system. Rather, use of a farecard requires one of the following approaches:

- Modification of TVMs (or installation of stand-alone vending/validating units in stations) to allow the rider to use the stored value on the farecard to purchase a validated paper ticket to serve as POP for that ride.

- Installation of special in-station card processing units so that when the card is inserted (or touched to the screen, if a contactless smart card), value is deducted and the time is written to the card. Since no paper ticket is issued, this approach requires that inspectors carry hand-held readers to ascertain whether the rider has paid for the trip (or has a valid pass).[5]

- If contactless smart cards are used, card readers can be mounted at each door of an LRT car; a rider must then “tag on” and “tag off” (i.e., touch the farecard to the reader on boarding and alighting the vehicle); this approach would be especially appropriate in a zonal fare structure.

With any of these arrangements, the farecard could carry a time-based pass instead of using stored value. An electronic pass avoids requiring cardholders to use a TVM (or stand-alone card reader) on every trip, as long as the inspectors carry hand-held readers. If the pass is of the “rolling” type (i.e., it is activated on first use, then valid for a given number of days), however, the passenger would have to validate the pass prior to using it for the first time.

Important issues affecting the selection of an approach and the decision to use electronic media at all are reviewed below.

Considerations

Key considerations in selecting an approach for integrating electronic media into an SSFC system include the following:

[5] A new development that could obviate the need for hand-held readers is a smart card that contains a built-in LCD or LED display. The rider simply presses a button on the card to display fare details (e.g., the expiration date of a pass, or the date and time of the most recent stored-value transaction). This would allow conductors to check a card’s validity. Such a card is now being developed by at least one cardmaker. An alternative to this is a “sleeve” into which a card is inserted; the sleeve can then be used to display the fare details.

- **Passenger Convenience.** The specific approach will affect passenger convenience. For instance, If the fare inspectors are not equipped with hand-held readers, passholders would need to stop at a validator/processing unit to get a paper proof-of-payment receipt for each trip.

- **Options for Purchasing and Revaluing Farecards.** Value is typically added to stored-value farecards at TVMs and attended sales locations. In addition, an agency may decide to dispense magnetic farecards from TVMs. Although some TVMs are capable of dispensing smart cards, these tend to be quite expensive and have seen little use thus far; instead, smart cards are typically validated or revalued, but not dispensed, at TVMs. The cards are purchased at attended sales locations or transit customer service centers.[6]

- **Payment Options Supported on Farecards.** Electronic farecards can technically support any payment option, and smart cards can actually carry multiple options (e.g., stored value plus a pass) that allow a single card to be used for multiple services. However, each agency will have to decide which payment options will be supported on the SSFC system.

- **Customer Education.** It will be important to educate farecard holders on the procedures for using the cards in the SSFC system. Card users will have to be clearly instructed that they have to validate stored-value cards for each trip (i.e., they cannot board the vehicle simply because they are carrying a card that contains a stored-value balance). In contrast, those passengers with electronic passes will be able to board without validating the card, but only if inspectors are equipped with hand-held readers. Use of stored-value farecards in an SSFC environment is quite different from use in a barrier or pay-on-boarding system; thus, regional farecard holders who use a variety of types of service will have to receive clear explanation of the differences in fare payment procedures.

- **Capital Cost.** Modifying TVMs to accept farecards, installing stand-alone card processing units, and procuring hand-held readers all carry significant costs. The extent of the cost impact will depend on the exact nature of the system enhancements (e.g., the type of processing units and whether or not there will be hand-held units).

- **Maintenance Requirements.** Electronic farecard readers become new items that require maintenance; this could be somewhat offset by reduced costs for maintaining cash acceptance equipment if the volume of incoming cash drops. Contactless smart card readers require very little maintenance as they have no moving parts or slots; magnetic stripe farecard readers require substantial and ongoing preventive maintenance to keep the heads clean. If portable inspection devices are used, this adds to the maintenance requirements.

[6] One exception is new TVMs being developed by Cubic for Singapore, which will issue contactless smart cards in exchange for a deposit and refund the deposit when a card is returned in good condition.

- **Revenue Accounting (in a Regional System).** If the agency is participating in an integrated regional payment system, there will be a need to establish a mechanism (e.g., a regional "clearinghouse") for revenue accounting and allocation among the agencies. The purpose is to ensure that each agency receives the proper revenue for rides made using the regional farecard. This will require the agency to track and report ridership and revenue figures to the clearinghouse accurately.

Industry Practice

Thus far, at least some of the regional farecard programs under development in the United States plan to use in-station processing units with hand-held readers as the strategy for incorporating SSFC services. In contrast, several European systems have introduced vehicle-mounted units that require "tagging" on and off. Neither approach has been demonstrated as yet in North America.

The current use of electronic fare media in North America is primarily restricted to non-SSFC services; the Vancouver system described in Figure 4-1 is the lone exception at this point, although the TransLink pilot project, including SCVTA, was scheduled to begin in late 2001. Magnetic-stripe stored-value systems have been in operation in Washington, DC, and San Francisco for more than 25 years and recently have been implemented in Chicago and New York City. To date, smart cards have been introduced in Washington, DC; Chicago; Ventura County (CA); and several towns outside of Toronto, as well as in Vancouver. As indicated above, regional smart card–based systems are being planned in several areas.

A number of smart card systems are operating or now being implemented in other parts of the world. These include regional multi-agency systems in Hong Kong, Seoul, Rome, Paris, London, Singapore, and elsewhere. Profiles of three European SSFC systems using smart cards are provided in the box on the next page; these systems involve a range of approaches to using electronic fare media.

Figure 4-1: West Coast Express Smart Card Program

The West Coast Express (Vancouver) Xpress card can be loaded with up to $100 in stored value using cash or credit/debit card; a 5% prepayment bonus is added to any revaluing amount. The stored value can subsequently be used to purchase single ride tickets, round trip tickets and weekly passes (but not monthly passes). The program is structured to help reduce the amount of cash used at TVMs and to minimize smaller-value credit/debit card transactions (i.e., monthly pass purchases are excluded from the program since these would already be made primarily with a credit/debit card purchase of a desirable amount). WCE promotes the program based on (1) the 5% purchase bonus, (2) the convenience and speed of ticket purchase transactions using the smart card (i.e., in comparison to using cash or credit/debit), and (3) attractive limited edition card graphics.

SOURCE: *www.westcoastexpress.com*

ATC in Bologna, Italy, is shifting to an SSFC bus operation. The only "fare paid area" will be on board. A contactless smart card will carry a stored-value balance and/or a period pass. TVMs will either (1) accept stored value, coins, or a debit card to purchase a period pass that would be stored on the card or (2) use coins or a debit card to add to smart card stored value—or purchase a single-trip ticket if the customer does not have a smart card. The smart cards are intended to support regional integration with other public payments (e.g., other public transport, parking, and city services).

Passengers who have a smart card will board through any door and use an on-board validator; the validator will either confirm that the passenger has a valid period pass or deduct the cost of the ride from the stored-value balance. Passengers without smart cards would board at the front door using a ticket purchased at a TVM or with cash—and would be provided a POP receipt. Fare inspectors will use portable card readers to check smart cards for a valid period pass or single-trip validation information.

An interesting feature is the "peer pressure" approach. All smart card passengers—even those with a card that carries a period pass—are expected to use the on-board validator as they board, so that all the other passengers can see that they are getting a positive signal from the device.

TPG in Geneva, Switzerland, uses SSFC throughout its bus/streetcar, light rail, and ferry operations. TPG has installed 520 TVMs at stops in the central area, where passengers can purchase tickets and day passes, to complement a network of third-party attended sales locations where passes and Cart@bus stored-value smart cards are sold. These smart cards use a contact interface and are "disposable" (i.e., each card is purchased with a certain stored value and cannot be revalued).

TPG offers several incentives to encourage customers to use the smart card for ticket purchases at the TVMs (although coins and credit/debit cards are also accepted): (1) bonus value is offered, depending on the prepayment amount, from 5% extra value on a 20-franc card to 10% on a 50-franc card; (2) the final ride can be taken with any positive card balance; and (3) a free 20-franc card is offered in exchange for handing in used cards with original value totaling 200 francs.

HKL in Helsinki, Finland, operates SSFC streetcar, heavy rail, and commuter rail services. It is one of several public transport agencies in the greater Helsinki area participating in the "Travel Card" regional contactless smart card program, which is operated by the Helsinki Metropolitan Area Council (YTV). Travel Cards can be revalued using cash or credit card at HKL TVMs and attended sales locations—part of a regional network of card-revaluing locations.

The cards can carry a period pass valid for 14 to 366 days and/or a stored-value balance from 30 to 1000 marks. The stored-value balance can also be used as a payment option to purchase a period pass. There is an initial charge of 30 marks when the card is issued, and a card is valid for 3 years. The cards are used with validators located at bus boarding doors and the entrances to rail station platforms, and fare inspectors use portable card readers. Passengers boarding without a smart card are given a paper POP receipt; it uses a standard format so that it can also serve as a transfer POP with other participating agencies in the region. A passenger uses one of the three buttons on the validator to select a zonal fare option.

Summary and Recommendations

As more and more regions seek to develop multi-agency integrated farecard programs, SSFC systems in these regions increasingly will be faced with the need to accommodate electronic fare media (i.e., magnetic-stripe cards and/or smart cards). The challenge is that these farecards, typically carrying either stored value or electronic period passes, cannot be directly used in a proof-of-payment environment (i.e., with visual fare inspection). Incorporating electronic farecards into an SSFC system requires the provision of special equipment and procedures that allow (1) the cardholder to properly validate the card for each trip and (2) the inspector to check the validity of the card. The alternative approaches to facilitate use of electronic farecards in SSFC are as follows:

- Modification of TVMs (or installation of separate vending/validating equipment in stations) to allow the rider to use the stored value to buy a validated paper POP ticket for that ride.

- Installation of stand-alone card processing units that will deduct value for a ride and "validate" the card for that ride (but not print out a paper ticket). In this approach, the fare inspectors must be equipped with hand-held card readers; they will then be able to determine whether the rider has paid for the trip (or has a valid pass).

- Contactless smart card readers can be mounted at each door of an LRT car, allowing a rider to "tag on" and "tag off" on boarding and alighting the vehicle.

- In any arrangement in which the inspectors have hand-held units, a cardholder with an electronic pass—rather than stored value—does not have to stop and "validate" the card at a TVM or card reader on every trip.

None of these approaches has been used in the United States to date, although several regional farecard systems under development include plans to incorporate SSFC systems. Europe and Asia are ahead of the United States in the use of electronic media, and there are several examples of the use of smart cards in SSFC systems there. There is no clearly preferable approach for SSFC; each agency will have to consider the costs and benefits of the alternatives as the need arises.

Using **electronic fare media** in an SSFC system requires that an agency develop special accommodations to (1) ensure that a card user deducts the proper value for each trip and (2) enable fare inspectors to check that the card has been properly "validated." This will require the agency to modify its TVMs to accept the farecards, install separate card processing/validating units, and possibly provide hand-held card readers to its fare inspectors.

Station Monitoring and Security

Issues/Decisions

Each agency must make decisions regarding station monitoring and security strategies. Questions to be addressed include the following:

- Will personnel always be present to monitor stations?
- Will station monitoring personnel be police, security, or other agency staff?
- Will remote monitoring equipment be used to complement or replace the use of monitoring personnel?
- Will staff in one or more centralized locations actively monitor equipment, or will the equipment simply record station activity for potential use in security investigations?
- Will station monitoring be selective, i.e., monitoring only selected stations or only monitoring during certain time periods?

Related Sections

Inspection Strategy

Types of Inspection Personnel

Fare Media Distribution

The alternative techniques and approaches to station monitoring and security are discussed in the sections that follow.

Techniques/Approaches

Basic alternative station monitoring and security approaches include the following:

- On-site monitoring using security personnel—this could range from sworn police officers, to an agency security force, to a private contracted security force.
- On-site monitoring using agency non-security staff—this could range from dedicated presence by fare media sales staff or a “station manager” to the sporadic availability of a variety of agency staff as they pursue other duties (e.g., supervisors, fare inspectors, and equipment maintenance personnel).
- On-site personnel complemented or replaced by remote monitoring equipment (e.g., surveillance cameras and assistance telephones)—surveillance camera systems can take various forms, from systems that transmit images in real-time to a monitored central location to systems that record images in case they are needed later for security investigations.

For each of these alternatives, selective use of on-site personnel or equipment to monitor only certain stations and/or certain times of day can also be considered.

Table 4-6 discusses the advantages and disadvantages of each technique in the context of several key considerations, which are discussed below.

Considerations

Key considerations in selecting an approach for station monitoring and security include the following:

- **Perceived Passenger Security.** Passengers tend to feel most secure with a visible and uniformed security presence. However, if the public does not perceive the security threat at a station to be particularly high, armed police/security may be considered excessive. Using remote monitoring equipment and/or selective station monitoring has the potential to erode perceived passenger security if it is believed that crime or vandalism has escalated.

- **Support for Customer Assistance.** With an SSFC system, it is important to take advantage of all opportunities to provide customer service support. Any on-site personnel, of whatever type, can have general customer assistance as part of their duties. Surveillance cameras have no direct customer assistance role, but assistance phones can provide both security and customer assistance.

- **Cost.** The use of contracted security services is generally less expensive than the use of an agency or contracted police force. The different types of agency staff that could contribute to on-site station monitoring have varying costs. There is a general choice between using lower-wage staff dedicated to station presence (e.g., customer

Table 4-6: Alternative Approaches to Station Monitoring

	On-Site Monitoring, Security Personnel	On-Site Monitoring – Other Staff	Remote Monitoring	Selective Monitoring (Staff or Remote)
Perceived Passenger Security	Customers will feel most secure when there is a visible security presence	In certain areas perceived as being dangerous, people may feel the need for armed security, rather than other agency staff	Liaison with security required for effective response time	Selective approach will likely erode perceived security if there is perceptible increase in security problems
Support for Customer Assistance	Contract security personnel may be able to provide only limited customer assistance	Agency staff at a station can best provide customer assistance	Assistance phones can serve both security and customer assistance roles	Assistance phones can be supplemented with on-site staff during peak periods
Cost	Police salaries will be higher than agency staff; contract security likely to be lowest cost	Higher classification staff may cost more, but might complete supplementary duties	Small security staff can monitor cameras and phones; operating costs for video communications	Can save on labor costs and on video transmission (if not owned)
Station Design	Works with both enclosed and streetside stations	Works with both enclosed and streetside stations	May be more difficult to locate cameras that cover streetside stations	May be more difficult to locate cameras that cover streetside stations

"ambassadors") or higher-wage staff who provide station monitoring as an ancillary part of some other core duties (e.g., maintenance technicians). Remote monitoring equipment, surveillance camera systems in particular, can have widely varying costs, depending on system features.

- **Station Design.** The extent of the need for station monitoring is related to the physical design of the stations. Closed platform environments often include features, such as stairwells and elevators, that could be trouble spots requiring monitoring. Monitoring with on-site personnel can work in a closed or open platform environment, although personnel requirements may be higher for closed platform stations. Remote monitoring equipment similarly becomes more expensive for the closed station environment (i.e., more cameras may be required to view all areas). However, an open platform station can, in some cases, also be difficult to monitor with cameras; camera mounts that properly view the platform might need to be at an adjacent location, often on property or buildings not owned by the agency.

Industry Practice

The different station monitoring and security approaches of several SSFC agencies with some type of occasional or full-time personnel presence in stations are shown in Table 4-7. An example of one agency's approach is described in the box at right. Figure 4-2 indicates the percentage of these agencies that indicated the use of police, security, or agency personnel. The use of police is relatively low; most agencies use a contracted or staff non-police security force. Most agencies have non-security staff on site, and, in some cases, such staff complement the security or police presence. In most cases, this involves the sporadic availability of agency staff with other duties (e.g., maintenance staff and vehicle operators).

Calgary Transit on-board fare enforcement and security has been provided by Protective Services (PS) officers, a staff unit with sworn authority for enforcing specific infractions (primarily issuing fare evasion summons and a mandate to arrest for outstanding warrants). In 1999, a Hazard Assessment suggested that PS officers should be provided with enhanced safety equipment (e.g., defensive spray), given their arrest mandate. However, the City became concerned about its potentially increased liability exposure and opted to instead shut down the PS unit and contract this role to the Calgary Police Service.

Source: Calgary Transit Report to Council—January 2001

Generally, fare inspectors are not reported as contributing to station security, although they often provide the de facto frontline security presence on board. Where station platforms are defined as paid areas, station security personnel sometimes use manual fare inspection at station entrances as a technique to reduce security problems related to use of the platforms by non-passengers.

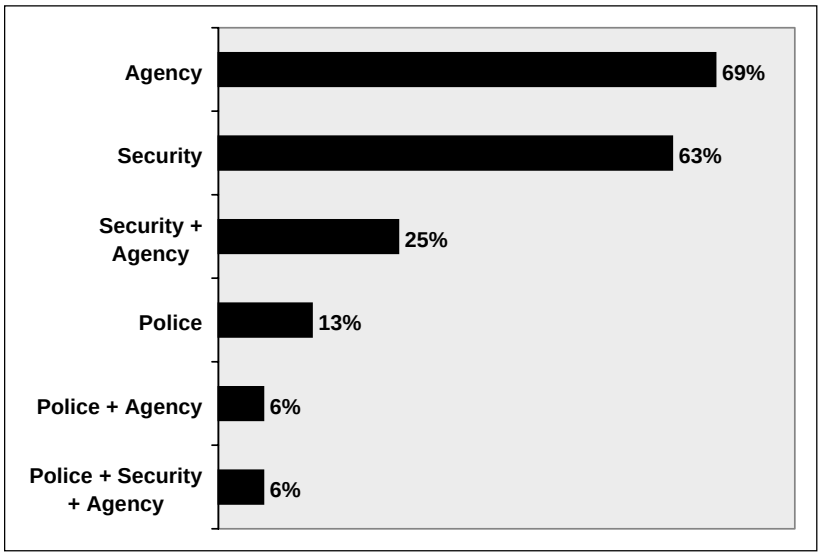
In addition to full- or part-time on-site monitoring, 13 of the above agencies indicated that they monitor security cameras at stations or stops. The scale of the reported programs varies considerably. For instance, MTA (Baltimore) reports a single equipped station. At the other extreme, LACMTA, NJ Transit, and OC Transpo report that all their stations are monitored from central rail operations centers.

Wide-ranging degrees of capability and sophistication can be designed into a remote monitoring system. A minimalist approach, in terms of capital and operating costs, would

Table 4-7: On-Site Station Personnel Reported

Agency	Type of Personnel
Bi-State (St. Louis)	Fixed-post contracted security Bus operators Police officers
DART (Dallas)	Supervisors Agents Maintenance
Denver RTD	Contract security Supervisors Other staff
GO Transit – rail (Toronto)	Ticket seller
HKL (Helsinki)	Security
NFTA (Buffalo)	Maintenance
NJ Transit (New Jersey)	NJ Transit police Operations staff
OC Transpo (Ottawa)	Transit security Supervisors
Sacramento RTD	Contract security
San Diego Trolley	Returning to work employees Volunteer ambassadors Station security
San Francisco Muni	Station agents Supervisors
SCRRA MetroLink (Los Angeles)	Ambassadors assigned to stations on a rotating basis
SCVTA (San Jose)	Contract security
Sound Transit (Seattle)	Agency security
Tri-Met (Portland)	Private security at some stations Rail and road supervisors on a limited basis
Tri-Rail (Miami)	Security zone patrols

Figure 4-2: Use of Different Types of On-Site Station Personnel



transmit compressed video images over phone lines to a central location where they could be stored on videotape (i.e., for review in the event of reported security issues). Where security staff actively monitors the cameras, labor costs increase and there are additional capital requirements (e.g., monitors and control center). A discussion of the experience of one agency is described in the box below.

Selective monitoring, through staff or security personnel rotating among various stations, seems to be a common practice. In many cases, the motivation for installing remote

The San Diego MTDB purchased a $1.1 million remote surveillance system in 1996, with 50 cameras to cover five high-volume stations. Unfortunately, the system has had technical problems, primarily involving lockup of the software that transmits video images over phone lines. Because images are recorded, rather than monitored by staff, the lockups are not routinely detected. The issue has come to the fore recently because of several instances where police asked to review a tape in relation to reported station incidents. An upgrade planned for spring 2001 will provide centralized monitoring, fiber-optic transmission lines, remote pan-tilt-zoom control, and remote iris (i.e., for varying light levels) control.

Source: San Diego Union-Tribune, January 30, 2001

monitoring equipment occurs when stations with a relatively light on-site staff presence experience an increase in security issues, but the agency cannot afford to increase its operating costs with additional security personnel.

Summary and Recommendations

The chief findings from the review of agency station monitoring and security practices can be summarized as follows:

- Most agencies monitor stations with either contract security or various agency staff located in the stations some or all of the time. Police presence is less common. In many cases, the agency personnel involved in monitoring stations have other duties as well.
- Several factors will affect each agency's approach to on-site monitoring. If there is a strong need for customer assistance and customers perceive few security threats, the use of agency staff, perhaps with some patrol support from the local police jurisdictions, could be appropriate. Contract security personnel or perhaps even a police force might be needed to address more serious security concerns. If there is only limited need for customer assistance, security forces might be able to provide this as part of their duties, but, in some cases, distinct security and customer assistance personnel could be warranted.
- Most agencies have implemented surveillance camera systems to monitor their stations, although the degree of capability and staff support for these systems varies considerably. A camera system can be an effective alternative to increasing the number of security personnel, as long as the cameras are monitored from a central location and there is an effective liaison with police to ensure timely response to security problems. On the other hand, if passengers perceive security problems in a station, they may quickly lose confidence without adequate on-site security presence (i.e., despite the presence of a surveillance camera system).

Station monitoring/security is best addressed through a *mix of on-site personnel and remote monitoring*, geared to the agency's specific security and customer assistance requirements. These requirements may vary on a station-by-station basis. On-site security personnel can be either *contract security or a police force*, depending on the degree of security required; police can either be provided from an agency staff unit or through a service contract with the city police force. *Remote monitoring must be carefully designed to meet clearly defined objectives*, since such systems can be developed with widely varying features and effectiveness.

Marketing/Educating Passengers

Issues/Decisions

The self-service nature of self-service/proof-of-payment fare collection requires that an agency conduct effective marketing and education of passengers in explaining the procedures and rules for fare payment in the system. The marketing/education function is related to many other decision areas, and an agency must address the following types of information in its marketing/education process:

- The fare structure and the types of payment options available;
- How and where to purchase a ticket or pass, including instructions on the use of the TVMS, as well as the location of attended sales outlets;
- How and where to validate a ticket; and
- The nature of the inspection and enforcement procedures, including the fine structure.

The types of techniques and approaches, the key considerations, and a summary of current practice and recommendations in this area are reviewed in the sections that follow.

Related Sections

Treatment of Fare Evaders

Fare Evasion Fine Structure

Fare Structure

Fare Media Distribution

Use of Electronic Fare Media

Station Monitoring and Security

Validation of Tickets

SSFC at Stops without TVMs

TVM Placement

TVM Fare Media Options

TVM Ticket Purchase Options

TVM User Interface

Techniques/Approaches

The passenger education strategy for SSFC should be tied into the overall system marketing plan; however, the informational requirements for SSFC necessitate special targeted efforts. The key techniques and approaches for educating passengers and providing general marketing related to SSFC services include the following:

- Post signs in stations and on vehicles explaining procedures.
- Print SSFC/POP rules on tickets.
- Print/distribute informational materials (e.g., brochures and flyers) describing the SSFC rules and procedures.
- Prominently post the customer service telephone number in stations, on vehicles, and on tickets.

- Train agency personnel in dealing with and informing passengers about SSFC rules/procedures.

- Use surveys and focus groups of passengers and non-passengers to (1) identify issues and problem areas (e.g., confusion regarding SSFC and/or use of the TVMs), (2) provide input into the design of marketing materials and user interfaces, and (3) gauge the effectiveness of existing marketing techniques.

These should not be considered as alternative approaches; a comprehensive marketing/ education strategy should include all, or at least most, of the above. Note that in systems using electronic payment media, there will also be passenger education requirements specifically related to the use of farecards in a POP environment; this is discussed in the Use of Electronic Fare Media section.

Considerations

Key considerations in developing a marketing/education strategy related to SSFC include the following:

- **Complexity of Fare Structure and Payment Options.** This relates to riders' abilities to understand the fares and available payment options and is a key factor affecting ease of use of the TVMs.

- **Ease of Use of TVMs.** This relates to riders' abilities to purchase and validate the appropriate fare instrument. The complexity of the instructions and number of steps needed to purchase and validate a ticket will affect the length of time required for each purchase, which in turn affects queuing at TVMs and can also affect revenue (e.g., if riders end up buying tickets that do not represent the appropriate number of zones). Complexity can also conceivably deter people from using the transit system altogether. The ultimate goal should be to minimize the number of steps and make the purchase process as simple and straightforward as possible. However, it is necessary to provide clear instructions, regardless of the complexity of the fare structure and difficulty in using the TVMs.

- **Policy Regarding Treatment of Fare Evaders.** The agency's policy (official or unofficial) regarding the treatment of fare evaders will affect passengers' attitudes toward the agency and possibly their use of the system altogether. For instance, inspectors' discretion regarding issuing citations versus giving warnings (e.g., where out-of-town visitors have clearly misunderstood the POP rules) will influence passengers' general sense of "fair play."

- **Cost of Producing Signs and Other Materials.** The cost associated with the various techniques and approaches is a consideration in developing a marketing/education strategy.

Industry Practice

Most agencies currently rely on signage posted in stations and sometimes in vehicles to provide information on use of the SSFC system. The distribution of specific SSFC educational/ marketing materials to passengers is much less common among the North American LRT operators. San Francisco Muni, for one, has distributed printed materials as part of its conversion to proof of payment on certain LRT lines. Some agencies have used surveys and/or focus groups to improve passenger information strategies (see box describing San Diego Trolley's efforts in this area).

Summary and Recommendations

San Diego Trolley recently undertook a special project to aid in the design of new TVM graphics/usage instructions. The agency first surveyed riders in order to understand the nature of rider confusion with existing TVM instructions. Once the issues were identified, the agency created several new prototypes. Focus groups were then held to test the reactions to the different designs. Based on these inputs, a new TVM interface was developed for use on the system's new TVMs.

It is essential that passengers using an SSFC system clearly understand the rules and required procedures associated with proof of payment and inspection. Therefore, it is incumbent on the agency to provide adequate information on these rules and procedures. The major elements of an effective marketing/education campaign include the following:

- **Disseminating information.** This can be done through some combination of posting signs in stations and on vehicles, printing the rules on the tickets themselves, and distributing printed materials. Customer information numbers should also be clearly posted along with the instructions on using the system.

- **Training agency staff.** All personnel who may deal with passengers using the SSFC system (e.g., fare inspectors, attended ticket sales staff, and customer information staff) must be trained in effectively communicating the SSFC rules and procedures.

- **Conducting market research.** Surveys and focus groups can be used to determine the key issues related to understanding and using SSFC and to help design better user interfaces and education materials.

The key factors to be considered in designing a marketing/education strategy include the complexity of the fare structure and payment options, the clarity of instructions for using the TVMs, the policy toward fare evaders, and the cost of alternative techniques. In general, the simpler and more straightforward the fare structure, the easier it will be for the passenger to understand and use the system. However, an effective marketing/education strategy is necessary, regardless of the complexity of the fare structure.

A **marketing/passenger education strategy** for an SSFC system must clearly explain the rules for proof of payment and the procedures for buying and validating a ticket. An agency introducing SSFC should strongly consider providing printed materials in addition to posted signage and should also consider using market research in developing an effective education campaign.

Chapter 5: Capital and Equipment Issues

This chapter discusses the types of SSFC capital and equipment issues an agency must address. The major decision and issue areas are summarized below:

- **Types of SSFC Equipment.** What types of ticket sale and validation equipment are available? What are the core equipment requirements?
- **Determining TVM Quantities.** How should the required number of TVMs at each station be calculated?
- **Validation of Tickets.** What are the relative advantages of different validation approaches (e.g., at time of purchase, after purchase, and during boarding)?
- **SSFC at Stops/Stations without TVMs.** How can the agency provide for ticket sale and validation at stations without TVMs? Will there be attended and/or on-board sales options?
- **TVM Placement.** Where should TVMs be placed in stations (or on vehicles)? What customer amenities should be built into TVMs?
- **TVM Fare Media Options.** What are the advantages of different fare media options (e.g., multiple ticket stocks for different payment options)?
- **TVM Ticket Purchase Options.** What types of purchase options should be supported at TVMs (e.g., credit/debit and use of stored value)? Should all TVMs accept the same options? Will TVMs provide change?
- **TVM User Interface.** What design features should be considered to maximize the convenience of the TVM user interface for customers? How will passengers be informed about fare/purchase options, as well as TVM malfunctions?

Individual Sections

Key considerations and techniques or approaches in each area are shown in Table 5-1.

Table 5-1: Summary of Capital and Equipment Issues and Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Types of SSFC Equipment	• Sales • Validation • Inspection	• Ticket Vending Machines (TVMs) • Attended sales devices • Stand-alone validators • Portable or hand-held devices
Determining TVM Quantities	• Cost • Passenger wait time • Passenger convenience • Infrastructure constraints	• Install enough TVMs at each stop/station such that queues—except perhaps during certain periods of unusually high demand—will not exceed "tolerable" levels • Install enough TVMs to meet the off-peak demand, but plan to augment these with additional sales staff during peak periods • Install at least two TVMs at each location to provide a backup in case one is out of order
Validation of Tickets	• Cost • Passenger convenience • Evasion opportunities • Fare options • Maintenance	• Automatic validation at the time of ticket purchase only (i.e., no advance purchase tickets) • Validation of advance purchase fare media (i.e., multi-ride tickets or stored-value farecards) on the platform before boarding, using a stand-alone validator • Validation of advance purchase tickets using a self-service validator during boarding
SSFC at Stops/ Stations without TVMs	• Station and stop layout • Cost • Dwell and running time impacts • Driver responsibilities	• Cash passengers use only the front door and pay at a driver-attended farebox • Cash-accepting TVMs installed at rear-door entrances • Temporary attended sales locations (e.g., during busiest periods)
TVM Placement	• Type of paid area • Space required • Power supply and data lines • Customer amenities	• Before the entrances to rail platforms • On rail platforms or at streetside stops • On-board railcars or buses
TVM Fare Media Options	• Cost • Passenger convenience • Inspection	• Using distinct type of ticket stock (colors/graphics) for each type of fare medium provided • Offering some payment options at attended locations only (i.e., only selected fare media through TVMs) • Offering only a limited set of fare media through certain TVMs
TVM Ticket Purchase Options	• Cash handling • Cost • Passenger convenience • Data lines • Passenger security	• Offering change • Accepting credit and/or debit cards • Accepting stored value in lieu of cash for purchasing POP tickets • Not accepting any cash
TVM User Interface	• Cost • Transaction time • Passenger convenience • Fare structure • Accessibility	• Software programmable buttons or touch-screen • Accessibility features, such as wheelchair access, audible feedback, and multiple languages

Types of SSFC Equipment

Issues/Decisions

Later sections in this chapter address several specific topics that must be considered in selecting and implementing equipment as part of an overall SSFC system. This initial section introduces the various types of equipment used in SSFC and discusses key considerations in their use for fundamental SSFC functions. The key questions that must be addressed include the following:

- What types of equipment are needed for an effective SSFC system?
- What are the core functional requirements of SSFC equipment?
- What additional features are available to suit agency-specific requirements?

Related Sections

Use of Electronic Fare Media

Determining TVM Quantities

Validation of Tickets

SSFC at Stops/Stations without TVMs

Fare Media Distribution

TVM Fare Media Options

TVM Ticket Purchase Options

TVM User Interface

Options

Several different types of equipment can be used in SSFC systems:

- **TVMs** are self-service devices used for the sales and validation of fare media in a barrier-free system. TVMs can be installed off board or on vehicles, and there is a range of potential capabilities.
- **Attended sales devices** are functionally equivalent to TVMs, but the customer does not operate them. Examples of attended devices include Ticket Office Machines (TOMs), retail point-of-sale devices, and fareboxes. By definition, an SSFC system does not rely exclusively on attended devices (i.e., they are not self-service). However, it can be useful—and sometimes necessary—to complement self-service devices with attended devices. For example, attended sales can reduce the peak-period demands on TVMs so that fewer are needed. Also, where stops and stations cannot accommodate TVMs, passengers will need to be able to pay on board (e.g., via a driver-attended farebox). (See the section SSFC at Stops/Stations without TVMs.)
- **Stand-alone validators** are used with advance purchase fare media (i.e., multi-ride tickets or stored-value farecards) that need to be validated at the time of use before they can be used as proof of payment. Other types of proof of payment (i.e., transfers and single-ride tickets) are validated when they are issued. A stand-alone device allows post-sale validation to be done quickly by avoiding the queues at TVMs or other devices.

- Fare inspectors can use **portable** or **hand-held devices.** Such devices can provide useful functions to assist fare inspectors, but are not currently used in most systems. If electronic fare media are used, however, hand-held devices become essential—because these media generally cannot be visually inspected.

Considerations

Table 5-2 summarizes the functional requirements of each equipment option in the context of several key functional considerations, which are discussed below.

- **Sales.** Requirements are based on the fare media accepted in the SSFC operation. Prepaid fare media (i.e., passes, unvalidated tickets, and stored-value farecards) should be available at various convenient locations, such as retail points of sale. However, some passengers will arrive at the boarding station or stop without prepaid

Table 5-2: SSFC Equipment Functional Requirements

	Ticket Vending Machines	Attended Sales Devices	Stand-Alone Validators	Hand-Held Devices
Sales	May be no attended sales, so core requirement is to sell a validated single-ride ticket for cash May also sell some or all prepaid fare media May issue and revalue advanced farecards	Often a combination of station Ticket Office Machines and attended retail points of sale At stations, might sell validated single-ride tickets Usually sell the full range of prepaid fare media May issue and revalue advanced farecards	No sales function	No sales function
Validation	If TVM sells multi-ride tickets and unvalidated single-ride tickets or revalues advanced farecards, TVM can include a built-in validator	If a station TOM sells multi-ride tickets and unvalidated single-ride tickets or revalues advanced farecards, TOM location should have an adjacent validator	Usually located for use on platform or while entering vehicle For quick use by passengers who already have an unvalidated ticket or a stored-value farecard	Usually, no validation function; however, with 100% inspection, these may be used to validate stored-value farecards
Inspection	No inspection function	No inspection function	No inspection function	In any SSFC system, an inspector could use a portable device to track inspection outcomes and help issue citations A hand-held farecard reader is essential for electronic farecards that do not carry printed validation information

fare media (or transfers issued on a connecting service). These passengers need TOMs and/or TVMs at stations in order to purchase single-ride tickets. If some or all stations and stops have no ticket sales facilities, these passengers will need to be able to pay or purchase a single-ride ticket on board. Potential on-board sales devices include driver-attended fareboxes and small-scale TVMs.

- **Validation.** Passengers with unvalidated tickets or stored value on an electronic farecard need to validate a single ticket—or deduct the value of the trip from the farecard—when they arrive at the station or stop. A validation device may be built into a TVM—and/or there will be stand-alone validators available so that arriving passengers who already have fare media can avoid the TVM/TOM queues. Another alternative is validation as the passenger enters the vehicle—at a farebox or perhaps at a stand-alone validator installed beside one or more doors.

- **Inspection.** Visual inspection is used when validation information is printed on paper fare media. A hand-held device is not essential because fare inspectors can write out citations by hand—although such a device could provide useful assistance (e.g., record inspection outcomes and print out citations). If a farecard cannot be read visually (i.e., the validation data is recorded on the card electronically), a hand-held farecard reader becomes essential.

Industry Practice

TVMs. Most SSFC systems use TVMs for some, and, in most cases, all, stations; these devices include the following features and/or requirements:

- The devices have to be able to accept coins and probably bills as well. Some provide change. They may also accept stored value as payment from an electronic farecard and perhaps credit/debit card payments, although this requires a communications link for the on-line authorization transaction. TVMs at a few systems accept tokens.

- In addition to printing paper tickets, TVMs can update electronic farecards. TVMs can issue a new magnetic-stripe farecard, encoded with stored value or the equivalent of prepaid fare media, or can update a customer's existing farecard. Smart cards are not usually issued by TVMs, although machines are being developed with this capability; however, a previously issued card can be updated.

- There are several user interface and accessibility options available. User interface options include software-programmable function buttons and the touchscreen. Accessibility options include audible messages and multiple language support. (See TVM User Interface section.)

Table 5-3 indicates the TVM vendors for those North American SSFC systems that responded to the survey. Figure 5-1 illustrates recent TVM models from several major current TVM vendors for SSFC systems: Ascom, Scheidt & Bachmann, Schlumberger, and Ventek. Other TVM vendors include Cubic Transportation Systems, GFIGenfare, and ERG Group. Contact information for equipment vendors is provided in Appendix D.

Table 5-3: North American SSFC System TVM Vendors

	TVM Vendor				
Agency	**Ascom / Autelca**	**GFI**	**Schlumberger**	**Scheidt & Bachmann**	**Ventek**
BSDA (St. Louis)				✓	
Calgary Transit	✓				
DART (Dallas)			✓		
Denver RTD				✓	
LACMTA (Los Angeles)		✓			
Maryland MTA (Baltimore)				✓	
NFTA (Buffalo)	✓			✓	
NJ Transit (New Jersey)	✓				
Sacramento RTD	✓				
San Diego Trolley	✓			✓	✓
San Francisco Muni	✓			✓	
SCRRA MetroLink (Los Angeles)	✓				
SCVTA (San Jose)	✓				✓
Sound Transit—rail (Seattle)				✓	
Tri-Met (Portland)	✓			✓	
Tri-Rail (Miami)	✓				
VRE (Northern Virginia)			✓		

Figure 5-1: Examples of Current TVM Models from Major Vendors

Ascom | Scheidt & Bachmann | Schlumberger | Ventek

Source: Parsons Transportation Group / www.1.slb.com

TOMs. Nearly every SSFC system uses attended sales locations, at stations and stops and/or operated by third parties. Only those attended sales locations in stations sell validated single-ride tickets (i.e., for immediate use). The typical role for attended sales locations is to vend higher value fare media that are not for immediate use (e.g., multi-ride tickets and passes). Attended sales locations support the same purchase options as TVMs, although they are more likely to support credit/debit card acceptance and provide change. (Figure 5-2 shows a typical TOM configuration.)

Figure 5-2: Ticket Office Machine Equipment

Another common role for attended outlets is issuing and revaluing electronic farecards. This can include collecting personal information (e.g., when customers register to be able to replace a lost or stolen smart card with a restored balance). Issuing and revaluing farecards requires a communications link to transmit transaction records periodically; for this reason, some third-party outlets may not provide this service. In the case of magnetic-stripe farecards, such outlets might opt to sell pre-valued farecards (i.e., in a similar manner to the sale of other fare media such as passes).

Validators. Stand-alone validators are simple devices (compared with sales devices), because they do not need to accept cash or credit/debit cards. Alternative validator configurations include the following:

- The validator may include a printer to validate an inserted paper ticket with a date/time stamp; a sensing mechanism is used with multi-ride tickets to determine the number of previous ticket validations. This is the most common SSFC validator type in North America, because very few of these operations have begun accepting electronic farecards.

- The validator may include a magnetic-stripe reader that checks the validity of the ticket's magnetic stripe and deducts the fare from the stored-value balance; depending on the type of cards used, the date and time may be stamped on the card as well. An example of such a card is shown in Figure 5-3, for the new Vancouver SkyTrain magnetic ticket validators. If the card does not support printing (i.e., plastic/polyester cards like those used in the newer barrier systems such as in New York and Chicago), the validator can dispense a single-ride ticket for proof of payment.

- A plastic smart card can be similarly verified and debited, but the validation information cannot be printed on the card. Again, a paper single-ride ticket can be printed for proof of payment.

- Rather than providing a paper single-ride ticket after successfully reading a magnetic or smart card, the validator can store the validation information as card data that can be checked by fare inspectors with hand-held card readers.

Figure 5-3: Typical Paper Ticket Validation

Source: www.translink.bc.ca

Validators used to date in North American SSFC systems have been produced by Ascom, Monetel, Elgeba, and Klussendorf. Cubic and ERG have also developed validators for use specifically with contactless smart cards.

Hand-held Devices. Hand-held devices can also have several different configurations, depending on the functionality required. For instance, the unit might simply be used to record inspection statistics, or it can be equipped with one or more of the following options: (1) a thermal printer for issuing citations—and possibly proof-of-payment tickets or transfers; (2) an electronic farecard reader to check the validity of magnetic-stripe or smart cards; and/or (3) a wireless communications interface to link with a prior offenders database and check on an evader's previous infractions—and perhaps to transmit citation records for real-time processing as well. There are two basic types of hand-held devices on the market at this point:

- Older models are derived from warehouse-type hand-held computers, which, although rugged, are relatively bulky; this basic technology has also been used by rental car companies, to check in returning rentals. This type of unit has been used to a limited degree in transit: for instance, Maryland MTA purchased units for use on the Baltimore light rail service in 1995. Newer, smaller versions of this type of device can read electronic farecards and print proof-of-payment tickets or transfers (an example of such a unit, made by Ascom, is shown in Figure 5-4). For instance, Cubic is building hand-held units that can read contactless smart cards for use in the London PRESTIGE project.

- Some newer units use mass-market personal digital assistants (PDAs) such as Palm or Pocket PC-based devices. The PDA software is customized to address the needs of each agency. In order to improve the durability of the units, as well as to facilitate the provision of a farecard reader and printer, some vendors insert the PDA into a rugged custom-made housing; an example of such a unit is SchlumbergerSema's Avantix Mobile, which is currently in use on rail service in the United Kingdom. Other PDA-based units are being offered by Cubic[1] and ERG; these units feature contactless smart card readers built directly into the PDA devices.

Hand-held or portable devices have seen limited use in SSFC systems to date, but will grow in importance as the agencies begin to accept electronic fare media (see Use of Electronic

[1] Cubic offers the aforementioned device it is building for the PRESTIGE project, as well as a Pocket PC-based unit that uses the Cassiopeia PDA.

Figure 5-4: Hand-Held Device with Printer and Smart Card Reader

Source: www.ascom.com

Fare Media section) and thus need to check the validity of riders' farecards. As suggested above, the real-time enforcement capabilities offered by wireless communications may also increase the attractiveness of hand-held units in SSFC systems.

As noted here, there are several vendors for the various ancillary SSFC devices such as validators and hand-held card readers. However, such devices are typically procured as part of a purchase focusing on acquiring TVMs. The TVM vendor or a systems integrator will generally undertake to supply a comprehensive and integrated system. This role includes selecting vendors for these ancillary devices and establishing all communications and central computer systems. Thus, in developing the procurement specifications, it is crucial that the agency establish clear performance, implementation, and quality requirements.

Summary and Recommendations

The TVM is the basic piece of equipment in an SSFC system, but an agency typically needs one or more ancillary types of equipment as well. Key points regarding the various types of equipment are as follows:

- The core requirement for TVMs is to sell a paper single-ride ticket for cash, to accommodate passengers arriving at the stop without prepaid fare media. However, procuring modern TVMs involves decisions regarding other fare media, purchase options, and user interface features.

- In addition to TVMs at most, if not all, stops, most SSFC systems include attended sales locations—both station TOMs and retail point-of-sale devices. Attended locations focus on selling the full range of prepaid fare media; more expensive fare media might not be offered through TVMs. The focus is often on creating a widespread network of fare media vendors to promote the advance purchase of fare media.

- In addition to any validators that might be built into TVMs or provided adjacent to TOMs, stand-alone validators allow pre-purchased tickets to be validated without requiring the passenger to wait in a TVM/TOM queue. The validator configuration depends on the type of fare technology used for unvalidated tickets: the validator will either (1) print on a paper ticket or on some types of magnetic-stripe farecards, (2) provide a paper POP ticket after reading a magnetic-stripe or smart card, or (3) update the magnetic-stripe or smart card to be subsequently checked by an inspector using a hand-held device.

- Hand-held devices can serve several types of functions in an SSFC system, including checking electronic fare media for proper validation, recording inspection statistics, printing citations (as well as proof-of-payment tickets or transfers), and using wireless communications to check on an evader's previous infractions—and perhaps for transmitting citation records for real-time processing. These devices will see increasing use as SSFC systems begin to accept electronic farecards.

All of these devices are typically procured as an integrated package, together with associated communications and central computer systems. The implementation will typically be led by the TVM vendor or a separate systems integrator.

Besides TVMs, an SSFC system should include various types of supporting sales and validating equipment. Equipment functional requirements should be determined primarily based on the fare media to be used, as well as the purchase options and user interface features desired. TVMs, TOMs, retail point-of-sale devices, stand-alone validators, and hand-held devices need to operate together as an integrated system. This system needs to support an operational concept defining the agency's overall sales, validation, and inspection requirements.

Determining TVM Quantities

Issues/Decisions

Because TVMs represent the backbone of an SSFC system, determining the appropriate number of machines is a crucial aspect of system design. The number of TVMs in a station or at a stop affects the waiting time for passengers buying tickets and directly affects the cost of implementing the system. The primary questions related to identifying the appropriate quantity of TVMs are as follows:

- Should every platform be TVM-equipped?
- What is the minimum number of TVMs per platform, and should a platform always have more than one TVM for redundancy in case one breaks down?
- What is the expected relative percentage of TVM transactions of various types, and how long will it take passengers to complete each type of transaction?
- What is considered "acceptable" TVM waiting time during peak periods?
- How should additional ticket sales capacity for peak periods be provided?

Related Sections

Types of SSFC Equipment

Validation of Tickets

TVM User Interface

TVM Fare Media Options

TVM Ticket Purchase Options

TVM Placement

Techniques/Approaches

Approaches to Handling Peak Ticket Sales Volumes

Two alternative approaches to handling peak ticket sales volume are as follows:

- Install enough TVMs at each stop and station so that queues—except perhaps during certain periods of unusually high demand—will not exceed "tolerable" levels.
- Install enough TVMs to meet the off-peak demand, but plan to augment these with additional sales staff during peak periods.

Of course, it is also possible to mix these techniques at different stations and stops. With regard to low-volume locations, the agency can choose to install a single TVM. In doing this, the agency must understand that it will have to deal with passengers found without valid POP because the TVM where they boarded was out of order. Inspectors can be instructed to not issue a citation in such a case, or the passengers may have to appeal the

citation. (In any case, inspectors should be instructed to check the TVM in question, via radio or direct inspection, and report the problem as soon as possible.)

An alternative approach is to install at least two TVMs at each location in order to provide a backup in case one is out of order.

Table 5-4 reviews these approaches in the context of several key considerations, which are discussed below.

Table 5-4: Approaches to Handling Peak Sales Volumes

	Enough TVMs to Avoid Excessive Wait Time	Add Attended Sales to Cover Peaks	Always at Least Two TVMs
Cost	Depending on passenger volume and maximum wait time threshold, some stations could require a large number of TVMs	Can reduce number of TVMs Can relocate attended sales to different stations between a.m. and p.m. peaks	If many stations only require 1 TVM based on passenger volume, this could substantially increase the overall number of TVMs
Passenger Wait Time	Keeps maximum passenger waits near a planned level	Could provide reduced waiting time during pass purchase peaks	Will vary depending on passenger volumes
Passenger Convenience	Multiple TVMs will provide redundancy if some (or certain features) go out of service With more TVMs, each could be assigned a specialized role based on transaction time	Some passengers will appreciate option of using attended sales	When a single TVM goes out of service, there could be customer service problems if passengers encounter enforcement If both sides of the platform can be reached, backup could be the single TVM on the other side
Infrastructure Constraints	Must have enough space for all the TVMs (and their queues)	Need booths for attended staff as well as space for TVMs	Must have enough space for all the TVMs (and their queues)

Methodologies for Calculating TVM Requirements

This section describes basic methodologies for calculating the number of TVMs required in an SSFC system. The most straightforward approach involves estimating the throughput of each TVM based on the average transaction time. This would use a weighted average that depends on the proportion of transactions of various types and the average transaction time expected for each. For example, if the weighted transaction time were estimated at 12 sec, the average throughput would be 300 passengers per TVM per hour. If the peak period demand were 1,100 passengers per hour at that location, four TVMs would be indicated—although the agency might choose to install an additional TVM to reflect the uncertainties involved in the estimates. Alternatively, if the weighted transaction time were estimated at 20 sec, the average throughput would be 180 passengers per TVM per hour, which would translate into a need for seven TVMs.

Thus, using this methodology, the number of required TVMs would be calculated through the following set of formulas:

$$\text{No. Required TVMs } (\textit{round up}) = \frac{\text{Demand (peak period passengers/hr)}}{\text{Throughput (passengers/hr)}}$$

$$\text{Throughput} = \frac{3,600 \text{ (sec/hr)}}{\text{Average Transaction Time (seconds/passenger)}}$$

$$\text{Average Transaction Time} = \Sigma^{(\textit{over transaction types})} (\% \text{ passengers} \times \text{transaction time})$$

Of course, anticipated transaction times can vary significantly, depending on the nature of the transaction (e.g., combination of coins, bills, and change) and the ease of use of the TVM (related to on-screen menu navigation, as well as complexity of fare structure). For example, the 1999 specifications for the automated fare collection (AFC) system specifications being procured for MARTA (Atlanta) require that TVMs vending a magnetic-stripe stored-value farecard should take only 5 sec for cash payment by an experienced user under ideal conditions; this increases to 15 sec for credit card authorization.[2] Expected transaction times would typically be somewhat longer, based on factors such as passengers fumbling for cash or local factors such as cold weather. Recent observations of TVM use in St. Louis, for instance, found that the average cash payment transaction time for users familiar with the system was more than 20 sec.

This simplified methodology does not reflect the fact that passenger arrival rates and transaction times will vary considerably around these averages. The result of these variations is that, even with enough TVMs to provide the theoretical throughput to meet passenger demand, there will still be queuing—the degree and variability in this queuing will increase as demand approaches throughput. Mathematical queuing theory can be used to estimate the probability that a passenger will encounter a queue of a certain length (i.e., for given demand and throughput). This approach was recently used by NJ Transit in estimating TVM quantities for converting the Newark City Subway (NCS) to SSFC operation.[3]

Figure 5-5 shows an example of a tool for assessing the queuing implications of varying TVM quantities. Various assumptions must be made about the different types of transactions (i.e., average transaction time based on the fare media being purchased and the purchase option used) and about the relative percentages of each type. The weighted average transaction time—and thus the estimated throughput per TVM—is calculated. The overall demand at this location is entered, as well as the percentage of passengers that will use TVMs (i.e., those who do not already have a pass, pre-purchased ticket, or transfer).

The calculations are based on the ratio of the arrival rate to the throughput ("service rate"). The results indicate the probability that an arriving passenger will encounter a queue of a certain length or less; queue lengths can be multiplied by the average transaction time to estimate average waiting times. In the example shown, it is estimated that an arriving passenger would meet a queue of five people or fewer 34% of the time—with two TVMs. By increasing the

[2] Metropolitan Atlanta Rapid Transit Authority, *RFP P2980—Furnishing and Installing the Systemwide Fare Collection System,* 1999.
[3] Booz-Allen & Hamilton, *Newark City Subway Proof of Payment System,* April 1997.

Figure 5-5: Example from a Queuing-Based TVM Quantities Model

Arrival Rate (pax per hour):	4000
% Arrivals for Device Type:	10%
Arrival Rate (pax/hour):	400
Service Rate/TVM (pax/hour):	214

Fare Media — ***% Arrivals Breakdown***

	Cash	Credit/ Debit	Stored Value
Single-Ride Ticket	20%	2%	15%
Multi-Ride Ticket	10%	10%	10%
Pass	3%	25%	5%
Check-Total:			100%

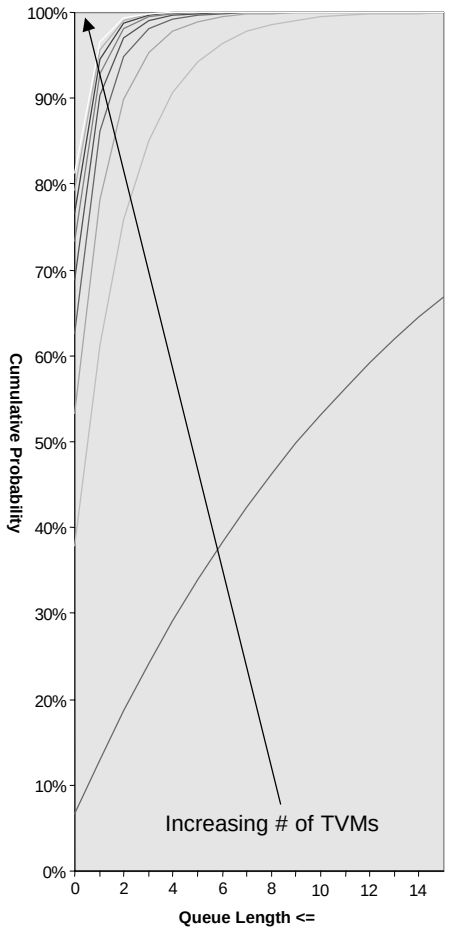
Fare Media — ***Avg. Trans'n Time (s)***

	Cash	Credit/ Debit	Stored Value
Single-Ride Ticket	20	15	5
Multi-Ride Ticket	25	20	10
Pass	25	20	10
Weighted Average Trans'n Time (s):			16.8

Purchase Option

# Devices	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
Arrival Rate/Device (pax/hour)	400	200	133	100	80	67	57	50	44	40
Arrival/Service Rate Ratio	1.87	0.93	0.62	0.47	0.37	0.31	0.27	0.23	0.21	0.19

Prob. Queue <=	**Prob. Wait <=**									
0	**17**	0%	7%	38%	53%	63%	69%	73%	77%	79%	81%
1	**34**	0%	13%	61%	78%	86%	90%	93%	95%	96%	97%
2	**50**	0%	19%	76%	90%	95%	97%	98%	99%	99%	99%
3	**67**	0%	24%	85%	95%	98%	99%	99%	100%	100%	100%
4	**84**	0%	29%	91%	98%	99%	100%	100%	100%	100%	100%
5	**101**	0%	34%	94%	99%	100%	100%	100%	100%	100%	100%
6	**118**	0%	38%	96%	100%	100%	100%	100%	100%	100%	100%
7	**134**	0%	42%	98%	100%	100%	100%	100%	100%	100%	100%
8	**151**	0%	46%	99%	100%	100%	100%	100%	100%	100%	100%
9	**168**	0%	50%	99%	100%	100%	100%	100%	100%	100%	100%
10	**185**	0%	53%	99%	100%	100%	100%	100%	100%	100%	100%
11	**202**	0%	56%	100%	100%	100%	100%	100%	100%	100%	100%
12	**218**	0%	59%	100%	100%	100%	100%	100%	100%	100%	100%
13	**235**	0%	62%	100%	100%	100%	100%	100%	100%	100%	100%
14	**252**	0%	64%	100%	100%	100%	100%	100%	100%	100%	100%
15	**269**	0%	67%	100%	100%	100%	100%	100%	100%	100%	100%
Avg. Queue upon Arrival		0.0	14.0	1.6	0.9	0.6	0.5	0.4	0.3	0.3	0.2
Avg. Wait Time (s)		0	252	44	32	27	24	23	22	21	21



SOURCE: *Multisystems, Inc.—developed for TCRP Project A-24 (2001)*

number of TVMs to four, the queue should nearly always be five persons or fewer. Each agency would set its own level of service standard.

In some cases, microsimulation analysis may be warranted. For instance, there might be complex peaking effects in the arriving passenger flow or space constraints that could cause extreme queuing at certain TVMs and temporarily limit access to others. A microsimulation model can capture the use of platform space by TVM queues and the specific variations in queue length over time. As with any microsimulation, the specific results vary randomly among different runs of the model; multiple runs and statistical sampling techniques must be used to assess the precision and accuracy of the results. This type of approach was recently used in assessing the impact of transaction time changes as a result of a fare increase on passenger flows in the World Trade Center PATH station.[4]

[4] R. Stern, presentation at FTA Bus Rapid Transit Fare Collection Workshop, April 2001.

Considerations

Key considerations in determining TVM quantities include the following:

- **Cost.** TVMs are one of the most significant capital cost items in implementing a new SSFC system. Deciding how many to install will have a major impact on the overall cost of the system.

- **Passenger Wait Time.** Providing an insufficient number of TVMs can result in many complaints from passengers about excessive delays waiting in line. An agency must decide on what level of service (e.g., maximum number usually in the queue) will be provided during the peak period. Another decision is whether this level of service will be provided for the highest demand that the agency ever expects to occur—or only for some lower demand level that is not exceeded a certain percentage of the time (e.g., the 85th percentile peak).

- **Passenger Convenience.** If it seems that some locations could avoid excessive queuing with only a single TVM, the occasional breakdown of this TVM must also be considered. Will customers have the option to use another TVM nearby? If there is no alternative, some customers may board without tickets, and there could be customer service problems related to fare enforcement. More TVMs mean that if some break down—completely or partially—there will be redundancy. Some customers will also appreciate the option of using attended sales when they need customer service.

- **Infrastructure Constraints.** Additional TVMs also involve the additional space needed as well as the infrastructure for power supply and data communications. There may well be infrastructure constraints that limit the maximum number of TVMs that can be installed at certain locations. Temporary attended sales staff will also have space and infrastructure requirements.

Industry Practice

Table 5-5 summarizes the use of TVMs by various SSFC systems. As indicated, two of the four agencies that do not use TVMs (SEMIACS and TTC) are bus or streetcar operations—as TVM use can be challenging in a streetside environment. However, the others are GO Transit, which has rail stations, and OC Transpo, which has stations for at least its Transitway buses.

Number of TVMs Needed to Meet Peak Demand for a Platform

Agencies usually try to base the number of TVMs needed for a particular platform or entrance on the peak period demand, intending to avoid excessive passenger queuing. However, because of significant fluctuations in demand patterns, it is not always possible to provide enough machines to maintain short queues at all times. Of 19 agencies that responded to a survey question on specific TVM issues, 10 indicated that passengers experience long queues during peak periods.

Table 5-5: Use of TVMs for Various Types of SSFC Service

Agency	SSFC Mode		Use TVMs
	Rail or Ferry	Bus or Streetcar	
ATC (Bologna)		✓	✓
Bi-State (St. Louis)	✓		✓
Calgary Transit	✓		✓
DART (Dallas)	✓		✓
Denver RTD	✓		✓
GO Transit (Toronto)	✓		
HKL (Helsinki)	✓		✓
LACMTA (Los Angeles)	✓		✓
Maryland MTA	✓		✓
Muni (San Francisco)	✓		✓
NFTA (Buffalo)	✓		✓
NJ Transit (New Jersey)	✓		✓
OC Transpo		✓	
Sacramento RTD	✓		✓
San Diego Trolley	✓		✓
SCRRA MetroLink (Los Angeles)	✓		✓
SCVTA (San Jose)	✓		✓
SEMIACS (Nice)		✓	
Sound Transit (Seattle)	✓		✓
TPG (Geneva)	✓	✓	✓
Tri-Met (Portland)	✓	✓	✓
Tri-Rail (Miami)	✓		✓
TTC (Toronto)		✓	
VRE (Northern Virginia)	✓		✓

Minimum Number of TVMs for a Platform

Agencies often install at least two TVMs on each individual platform. This provides a backup machine if one is out of service—or has certain components that are not working. In some cases, the backup TVM is immediately adjacent, but, in many cases, the passenger is expected to move farther down the platform or cross over to another platform. SF Muni, for example, has noted that passengers consider the provision of single TVMs at separate ends of the platform inconvenient.

NJ Transit, in converting the Newark City Subway to SSFC, installed only a single TVM on platforms where the boarding volumes were less than 150 passengers per day (i.e., even though the agency had adopted a policy to generally provide at least two TVMs per platform).

As explained in the box at right, some agencies have only one TVM. Moreover, in some cases, an entire platform might have only a single TVM—even if accessing the opposite platform TVM is inconvenient or not feasible. If this is the case, the agency must accept that a passenger will at times encounter an out-of-service TVM and then later be inspected; the inspector might waive the fine or the passenger might need to appeal the citation.

Using Attended Sales to Complement TVMs for Peak Demand

As shown in Table 5-6, using attended sales to temporarily cover additional demand during peak periods—as an alternative to installing a larger number of TVMs—is not a common practice. Of the 10 agencies indicating long TVM queues in peak periods as a problem, only

Table 5-6: Supplementary Use of Attended Sales

Agency		Peak Period Queuing Issue at TVMs	Use Temporary Attended Sales	Sell Passes from TVMs	Sell Passes through Attended Locations
ATC (Bologna)				✓	✓
Bi-State (St. Louis)			✓		✓
Calgary Transit					✓
DART (Dallas)					✓
Denver RTD		✓			✓
HKL (Helsinki)				✓	✓
LACMTA (Los Angeles)		✓			✓
MD MTA (Baltimore)		✓	✓	✓	✓
Muni (San Francisco)		✓			✓
NJ Transit (New Jersey)	NCS	✓		✓	✓
	HBLRT	✓		✓	
Sacramento RTD		✓			✓
San Diego Trolley		✓	✓		✓
SCRRA MetroLink (Los Angeles)		✓		✓	✓
SCVTA (San Jose)					✓
Sound Transit—rail (Seattle)		✓		✓	✓
TPG (Geneva)					✓
Tri-Met (Portland)		✓		✓	✓
Tri-Rail (Miami)				✓	✓
VRE (Northern Virginia)				✓	✓

those in Baltimore and St. Louis reported using temporary additional sales staff. San Diego Trolley noted that it is considering barriers at specific stations because of extreme peaking after sports events.

Table 5-6 also shows that attended sales for passes—in lieu of or as a supplement to selling passes through TVMs—is a more common practice. For weekly or monthly passes that start on a specific day, sales are usually concentrated on the few days before the pass period begins. Without attended sales (whether through ticket offices or third-party vendors), a larger number of TVMs would be needed during that time. The only agency that indicated no use of attended sales to sell passes was NJ Transit, for Hudson-Bergen Light Rail; NJ Transit sells passes only through TVMs and by mail.

Summary and Recommendations

The TVM quantities an agency needs to meet demand adequately (i.e., without subjecting passengers to unreasonable queues) can be determined through several methodologies as follows:

- Comparing peak period demand with average throughput per TVM, using straightforward equations;

- Modeling the statistical likelihood of various lengths for the TVM queues to select a number of TVMs that reduces the chance a person will encounter a queue of a certain length; and

- Using microsimulation techniques, to assess the use of limited space and varying peak demand over time by TVM queues.

TVM quantities should be determined based on an *analysis of the average transaction time and peak period demand.* Ideally, the analysis should also use modeling to *consider the effects of queuing* when overall TVM throughput is not much above passenger demand (i.e., because of the randomness in arrivals and variations in individual transaction times).

If only a single TVM seems warranted on the basis of passenger demand, consider providing a *backup TVM* to provide a reasonable alternative in the event of equipment failure. It may also be appropriate to use *attended sales locations* for fare options that create extreme surges in demand such as period passes, or if a very large number of TVMs is called for only to serve peak period passenger demand.

Validation of Tickets

Issues/Decisions

Validation of tickets is one of the fundamental requirements in a POP system. Some of the issues and decisions that must be addressed in this area are as follows:

- Will some fare media be validated after purchase?
- Will there be separate devices solely for the validation after purchase?
- Will after-purchase validation be off board or on the vehicle?
- Will validation involve paper or electronic fare media?
- What validation information is needed for fare inspection?
- How will validators meet the needs of passengers with disabilities?
- How will validators meet the needs of passengers who are illiterate or do not understand English?
- How many validators are needed in each location?

Related Sections

Types of SSFC Equipment

TVM Fare Media Options

SSFC at Stops/Stations without TVMs

Use of Electronic Fare Media

Techniques/Approaches

The basic validation techniques are as follows:

- Automatic validation at the time of ticket purchase only (i.e., no advance purchase tickets);
- Validation of advance purchase fare media (i.e., multi-ride tickets or stored-value farecards) on the platform before boarding, using a stand-alone self-service validator; and
- Validation of advance purchase tickets using a self-service validator during boarding; in a zone-based system, validation may also be required on alighting (e.g., “tag on–tag off” if using contactless smart cards).

Table 5-7 reviews the advantages and disadvantages of each technique in the context of several key considerations discussed below.

Table 5-7: Alternative Validation Techniques

	At Purchase	After Purchase	On-Board
Cost	With no advance purchase (other than pass) option, more TVMs may be needed	All platforms need stand-alone validators and/or validators in TVMs; need enough validators to minimize queues during peak periods	Validation devices (or TVMs) need to be placed at each entering passenger channel
Passenger Convenience	Requires ticket purchase for every trip (unless using a pass); can result in long lines	Stand-alone validators are small and can be placed directly adjacent to passenger walkways	Passenger boarding rate reduced
Evasion Opportunities	Passengers cannot claim they "didn't know" the ticket needed to be validated	Some passengers might not (or claim they didn't) know the ticket needed to be validated	Passenger might try to validate only if an inspector boards
Fare Options	Limits fare options (on SSFC systems) to passes, single-ride tickets, and transfers	Allows advance purchase of multiple tickets	Allows advance purchase of multiple tickets
Maintenance		Adds stand-alone validator as a distinct type of device	Maintenance might require taking vehicle out of service

Considerations

Key considerations in validation of tickets include the following:

- **Cost.** Stand-alone validators can enable advance purchase ticket options that reduce the number of transactions and perhaps the number of TVMs required. Although validators are much less expensive than TVMs, several may be needed for each platform. The specific validator cost depends on the type of fare media (e.g., paper, magnetic stripe, and smart card).

- **Passenger Convenience.** Stand-alone validators can increase passenger convenience if there are enough to avoid queues comparable to those at the TVMs. A difficulty with on-board validators is that all boarding passengers will be somewhat delayed.

- **Evasion Opportunities.** Advance purchase tickets need to be validated at time of use. One agency's approach is discussed in the box below. Some passengers may not understand that they need to do this; also, evaders may claim that they "didn't know" they needed to validate the ticket. If the validator is on board, some passengers might attempt to stay near a validator and only use it if they see an inspector boarding.

- **Fare Options.** Without post-purchase validation, the only fare options that can be used on the SSFC system are single-ride tickets, period passes, and transfers.

In Vancouver, advance purchase tickets with a magnetic stripe were implemented in February 2001; a reader on the platform is used to check the ticket—i.e., that it is valid and has not been previously used—before printing the date/time stamp. Although this would not prevent a later attempt to alter the date/time stamp for reuse, it could help prevent the validation of counterfeit paper tickets.

- **Maintenance.** Using separate validators increases maintenance requirements because the number of distinct equipment items increases. However, the specific maintenance requirements of validators are sensitive to the technology used. Validators with contactless smart card readers require very little maintenance, while magnetic-stripe readers require frequent cleaning. On-board equipment maintenance may require that the vehicle be taken out of service.

Industry Practice

As indicated in Table 5-8, most North American SSFC systems have stand-alone platform validators; only Calgary and Sacramento indicated supplementary validation at TVMs. It is common practice in North America to provide stand-alone validators at various locations on the platform. Methodologies presented in the section Determining TVM Quantities can also be used for estimating validator quantities. Figure 5-6 describes an alternative validation approach that avoids the need for separate validators. (The different types and manufacturers of validators are discussed in the Types of SSFC Equipment section.)

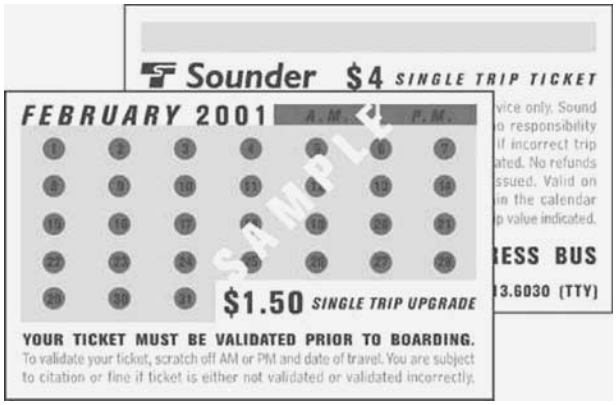
The most common type of validation is simply printing the date and time on the ticket to prevent it from being reused on another trip. San Diego reported problems with the alteration and reuse of date/time stamps—one reason the agency discontinued advance purchase tickets beginning in 2001.

A zonal or station-to-station fare structure requires additional validation information on the ticket (i.e., the origin and destination zones). For instance, GO Transit's 10-ride paper tickets are only validated with a cancellation mark, but the origin and destination stations are printed on the ticket when it is sold. On-board validation was reported by some surveyed European operations, but does not appear to be used in North America at this point. Cancellation of the 10-ride tickets on GO Transit buses seems similar to on-board validation, but is actually a form of pay-on-boarding because validation is completed in view of the driver.

Table 5-8: Transit Agency Validator Locations

Agency	Location		
	Stand-Alone	Combined With TVM	On-Board
ATC (Bologna)			✓
Bi-State (St. Louis)	✓		
Calgary Transit	✓	✓	
DART (Dallas)	✓		
Denver RTD	✓		
GO Transit - rail (Toronto)	✓		
HKL (Helsinki)	✓		✓
NJ Transit (New Jersey)	✓		
Sacramento RTD	✓	✓	
SCRRA MetroLink (Los Angeles)	✓		
SCVTA (San Jose)	✓		
SEMIACS (Nice)	✓		
Sound Transit (Seattle)	✓		
Tri- Met (Portland)	✓		
Tri-Rail (Miami)	✓		
VRE (Northern Virginia)	✓		

Figure 5-6: Sound Transit Scratch-Off Tickets



Source: www.sounder.org

An interesting exception to using stand-alone validators is the approach of Sound Transit's Sounder commuter rail. Its advance purchase tickets can only be used for a single trip during a particular calendar month (i.e., the month is printed on the ticket). These tickets are validated at the time of use without need for a device; the passenger scratches off the date of use—as well as a.m. or p.m. Although the ticket notes that it should be scratched off before boarding, some passengers will attempt to validate the ticket only if they see an inspector approaching (indeed, this was a problem when this approach was tried in San Diego; it was subsequently discontinued). Sounder started operating in September 2000, and survey inspectors were initially only issuing warnings; thus, the agency has not yet had a chance to fully assess this approach to advance purchase tickets under full fare inspection operations.

Summary and Recommendations

Offering stored-value farecards or multiple-ride tickets requires passengers to validate the card or ticket before boarding. Building the validator into TVMs requires boarding passengers to queue with passengers purchasing tickets, so stand-alone validators are usually used for advance purchase options. These validators are lower cost devices because they do not need to support ticket purchases; thus, several can be provided at convenient platform locations.

On-board validators increase boarding time for those passengers with advance purchase tickets and can also slow down those with single-trip tickets, passes, and transfers. However, on-board validators may be necessary with some bus or streetcar SSFC operations (i.e., where equipment cannot be reasonably installed at every stop).

All agencies should provide **validation** options for pre-purchased fare media, so as to expand the available fare options and to eliminate the need for all passengers to use TVMs before each trip. *Stand-alone platform validators* should be provided if feasible. *On-board validators* slow down boardings, but should be provided if necessary (i.e., if platform devices are not feasible at some or all stops).

SSFC at Stops/Stations without TVMs

Issues/Decisions

In some systems, it will not be feasible to install off-board TVMs at some or all stations (or stops)—e.g., in bus or streetcar operations with many streetside stops. In such cases, the following questions will need to be addressed:

- What fare payment options will be available to boarding passengers at these locations?
- Will there be attended and/or on-board sales options?

Related Sections

Types of SSFC Equipment

Validation of Tickets

Fare Media Distribution

Fare Structure

Techniques/Approaches

Several potential approaches can be used to accommodate passengers without prepaid fare media in systems that cannot provide TVMs at all stations/stops:

- Cash passengers boarding at these stations could use only the front door and pay at a driver-attended farebox.
- A cash-accepting TVM can be installed at rear door entrances so that cash passengers would not have to use only the front door.

An additional approach that could be used with either approach is for staff to set up temporary attended sales locations for these stops and stations (i.e., during the busiest periods).

Considerations

Key considerations regarding SSFC at stops and stations without TVMs include the following:

- **Station/Stop Layout.** If there is no space for a TVM, there is not likely to be space for attended sales either.
- **Cost.** The least expensive approach would use an on-board farebox, with cash passengers boarding through the front door only. Other options will cost more, but might be needed to avoid delays resulting from higher boarding volumes.
- **Dwell/Running Time Impacts.** The particular arrangement can significantly affect boarding times—and thus vehicle dwell and running times. Full off-board payment/validation (e.g., through an attended sales operation) will facilitate the fastest boarding speeds, while an option requiring everyone lacking prepaid media to board via a farebox at the front door will result in the slowest boarding speeds.

- **Driver Responsibilities.** Requiring all cash passengers to use the farebox increases the driver's responsibility for fare collection and enforcement. Providing off-board attended sales or on-board sales devices at all doors significantly reduces the driver's responsibilities; in some cases, a driver-attended farebox may not be needed.

Table 5-9 summarizes the advantages and disadvantages of each technique in the context of several key considerations.

Industry Practice

Those few North American SSFC systems that do not have TVMs at each stop are bus/streetcar operations. The Toronto Queen Street streetcar and Ottawa articulated bus SSFC operations have no TVMs at all, while San Francisco Muni uses on-board payment to compensate for there being particular stops without TVMs. As in Pittsburgh, the MBTA's Green Line in Boston currently requires everyone to board—and pay their fares—through the front door of the lead car. Also as with PAT in Pittsburgh (see the box below), the MBTA is considering switching to SSFC.

In the planned SSFC conversion for light rail in Pittsburgh (currently using pay-on-boarding), certain stops will not physically support full-size TVMs. After reviewing a range of alternatives, the plan is to install no TVMs at these stops but to still allow all doors boarding throughout the system. At the time of the study, about 70% used prepaid fare media, so only a minority of riders will need to pay on-board. Passengers without prepaid media will have the choice to use either the farebox when boarding through the front door or on-board TVMs/validators at other entrances.

Source: Booz-Allen & Hamilton, Port Authority of Allegheny County Stage II Light Rail Program—Fare Collection Review and Cost Analysis Update, 1998

Where TVMs are not installed at low-volume stops only, the negative effect on dwell time of front-door-only boarding for cash passengers will be less severe. The effect on boarding time becomes a greater issue for multi-car light rail trains or longer buses. Figure 5-7 shows a

Table 5-9: Alternative Techniques If Some Stations Cannot Have TVMs

	Attended Sales on Platform	On-Board Farebox	On-Board Farebox with On-Board TVMs
Station/Stop Layout	Would need space for the temporary staff operation	Option if there is no space for any off-board payment	Option if there is no space for any off-board payment
Cost	Requires some type of portable ticket issuer (e.g., farebox or portable TOM)	Avoids the need for additional on-board sales equipment	TVM required on board at all doors besides front. Also option of eliminating farebox
Dwell/Running Time Impact	Keeps all fare payment off board to minimize dwell time	Only passengers with prepaid fare media can use all doors; those paying cash need to use front door	Faster boarding time than farebox-only, because cash passengers are no longer limited to the front door
Driver Responsibilities	Avoids any driver involvement in fare collection	Drivers need to monitor all cash passengers	Drivers only need to monitor some cash passengers. Possibility to eliminate need for driver involvement

Figure 5-7: Adelaide Ticket Validator / Dispenser

Source: www.adelaidemetro.com.au

Buses in Adelaide, Australia, have small validators at the vehicle doorways for passengers to use as they board with magnetic stripe tickets purchased at off-board outlets. Those boarding without a pre-purchased ticket can obtain a validated ticket from a driver-operated device after paying on-board. To permit all-doors-boarding by even those passengers paying on-board—and to reduce the number of on-board payments the driver needs to supervise—validators at each door are also equipped to accept payment by coin and to dispense a validated ticket.

Source: Federal Transit Administration, Resource Paper for BRT Fare Collection Workshop, 2001

combined ticket dispenser and validator used to enable all-doors-boarding for cash passengers in Adelaide, Australia.

Summary and Recommendations

In certain circumstances, an agency might decide to not equip all stations or stops with TVMs. The reasons for this decision include the following:

- Certain stops simply may not be large enough to support installation—and use—of a TVM readily.
- The level of demand at one or more stops may be too low to warrant a TVM.
- For an operation with many streetside stops, there can be concerns about cost, as well as about the potential for theft or vandalism in a less supervised environment.

- The agency may feel that there are numerous outlets where prepaid fare media can be purchased—and that most riders already board with fare media, even without TVMs at each stop.

Cash customers will need some method to purchase their fares if there are no TVMs. This can be limited to a driver-attended farebox, although this will result in slower boarding speeds. Cash passengers can also use the rear doors if these doors are equipped with self-service on-board TVMs. If front-door-boarding delays for cash passengers are a problem only during certain peak periods—and additional on-board TVMs are not used—another alternative is the temporary use of attended sales at the stop for single-ride tickets.

The decision regarding **alternatives to in-station TVMs** should be driven at least in part by (1) the number of stops involved and (2) the expected boarding volumes at those stops. If there are many stops (e.g., streetside in a downtown area) and volumes will be heavy at most stops, multi-door fare payment (i.e., with on-board TVMs) should be provided. If logistically feasible, temporary off-board attended sales should also be considered for particularly heavy volume times and/or stops.

TVM Placement

Issues/Decisions

The placement of TVMs in stations—or on vehicles—is an important consideration in SSFC system design. The key questions that must be addressed include the following:

- Where should TVMs be located within a station or stop area?
- Will the platform be designated a “paid area”?
- What are the space requirements for TVMs?
- Are the required power and data line connections available?
- What customer amenities should be built into TVM installations?

Related Sections

Types of SSFC Equipment

Determining TVM Quantities

Validation of Tickets

TVM Ticket Purchase Options

TVM User Interface

Techniques/Approaches

The basic alternatives on where to locate offboard TVMs are as follows:

- Before the entrances to rail platforms or
- On rail platforms or at streetside stops.

In addition, there may be a need to place TVMs on board railcars or buses.

Considerations

Key considerations regarding TVM placement include the following:

- **Type of Paid Area.** Deciding to define a rail platform or streetside location as a “paid area” for SSFC fare enforcement requires that there be well-defined entrances to that area with TVMs located just before each.
- **Space Required.** TVMs require a substantial amount of space in stations or their entrances. Space is needed for the devices themselves, and clear space is also needed in front of each TVM, where passengers complete TVM transactions or wait to do so. This space should be dedicated to TVM use. Otherwise, TVMs—or passengers using them—may interfere with the passenger waiting or circulation areas. For safety and passenger convenience reasons, however, TVMs should not be installed in locations that are far removed from the main circulation paths. For on-board placement, small

TVMs are needed to allow use by passengers as they enter the vehicle—while avoiding undue interference with circulation or significant loss of seating. Finally, regardless of placement, TVMs need to be easily accessible by revenue collectors and maintenance personnel.[5]

- **Power Supply and Data Lines.** Each TVM will require a power supply (this applies to stand-alone validators as well). Although this could involve batteries and/or solar power, in most cases, a circuit is wired to an external source. In addition, TVMs may require data communications—for alarms and reporting, transferring transaction records, or authorizing credit/debit transactions. Again, although wireless data services are sometimes used, this often involves a telephone circuit connection. These wired power supply and data line connections require installation of electrical conduit from the equipment to the main power and communications networks. For new stations, this infrastructure should be provided as part of the design—and provisions should be made for the potential to add supplementary TVMs and validators later, if needed. In selecting TVM locations for existing stations, the locations from which new circuits could be extended and the potential to upgrade power or communications service for the overall facility should be considered. Similarly, on-board TVMs would need to be connected with the vehicle's source for power and outside data communications.

- **Customer Amenities.** Passenger ease of use and perceived safety requires that TVMs be reasonably protected from the elements and well illuminated. In an indoor station or on-board environment, the main issue is to ensure that sufficient lighting is available. In an outdoor area, a canopy is often provided to help protect the devices and the passengers from rain. Security is a related issue. This can involve a human security presence or visible surveillance cameras. The ability to provide reasonable customer amenities—and the cost required—can vary for different TVM locations being considered.

Table 5-10 reviews these approaches in the context of several key considerations.

Industry Practice

Defining station platforms as paid areas—where TVMs would be installed at each platform entrance rather than on the platform itself—can increase perceived passenger security on platforms and opens up opportunities for supplementary (off-vehicle) fare enforcement. Off-platform installation tends to require a greater number of TVMs, however, and at more dispersed locations in the station. This can be difficult if distinct entrances are not well defined (e.g., streetside stops).

In addition, costs can be much greater for installing the required infrastructure (e.g., for power supply and data communications), especially if retrofitting an existing station. Agencies usually

[5] TVM placement may also be affected by other station design issues. For instance, if a station is to be established within a historic structure or on joint-use property owned by a private entity, there may be special considerations that restrict where TVMs can be placed. It will likely be necessary in such situations to work closely with the city or property owner in all aspects of station design.

Table 5-10: Alternative TVM Placement Approaches

	Before Platform	On Platform	On-Board
Type of Paid Area	TVMs should be located at all entrances approaching a paid area platform	If platform is not a paid area, TVMs can be on the platform; they should be visible and convenient to all passengers entering the platform	TVMs must be near doors, visible, and convenient to all entering passengers, even if the vehicle is crowded
Space Required	TVMs, and people using them, need to be located out of the main circulation path	Each TVM needs space for the device itself and for the users	TVMs need substantial space on board and may require major vehicle reconfiguration
Power Supply and Wiring and Data Lines	Devices tend to be dispersed to more locations, making it more expensive to provide power supply and wiring and data lines	Devices are often placed closer together, making it less expensive to provide power supply and wiring and data lines	On-board equipment must be adapted to use on-board power. Stored-value transactions can be transferred at the garage, but credit/debit authorization would require a secure mobile data channel
Customer Amenities	Devices tend to be more dispersed, so illumination, weather protection, and surveillance can be more expensive to provide	Devices are often placed closer together, making it easier to ensure weather protection and surveillance	On-board TVMs are well lit and protected from the elements

have limited options for equipment power supply, but there are often several alternatives for TVM data communications. For the periodic transmission of alarms or batches of stored-value transactions, agencies may find a conventional dial-up telephone circuit to be more cost-effective than a leased line or wireless data services. These services are, however, sometimes used to support credit/debit card authorization (i.e., to avoid the extra delay while establishing a dial-up connection). Figure 5-8 illustrates that most SSFC systems limit the paid area to on board.

Figure 5-8: Paid Area Definitions for SSFC Systems

An on-board TVM installation may involve addressing space constraints, as well as an upgrade to the vehicle's power supply and data communications capabilities. If the device is not near the source of power or communications (e.g., at a rear door in a bus), even space for the required wiring may be constrained.

Some TVM locations, such as those inside stations, will protect users from the elements and provide illumination (i.e., for ease of use and improved safety). In exterior locations—as shown in the example in Figure 5-9—an overhead canopy with lighting fixtures is often installed. Although some stations use remote surveillance cameras, in most cases, security surveillance takes the form of station attendants, security guards, or assistance phones.

Figure 5-9: TVMs on Platform at Los Angeles Blue Line Station

Source: Multisystems, Inc.

Summary and Recommendations

For off-board TVM placement, a key factor is whether an off-board paid area for fare enforcement is used. Such paid areas need TVMs at each defined entrance, and each TVM needs space for the device, as well as for the passengers using it or waiting to do so. Specific TVM placement location decisions should also consider revenue collection and maintenance accessibility, as well as the feasibility and cost of providing infrastructure (e.g., power supply, data communications lines, canopies, illumination, and surveillance). On-board TVM locations must often deal with challenging space, power supply, and data communications issues.

With regard to **placement of TVMs,** a paid area on the platform or streetside will define specific entrance locations for off-board TVMs. However, because of space constraints and higher costs of this approach, it is often more appropriate to place the TVMs directly *on the rail platform.* Regardless of placement, it is important to *ensure proper illumination, weather protection, and security.*

TVM Fare Media Options

Issues/Decisions

Both the fare structure and TVM ticket stock capabilities affect the specific role of TVMs in the fare media distribution strategy. Questions that must be addressed include the following:

- Which fare media and payment options will be provided through TVMs?
- Should TVMs at some stops offer a more limited range of fare media than those at others?
- Should there be any differentiation in ticket stock to assist fare inspection?
- If the various fare options involve distinct ticket stock, how many different types of ticket stock do the TVMs support?

Related Sections

TVM Ticket Purchase Options

TVM User Interface

Fare Structure

Fare Media Distribution

Use of Electronic Fare Media

Techniques/Approaches

In selecting the types of fare media that will be available from TVMs, an agency can consider several approaches, including the following:

- Using a distinct type of ticket stock (e.g., distinct colors and graphics) for each type of fare medium provided;
- Offering some payment options at attended locations only (i.e., only offering selected fare media through TVMs); and
- Offering only a limited set of fare media through certain TVMs.

These approaches are not mutually exclusive; an agency could use all three.

Considerations

Key considerations regarding TVM fare media options include the following:

- **Cost.** The fare media available through TVMs—and the ticket stock used—affect both the capital cost of the TVMs and ongoing maintenance costs for replenishing fare media stock.
- **Passenger Convenience.** Using distinct ticket stock for different types of fare media provides convenience to passengers simply by making it easier to distinguish the type

of payment option they are carrying. Limiting the availability of fare media at TVMs altogether—or offering certain types only at selected TVMs—reduces convenience.

- **Inspection.** Using distinct ticket stock for different fare media can assist fare inspectors by allowing them to more quickly identify the type of payment option the passenger is using. It would also help to use the same ticket stock for a certain fare medium (e.g., day pass or multi-ride ticket) regardless of whether it is issued from a TVM or an attended sales location. The inspector can then quickly focus on looking for the validation information that corresponds to that payment option.

Table 5-11 discusses the advantages and disadvantages of each approach in the context of the key considerations.

Table 5-11: Alternative Fare Media Stock Techniques

	Distinct Ticket Stock for Different Fare Options	Offer Some Fare Media at Attended Locations Only	Offer Fewer Fare Media at Selected TVMs
Cost	TVMs that can support multiple types of ticket stock tend to be more expensive	Could reduce TVM cost (e.g., might not need credit/debit card support) Staff needed for attended locations	Could reduce costs if selected TVMs do not need certain components
Passenger Convenience	Easier for the passenger to distinguish high-value fare media—so as to take better care of the media	Less convenient if the attended locations are only open limited hours	Passengers who use stops with limited-function TVMs might need to go out of their way for their preferred fare media
Inspection	Fare inspectors can identify the type of fare medium by its size or color as they approach, which could allow faster inspection	Not applicable	Not applicable

Industry Practice

Agencies often sell prepaid fare media (e.g., passes and multi-ride tickets) through TVMs, usually in addition to attended sales locations in some or all stations. Looking at Table 4-5 (in the Fare Media Distribution section of Chapter 4), 12 of the 20 agencies with TVMs sell certain types of passes through both attended sales and TVMs.

Table 5-12 summarizes the fare media and payment option types available through TVMs for SSFC systems in North America and Europe. Although all 20 agencies offer single-ride tickets, only 13 also offer round-trip tickets—and only 9 also offer multiple-trip tickets. Only nine offer a day pass, although it must be kept in mind that day passes are not used by all agencies; most agencies offering a day pass at all seem to make it available through their TVMs. Virtually every agency offers a monthly pass, but only 10 sell them through TVMs. Although a wide range of different payment options is offered at various TVMs, only eight of the agencies offer at least four distinct options.

The number and types of different ticket stocks used in a given TVM have traditionally been rather limited, because of the limited variation often allowed by some models of TVMs. In many

Table 5-12: Fare Media Offered at TVMs

Agency		Fare Media Offered					
		Single-Trip Ticket	Round-Trip Ticket	Multiple-Trip Ticket	Day Pass	Monthly Pass	Other
ATC (Bologna)		✓		✓		✓	Annual
Bi-State (St. Louis)		✓	✓	✓	✓		
Calgary Transit		✓			✓		
Denver RTD		✓	✓				
DART (Dallas)		✓	✓	✓	✓		
HKL (Helsinki)		✓		✓		✓	
LACMTA (Los Angeles)		✓	✓				
Maryland MTA (Baltimore)		✓	✓		✓	✓	Weekly
Muni (San Francisco)		✓				✓	
NFTA (Buffalo)		✓	✓				
NJ Transit (New Jersey)	Hudson-Bergen	✓	✓	✓		✓	
	Newark Subway	✓		✓		✓	
Sacramento RTD		✓			✓		
San Diego Trolley		✓	✓				
SCRRA (Los Angeles)		✓	✓	✓		✓	
SCVTA (San Jose)		✓			✓		
Sound Transit (Seattle)		✓	✓		✓	✓	Weekly Biweekly
TPG (Geneva)		✓	✓		✓		
Tri-Met (Portland)		✓	✓	✓	✓	✓	
Tri-Rail (Miami)		✓	✓	✓		✓	
VRE (Northern Virginia)		✓		✓		✓	

NOTE: *The Geneva single-trip and round-trip tickets are each a time-limited ticket (i.e., like a transfer) differing only in their duration of validity.*

cases, all fare media issued from a TVM use the same basic ticket stock (i.e., a monthly pass would look much like a day pass), and a given fare medium often looks different if sold from a TVM than through an attended sales outlet. This can be confusing for passengers—and for inspection staff. Some agencies choose to distribute most of their prepaid fare media through attended sales, due in part to the flexibility attended sales offer in producing visually distinct fare media that can be more quickly recognized by fare inspectors and bus drivers. Figure 5-10 shows examples of such visually diverse fare media from one agency; in this case, only the adult/youth single-ride tickets and day passes are sold from the TVMs.

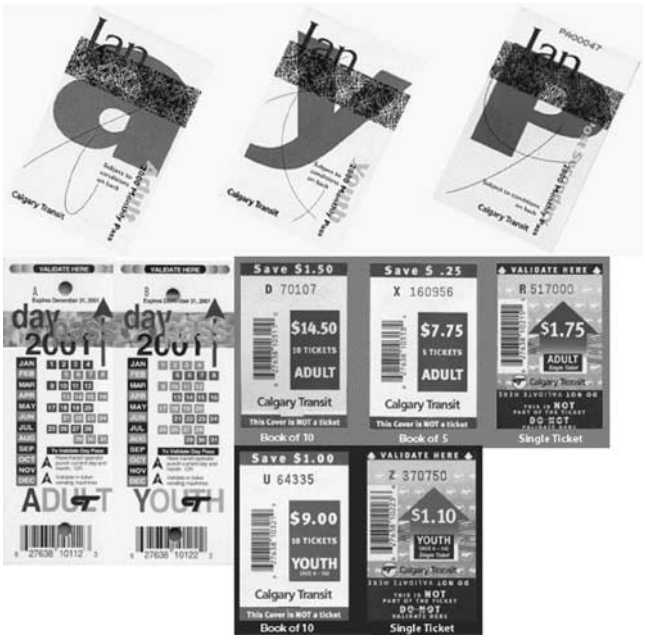
Multiple ticket stock capability available through TVMs has been increasing in recent years, with the introduction of new TVM designs (see the box below for an example). This will allow agencies to offer a greater range of visually distinct payment options and to develop greater compatibility between fare media issued through TVMs and from attended sales locations. However, some agencies will continue to prefer not to sell certain types of media (e.g., monthly passes) through TVMs—for reasons unrelated to ticket stock issues (e.g., avoiding long lines at TVMs from pass sales on certain days or reluctance to provide credit/debit card support at TVMs; see Fare Media Distribution section).

The newest NJ Transit TVMs support 7 different ticket stocks, each with independent units for thermal printing and magnetic stripe encoding (to increase the ability to use stock with varying dimensions).

Summary and Recommendations

Key findings regarding the types of fare media sold through TVMs are as follows:

Figure 5-10: Visual Diversity of Non-TVM Fare Media at Calgary Transit



Source: www.calgarytransit.com

- Although SSFC systems invariably sell single-ride tickets through TVMs, roughly one-half also offer round-trip tickets and/or multiple-trip tickets. Less than one-half offer a day pass, and one-half of the systems sell monthly passes through TVMs. Although a wide range of different payment options is offered at various TVMs, only one-third of SSFC systems offer at least four distinct options.

- Early model TVMs often limited agencies' ability to issue distinct types of ticket stock. More recent models have been overcoming this limitation, but agencies are not yet routinely using such features; many agencies continue to offer most prepaid media only through attended sales locations, and, in general, fare media sold through TVMs continue to differ visually from comparable options sold at attended sites.

- Besides ticket stock issues, some agencies will continue to sell certain types of media (e.g., monthly passes) only through attended sales locations because they do not wish to provide credit/debit card support at TVMs or because they wish to avoid long lines developing at TVMs for buying pass sales on certain days.

Newer TVMs can support many types of distinct ticket stock for different **fare media.** Agencies should consider using a *range of distinct tickets.* This approach can assist fare inspectors by allowing them to identify valid tickets of different types more quickly. *Using the same ticket stock for a particular payment option* (e.g., day pass or multi-ride ticket) regardless of whether it is issued from a TVM or an attended sales location will also help inspectors and will reduce confusion on the part of passengers. However, an agency may decide to *not offer certain fare media at TVMs*—or *at some TVMs but not others* for operational reasons (e.g., avoiding peaks from pass sales on certain days or not wanting to equip TVMs with credit/debit card capabilities).

TVM Ticket Purchase Options

Issues/Decisions

The forms of payment an agency will accept for purchase of tickets in its TVMs affect customer convenience, system costs, and other considerations. The key questions that must be addressed are as follows:

- Which purchase options should be offered, given the types of fare media to be sold through TVMs?
- Should TVMs at some stops only offer a limited range of purchase options?
- Will change be offered for cash purchases?
- Will stored-value be accepted for purchasing other fare media (e.g., POP single-ride tickets)?

Related Sections

TVM Fare Media Options

Use of Electronic Fare Media

TVM User Interface

Fare Structure

Techniques/Approaches

Most TVMs accept coins and bills; alternative options include the following:

- Offering change,
- Accepting credit and/or debit cards, and
- Accepting stored value (i.e., in lieu of cash) for purchasing POP tickets.

With the latter two approaches, there is the additional possibility of not accepting any cash.

Considerations

Key considerations regarding TVM ticket purchase options include the following:

- **Cash Handling.** TVMs are geographically dispersed in a transit system, and reducing the amount of cash handled will reduce revenue servicing costs. Providing change will tend to decrease the cash received in certain denominations, while increasing that received in others (i.e., depending on the specific fare levels). Of course, certain coins required for change but less frequently received from passengers (e.g., dollar coins) will actually need to be restocked if change is provided. Although credit/debit card acceptance can displace some cash use, cash acceptance will still be needed for low-cost fare media (e.g., for single rides or round trips).
- **Cost.** Providing change and accepting cards introduces new TVM components and increases TVM cost. On the other hand, not accepting cash can substantially reduce

TVM cost. Accepting credit/debit cards also introduces new costs in the form of "interchange" fees for processing transactions.

- **Passenger Convenience.** Providing change and/or accepting cards offers additional convenience to passengers. In fact, customers may expect to be able to use cards for anything other than very small purchases. Not accepting cash requires some passengers to use attended sales locations.

- **Data Lines.** With no card transactions, a data communications line would only be needed for monitoring alarms or retrieving reports. Accepting stored-value farecards requires periodically sending batches of transaction records, while accepting credit/debit cards requires real-time communications for authorization.

- **Passenger Security.** Some passengers may worry about opening their wallet or purse at TVMs in stations or streetside stops. A particular issue with debit cards is the concern over entering a Personal Identification Number (PIN). Contactless smart cards offer the advantage of allowing use without removing the card from a wallet or purse.

Table 5-13 discusses the advantages and disadvantages of each approach in the context of these key considerations.

Table 5-13: Alternative Purchase Options (to Cash-Only)

	Provide Change	Credit/Debit	Stored Value	No Cash
Cash Handling	Some types of coins and currency will increase (depends on fare media prices). Certain change (e.g., dollar coins) may need to be restocked	Reduces cash in the TVM, especially if vending high-value fare media	Reduces cash for lower-value fare media	Eliminates TVM cash handling (but requires establishing attended sales options and these will likely accept cash)
Cost	Coin recirculation into change hoppers can decrease need to restock change, but increases TVM cost	Increases cost of TVM; more significant cost is for transaction processing	Increases TVM cost	TVMs markedly less expensive without coin, bill, or change equipment
Passenger Convenience	Much easier than needing exact change, especially if there are a range of fare options and/or zones	Many customers will expect credit/debit option for all but very small purchases	Can make small-value purchases more convenient Can make it easier to avoid offering change	Requires all passengers to use credit/debit or stored value; attended sales (accepting cash) may be needed for some passengers
Data Lines	Needed for monitoring (e.g., for alarms) data transmission	Need to connect with acquiring bank	Need to connect with central agency processing center	As required for credit/debit and stored value
Passenger Security	Less of a concern than with credit/debit	Some will be reluctant to enter PIN in view of others in TVM line	Contactless smart cards can avoid concerns about opening wallet or purse	Some will be reluctant to enter PIN in view of others in TVM line

Industry Practice

Table 5-14 indicates the general range of different payment options accepted at SSFC TVMs. As shown, most TVMs accept cash. The only case where there is no other option but coins is Calgary; the lowest Canadian bill denomination is currently CAN$5. Most U.S. agencies accept at least 1-dollar bills, since the single-ride fare, in most cases, is close to or exceeds $1. Most agencies have, in fact, installed validating bill acceptors that can distinguish higher denomination bills (although this is often limited to $5 or $10), especially if they sell somewhat higher value fare media at the TVMs (e.g., multi-ride options or day passes).

Many agencies, especially those accepting bills, offer change—or provide a separate machine to exchange bills for coins. A limit is sometimes set on the maximum amount of change to discourage the purchase of single fares with large bills. In Portland, for example, TVMs accept $20 bills, but no more than $16 in change will be provided. In Calgary, although the TVMs do not provide change, customers who pay as much as CAN$2 can get change by taking their tickets to an agency customer service representative.

Table 5-14: TVM Purchase Options*

Agency	Purchase Option					
	Coin	$1 Bill	High Bills**	Credit	Debit	Other
ATC (Bologna)	✓				✓	Farecard
Bi-State (St. Louis)	✓	✓	✓			
Calgary Transit	✓					
DART (Dallas)	✓	✓	✓			
Denver RTD	✓	✓	✓			Token
HKL (Helsinki)	✓	✓	✓	✓		
LACMTA (Los Angeles)	✓	✓	✓			Token
Maryland MTA (Baltimore)	✓	✓	✓			
Muni (San Francisco)	✓	✓	✓			
NFTA (Buffalo)	✓	✓	✓			Token
NJ Transit (New Jersey)	✓	✓	✓	✓	✓	
Sacramento RTD	✓	✓				
San Diego Trolley	✓	✓	✓			
SCRRA MetroLink (Los Angeles)	✓	✓	✓	✓	✓	
SCVTA (San Jose)	✓	✓	✓			
Sound Transit—rail (Seattle)	✓	✓	✓	✓	✓	
TPG (Geneva)	✓			✓	✓	Farecard
Tri-Met (Portland)	✓	✓	✓	✓	✓	
Tri-Rail (Miami)	✓	✓	✓	✓		
VRE (Northern Virginia)				✓	✓	

* The table does not explicitly note several specific additional TVM options (e.g., purchasing a ticket that includes an extra cost transfer and purchasing an upgrade ticket to display with the proof or payment from a lower price connecting service) in place at some of these agencies.

** “High” bills are anything over $1.

Credit/debit card acceptance is less common for SSFC TVMs and is generally limited to commuter rail agencies with higher price tickets and passes; one example is described in the box at left. As consumers become increasingly comfortable with using credit and debit cards for transactions in the $5 to $10 range, the potential for agencies to reduce the volume of cash collected in TVMs will increase; however, the transaction fees will be an issue for some agencies.

VRE has accepted no cash at all—only credit or debit cards—since its inception. The stations are geographically dispersed and VRE wanted to avoid high costs for cash collection. Recently, VRE initiated procurement of a fare system enhancement. New purchase options—that retain the "no cash" principle—include

- A "Club Card" that can be read by the credit/debit card reader and will allow riders to post-pay their monthly bills.
- A "promise to pay" coupon with two parts: one with name and phone number that is turned in to the inspector and the other to remind the passenger to pay at a VRE ticket office.

Source: H. Shock, VRE, presentation at 2001 APTA Fare Collection Workshop

Buffalo, Denver, and Los Angeles report accepting tokens as a purchase option at TVMs. In each of these cases, the TVMs sell only single-trip and round-trip tickets; although there are additional costs to collect and recirculate tokens to the attended sales locations, the use of tokens can significantly reduce the quantity of coins and bills. Similarly, San Diego and San Jose indicate that they are interested in retrofitting their TVMs to accept tokens. For San Diego Trolley, this interest is in part related to the decision to discontinue the sale of multi-ride tickets in 2001. Bulk-discount tokens are accepted in the bus system already, and extending this to LRT TVMs would provide an option for multi-ride prepaid discounts on San Diego Trolley (i.e., in lieu of the discontinued tickets).

Of agencies currently reporting use of a stored-value farecard with TVMs, only the Geneva system allows farecard use at TVMs to purchase tickets (there is a similar arrangement with the West Coast Express commuter rail system in the Vancouver area). The Bologna and Helsinki farecards, although revalued at various locations including the TVMs, will be used directly with stand-alone validators and inspected with portable readers.

Transit agencies do not typically vary the purchase options available at different TVMs in the system, because this can be confusing for customers. In some cases, agencies with a mix of older and newer TVMs may wish to add credit/debit card acceptance but find that older TVMs are not readily upgradeable. One strategy would be to distribute the TVMs enabled for credit/debit acceptance among the stations (i.e., so that passengers at any station would have this option).

Summary and Recommendations

Based on the review of TVM ticket purchase options, the following key points emerge:

- Almost all TVMs accept cash—usually both coins and bills. Although bill acceptors usually accept multiple denominations, there is usually a limit to the largest denomination accepted. A few TVMs even accept tokens.

- Many TVMs, especially if accepting higher denomination bills, also make change.

- In general, only commuter rail systems accept credit and/or debit cards at SSFC TVMs. However, as passengers become increasingly accustomed to using these cards for lower value purchases, there may be increasing opportunities for agencies to decrease cash handling costs.

- North American SSFC agencies rarely use electronic farecards, although several initiatives under development are expected to involve SSFC operations (and smart cards are currently used as with TVMs at West Coast Express in Vancouver). Some agencies in Europe are using farecards with SSFC TVMs. When a farecard is used with a TVM, it could serve as an alternative purchase option—and could also be revalued through the TVM. On the other hand, if the farecard is only used to purchase single-ride tickets, such transactions could be done with stand-alone validators. TVMs may have little need to support the farecard at all if cards can be revalued through various attended locations and remote methods (e.g., credit card revaluing via phone, mail, or Internet).

- If an agency has a mix of older and newer TVMs, only the newer TVMs might support certain purchase options. Ideally, a mix of older and newer TVMs would be installed at each station so customers will not need to wonder which stations support what purchase options.

Most modern TVMs will support a wide range of **purchase options,** including providing change and accepting credit/debit cards. Although agencies must be aware of the transaction fees associated with using credit and debit cards, LRT operators should *consider adding credit/debit capabilities* as they replace existing TVMs. This will improve customer convenience and will reduce the amount of cash in the system. SSFC agencies *should also consider allowing electronic farecards* accepted in the overall transit system (or in the region) to be used for the purchase of low-cost SSFC fare options (e.g., single-ride tickets). In some cases, however, stored-value farecards might be usable directly with stand-alone validators for this purpose—thus eliminating the need to adapt TVMs. Finally, commuter rail service agencies with high ticket and pass prices should consider *eliminating cash acceptance in the TVMs*; in such cases, attended sales options that do accept cash will be needed.

TVM User Interface

Issues/Decisions

Given that fare payment in these systems is self-service, the nature of the user interface for an agency's TVMs is crucial, both for maximizing customer convenience and to maximize throughput. An effective user interface will also ensure that the passenger purchases the appropriate ticket for his/her trip. Input from marketing and graphics personnel is an important element in the design process. The key questions that an agency must address in this area include the following:

Related Sections

Types of SSFC Equipment

TVM Fare Media Options

TVM Ticket Purchase Options

Fare Structure

- How will fare options be presented, and, if applicable, how will zone-based fares be presented and selected?
- How will purchase options be presented?
- How will TVMs meet the needs of passengers with disabilities?
- How will TVMs meet the needs of passengers who are not literate in English?
- If TVMs do not all offer the same fare and purchase options, how will a passenger know before entering the wrong line?
- If a TVM is operating in a "degraded operation" mode (e.g., the bill acceptor is out of service), how will a passenger know before entering the wrong line?

Features/Approaches

Two primary types of features can be used to enhance the TVM user interface:

- Software-programmable buttons or touchscreens, rather than an array of separate selection buttons and
- Accessibility features, such as wheelchair access, audible feedback, and multiple languages.

These can be used to address most of the issues identified above. Moreover, if an agency uses a mixture of TVMs with differing capabilities, it will also have to implement some type of indication to let passengers know what functions each TVM supports—and whether the TVM is currently operating in a degraded mode.

Considerations

Key considerations regarding TVM user interface options include the following:

- **Cost.** Several different types of technology are involved in these options, each of which adds to TVM costs. These types of technology are as follows:

  — Providing a touchscreen user interface is currently more expensive than the traditional labeled buttons, although, as a newer technology, the cost should decrease over time.

  — Accessibility features also add cost, but many are legally mandated by the Americans with Disabilities Act (ADA); multiple language capabilities are increasingly dictated by the growing ethnic diversity of many urban areas.

  — Segregating the TVMs into groups with different functions (e.g., cash only and credit/debit-only) is an operational concept. However, this approach requires a user interface that can communicate the current role of each TVM to approaching passengers while they are still too far away to read the screen (e.g., a changeable message sign). The sign should also be able to support other user interface needs (e.g., TVM operating in a degraded mode, next vehicle arrival time, and service announcements).

- **Transaction Time.** If well designed, menu screens can help even inexperienced TVM users complete transactions more quickly. Accessibility features will help certain users complete their transactions more quickly. However, for other users who are inexperienced with the user interface, there is, in fact, some potential for the accessibility features to slow down their initial use of the device—because of the increased number of initial options to choose from.

- **Passenger Convenience.** These features are all explicitly intended to improve passenger convenience. One exception could be with TVM users who are familiar with the TVM user interface, but use one of the less popular fare options; because the initial menu screen will tend to be reserved for the most frequently used options, some choices might be “buried” in several layers of menus.

- **Fare Structure.** Where the fare structure is complex (e.g., zonal fares or a range of payment options available through the TVMs), these user interface enhancements can play a critical role. They can help orient unfamiliar users and can streamline the process for the most common transactions.

- **Accessibility.** Beyond the options that most clearly target accessibility needs, a well-designed overall user interface can also help make the TVM more usable by persons with cognitive disabilities. It is also possible to provide special accessibility enhancements only on selected machines (i.e., directing persons with disabilities to the equipped TVMs); however, if there is only one TVM in a stop or station, that device will have to meet at least minimum ADA requirements.

Table 5-15 reviews the general features within the context of these key considerations.

Table 5-15: TVM User Interface Enhancement Features

	"Soft" Buttons or Touchscreen	Adding Accessibility Features
Cost	Additional costs for screen and software, but opportunity to reduce the number of buttons	Agency could limit additional cost by equipping only selection of TVMs in each station
Transaction Time	Can reduce overall transaction time for unfamiliar users by "leading them through" the transaction	Slight negative impact for unfamiliar users (who don't need the features); additional initial options presented
Passenger Convenience	Can sometimes reduce convenience for familiar users, if their choice is "buried" in menus; the most common transactions can appear on initial screen	More usable for those with disabilities; wheelchair height TVMs somewhat less convenient for taller users
Fare Structure	Can help support a complex fare structure (e.g., with zones), using a separate button for each option	Not applicable
Accessibility	A well-designed interface can assist those with cognitive disabilities	Options include height and viewing angle to support wheelchair use, audible and/or multiple language instructions, and Braille instruction "paths"

Industry Practice

The basic user interface concept used in current model TVMs essentially originated with the earliest North American SSFC implementations in the early 1980s (e.g., 1981 in Edmonton—see Figure 5-11). This basic concept involves buttons to select a payment option for purchase and a display screen to provide feedback to the user. Some agencies subsequently needed TVMs with numerous selection buttons—to offer various fare media types, a zonal fare structure, or reduced-fare categories—to the point where the interface became confusing for users unfamiliar with the device. For example, the original TVMs at the San Diego Trolley had as many as 28 individual buttons on their front face; another example is described in the box. Regional fare integration arrangements at some agencies can further complicate the user interface.

At NJ Transit, one concern in the user interface design—for converting the Newark City Subway to SSFC operation—was the complex menu structure needed for the full range of fare options. It was felt this might confuse inexperienced users and result in their purchasing tickets with unintended restrictions on their use. For this reason, the menu structure includes "warning screens" that allow the user to confirm the validity of the ticket before finalizing the purchase. The result was a required sequence of at least five menus for any purchase. It was felt that experienced users would find the full sequence time consuming and repetitive, so a "fast-fare" button was provided on the initial menu for quick access to an unrestricted single-trip ticket, the most common purchase.

Source: J. Lorenc, J. and J. Lutin., NJ Transit, Presentation at 2000 APTA Light Rail Conference

By the mid-1990s, the TVM interface was borrowing from the success of banking ATMs—using a larger graphic display and a few software-programmable buttons to move through a series of menus. Although this reduced the number of front panel buttons, it often meant that the user might have to go through several on-screen menus to complete a transaction. Typical examples of recent

TVMs at BSDA in St. Louis vend single-trip tickets, round-trip tickets, two types of multi-trip ticket and a day pass. Since there is a small charge for a transfer, the single-trip and round-trip tickets must each use a separate button for a version that includes a transfer. In addition, each of these seven resulting options is offered in a reduced-fare version. This combination leads to a total of 14 required buttons on older Metrolink TVMs.

Figure 5-11—Edmonton TVM

Source: Edmonton Journal

Figure 5-12—Denver TVM

Source: Multisystems, Inc.

installations for this type of equipment include Denver (see Figure 5-12) and NJ Transit (see the previous box).

Recent user interface innovations focus on the use of touchscreens and audible messages. For example, new TVMs brought into service in St. Louis in May 2001—for the St. Clair County (IL) extension of MetroLink—feature audible instructions available in English, Spanish, and German. TVMs recently implemented for Sound Transit commuter rail use a touchscreen interface (see the box below).

Each regional "Puget Pass" in the Seattle area has a "face value" denomination that can vary between $0.50 and $4—in $0.25 increments. Using a touchscreen interface, the new Sound Transit TVMs sell regional Puget Passes in six of these face value denominations—each with weekly, biweekly and monthly versions—for a total of 18 different regional passes. In addition, upgrade tickets are available through the TVMs for the residual value between any Puget Pass denomination and the value of any Sound Transit ticket.

Source: www.pugetpass.org

Table 5-16 lists the year of purchase to indicate the general type of TVM user interface. Some agencies (e.g., in Portland, St. Louis, and San Diego) have several different types in use—

Table 5-16: Age of Installed TVMs

Agency	Year TVMs Purchased
Bi-State (St. Louis)	1993/1997/2000
Calgary Transit	1985/1987/1993
DART (Dallas)	1995
Denver RTD	2000
LACMTA (Los Angeles)	1988 (and later)
Muni (San Francisco)	1988/1995
NFTA (Buffalo)	1998
NJ Transit (New Jersey)	1996/1998
San Diego Trolley	1980/1985/1991/1992/1997/2001
SCRRA MetroLink (Los Angeles)	1992
SCVTA (San Jose)	1987/2000
Sound Transit—rail (Seattle)	2000
TPG (Geneva)	1999
Tri-Met (Portland)	1985/1997
Tri-Rail (Miami)	1995
VRE (Northern Virginia)	1972

because their systems have expanded over the years. However, nearly one-half of the agencies are using some TVMs that are at least 10 years old, suggesting that many of the existing TVMs will be replaced within the next several years.

Summary and Recommendations

The TVM user interface often needs to support numerous options. These can include various payment media, zone fares, reduced-fare categories, paid transfers, and upgrade tickets. The findings of the review of TVM user interface options include the following:

- Most modern TVMs offer a user interface with software-programmable buttons and menu screens, and some of the latest models use a touchscreen.

- In addition, it is now common for TVMs to offer various accessibility enhancements, including Braille instructions, audible feedback, and selection among multiple languages.

- About two-thirds of the surveyed agencies are using relatively modern TVMs for at least part of their complement, reflecting that older SSFC agencies have been actively upgrading their TVM equipment. Moreover, several of the SSFC systems are relatively new and, therefore, have newer equipment. In addition, nearly one-half of the surveyed agencies are using at least some equipment purchased more than 10 years ago, suggesting that the upgrade trend will continue.

The **TVM user interface** must often encompass a wide range of fare and payment options. It also needs to be convenient and clear for a diverse group of users, including first-time passengers, experienced commuters, and persons with disabilities. Therefore, it is important to involve agency marketing and graphics staff in designing the interface. New TVMs should aim to make the best use of the latest user interface technologies, including *programmable "soft" buttons and touchscreens.* However, it is important that this involve careful design of the menu screens structure.

Appendix A: Glossary

Barrier Fare Collection—payment at a turnstile or faregate (or to a ticket agent) on entering (and sometimes also on exiting) a station or loading area; most common approach for heavy rail systems.

Bus Rapid Transit (BRT)—a transit service concept typically involving buses operating in an exclusive right-of-way; in some cases, there are stations along the route, and POP may be used, making the service similar to light rail in a number of respects.

Citation—the typical penalty for fare evasion, similar to a parking or traffic violation, in which the fine is paid via mail and does not require a court appearance.

Conductor-validated Fare Collection—approach often used on commuter rail systems in which a conductor inspects all passengers for valid payment or collects payment from any passenger lacking a valid payment instrument.

Electronic Fare Media—farecards based on either a magnetic-stripe or smart card technology that contain stored-value or time-based passes.

Evasion Rate—the percentage of passengers inspected who do not have adequate proof of payment; this figure is typically used as an estimate of the expected rate of evasion among all riders (i.e., not just those actually inspected).

Fare Inspector—used to refer to personnel who check that passengers have paid for the transit services they are using; inspectors may be transit agency police, local police, county sheriffs, security officers, conductors, or special enforcement officers and may be directly employed by the agency or hired through a contracting arrangement.

Fare Media—forms of fare payment (e.g., single-ride tickets, round-trip tickets, flash passes, tokens, and electronic farecards); also known as payment options.

Fare Structure—the combination of fare strategies (e.g., flat fare, zonal fares, and peak/off-peak differential) and price levels for each fare element.

Flat Fare—a single price per trip, regardless of distance traveled or time of day.

Hand-held Device—a portable device that a fare inspector can use to check the validity of an electronic farecard (i.e., to determine whether the value for the ride has been deducted or if the card represents a valid time-based pass); in a system that allows on-board payment, such a device can be used to issue a ticket to a rider who does not already have one.

Inspection Rate—the percentage of passengers who have been approached by a fare inspector and asked to produce proof of payment.

Inspection Strategy—an agency's basic approach to fare inspection, defining when and where inspection personnel are going to be deployed; the basic strategies include covering the whole system, random inspections (i.e., at the discretion of inspection teams), targeting peak periods, targeting problem areas, and 100% sweeps.

Inspector Productivity—the average number of passengers an inspector checks per day; this is calculated as the inspection rate multiplied by the daily ridership divided by the total number of inspectors.

Paid Area—area in which passengers are always required to have a valid ticket or pass; typically includes on board the vehicle and may or may not include platforms and/or inside enclosed stations.

Pay-on-boarding Fare Collection—payment—in a farebox or via a card reading device—on boarding a vehicle; most common approach for buses, also used in a few light rail systems.

POP—proof of payment.

Remote Sale of Fare Media—sale of tickets or passes (often on a consignment basis) at locations off of transit agency property (e.g., by third-party outlets such as grocery and convenience stores)—or via mechanisms such as mail, Internet, and telephone.

SSFC—self-service (barrier-free) fare collection, otherwise known as proof of payment or POP.

Ticket Office Machine (TOM)—portable device used to vend tickets in a third-party or attended sales location.

TVM—ticket vending machine.

Validation—the process of encoding or marking a POP ticket to indicate that the bearer can legally use the transit service; typically involves encoding the date and time at a station or on a vehicle; sometimes tickets are sold pre-validated.

Validator—piece of equipment used to encode date and time on POP ticket; can be part of a TVM or can be stand-alone unit.

Zonal Fares—fare structure in which pricing is based on the number of zones crossed (as a proxy for distance traveled); a variation for rail is station-to-station fares.

Appendix B: Survey Effort and Results

Introduction: Survey and Results

In an effort to collect information on the state of the art in self-service, barrier-free fare collection (SSFC), a survey was distributed to 40 transit systems in North America and Europe. Twenty-six agencies (65 percent) responded to the survey. Of the 26 respondents, 18 were U.S. transit systems, 4 were Canadian systems, and 4 were European systems. The respondents are shown in Table B-1.

The results of the survey are discussed in the following sections:

- SSFC Service Profile,
- SSFC Selection/Implementation,
- Fare Structure and Media,
- Fare Purchase Options,
- Operational Characteristics,
- Enforcement Characteristics, and
- Inspection and Evasion Characteristics.

Each section summarizes the results of portions of the survey. The responses are summarized in a series of tables following the text.

SSFC Service Profile

As explained in the Toolkit, SSFC is a method of fare collection usually associated with light rail and commuter rail systems, but sometimes used for other modes as well. The service profiles of the 26 respondents are presented in Table B-2.

SSFC Mode

As shown in Table B-2, 7 of the 26 respondents indicate that SSFC is used or will be used on the bus mode. The following is a summary of the implementation of SSFC on different modes.

- Eighteen respondents (65 percent) operate or plan to operate a light rail system and/or a streetcar service that uses SSFC.

Table B-1: Survey Respondents

Transit Agency	City	Type of Service*
Maryland MTA	Baltimore, MD	L
ATC	Bologna, Italy	B
NFTA-Metro	Buffalo, NY	L
Calgary Transit	Calgary, Alberta	L
Dallas Area Rapid Transit (DART)	Dallas, TX	L/C
Regional Transportation District	Denver, CO	L
Lane Transit District	Eugene, OR	B
Transports Publics Genevois (TPG)	Geneva, Switzerland	L/B/F
Helsingin Kaupungin Liikennelaitos (HKL)	Helsinki, Finland	L/C/F
Oahu Transit Services	Honolulu, HI	B
LACMTA	Los Angeles, CA	L/B
Southern CA Regional Rail Agency	Los Angeles, CA	C
NJ Transit	Newark, NJ	L
SEMIACS	Nice, France	B
OC Transpo	Ottawa, Ontario	L/B
Tri-Rail	Pompano Beach, FL	C
TRI-Met	Portland, OR	L
Sacramento RTD	Sacramento, CA	L
San Diego Trolley	San Diego, CA	L
MUNI	San Francisco, CA	L
SCVTA	San Jose, CA	L
Sound Transit	Seattle, WA	L/C
Bi-State Development Agency	St. Louis, MO	L
GO Transit	Toronto, Ontario	C
Toronto Transit Commission	Toronto, Ontario	L
Virginia Railway Express (VRE)	Washington, DC	C

** Type of Service: L = light or heavy rail, C = commuter rail, B = BRT or bus, F = ferry*

- Seven respondents (27 percent) use SSFC on commuter rail. Of these, three (DART, HKL, and Sound Transit) also are in the light rail group.

- LACMTA and HKL are the only systems of the 26 respondents that have implemented SSFC on heavy rail.

- Of the 26 agencies surveyed, 2 have implemented SSFC on ferry boat service.

Some of the survey respondents use SSFC on more than one mode. Five systems (23 percent) operate two modes with SSFC. These are generally a light rail application with either bus or

Table B-2: SSFC Service Profile

Agency Name	POP Mode					Line Mileage			Number of Stations			Paid Area	
	MB	LR	CR	HR	FB	Subway	Surface	Elevated	Subway	Surface	Elevated	On-Board	Stations
ATC (Bologna, Italy)	Future						2,303			NR		X	
Bi-State (St. Louis, MO)		Current				2	14	1	3	15	2	X	X
Calgary Transit		Current					29			32		X	
DART (Dallas, TX)		Current	Current			3	29		1	22		X	
Denver RTD		Current					14			20		X	
Go Transit (Toronto, ON)			Current				361			50		X	X
HKL (Helsinki, Finland)		Current	Current	Current	Current	67	232		16	243		X	X
LTD (Eugene, OR)	Future						10			28		X	
LACMTA		Current		Current		17.4	22	20	16	22	14	X	
Maryland MTA		Current					36			32		X	
New Jersey Transit		Current				4.2	6.5		11	15		X	X
NFTA (Buffalo, NY)		Current				5.2	1.2		8	6		X	X
The Bus (Oahu, HI)	Future						50			150		X	
OC Transpo (Ottawa, ON)	Current	Future					NR			22		X	
Sacramento RT		Current					20.6			30		X	
San Diego Trolley		Current					93.6			48		X	X
San Francisco Muni		Current				11.5	40			15		X	X
Santa Clara VTA	Current	Current					28.4			47		X	
SEMIACS (Nice, France)	Current						NR			NR		NR	NR
Sound Transit (Seattle, WA)		Future	Current				40			7		X	
SCRRA Metrolink (Los Angeles, CA)			Current				416			48		X	
TTC (Toronto, ON)		Current					30.5			NR		X	
TPG (Geneva, Switzerland)	Current	Current			Current		640			520		X	X
Tri-Met (Portland, OR)		Current					33			50		X	X
Tri-Rail (Pompano Beach, FL)			Current				72			18		X	
Virginia Railway Express			Current				NR			18		X	

NR - Not reported

LEGEND: MB=motorbus; LR=light rail/streetcar; CR=commuter rail; HR=heavy rail; FB=ferry boat

commuter rail as the second SSFC mode. Only two respondents, HKL and TPG, operate more than two modes with SSFC.

Paid Area

All respondents consider on board the vehicle as a paid area (i.e., passengers are required to have a ticket or pass in these areas). Nine of the respondents, all of which operate at least one rail mode, also consider stations as paid areas. These nine respondents represent 41 percent of the 22 systems that operate a SSFC rail mode.

SSFC Selection/Implementation

There are many reasons why a transit system would consider an SSFC system. Among these are costs, speeding the boarding process, and ease of use. The reasons indicated by respondents for selecting and implementing SSFC are summarized in Table B-3. Because some respondents listed more than one reason for implementing SSFC, the percentages presented here are not additive, but rather represent the overall proportion of respondents citing a particular answer.

- Cost-effectiveness was the most often cited reason for choosing SSFC. Seventeen respondents (65 percent) indicated that cost-effectiveness was one of the reasons that SSFC was implemented.

- The second most often cited reason was to speed the boarding process. This was cited by 11 respondents (42 percent) as one of the reasons for implementing SSFC. More than one-half of these systems use (or plan to use) SSFC on the bus mode.

- The local operating environment (e.g., street-level rail operation in mixed traffic) was the third most often cited reason. Six respondents (23 percent) indicated that the local operating environment was one of the reasons influencing their decision to implement SSFC.

- The remaining reasons for implementing SSFC consist of the following:

  – Ease of Operation–requires fewer personnel and less equipment (i.e., no faregates);

  – Maintainability–with less equipment, maintenance is easier;

  – Ease of Use–fewer obstacles between passengers and vehicles;

  – Integration/Technology–easier to integrate with other regional services and can accommodate different technologies; and

  – Vehicle Design–allows multi-door boarding on buses (particularly useful when using articulated vehicles) and light rail vehicles (LRVs).

Table B-3: SSFC Selection/Implementation

Agency Name	Reasons for Selecting POP								Would you choose POP today?
	Cost Effective	Speed Boarding	Ease of Operation	Maintainability	Ease of Use	Integration/ Technology	Operating Environ.	Vehicle Design	
ATC (Bologna, Italy)	X	X							Yes
Bi-State (St. Louis, MO)	X		X	X	X				Yes
Calgary Transit	X			X	X				Yes
DART (Dallas, TX)	X								Yes
Denver RTD		X							Yes
Go Transit (Toronto, ON)		X							Yes
HKL (Helsinki, Finland)	X								Yes
LTD (Eugene, OR)		X							Yes
LACMTA	X					X			No
Maryland MTA	X								Yes
New Jersey Transit							X	X	Yes
NFTA (Buffalo, NY)	X						X		Yes
The Bus (Oahu, HI)		X							Not applicable
OC Transpo (Ottawa, ON)		X						X	Yes
Sacramento RT	X								Yes
San Diego Trolley	X	X					X		Yes
San Francisco Muni	X		X						Yes
Santa Clara VTA	X	X							Yes
SEMIACS (Nice, France)							X		Yes
Sound Transit (Seattle, WA)	X					X			Don't Know
SCRRA Metrolink (Los Angeles, CA)	X	X	X		X				Yes
TTC (Toronto, ON)		X							Yes
TPG (Geneva, Switzerland)		X							Yes
Tri-Met (Portland, OR)	X						X		Yes
Tri-Rail (Pompano Beach, FL)	X								Yes
Virginia Railway Express	X						X		Yes

NOTES:

- Notable policy shifts include five systems (DART, Denver RTD, Sacramento RT, San Diego Trolley, and Tri-Rail) that increased inspection rates due to fare evasion.
- LACMTA indicated fare evasion and the lack of flexibility as the reasons it would not consider POP today.
- LACMTA indicated that it is considering a barrier system to reduce evasion. Difficulties encountered include inability to inspect on over-crowded cars
- San Diego Trolley has considered adding gates at some stations due to difficulties inspecting during special events.
- Some stations at San Francisco Muni still use gates, particularly in subway. However, Muni is considering the elimination of all gates to save money.

When asked if they had to make the decision again, would they choose SSFC today, 23 respondents (89 percent) indicated that they would choose SSFC again. Only one respondent, LACMTA, indicated that it would not choose SSFC, because of the high fare evasion (i.e., because of the difficulty of inspecting crowded cars) and its lack of flexibility (e.g., systems cannot easily implement distance or time-based fare structures). Of the remaining two respondents, one, Sound Transit, was not sure if it would choose SSFC again, and the other, Oahu's The Bus, indicated that the question did not apply because its SSFC system is in the planning stages.

Fare Structure and Media

An SSFC system is adaptable to most fare structures (e.g., flat-fare or zone system) and can accommodate numerous types of fare media from single-trip tickets to annual flash passes. This section summarizes the fare structures and media types used by the respondents in their SSFC services.

A flat-fare structure (i.e., one price per trip regardless of distance traveled) is the predominant fare structure in use at SSFC systems. As shown in Table B-4, 15 respondents (58 percent) indicate that their SSFC services use a flat-fare structure. Ten respondents (38 percent) use a zonal fare structure in their SSFC services.

In addition to the basic fare structure, respondents were also asked about transferring between SSFC routes and other service. In most cases, transfers are free. However, five of the respondent systems charge an additional fare (from 10¢ to as much as the cost of a single ride). Generally, transfers are issued in one of the following manners:

- From a bus operator when transferring from bus to rail;
- At TVMs in rail stations (in some cases the SSFC ticket is the transfer and is valid for a specified time period);
- From the LRV operators, particularly in street-level operations; and
- At the time of purchase for some multi-ride tickets (e.g., transfers are included in ticket books).

In addition to the aforementioned, some systems (e.g., SCVTA) allow only pass users to transfer for free between different services.

Fare Purchase Options

The availability of options for purchasing SSFC fare media varies widely among the respondents. The number of locations where patrons can purchase media ranges from as few as 14 (NFTA in Buffalo, NY) to as many as 1,250 (ATC in Bologna, Italy). The number of locations is largely a function of the number of modes, routes/lines, and stations operated by an agency. The types of purchase and payment options are summarized in Table B-5.

Table B-4: Fare Structure and Media

Agency Name	Fare Structure		Media Types									Validated		
	Type	Transfer	Single	Round Trip	Multi-Ride	Day Pass	Weekly Pass	Bi-weekly Pass	Monthly Pass	Stored Value	Other	On Print	After Purchase	Other
ATC (Bologna, Italy)	Zone	Free	X		X				X		X		X	
Bi-State (St. Louis, MO)	Flat	10¢	X	X	X	X	X		X		X	X	X	
Calgary Transit	Flat	Free	X			X			X		X	X	X	
DART (Dallas, TX)	Flat	Free	NR	NR	NR	NR	NR	NR	NR	NR	NR	X	X	
Denver RTD	Zone	Free	X	X	X				X		X	X	X	
Go Transit (Toronto, ON)	Zone	Free	X		X	X			X		X	X	X	
HKL (Helsinki, Finland)	Flat	Free	X		X				X		X	X	X	
LTD (Eugene, OR)	Flat	Free	NR	NR	NR	NR	NR	NR	NR	NR	NR			X
LACMTA	Flat	25¢	X	X	X		X	X	X		X	X		X
Maryland MTA	Flat	Free	X	X		X	X		X					X
New Jersey Transit	Flat	45¢	X	X					X				X	
NFTA (Buffalo, NY)	Flat	Free	X	X					X			X		
The Bus (Oahu, HI)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OC Transpo (Ottawa, ON)	Flat	Free				X			X		X			X
Sacramento RT	Flat	Free	X			X			X		X	X	X	
San Diego Trolley	Zone	Free	X	X		X			X		X	X	X	
San Francisco Muni	Flat	Free	X						X			X		
Santa Clara VTA	Flat	Passes	X			X			X			X		
SEMIACS (Nice, France)	Flat	Free	X	X	X	X	X		X	X			X	
Sound Transit (Seattle, WA)	Zone	(a)	X	X		X	X	X	X			X	X	
SCRRA Metrolink (Los Angeles, CA)	Zone	Free	X	X	X				X			X	X	
TTC (Toronto, ON)	Flat	Free	X			X	X		X		X	X		
TPG (Geneva, Switzerland)	Zone	Free				X	X		X	X	X	X		
Tri-Met (Portland, OR)	Zone	Free	X		X	X			X		X	X	X	
Tri-Rail (Pompano Beach, FL)	Zone	Free	X	X	X				X			X	X	
Virginia Railway Express	Zone	Free	X		X				X				X	

N/A - Not applicable
NR - Not reported
(a) When transferring to CR, passenger pays difference between rail ticket price and the other mode's fare.

NOTES:

- Annual passes are available at ATC, OC Transpo, and Tri-Met.
- TPG sells day passes, 3-stop tickets and one-hour tickets at its TVMs.
- Other media sold by Calgary include senior and student passes.
- Other media indicated by LACMTA and San Diego Trolley include transfers.
- TTC Other is cash.

Table B-5: Fare Purchase Options

Agency Name	Purchase Locations									Payment Options					
	Number of Locations	TVM	Agent	Outlet	On-Board	Mail	Internet	Grocery Store	Other	Coin	Low Bill	High Bills	Credit	Debit	Check/ Voucher
ATC (Bologna, Italy)	1,250	X	X						X	X				X	
Bi-State (St. Louis, MO)	150	X	X					X	X	X	X	X			
Calgary Transit	NR	X	X	X				X		X	X	X	X	X	
DART (Dallas, TX)	NR	X	X	X		X	X	X		X	X	X	X		
Denver RTD	25	X	X					X		X	X	X			X
Go Transit (Toronto, ON)	N/a		X	X					X	NR	NR	NR	NR	NR	NR
HKL (Helsinki, Finland)	260	X	X	X	X		X		X	X	X	X	X		
LTD (Eugene, OR)	N/A	Future								NR	NR	NR	NR	NR	NR
LACMTA	>850	X	X	X	X	X				X	X	X	X	X	X
Maryland MTA	N/a	X	X			X				X	X	X			
New Jersey Transit	>200	X	X	X		X		X		X	X	X	X	X	X
NFTA (Buffalo, NY)	14	X		X		X				X	X	X			X
The Bus (Oahu, HI)	N/A	Future	Future	Future						NR	NR	NR	NR	NR	NR
OC Transpo (Ottawa, ON)	405		X	X						NR	NR	NR	NR	NR	NR
Sacramento RT	NR	X	X	X		X	X	X	X	X	X		X	X	X
San Diego Trolley	250	X	X	X		X		X	X	X	X	X	X		X
San Francisco Muni	200	X	X	X	X			X		X	X	X			
Santa Clara VTA	200	X	X			X		X		X	X	X			
SEMIACS (Nice, France)	130		X		X			X		NR	NR	NR	NR	NR	NR
Sound Transit (Seattle, WA)	>100	X	X	X		X	X	X	X	X	X	X	X	X	
SCRRA Metrolink (Los Angeles, CA)	100	X	X			X	Future		X	X	X	X	X	X	X
TTC (Toronto, ON)	NR	X	X	X	X					X	X	X		X	
TPG (Geneva, Switzerland)	750	X	X		X			X	X	X			X	X	X
Tri-Met (Portland, OR)	>300	X	X	X		X	X	X		X	X	X	X	X	
Tri-Rail (Pompano Beach, FL)	NR	X	X			X				X	X	X	X		
Virginia Railway Express	56	X		X			X	X					X	X	X

NR - Not reported
N/A - Not applicable
n/a - Not available

NOTES:

- Other purchase locations include social service agencies, employers, regional clearinghouses, news vendors and other retailers.
- Other payment options include checks, transit vouchers, tokens and stored value farecards.

Purchase Locations

The types of locations where SSFC media can be purchased are summarized below; many of the respondents sell fare media through more than one type of venue, so the percentages quoted below are not additive:

- TVMs are available at 23 (88 percent) of respondent systems. Along with in-house sales agents, TVMs are the most popular method of distributing fare media among the respondent systems.

- Twenty-three (88 percent) agencies have agency-operated ticket windows staffed with sales agents. Interestingly, agents and TVMs are available at nearly all of the systems surveyed (20 of the 26 respondents).

- Third-party sales outlets are used by 16 (62 percent) of the respondent systems. Third-party outlets are generally used by larger multi-modal operators.

- On-board sales are available at six (23 percent) of the respondent agencies. Generally, on-board sales are available on bus services or street-level light rail operations, particularly when transfers must be purchased.

- SSFC media can be purchased through the mail at 11 (42 percent) of the respondent systems.

- More recently, some systems have begun exploring internet sales. Seven (27 percent) of the respondent system offer this option.

- A subset of the third-party outlets, grocery and convenience stores, is used by 14 (54 percent) of the respondents to sell SSFC media. Media are typically sold on a consignment basis at these locations.

- The remaining venues where SSFC media are sold consist of employers, social service agencies, regional clearinghouses, news vendors, and other retail locations.

Payment Options

As shown in Table B-5, all but one of the systems responding accept cash at agency-operated venues (e.g., TVMs and sales agents). VRE is the only system that does not accept cash. VRE fare media are available through TVMs on the station platforms via credit/debit card transactions only.

The following summarizes observations on the responses pertaining to payment options.

- Four respondents (15 percent) accept only cash at their agency-operated sales locations.

- In addition to cash, credit, debit, and other (e.g., checks, transit vouchers, and tokens) payment options are available at 17 (65 percent) of the respondent systems. Of these, five do not offer credit/debit transactions at their TVMs.

- Nine (35 percent) of the respondent systems indicate that cash is the only method of payment accepted by their TVMs.

Most of the systems responding to this portion of the survey indicated that cash is the predominant method of payment for SSFC fare media. Some systems reported that cash transactions represent as much as 99 percent of their total transactions. However, some systems (e.g., San Diego Trolley, Metrolink, and TPG) indicate that cash transactions constitute from 40 to 55 percent of the total.

Operational Characteristics

Agencies were asked where passengers board vehicles. In nearly all cases (24 of the 26 systems responding), passengers board vehicles at the front and the back of the transit vehicles. With regard to whether passengers board on one or both sides of the vehicle, 13 respondents (62 percent) indicated that passengers board only on one side, 3 respondents (12 percent) indicated that it depends on the boarding location (i.e., only some station configurations permit dual-side boarding), and 2 respondents (8 percent) indicated that passengers board on both sides of the vehicle. Eight of the respondents either did not respond or indicated that the questions did not apply to their operation (i.e., they have not yet implemented the SSFC system). The results of this section of the survey are summarized in Table B-6.

Enforcement Characteristics

In this section of the survey, respondents were asked a series of questions regarding legal framework, penalties, fines, and other issues related to enforcement (e.g., inspector staffing and duties). The results of this section of the survey are summarized in Tables B-7 and B-8.

Legal Authority and Penalties

The summary of response to questions regarding legal authority and penalties is presented in Table B-7. In order to enforce the fare policy with regard to SSFC, agency inspectors need to have certain legal authority. In most cases, the requisite legal authority is granted through state or provincial law. Key points are as follows:

- Seventeen respondents (65 percent) have legal powers for fare inspection and enforcement granted by state or provincial governments.

- Local/municipal authority provides the legal basis for fare inspection and enforcement at five (19 percent) of the respondent systems.

- Three respondents (12 percent) either did not provide answers or indicated that the questions did not apply (i.e., future SSFC system).

Table B-6: Operational Characteristics

Agency Name	Boarding Locations				Average Daily Ridership (POP Mode)				
	Front	Back	One Side	Both Sides	MB	LR	CR	HR	FB
ATC (Bologna, Italy)	X	X	X		NR				
Bi-State (St. Louis, MO)	X	X	NR	NR		42,000			
Calgary Transit	X	X		X		187,700			
DART (Dallas, TX)	X	X	X			38,000	4,800		
Denver RTD	X	X	NR	NR		22,467			
Go Transit (Toronto, ON)	X	X	(a)	(a)			136,000		
HKL (Helsinki, Finland)	X	X	X		289,600	155,200	46,600	142,000	3,900
LTD (Eugene, OR)	X	X	NR	NR	N/A				
LACMTA	X	X	NR	NR		90,525		120,516	
Maryland MTA	X	X	NR	NR		NR			
New Jersey Transit	X	X	(a)	(a)		9,000			
NFTA (Buffalo, NY)	X	X	X			25,000			
The Bus (Oahu, HI)	N/A	N/A	N/A	N/A	N/A				
OC Transpo (Ottawa, ON)	X	X	X		300,000				
Sacramento RT	X	X	X			28,481			
San Diego Trolley	X	X	(a)	(a)		83,474			
San Francisco Muni	X	X	X			140,000			
Santa Clara VTA	X	X	(a)	(a)		29,771			
SEMIACS (Nice, France)	X		NR	NR		130,000			
Sound Transit (Seattle, WA)	X	X	X				1,230		
SCRRA Metrolink (Los Angeles, CA)	X	X	X				31,000		
TTC (Toronto, ON)	X	X	NR			269,600			
TPG (Geneva, Switzerland)	X	X	X		NR	NR			NR
Tri-Met (Portland, OR)	X	X	X			65,100			
Tri-Rail (Pompano Beach, FL)	X	X	X				8,000		
Virginia Railway Express	X	X	X				10,000		

NR - Not reported
(a) - depends on station

Table B-7: Enforcement Characteristics—Legal Authority and Penalties

Agency Name	Legal Framework		Penalty			Repeat Offenders Policy and Procedures
	Authority	Court Jurisdiction	Type	Minimum Fine	Maximum Fine	
ATC (Bologna, Italy)	Regional	State/Provincial	Fare surcharge	$33	$124	Liens on assets if not paid
Bi-State (St. Louis, MO)	State (IL/MO)	Municipal/County	Citation	$25	$500	Judges discretion
Calgary Transit	NR	NR	NR	$97	$97	N/A
DART (Dallas, TX)	NR	NR	NR	NR	NR	NR
Denver RTD	State	County	Citation	$48	$118	Can result in trespass and eventual exclusion
Go Transit (Toronto, ON)	Provincial	Provincial	Citation	$58	$3,225	None
HKL (Helsinki, Finland)	Local	County	Fare Surcharge	$37	N/A	None
LTD (Eugene, OR)	State	Municipal/County	Citation	NR	$250	Exclusion indefinitely
LACMTA	State	County	Citation	$76	$250	Bail amount increases up to maximum of $250; court discretion
Maryland MTA	State	State	Criminal Charge	$35	$35	None
New Jersey Transit	State	Municipal	Citation	NR	$50	Mandatory Court Appearance
NFTA (Buffalo, NY)	State	Municipal	Civil Penalty	$20	$80	Entered on list
The Bus (Oahu, HI)	N/A	N/A	N/A	N/A	N/A	N/A
OC Transpo (Ottawa, ON)	Provincial	Provincial	Citation	$52	$1,290	Given summons to appear (second fine or higher)
Sacramento RT	State	County	Citation	$54	$250	Commissioner's discretion, increased fine
San Diego Trolley	Local	Superior Court	Citation	$25	$100	Work with DA; 3rd offense considered misdemeanor
San Francisco Muni	Municipal	State	Citation	$103	$250	Incremental fine
Santa Clara VTA	State	Municipal	Citation	$145	$325	None
SEMIACS (Nice, France)	NR	State/Provincial	Fare surcharge	$4	NR	Judicial procedure
Sound Transit (Seattle, WA)	State	County	Citation	$50	$250	Incremental fine
SCRRA Metrolink (Los Angeles, CA)	State	Municipal	Citation	(a)	$275	Tracked by database info forwarded to court
TTC (Toronto, ON)	Municipal	Municipal	Citation	$74	$323	Summons and court appearance
TPG (Geneva, Switzerland)	Federal & County	County	Citation	$37.50	$50	None
Tri-Met (Portland, OR)	State	County	Citation	(b)	(c)	Exclusion from system, if violated may be arrested for trespassing
Tri-Rail (Pompano Beach, FL)	State	County	Citation	$50	$50	Exclusion
Virginia Railway Express	State	Municipal	Citation	NR	$150	Court Discretion

NR - Not reported
N/A - Not applicable
(a) Court discretion
(b) Warning
(c) $75 fine and exclusion from the system for up to a maximum of 90 days.

NOTES:
- In addition to the fine, fare evaders at LACMTA pay bail in increasing amounts depending on the number of offenses (i.e., $25, $50, $100, up to $250).
- In addition to the fine, San Diego Trolley charges a penalty assessment equal to 170% of the fine amount.
- Fare evaders at Sound Transit pay court costs in addition to the fine.

Table B-8: Enforcement Characteristics—Inspector Staffing and Duties

Agency Name	Staffing			Field Attire		Ancillary Duties				
	In-House	Contracted	Police	Uniforms	Plainclothes	Security	Law Enforcement	Customer Service	Passenger Counts	Other
ATC (Bologna, Italy)	X		No		X					
Bi-State (St. Louis, MO)		X	Yes	X		X				
Calgary Transit	X		No	X	X					
DART (Dallas, TX)	X		Yes	X		X				
Denver RTD	X		No	X					X	
Go Transit (Toronto, ON)	X		Yes	X		X	X			
HKL (Helsinki, Finland)	X		No	X				X		
LTD (Eugene, OR)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
LACMTA		X	Yes	X		X	X			
Maryland MTA	X		Yes	X		X	X			
New Jersey Transit	X		No	X				X		
NFTA (Buffalo, NY)	X		No	X				X	X	
The Bus (Oahu, HI)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
OC Transpo (Ottawa, ON)	X		No	X						
Sacramento RT	X		(a)	X	X					
San Diego Trolley	X		No	X		X				
San Francisco Muni	X		No	X		X				
Santa Clara VTA	X		No	X						
SEMIACS (Nice, France)	X		Yes	X		NR	NR	NR	NR	NR
Sound Transit (Seattle, WA)		X	No	X						X
SCRRA Metrolink (Los Angeles, CA)	X	X	(a)	X		X		X	X	X
TTC (Toronto, ON)	X		No	X						
TPG (Geneva, Switzerland)	X		No	X		NR	NR	NR	NR	NR
Tri-Met (Portland, OR)	X	X	(b)	X		X	X			
Tri-Rail (Pompano Beach, FL)		X	No	X		X				
Virginia Railway Express	X		No	X						X

NR - Not reported
N/A - Not applicable
(a) Inspection performed by agency staff and agency police; police provide support for inspectors.
(b) Local contracted police/sheriff

NOTES:
- Inspections at Sound Transit, Metrolink and Virginia Railway Express are performed by conductors. Conductors have additional operations and safety related duties.
- Metrolink security provided by contracted sheriff's deputies.

Generally, fare evaders are not required to appear in court unless they are appealing the fine or have received a summons because of prior offenses. However, evasion penalties are typically processed through a court system, because a fine or bail forfeiture is usually involved and these require processing through a criminal court system. The courts of jurisdiction for evasion cases are mostly at the local level (i.e., municipal and/or county courts). Key points are as follows:

- Seventeen respondents (65 percent) indicated that local courts have jurisdiction over fare evasion cases.
- State or provincial courts have jurisdiction at five (19 percent) of the transit properties.
- Three respondents (12 percent) either did not provide answers or indicated that the questions did not apply (i.e., future SSFC system).

As mentioned previously, the typical penalty for fare evasion is a citation or bail forfeiture. That is, the penalty is akin to a parking or traffic violation in which the fine is paid via mail and does not require a court appearance. Key points are as follows:

- Citations are the penalty issued at 20 (77 percent) of the respondent systems.
- Three (12 percent) of the agencies indicated that fare evasion penalties consist of a fare surcharge, in which collection is handled through a collection agency or small claims court.
- Three respondents (12 percent) either did not provide answers or indicated that the questions did not apply (i.e., future SSFC system).

Fines are largely determined by state or local ordinance and range from $4 per offense to more than $3,000. The extent of the fine and other penalties is usually a function of the number of prior fare evasion offenses. Eighteen respondents (69 percent) indicated that penalties for fare evasion escalate with repeated offense.

Although some agencies' inspectors have the ability to check prior offenses in the field (e.g., through central dispatch), most repeat offenders are identified through administrative procedures or through the court system. Generally, repeat offenses result in a higher fine and/or the evader's being issued a summons to appear in court (e.g., OC Transpo). However, in some cases, repeat offenses can result in temporary exclusion from the transit system, which if violated could result in criminal trespassing charges (e.g., Tri-Met).

Inspector Staffing and Duties

Fare inspectors may include transit agency police, local police, county sheriffs, security officers, conductors, or special enforcement officers. These personnel may be directly employed by the transit agency or hired through a contractor. As such, their duties and powers can vary from one system to another. A summary of the inspector staffing and duties is presented in Table B-8. Key points are as follows:

- In-house personnel (i.e., directly employed by the agency) perform inspections at 18 (69 percent) of the respondent systems. Of these, three systems employ their own police officers, who conduct inspections at least part of the time.

- Four respondents (15 percent) use contract employees to perform fare inspections. Of these, two systems (8 percent) contract with local police departments.

- Two of the respondent systems (8 percent) indicated that they use both in-house and contract personnel to perform inspections. In both cases, the contracted portion of the inspection force consists of local police officers or county sheriffs.

Almost universally, fare inspectors wear a uniform that identifies them to members of the public; 23 systems (88 percent) require inspectors to where uniforms. However, two systems also indicated that they use plainclothes inspectors to supplement their enforcement efforts.

Some of the respondent systems indicated that their inspectors have ancillary duties beyond fare inspection. Ten (38 percent) of the respondent systems require inspectors to perform ancillary duties. These duties include the following:

- Security—10 systems indicated that inspectors have security responsibilities (e.g., deterring vandalism, crowd control at special events, and deterring trespassers);

- Law Enforcement—four systems require inspectors (mostly police officers) to provide law enforcement (e.g., detaining and/or arresting individuals suspected of criminal activity);

- Customer Service—three systems require inspectors to provide services such as passenger information and assistance while in the field;

- Passenger Counts—two of the respondents indicated that inspectors assist with passenger counts and similar data collection activities; and

- Three of the systems are commuter railroads. Conductors who perform fare inspections at these systems also have other duties, primarily safety functions related to the operation of the train.

Inspection and Evasion Characteristics

Information provided by the respondent systems was used to calculate several indicators related to inspection and evasion. These indicators are presented in Table B-9 and are discussed below.

Inspection Rate

The inspection rate is essentially the percentage of passengers who have been approached by a fare inspector and asked to produce proof of payment. Among the respondent systems,

Table B-9: Inspection and Evasion Characteristics

Agency Name	Number of Inspectors	Annual Cost of Inspectors	Average Daily Ridership	Inspection Rate	Evasion Rate	Cost per Inspector	Inspectors per 1,000 Daily Riders	Daily Inspections per Inspector	Inspection to Evasion Ratio
ATC (Bologna, Italy)	NR	NR	NR	NR	6.0%	- -	- -	- -	- -
Bi-State (St. Louis, MO)	15	$414,000	42,000	20.0%	2.0%	$27,600.00	0.36	560	10.0
Calgary Transit	NR	NR	187,700	NR	NR	- -	- -	- -	- -
DART (Dallas, TX)	NR	NR	42,800	n/a	NR	- -	- -	- -	- -
Denver RTD	NR	NR	22,467	25.0%	2.0%	- -	- -	- -	12.5
Go Transit (Toronto, ON)	n/a	n/a	136,000	4.0%	0.8%	- -	- -	- -	5.0
HKL (Helsinki, Finland)	55	$1,300,000	637,300	1.0%	2.0%	$23,636.36	0.09	116	0.5
LTD (Eugene, OR)	N/A	N/A	N/A	N/A	NR	- -	- -	- -	- -
LACMTA	461	$53,000,000	211,041	20.0%	6.0%	$114,967.46	2.18	92	3.3
Maryland MTA	40	$1,400,000	NR	NR	0.5%	$35,000.00	- -	- -	- -
New Jersey Transit	22	$1,200,000	9,000	40.0%	1.5%	$54,545.45	2.44	164	26.7
NFTA (Buffalo, NY)	7	$356,696	25,000	11.5%	3.4%	$50,956.57	0.28	411	3.4
The Bus (Oahu, HI)	N/A	N/A	N/A	N/A	NR	- -	- -	- -	- -
OC Transpo (Ottawa, ON)	11	NR	300,000	NR	2.0%	- -	0.04	- -	- -
Sacramento RT	6	$384,000	28,481	10.0%	2.0%	$64,000.00	0.21	475	5.0
San Diego Trolley	29	$1,116,000	83,474	25.0%	6.0%	$38,482.76	0.35	720	4.2
San Francisco Muni	21	$1,250,000	140,000	15.0%	1.0%	$59,523.81	0.15	1,000	15.0
Santa Clara VTA	9	$700,000	29,771	12.0%	1.8%	$77,777.78	0.30	397	6.7
SEMIACS (Nice, France)	NR	NR	130,000	5.0%	15.0%	- -	- -	- -	0.3
Sound Transit (Seattle, WA)	3	NR	1,230	100.0%	0.3%	- -	2.44	410	333.3
SCRRA Metrolink (Los Angeles, CA)	59	$3,900,000	31,000	25.0%	1.5%	$68,421.05	1.90	131	16.7
TTC (Toronto, ON)	NR	NR	269,600	5.0%	2.4%	- -	- -	- -	2.1
TPG (Geneva, Switzerland)	NR	NR	NR	0.7%	2.0%	- -	- -	- -	0.4
Tri-Met (Portland, OR)	19	$1,300,000	65,100	n/a	4.0%	$68,421.05	0.29	- -	- -
Tri-Rail (Pompano Beach, FL)	35	n/a	8,000	75.0%	2.0%	- -	4.38	171	37.5
Virginia Railway Express	NR	NR	10,000	33.0%	NR	- -	- -	- -	- -
Average				23.7%	3.1%	$56,751.08	1.10	387	28.7
Minimum				0.7%	0.3%	$23,636.36	0.04	92	0.3
Maximum				100.0%	15.0%	$114,967.46	4.38	1,000	333.3

NR - Not reported
N/A - Not applicable
n/a – Not available

inspection rates range from a low of 0.7 percent (TPG) to a high of 100 percent (Sound Transit). The average inspection rate is 23.7 percent.

Evasion Rate

The evasion rate is the percentage of passengers inspected who did not have adequate proof of payment. Evasion rates among the respondent systems range from a low of 0.3 percent (Sound Transit) to a high of 15 percent (SEMIACS). The average evasion rate for the respondent systems is 3.1 percent.

Cost per Inspector

The cost per inspector varies greatly among the respondent systems. HKL in Helsinki has the lowest cost, at $23,636 per inspector. The highest cost is reported by LACMTA at $114,967 per inspector. The average cost among the respondents is $56,751 per inspector.

Inspectors per 1,000 Daily Riders

This indicator measures the overall presence of fare inspectors in the system relative to the number of patrons; the higher the figure, the greater the inspector presence. The lowest ratio of inspectors to passengers is reported by OC Transpo, which has 0.04 inspectors per 1,000 daily riders. The highest ratio is reported by Tri-Rail, which has 4.38 inspectors per 1,000 daily riders. On average, the respondent systems have an inspector-to-passenger ratio of 1.10 inspectors per 1,000 daily riders.

Daily Inspections per Inspector

The number of daily inspections per inspector is not a measure of inspector labor productivity, but rather a measure of an agency's commitment to the inspection function. As such, the level of this indicator is greatly influenced by the agency's policy on enforcement. In addition, inspectors' ancillary duties and passenger loads also affect this indicator. The average number of inspections per inspector for the respondents is 400 per day. The minimum number of inspections is performed by HKL, where inspectors average 116 inspections daily. Muni fare inspectors perform the most inspections, with an average of 1,000 inspections per day.

Inspection/Evasion Ratio

This indicator is an overall measure of enforcement efficiency. However, a high inspection/ evasion ratio is not necessarily desirable on an SSFC system. A high ratio may be the result of a high inspection rate, which results in higher costs. As such, this ratio should be balanced between inspection and evasion: a ratio between 10 and 20 is desirable. The average inspection/evasion ratio is 28.7 for all of the respondent systems. The highest ratio, 333.3, is at Sound Transit, which has an inspection rate of 100 percent and an evasion rate of 0.3 percent; if Sound Transit is removed, the average inspection/evasion ratio is 9.6. The lowest ratio of 0.3 is that of SEMIACS (Nice, France), which reports an inspection rate of 5 percent and an evasion rate of 15 percent.

Summary

Based on the survey undertaken for this study, it can be concluded that self-service fare collection has proven to be a fairly adaptable method of fare collection. It can be implemented in virtually every mode of public transportation and is flexible enough to accommodate most fare structures and transfer schemes, including transfers to non-SSFC modes. The following represents some key observations from the survey of SSFC systems.

- On board vehicles is universally considered a paid area, but slightly less than one-half of the rail systems surveyed also consider station platforms paid areas.
- The most often cited reasons for choosing SSFC are cost-effectiveness and speeding the boarding process.
- Most SSFC systems use a flat-fare structure and offer free transfers between SSFC and non-SSFC services.
- TVMs and agency-operated sales offices are the most prevalent methods of selling and distributing SSFC fare media. Most SSFC sales transactions are handled using cash.
- Vehicle design and station orientation seem to be the determining factors in where passengers board and alight vehicles.
- Most systems' legal authority is granted by state or provincial governments. Penalties are generally in the form of a fine or bail forfeiture that is processed by the local municipal or county court system.
- Repeat offenses usually result in a higher fine and, in some cases, temporary exclusion from the transit system. Repeat offenders are typically identified by the court system.
- Most systems use in-house uniformed staff to perform fare inspections. These individuals generally are not police officers.

An overall summary of inspection and evasion statistics and indicators is presented Table B-10.

Table B-10: Summary of Inspection and Evasion Statistics

Statistic/Indicator	Average
Inspection Rate	23.7%
Evasion Rate	3.1%
Cost per Inspector	$56,751
Inspectors per 1,000 Daily Riders	1.0
Daily Inspections per Inspector	400
Inspection-to-Evasion Ratio	28.7

Appendix C: Literature Review

Introduction

The initial task of TCRP Project A-24 (*A Toolkit for Self-Service, Barrier-Free Fare Collection*) focused on a comprehensive search for and review of written materials (in both hard copy and electronic formats) on self-service, barrier-free fare collection. The results of the literature search are described in this Appendix.

Sources and Types of Reports Identified

The study team conducted the literature search using a range of channels and sources and received assistance in the search from several industry organizations in North America and abroad. Input/assistance has been provided by staff at American Public Transportation Association (APTA), Partners for Advanced Transit and Highways (PATH—a research institution affiliated with the University of California), the European Commission, and the International Union for Public Transport (UITP).

Sources of Reports

The sources of documents reviewed for the study included the following.

Transportation-related Databases

The following US databases were especially useful:

- APTA Database (www.apta.com)
- PATH Database (www.path.berkeley.edu)
- Transportation Research Board's Transportation Research Information Services (TRIS) Online (http://ntl.bts.gov/tris)

We also conducted an Internet literature search to identify additional research/information on POP efforts around the world. Among the international websites we accessed, the following were particularly useful:

- The European Commission Directorate General (DG) for Energy and Transport (www.europa.eu.int).
- The European Local Transport Information Service (ELTIS)—an interactive guide to current transport measures, policies and practices implemented in cities and regions across Europe (www.eltis.org).
- UITP's MOBI+ online database (www.uitp.com);

- Ertico/ITS Europe—A public/private partnership for Intelligent Transport Systems (ITS) in Europe (www.ertico.com).

Individual Transit Agencies

A number of transit agencies have assessed the use of POP—vs. barrier or on-board collection techniques—for new LRT or commuter rail services, or for converting existing services. We contacted those agencies that have implemented POP, as well as those known to be evaluating the option, and solicited copies of reports on these efforts. We also reviewed reports addressing the integration of POP systems into regional payment programs.

Types of Reports

The reports identified through this literature search fall into several basic categories (the individual reports are listed in the annotated bibliography).

USDOT- and TCRP-Sponsored Research

A number of studies of POP systems have been conducted or sponsored by the US Department of Transportation; several of these are of historical interest in assessing POP characteristics. For instance, the USDOT/UMTA in 1979 published a four-volume report entitled *Self Service Fare Collection* that took a comprehensive look at the POP concept as applied in Europe. USDOT/UMTA also sponsored several evaluations of federal demonstrations of POP on LRT and bus in the mid-1980s (i.e., following the introduction of the concept in the US). Two key reports are *Self-service Fare Collection on the San Diego Trolley* (1984) and *Self-service Fare Collection on Buses in Portland* (1986). The latter is important in that it represents the most comprehensive assessment of the use of POP on bus. Our search identified no federally sponsored studies of POP since those evaluations. More recently, TCRP sponsored one previous study that included POP issues: Project A-1 (*Fare Structures, Policies, and Technologies*) reviewed POP usage as part of a comprehensive review of fare collection strategies—and compared POP against other types of fare collection.

Analyses of POP by Individual Transit Agencies

As indicated above, several transit agencies have assessed the use of POP for their transit systems, either as an option for a new service or perhaps to consider the possibility of switching existing fare collection to—or from—POP. We acquired and reviewed several such reports, including studies conducted by Baltimore MTA, Muni (San Francisco), PAT (Pittsburgh), New Jersey Transit, MARTA (Atlanta), GO Transit (Toronto), and Tren Urbano (San Juan, PR).

Other agencies have considered the implications of integrating a POP system into a regional electronic payment program. Several regions are in the process of developing regional “universal card” systems, using smart card—or a combination of smart card and magnetic stripe—technology. The use of stored value cards in POP is not as straightforward as it is in pay on entry–type fare collection systems, and agencies have had to give special consideration to the use of electronic technologies on LRT and commuter rail. We reviewed studies and/or system specifications for regional programs in the San Francisco Bay Area (TransLink), Los Angeles area and Seattle/Central Puget Sound region.

Magazine/Journal Articles and Conference Papers/Presentations

Beyond the above types of research, we identified a number of relevant articles, papers and presentations on POP-related issues. These items were identified through the database searches described earlier, as well as through review of documents collected by study team members (e.g., from attending industry conferences over the years). For instance, we conducted a search of past TRB Transportation Research Records (TRRs), and also reviewed the findings of the TCRP International Transit Study Program missions.

Summary

Through a comprehensive literature search, the study team has compiled and reviewed a broad list of materials related to design, implementation and/or usage of POP fare collection. Using both North American and international transportation research databases, internet searches, direct contact with individual transit agencies and attendance at industry conferences, we were able to identify reports on a wide range of POP issues. These reports, articles, and papers/presentations provided a considerable amount of information used in developing this Toolkit.

The bibliography resulting from the literature search follows this page. Those materials deemed most useful for the study have been annotated, while other relevant materials are simply listed. While some of the reports reviewed are relatively old, several of these contain some useful basic information (e.g., related to the decisions on whether to use POP vs. pay on entry– or barrier-type fare collection) and provide a historical perspective on the development of POP strategies. In developing the Toolkit, the study team used the most up-to-date information available in delineating the characteristics of POP; the information compiled from these earlier reports was used for background material where appropriate. The information provided by all of these reports was used to supplement the results of the survey of transit agencies described in Appendix B.

Annotated Bibliography

Baur, R., “Self-Service Fare Collection Systems for LRT: State of the Art Review.” *Light Rail Transit: System Design for Cost-Effectiveness* Transportation Research Board (1985).

> The advantages of SSFC over barrier systems are summarized; the advantages mentioned include the following:
>
> - Barriers do not stop fare evaders; manning of stations or deployment of inspection crews is necessary.
> - The costs for automatic fare collection equipment (i.e., as used in a barrier system) are much higher than for SSFC.
> - Barrier systems require more space (i.e., for faregates) than SSFC systems.
> - A barrier system can cause fare collection problems when several faregates are out of service at a station.
>
> The author notes that using a proof of payment system for LRT usually means that the integration of the bus system includes proof of payment on the buses. This has the

consequence that drivers have to issue proof of payment to all cash-paying passengers who do not transfer from another vehicle.

Bayliss, D., "What's New in European and Other International Light Rail Transit Projects?" *Light Rail Transit: New System Successes at Affordable Prices, TRB Special Report 221* (1989).

This paper provides a thumbnail sketch of a number of operations, usually focusing on the unique qualities of each.

Booz-Allen & Hamilton, *Review of Fare Collection Systems; Final Self-Service Fare Collection Report; Self-Service Fare Collection Schedule; Fare Collection Review and Cost Analysis Update.* For PAT (1997–1998).

In this series of reports, which were issued between August 1997 and December 1998, the discussion focuses on the form of SSFC that PAT should implement. The primary design problem is that the stations along the lines are or are going to be configured differently. Thus there is tension between what would work best at individual stations and the need to create a user-friendly (i.e., somewhat uniform) experience for riders over the whole system.

- The issue that initiated discussion of SSFC was the need to move to two-car train operation due to increasing ridership. One supporting factor was that about 79% of passengers were already purchasing prepaid fare media from out-of-station vendors. Another was the dwell time improvements expected with a transition to SSFC.
- Alternatives considered included (1) various alternatives retaining full inspection of all boarding passengers, either while boarding or on the platform; (2) SSFC based on either full TVM coverage or on partial TVM coverage (retaining a first car farebox for stations without TVMs); and (3) faregates for automated barrier entry to enclosed stations. The faregate alternatives were eliminated early in the process.
- SSFC alternatives generally have higher capital costs and lower operating costs than the increased staffing alternatives, with the overall annualized costs somewhat lower for SSFC alternatives. In the analysis, capital costs were spread out over an assumed 15-year economic life.
- The discussion of the enabling legislation (for inspection and enforcement) is interesting and is especially persuasive on the point that the freedom of an agency to act depends very much on the careful and considered wording of such legislation. There is an obvious need for an agency to think through all possible enforcement alternatives and scenarios before getting to this step. There is also a useful list of details that should be addressed by the legislation.
- The December 1998 report updated the previous analysis in the light of new factors. These included a new labor agreement that made available station attendants at lower wages, as well as changes in the scope of the Stage II reconstruction.

Booz-Allen & Hamilton, *Strategic Plan for Ticketing and Fare Collection, Newark City Subway Proof of Payment System.* Prepared for New Jersey Transit (April 1997).

The report reaches two noteworthy conclusions regarding inspection for fare evasion:

- A high fine-to-fare ratio, a high citation percentage (portion of inspected evaders issued a citation), and effective citation tracking are the most important factors for keeping down the evasion rate. They are more important than a high inspection percentage (portion of passengers inspected). An inspection rate of about 25% is suggested, but no specific fine-to-fare ratio and citation rate are recommended.
- There is no way of predicting the evasion rate effectively in advance. The writers performed a regression analysis and concluded that the inspection rate is not a very useful predictor of the evasion rate. Part of this is likely the confounding effect of related inspection effectiveness factors that vary at different agencies, such as randomness, blitzes, etc. It is suggested that the underlying relationship is roughly logarithmic—the type of curve that involves "diminishing returns." That is, too low of an inspection rate can increase evasion rates substantially, but past some point further increases in inspection rate lead to progressively smaller improvements. The general conclusion was that a 15% to 25% inspection rate should be able to achieve evasion rates in the area of 1% to 2%. (It was also noted that the reported evasion rate is always based on the percent of evaders from the completed inspections, but that this may not always be a statistically valid sample.)

Booz-Allen & Hamilton, *Strategic Plan for Ticketing and Fare Collection, Ticketing and Fare Collection Alternatives.* Prepared for New Jersey Transit (March 1997).

There is a brief evaluation of POP for New Jersey Transit rail (it is summarily dismissed from consideration for bus). The methodology employed would be a useful model for other such analyses.

Chung, F., "System-Wide Implementation of Proof-of-Payment on Go Transit's Commuter Rail System." Presented at the APTA Rapid Transit Conference in Pittsburgh, 1989.

The author states that POP solved several problems at GO Transit. (Some of the problems probably could have been solved without implementing POP, but it is unclear whether the individual solutions would have offered sufficient benefits by themselves to make sense.) These problems included the following:

- The manual barrier system created line-ups and bottlenecks at inspection points.
- The operating cost of ticket inspection also posed a limiting constraint on the number of passenger entry and exit points between parking lots and the stations and platforms.
- The logistics of printing, distribution, recording, storage and control of pre-coded tickets was quite an onerous task.
- The tickets were also as good as cash and had to be locked up in a safe after business hours.

POP showed striking early results at GO Transit: ridership and revenue increased 8.2% and 18.9%, respectively, in the first three months compared with the same three months the previous year.

Chung, F., "Technology and the Evolution of Fare and Service Integration in Go Transit." Presented at the UITP Congress in Toronto, 1999.

GO Transit's fare collection system has a number of unique elements. The paper describes both the current system and plans for the future. Key points include the following:

- Unlike most other applications, GO Transit's magnetic stripe card and CSC card are both based on stored rides, not stored value. At point of sale for multi-ride tickets, customers specify the origin-destination (O-D) pairs, and pre-pay for a certain number of rides. This is because there are no gates or turnstiles in the rail system.
- The CSC card could conceivably carry a combination of a stored ride application to accommodate GO Transit's zonal barrier-free fare system, and a different stored value application to accommodate the municipal transit systems' flat fare structures—along with the discount for the fare integration program.

Comps, P., "Integrating Proof-of-Payment Fare Systems with Modern Fare Systems." Presented at 8th Joint Conference on Light Rail Transit, November 2000.

This paper "explore[s] the options, methods, and obstacles to implementing and integrating POP fare collection systems with modern high-technology fare collection systems. Included are discussions of issues involving integration of machine-readable transfers, activate-on-first-use passes, stored-value and stored-ride tickets, and unlimited use passes, in both magnetic and smart card media."

Crain and Associates, *Self-Service Fare Collection on the San Diego Trolley*. Prepared for USDOT/UMTA (May 1984).

The positive experience of San Diego Trolley documented in this report evidently helped establish the later trend towards SSFC as the standard fare collection approach for new LRT systems. Several of the key issues that are described would be relevant for many systems:

- One issue was the advantages/disadvantages of police or transit police versus contracted inspection. For example, an important advantage was the ability to issue citations under an authorizing ordinance and thus streamline the collection of fines. The reason is that these fines would be treated legally as "bail forfeiture for not appearing in court" rather than "voluntary payment of premium fare in lieu of suing under civil proceedings."
- Another issue discussed dealt with the operating costs of inspection, which at some levels far exceeded the estimated value of the sum of avoided fare evasion and fines revenue. The report explores the hypothetical optimum level of enforcement.
- Another key issue addressed was the requirement that there be enough distance between stops that inspectors boarding at a given stop have time to check everyone before reaching the next stop (versus conflicting requirements).

Fox, G., "Tri-Met's Self-Service Fare Collection Program." *Bus Operations and Performance, Transportation Research Record 857,* Transportation Research Board (1982).

Tri-Met considered SSFC in part because "the traditional system of fare collection . . . [was going] . . . to impose major constraints on Tri-Met's plans to improve service and efficiency. . . ." Tri-Met eventually began to feel that SSFC would have a "pervasive and generally beneficial effect" if implemented. "[T]wo kinds of benefit were identified—nonquantifiable benefits, such as increased passenger convenience, reduced driver stress and work load, or improved system security, and quantifiable benefits, such as savings in bus hours or increases in revenue to which a dollar amount . . . [could] . . . be attached." However, achieving many of these benefits depended on Tri-Met taking steps beyond implementation of SSFC e.g. procurement of double door buses.

The largest operating cost for SSFC was fare inspection; the largest savings came from the reduction in the number of vehicles required to provide a given LOS, especially on the most heavily used lines and during the peak periods. The savings were projected to be far more dramatic on LRT than on buses. SSFC was also expected to generate additional revenue from (1) a reduction in fare evasion and (2) an increase in the number of fare zones.

Capital cost savings were expected from two sources: (1) reduced fleet size (a function of the reduced vehicle operating needs) and (2) avoidance of farebox replacement.

The discussion of the implementation plan reveals a noteworthy evolution: it became clear as time passed that phased implementation had many disadvantages compared with a one-time switch.

The discussion of the key features of the fare collection system that was actually implemented (in the Project Description section) describes some of the considerations that led to their adoption. Much of the thinking is still relevant today.

Lorenc, J. and Lutin, J., "Conversion of Newark City Subway from Conventional Fare to Proof of Payment Fare System." Presented at 8th Joint Conference on Light Rail Transit, November 2000.

NCS is an interesting case because the LRT POP was created amid a conventional fare collection system. This is a comprehensive report on the conversion, describing issues and their resolution in many areas of the operation:

- Some existing transactions were replaced with new ticketing options on the TVMs, clearly adding efficiency. Passengers who transferred to a bus originally would purchase the transfer on board with an upgrade fare, so a new TVM purchase option of "ticket with transfer" was created. Passengers with an NJT rail pass would originally pay a reduced upgrade fare on board, so a new TVM option of "feeder fare" was added (i.e. POP would be the rail pass plus the feeder fare ticket). A monthly NCS upgrade sticker for the rail pass is also sold.

- The system also paid attention to the details of the TVMs. Infrequent customers need about five screens to navigate the TVMs (since they warn and ask for confirmation if a POP ticket with any limitations on its use is requested). Since most purchases are actually for single ride, unrestricted-use tickets, a fast fare button was added as a shortcut for these customers.
- It was decided that most peak period inspection would involve intercepting all passengers approaching the fare-paid area of a selected platform—this mode of inspection is actually a human barrier system. They achieve systemwide inspection rates of about 40% through this 100% inspection at selected platforms, well over the basic targeted inspection rate of 20%.
- Comparative tests (FEO speed/accuracy) were performed to decide between placing the validation stamp on the front or rear; the tests established that the front was better.
- Ongoing accurate ridership data broken down by fare categories was needed to estimate fare evasion revenue loss. Initially, this was assessed through manual surveys, but they are in the process of testing automatic passenger counting equipment that would provide an ongoing reliable data stream. The initial comparisons show 1.6% evasion based on inspection data and 4.5% based on ridership estimates.

MARTA, “Proof of Payment Fare Collection Study—Executive Summary.” Prepared by MARTA inter-departmental staff team (July 1993).

This study discusses some of the trade-offs involved in the design of an enforcement scheme:

- Beyond achieving an appropriate inspection rate (25% is mentioned), the presence of inspectors could also (1) increase the public perception that everyone is paying their fare (i.e. even those with a pass who seem to walk right in) and (2) provide an opportunity to enhance customer service in the system.
- The “right” personnel for the inspector positions depends in part on the role they are supposed to play and is also driven by cost considerations. Alternatives include police officers, police cadets, or a combined force of supervisors and police officers. Officers cost more than cadets but have more authority. Substituting supervisors for police officers increases cost but increases the emphasis on customer service.
- The high ridership of MARTA (in comparison to other POP systems) could create an over-riding difficulty for the local judiciary. The volume of citations (estimated at 600 to 1200 per week) would likely exceed what the existing magistrate courts could process. Additionally, using the existing courts would also complicate enforcement because several different jurisdictions would be involved. Two options are considered: (1) setting up a state court (i.e. outsourcing the court function to the state) or (2) setting up an in-house court. Although the in-house court is probably slightly more expensive, it has the advantage of allowing MARTA to retain the fines revenue.
- The observed current evasion rate was 1.77%, and it is expected that POP would reduce this figure—and the associated revenue loss—to around 1%. (Fines revenue from a MARTA-operated court could further offset these losses.) However, these savings were not considered sufficient to cover the extra inspection/adjudication

costs—plus the net increase in equipment operating/capital costs from replacing the current equipment with TVMs. Part of the reason for POP equipment costing more in this case was that the existing equipment is a sunk cost at this time—for the upcoming 10-year period, only the existing system costs for new equipment and rehabilitation were considered.

MITRE Corporation, *An Assessment of Self-Service Fare Collection Equipment in Calgary and Edmonton*. Prepared for USDOT/UMTA (October 1984).

This report includes several useful fare collection equipment performance measures.

MITRE Corporation, *Self-Service Fare Collection: Volume I—Review and Summary.* Prepared for USDOT/UMTA (August 1979).

Volume I presents several observations (and related debates) from the European experience with inspection and enforcement, including the following:

- For most transit agencies, the “no-ticket” type of infraction is much more serious than the “wrong-ticket” type of infraction, since the former represents a total loss of revenue for the ride, while the latter only a partial loss of revenue. Copenhagen’s transit system acts on this distinction by making its drivers responsible for ensuring the payment of the base fare. Most other systems approach the problem less directly, using either the penalty structure or publicity to discourage “no-ticket” violations.
- Agencies that report high fare evasion rates also tend to experience low inspector productivity. The authors state that the relationship is not cause-and-effect, but rather “the result of a combination of factors, including the fraud rate itself and whether or not uniformed inspectors are used.” The authors also refer to a “downward spiral” that may occur, as a greater incidence of apprehending evaders means that inspectors are less productive, which in turn increases the evasion rate.
- There is a debate regarding the use of uniformed versus plainclothes inspectors. Agencies with plainclothes inspectors say they have higher rates of apprehending evaders and that the fraud rates they document are closer to reality. On the other hand, agencies with uniformed inspectors claim that this enhances the perception of the degree of enforcement occurring (and thus presumably discourage evasion).

MITRE Corporation, *Self Service Fare Collection: Volume 2—Survey of European Transit Properties.* Prepared for USDOT/UMTA (August 1979).

Volume 2 describes the implementation of SSFC in 11 European cities. It is descriptive rather than analytical and follows the same format for each city: (1) brief description of city; (2) brief description of operator and its operations; (3) longer descriptions of fare structure, enforcement and maintenance of fare vending equipment. The fare structure section discusses fare structure, fare media and fare media distribution/validation. The enforcement section discusses enforcement staff, enforcement procedures and fines. The maintenance section discusses maintenance staff and procedures.

MITRE Corporation, *Self Service Fare Collection: Volume 3—Hardware Considerations.* Prepared for USDOT/UMTA (September 1979).

Volume 3 discusses issues associated with SSFC equipment, particularly the differences between on-board and wayside validation. Key points include the following:

- With regard to capital costs, total equipment requirements of wayside validation versus on-board validation are a function of the number of stops versus the number and type of vehicles.
- The location of SSFC equipment favors certain fare structures over others.
- The validation process must be easy for passengers to understand and use, be quickly performed, and facilitate checking by ticket inspectors.

MITRE Corporation, *Self Service Fare Collection: Volume 4—Legal and Labor Issues.* Prepared for USDOT/UMTA (August 1979).

The examples are more than twenty years old, but the structure of the discussion remains useful. Section 2 is a summary of European procedures. Significant differences in inspection and fining practices resulted in variations in fare enforcement procedure and efficacy. There are four major factors relevant to the control of fare evasion (important subpoints are listed below each):

- The extent of legal authority available to the transit property for enforcement.
  - The power to inspect and to fine is not usually sufficient by itself to ensure an effective fare enforcement program; the power to enforce payment of fines and other penalties through court action is also needed.
  - The standard used to determine whether a rider is guilty of fare evasion is very important. For instance, a strict standard may make it so difficult to establish guilt that the legal authority is largely undermined.

- The type of penalty.
  - The problem with an on-the-spot cash fine is that it would be impractical and unreasonable to require riders to carry sufficient funds to pay the fine, However, this can be addressed by allowing evaders to opt for a citation instead.
  - One advantage of issuing citations is that they allow the transit property to maintain a record of offenders; records represent a valuable means of protecting against chronic fare evaders.

- The level of penalty and the frequency of ticket checks.
  - It is possible to trade off frequency of ticket checks and level of penalty. Yet a change in penalty is apt to have a more direct effect on evasion rates than a corresponding increase in the inspection level.
  - The basic alternatives are to have a single penalty or to penalize evaders at different rates, in accordance with type and number of offenses.

- The passengers' perceptions of enforcement methods.
  - A positive public attitude can equal a high level of compliance. Examples cited include Atlanta, Milan, Munich and Geneva
  - The pros and cons of plainclothes versus uniformed inspectors are discussed.

Section 3 highlights the contrasts between existing European SSFC and existing (late 1970s) U.S. practice and then identifies likely problems relating to implementing SSFC in the US. Among them, enforcement procedures and labor requirements are prominent. Some of the problems now seem dated or, at least, less troublesome than when they were new.

- Creation of enforcement powers
- Likely evasion rates
- Labor force requirements
- Productivity savings
  - Vehicle productivity
  - Easing driver workloads
- Revenue handling and ticket sales—redistribution or reduction in workforce?
- Section 13 (c) provisions—productivity savings could be constrained. (BART, Texas)
- Relationship between unsupervised access and security problems
- Liability
- Accessibility (ADA)
- Economy (of converting from existing fare collection system to SSFC)

Section 4 focuses on differences between European and U.S. enforcement procedures. First, it distinguishes the different elements of the legal authority that must be secured. Second, it identifies the methods available for classifying fare evasion as a crime (theft of service, trespass, etc.).

Parkinson, T., "Advocacy for Conventional Light Rail." *Light Rail Transit: New System Successes at Affordable Prices, TRB Special Report 221,* Transportation Research Board (1989).

Some of the highlights of this survey are listed below:

- Thorough checks of passengers have resulted in accurate evasion statistics for the nine North American systems reviewed; these range from below 1% to less than 3%. This is lower than typical evasion levels with pay-on-boarding or turnstile fare collection.
- Ticket inspectors or checkers play a much broader role than suggested by their titles; for instance, they serve to provide a high level of security. This results in an exceptionally high level of perceived passenger safety on all new light rail lines.
- On a typical light rail system, a self-service fare system has capital costs as low as one-tenth those of a barrier system, while operating costs, after taking security into account, are comparable to or lower than those for conventional systems.

Parkinson, T. and Transport Consulting Limited., *TCRP Report 13: Rail Transit Capacity*, Transportation Research Board (1996).

This report notes that fare collection by light rail operators occurs only on the older light rail transit lines. Even on those lines, however, fare collection in the Central Business District (CBD) is usually handled by station agents to ensure high passenger flow capacities. One agency, SEPTA, reported that the addition of electronic fareboxes to its light rail transit fleet has resulted in extended dwell times outside the CBD.

Fare payment continues to be an operational factor on those few light rail systems that still use on-board payment and checks. The flow rate analysis presented in this report shows that flat fare payments add almost exactly one second per boarding passenger. This can significantly affect running time over a line containing many stations. However, the far more drastic impact depends on the question of whether boarding is restricted to the manned door or is spread along all doors of the train.

Peat, Marwick, Mitchell & Co., *Self-Service Fare Collection on Buses in Portland, OR.* Prepared for USDOT/UMTA (September 1986).

The negative Tri-Met experience and this report evidently put a chill on further exploration of SSFC on North American bus systems. Success at Tri-Met was apparently undermined or complicated by several factors:

- Only sworn police officers could issue citations, so fines took the form of premium fare notices, which were issued by customer service personnel; and scofflaws had to be pursued through small claims court. Tri-Met used a collection agency for small claims court follow-up but later realized that the small value of the claims was making them a low priority for the collections agency.
- The court system originally indicated they were overloaded, and they discouraged Tri-Met from amending its ordinance to authorize Tri-Met personnel to issue citations. However, Tri-Met eventually concluded that they needed to take this step. Arranging for support from the court system turned out to be a bigger issue for a bus system than an LRT line because overall ridership (and thus the volume of notices/citations) was higher.
- Comprehensive changes in fare structure and fare media were introduced in conjunction with SSFC (they introduced more zones, ended prepaid single-trip tickets, and introduced 10-ride prepaid tickets, etc.).
- During the first 11 months of the demonstration period, riders were not required to pay the fare if the 10-ride ticket validator was down. Since the validator could be easily jammed, some customers were jamming them on purpose. Likewise during this period, if the ticket dispenser was down, cash customers could not receive proof of payment.

Tri-Met had also been anticipating some benefits with SSFC that never materialized:

- A substantial shift to the discounted 10-ride ticket had been expected, but many riders still wanted to pay cash onboard.
- Tri-Met had been hoping to see route travel time savings (based on dwell time reductions) approaching the 10% that had been reported by some European bus

operations. However, dropping a bus from a route requires that travel time improve by at least the headway; this did not happen.
- In addition, maintenance costs increased both because of the additional on-board equipment and because of the reliability problems with the machines.

Several reasons are suggested for the perception after the 1982–84 demonstration period that SSFC on buses was generally unsuccessful:

- Ongoing reliability problems with the on-board single-ride ticket dispensers and validators.
- Fare evasion was considered to have increased.
- There was a general recession during the demonstration period that hurt ridership and revenue; as a result, there was a search for "problems" to "fix" to improve the situation.

Pollack, M., "Barrier vs. Barrier-Free: Cost Benefit Analysis for Baltimore Light Rail." Presented at 8th Joint Conference on Light Rail Transit, November 2000.

Politicians asked for an assessment of the methods employed to address fare evasion, which was perceived as high by the public.

- An audit revealed a (statistically valid) evasion rate of 0.8%. The same audit also revealed that 86% of the valid POP comprised media other than a single-trip ticket. These passengers might not have needed to use a TVM before boarding, and this may have contributed to the public perception of high fare evasion.
- A survey of 10 U.S. light rail operations revealed an average inspection rate of 26.6% and an average evasion rate of 1.75%. The regression line suggests evasion rates could rise rapidly if the inspection rate drops below about 20%.
- An important premise of this report is that the transit agency has to concern itself with both the actual and perceived evasion rates. And there is the possibility that if the perceived evasion rate is high, it could lead to an increase in actual evasion. The authors try to balance capital, operating and maintenance costs in their analysis of nine alternative solutions to the "problem."

San Francisco Municipal Railway (MUNI), *MUNI Proof-of-Payment Program: N-Judah POP Evaluation* (June 2000).

Brief descriptions of some important chapters follow.

Chapter 3: MUNI Proof-of-Payment Description describes details that would be useful to consider in any analysis of a POP system. These include the following:

- MUNI transfer policy and procedures were changed to accommodate POP on the N-Judah.
- The ways passengers pay cash fares on MUNI's POP system depends on the boarding location. These differences make enforcement more complicated.

- The document describes the enforcement personnel, the relevant law under which violators are cited and the fines imposed on violators.

Chapter 4: Revenue Analysis describes the statistical method used to test whether the introduction of POP may have increased revenue.

Chapter 5: Operations Analysis describes the statistical methods used to test whether the introduction of POP may have had an impact on (1) dwell times, (2) running times or (3) headways. MUNI staff has also been asked for their observations on the effect on operations, if any, of POP.

Chapter 6: Citation Issuance Analysis compares MUNI to nine other systems that also use POP. The analysis involves a comparison of the systems (i.e., ridership, fare revenue, system length, fleet size, and number of stations); and a comparison of inspection and enforcement data (i.e., fare inspectors, inspection, evasion and citation rates, security). The statistical measures presented would be useful in any analysis of this type. Appendix F of the MUNI report summarizes the interviews held with personnel from other systems; it documents considerations that may be useful when assessing the inspection and enforcement practices of a transit property.

Other Sources

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Saporta, M., "Barrier-free Fare Collection System Could Benefit MARTA." *The Atlanta Journal-Constitution,* September 11, 2000, Business Section.

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Appendix D: Contact Information

This appendix presents information on key contacts related to self-service fare collection. Information is included for equipment vendors and transit agencies currently using SSFC.

Equipment Vendors and Distributors

The following companies manufacture and/or distribute ticket vending machines and other equipment used in SSFC systems:

Ascom Transport Revenue Systems, Inc.
3100 Medlock Bridge Rd., #370
Norcross, GA 30071-1439
www.ascom-usa.com
Contact: Peter Sands (770-368-2003)
Equipment: TVMs, validators, hand-held devices

Cubic Transportation Systems, Inc.
5650 Kearny Mesa Road
San Diego, CA 92111-1380
www.cubic.com
Contact: Stephen Shewmaker (858-268-3100)
Equipment: TVMs, validators, hand-held devices

Elgeba
Eudenbacherstrasse 10-12
53604 Bad Honnef, Germany
www.elgeba.de
(tel. 02224-8285-0)
Equipment: TVMs, validators, hand-held devices

ERG Group
151 Brunel Road, Suite 18
Mississauga, ON Canada L4Z 2H6
www.erggroup.com
Contact: Paul Gooderham (905-890-2794)
Equipment: TVMs, validators, hand-held devices

GFIGenfare
751 Pratt Blvd.
Elk Grove Village, IL 60007
Gfigenfare.com
Contact: William Menefee (847-593-8855)
Equipment: TVMs

Klussendorf USA
9353 Highway AIA South
Melbourne Beach, FL 32951
Contact: Walter Saltzman (321-725-6156)
Equipment: validators

Scheidt & Bachmann USA
31 North Ave.
Burlington, MA 01803
www.scheidt-bachmann.de
Contact: Mark Roberts (781-272-1664)
Equipment: TVMs, hand-held devices

SchlumbergerSema
1601 Schlumberger Drive
Moorestown, NJ 08057
www.slb.com
Contact: Michel Leger (856-234-8000, x 240)
Equipment: TVMs, hand-held devices

Ventek International
975 Transport Way
Petaluma, CA 94954
Ventek-Intl.com
Contact: Ken Ross (707-773-3373)
Equipment: TVMs

Agency Contacts

The agencies shown in Table D-1 were surveyed for information on their existing or planned SSFC systems.

Table D-1.1: Contact Information for Transit Agencies

Agency	Contact	Address	City	State	Country	Code	Phone	Fax	Email	Website
Agence Metropolitaine de Transport	Jean Meysonnier	500 Place d'Armes	Montreal	QU	CANADA	H2Y 2W2	514-287-8937	514-287-2460	jmeysonnier@amt.qc.ca	www.amt.qc.ca
ATC Spa Transporti Pubblici Bologna	Claudio Claroni	Via Saliceto 3	Bologna	- -	ITALY	40128	39-051-350.104	30-051-350.106	dora-ramazzotti@atc.bo.it	n/a
Bi-State Development Agency	Randy McGuire	707 North First Street	St. Louis	MO	USA	63102	314-982-1400 Ext. 2554	314-982-1546	mcguire@bsda-transit.org	www.bi-state.org
Calgary Transit	Fred Pittman	P.O. Box 2100 Station M	Calgary	AB	USA	T2P 2M5	403-537-7774	403-537-7737	fred.pittman@gov.calgary.ab.ca	www.calgarytransit.com
Dallas Area Rapid Transit	Tim Newby	P.O. Box 660163	Dallas	TX	USA	75266	214-749-2929	214-749-3693	tnewby@dart.org	www.dart.org
Denver Regional Transit District	Joseph Smith	1600 Blake Street	Denver	CO	USA	80202	303-299-2311	303-299-2338	joe.smith@rtd-denver.com	www.rtd-denver.com
Edmonton Transit	John Engelmann	11904 154 Street	Edmonton	AB	CANADA	T5V 1J2	780-496-8912	n/a	john.engelmann@gov.edmonton.ab.can	www.gov.edmonton.ab.can
GO Transit	Michael Wolczyk	20 Bay Street, Suite 600	Toronto	ON	CANADA	M5J 2W3	416-869-3600 Ext. 5424	416-869-1563	michaelw@gotransit.com	www.gotransit.com
Helsingin kaupungin liikennelaitos (HKL)	Tapio Tanskanen	HKL, PL 1400 00099 Helsingin Kaupunki	Helsinki	- -	FINLAND	- -	358 9 472 2231	358 9 472 3706	tapio.tanskanen@hkl.hel.fi	n/a
Lane Transit District	Graham Carey	P.O. Box 7070	Eugene	OR	USA	97401	541-501-7558	541-682-7478	graham.carey@ltd.lane.or.us	www.ltd.org
Los Angeles County Metro. Transportation Authority	Jim Cudlip	One Gateway Plaza	Los Angeles	CA	USA	90012	213-922-7608	213-922-7666	cudlipj@mta.net	www.mta.net
Maryland Mass Transit Administration	Simon Taylor	301 North Euta Street	Baltimore	MD	USA	21201	410-767-3778	n/a	n/a	www.marylandmta.com
New Jersey Transit	John Lorenc	One Penn Plaza East 5th Floor	Newark	NJ	USA	07501	973-491-7769	973-491-8805	jlorenc@njtransit.com	www.njtransit.com
Niagara Frontier Transportation Authority	James Nagle	164 Ohio Street	Buffalo	NY	USA	14203	716-842-3501	716-842-3540	nagle@nfta.buffnet.net	www.nfta.com
Oahu Transit Services (The Bus)	J. Roger Morton	811 Middle Street	Honolulu	HI	USA	96819	808-8484508	808-848-4419	rmorton@thebus.org	www.thebus.org
Ottawa Regional Transit Commission (OC Transpo)	Joel Koffman	1500 St. Laurent Boulevard	Ottawa	ON	CANADA	K1G 028	613-842-3636 Ext. 2351	n/a	n/a	www.octranspo.com
Sacramento Regional Transit District	Alan Storey	P.O. Box 2110	Sacramento	CA	USA	95812	916-648-8410	916-646-1084	astorey@sacrt.com	www.sacrt.com
San Diego Trolley	Stephanie Murphy	1255 Imperial Avenue Suite 900	San Diego	CA	USA	92101	619-595-4913	619-231-6760	smurphy@sdti.sdmts.com	www.sdcommute.com
San Francisco Municipal Railway (Muni)	Duncan Watry	425 Mason Street, 6th Floor	San Francisco	CA	USA	94102	415-923-2127	415-923-2620	duncan_watry@ci.sf.ca.us	www.sfmuni.com
Santa Clara Valley Transportation Authority	Karl Griebsch	3331 North First Street	San Jose	CA	USA	95134	408-952-8927	408-952-8935	karl.griebsch@vta.org	www.vta.org
SEMIACS	Pierre Dupeyrat	38 bd Raimbaldi	Nice	- -	FRANCE	06300	0033 4 92 17 52 88	0033 4 93 13 08 65	pmd.sem.sun@wanadoo.fr	n/a
Sound Transit	Tony Fuentes	400 South Jackson Street	Seattle	WA	USA	98107	206-689-3357		fuentest@soundtransit.org	www.soundtransit.org
Southern California Regional Rail Authority (MetroLink)	David Bostwick	700 South Flower Street 26th Floor	Los Angeles	CA	CANADA	90017	213-452-0314	213-452-0420	bostwick@scrra.net	www.metrolinktrains.com
Toronto Transit Commission	Donna Bryant	1138 Bathurst Street	Toronto	ON	CANADA	M5R 3H2	416-393-3957	416-535-1391	donna.bryant@ttc.ca	www.city-toronto.on.ca/ttc
Transports publics genevois (TPG)	Lier Thomas	Rte de la Chapelle 1 Case postale 950	Geneva	- -	SWITZ.	0041	022 308 34 15	022 308 34 00	lier.t@tpg.ch	www.tpg.ch
TransLink (SkyTrain, SeaBus)	Keenan Kitasaka	1700 Kingsway	Burnaby (Vancouver)	BC	CANADA	V5H 4N2	604-453-4602	604453-4629	keenan_kitasaka@translink.bc.ca	www.translink.bc.ca
Tri-Met	Kathryn Coffel	4012 SE 17th Avenue	Protland	OR	USA	97202	503-962-5860	503-962-6469	coffelk@tri-met.org	www.tri-met.org
Tri-Rail	Bonnie Arnold	800 N.W. 33rd Street, Suite 100	Pompano Beach	FL	USA	33064	954-788-7936	954-788-7878	arnold@tri-rail.com	www.tri-rail.com
Utah Transit Authority	Hugh Johnson	3600 S. West Street	Salt Lake City	UT	USA	84130	801-262-5626	n/a	hjohnson@uta.cog.ut.us	www.rideuta.com
Virginia Railway Express	Howard Shock	1500 King Street Suite 202	Alexandria	VA	USA	22914	703-684-1001	703-684-1313	hshock@vre.org	www.vre.org

Table D-1.2: Description of Transit Services Using POP Fare Collection

Agency Name	Q2.1 Ridership	Q2.2 Fare Revenue	Q2.3 Service Characteristics	Q2.4 POP	Q2.5 Modes	Q2.6 Line Mileage	Q2.7 No. Stations	Q2.8 Paid Area	Notes
ATC Spa Transporti Pubblici Bologna	101,500,000	$39,300,000	NR	Future	MB	Surface - 2,303	NR	On-board	Using a contactless Smart Card technology, not POP
Bi-State Development Agency	52,200,000	$34,150,000	see Appendix A.2	Currently Future	LR	Subway - 2 Surface - 14 Elevated - 1	Subway - 3 Surface - 15 Elevated - 2	On-board/Stn. Areas	
Calgary Transit	74,900,000	C$64,000,00	see Appendix A.2	Currently	LR	Surface - 29	Surface - 32	On-board	
Dallas Area Rapid Transit	61,000,000	$30,300,000	see Appendix A.2	Currently	LR CR	Subway - 3 Surface - 29	Subway - 1 Surface - 22	On-board	
Denver RTD	77,773,340	$45,137,682	see Appendix A.2	Currently	LR	Surface - 14	Surface - 20	On-board	
Go Transit	41,000,000	C$150,000,000	see Appendix A.2	Currently	CR	Surface - 361	Surface - 50	On-board/Stn. Areas	Use same fare collection system for bus, but driver checks all (non-POP)
Helsingin kaupungin liikennelaitos (HKL)	233,000,000	$88,000,000	see Appendix A.2	Currently	HR LR CR FB	Subway - 67 Surface - 232	Subway - 16 Surface - 243	On-board/Stn. Areas	
Lane Transit District	5,946,000	$4,501,736	see Appendix A.2	Future	MB (BRT)	Surface - 10	Surface - 28	On-board	Initial segment (extensions to service currently being planned)
Los Angeles County MTA	399,000,000	$229,510,015	see Appendix A.2	Currently	LR HR	Subway - 17.4 Surface - 22 Elevated - 20	Subway - 16 Surface - 22 Elevated - 14	On-board/Stn. Areas	
Maryland MTA	NR	NR	NR	Currently	LR	Surface - 36	Surface - 32	On-board	
New Jersey Transit	214,037,600	$450,000,000	see Appendix A.2	Currently	LR	Subway - 4.2 Surface - 6.5	Subway - 11 Surface - 15	On-board/Stn. Areas	
Niagara Frontier Transportation Authority	6,600,000	$3,800,000	see Appendix A.2	Currently	LR	Subway - 5.2 Surface - 1.2	Subway - 8 Surface - 6	On-board/Stn. Areas	
Oahu Transit Services (The Bus)	74,000,000	$30,000,000	see Appendix A.2	Future	MB (BRT)	Surface - 50	Surface - 150	On-board only	Planned BRT system
Ottawa Regional Transit Commission (OC Transpo)	80,000,253	C$88,358,573	see Appendix A.2	Currently	LR MB	110 articulated buses	Surface - 22	On-board	
Sacramento Regional Transit District	4,207,609	NR	see Appendix A.2	Currently	LR	Surface - 20.6	Surface - 30	On-board	
San Diego Trolley	28,743,326	$20,940,891	see Appendix A.2	Currently	LR	Surface - 93.6	Surface - 48	On-board/Stn. Areas	
San Francisco Municipal Railway (Muni)	42,000,000 (LR only)	$18,000,000	see Appendix A.2	Currently	LR	Subway - 11.5 Surface - 40	Total - 15 stations plus 85 boarding locations	On-board/Stn. Areas	Stations have gates, but other boarding locations are POP
Santa Clara VTA	54,915,641	$30,453,193	see Appendix A.2	Currently	LR MB	Surface - 28.4	Surface - 47	On-board	
SEMIACS	38,000,000	f 132,000,000	see Appendix A.2	Currently	MB	NR	NR	NR	
Sound Transit	4,574,000	$6,000,000	see Appendix A.2	Currently Future (LR)	CR LR (future)	Surface - 40	Surface - 7	On-board	LRT will have designated paid areas
Southern California Regional Rail Authority (MetroLink)	6,978,000	$31,873,000	see Appendix A.2	Currently	CR	Surface - 416	Surface - 48	On-board	
Toronto Transit Commission	392,600,000	C$585,200,000	see Appendix A.2	Currently	SC	Surface - 30.5	NR	On-board	
Transports publics genevois (TPG)	123,000,000	$49,000,000	NR	Currently	LR SC MB FB	Surface - 640	Surface - 520	On-board/Stn. Areas	
Tri-Met	81,237,600	$45,488,485	see Appendix A.2	Currently	LR SC	Surface - 33	Surface - 50	On-board/Stn. Areas	
Tri-Rail	2,398,637	$5,143,000	see Appendix A.2	Currently	CR	Surface - 72	Surface - 18	On-board	
Virginia Railway Express (VRE)	NR	NR	see Appendix A.2	Currently	CR	NR	Surface - 18	On-board	

Table D-1.3: Selection and Implementation of POP Fare Collection

Agency Name	Q3.1 Why POP	Q3.2 Switching	Q3.3 Documents
ATC Spa Transporti Pubblici Bologna	Speed boarding Reduce evasion	Allows integration of services (e.g., other transit, parking, municipal services)	Regional regulation to integrate fare payment on transit services
Bi-State Development Agency	Cost Ease of Operation Evasion Rates Maintainability Customer Convenience	N/A	NR
Calgary Transit	Ease of use Cost effective Maintainability	N/A	NR
Dallas Area Rapid Transit	Cost Effective	N/A	Attachments
Denver RTD	Speed boarding	N/A	NR
Go Transit	Speed and efficiency	N/A	n/a
Helsingin kaupungin liikennelaitos (HKL)	Cost Effective	N/A	NR
Lane Transit District	Speed boarding on BRT	N/A	N/A
Los Angeles County MTA	Low costs for capital and operating; Support regional fare integration;	Moving to barrier to reduce fare evasion; Inspections are difficult on crowded cars; Increase flexibility to change policies and structure	Attachment
Maryland MTA	Cost	N/A	NR
New Jersey Transit	Vehicle design (multi-door); Street level operation	N/A	Booz-Allen Study on NCS (1997-1998)
Niagara Frontier Transportation Authority	Cost Service Characteristics (free fare mall)	N/A	N/A
Oahu Transit Services (The Bus)	Speed boarding on BRT	N/A	POP one of several alternatives
Ottawa Regional Transit Commission (OC Transpo)	To speed boarding on artics	N/A	NR
Sacramento Regional Transit District	Cost Effective	N/A	n/a
San Diego Trolley	Speed boarding Cost Effective Operating Environment	Considering barriers at selceted stations due to problems with special events	NR
San Francisco Municipal Railway (Muni)	Cost Effective Ease of Operation	Considering eliminating all gates to save money	NR
Santa Clara VTA	Cost Speed boarding	N/A	NR
SEMIACS	In use for >100 years	NR	NR
Sound Transit	Cost Effective Expandability (to Smart Card)	N/A	N/A
Southern California Regional Rail Authority (MetroLink)	Speed boarding Cost Effective Ease of Operation Ease of Use	N/A	Booz-Allen Report
Toronto Transit Commission	Speed boarding	N/A	Attachments
Transports publics genevois (TPG)	Speed boarding	NR	NR
Tri-Met	Street level operation Cost	N/A	N/A
Tri-Rail	Cost Effective	N/A	None
Virginia Railway Express (VRE)	Cost Effective Operating Environment	N/A	NR

Table D-1.3: Selection and Implementation of POP Fare Collection

Q3.4 Do Differently	Q3.5 Policy Shifts	Q3.6 POP v. Non-POP	Notes
Yes	NR	NR	Smart Card application in use; not sure if this is true POP
Yes	No	Cost Ease of Operation Evasion Rates Maintainability Customer Convenience	
Yes	No	NR	
Yes	Increased inspection, concerns of abuse of unvalidated, non-expiring fare media	Manpower required for enforcement Difficulties fully integrating bus and rail fare systems	
Yes	Increased inspection with opening of new corridor	Compliance perception and boarding calculations	
Yes	No	Shortens customer path to train; non-POP requires controlled access not easily expandable	
Yes	Instituted penalty system	Saves time and money	
Yes	N/A	N/A	Planned BRT system
No, fare evasion and lack of flexibility	Contracted out to city police and county sheriff (formerly by transit police); Blue Line ridership is near capacity, difficult to inspect cars.	Less defined hard data for POP (e.g., ridership); Hidden non-tangibles easily overlooked/undermanaged (e.g., adjudication, citations, inspection, perceptions)	No attachment for Q3.3
Yes	NR	POP requires more police	
Yes	No	NR	none
Yes	Reduced number of inspectors from 12 to 7	Maintenance costs	
N/A	N/A	Fare evasion	Planned BRT system
Yes	Fare inspection teams targets for budget reductions; this would be a mistake	POP on articulated buses is necessary to maintain service efficiency	None
Yes	Increased inspectors as ridership increased	Cost of Inspectors vs. Ticket Agents	
Yes, but might consider Smart Card also	Increased inspection	Public perception of fare coll. integrity Control fare evasion More effective crowd management	
Yes	Transition from SFPD to Muni Fare Inspectors	Increased Productivity (fewer personnel) Ease (all door boarding) Expected faster throughput, not realized Revenue increased (possibly)	
Yes	No	NR	
Yes	NR	In France, proof is necessary Insurance, Transport contract	
Don't know yet	None	Passenger information (i.e., validation issues) Legal issues Impact of disputes on operation	Currently Sound Transit only issues warnings. POP system is still new.
Yes	NR	Convenient ticket location/availability Cost savings from reduced personnel requirements (e.g., sales/inspection)	
Yes	Decreased inspection = increased fare evasion	Increased boarding speeds Requires frequent inspection	
Yes	Introduced fare zones in 1994 to make easier for passengers	Easier communication Saves money	
Yes	None	Inspection	
Yes	Increased inspection rate to reduce fare evasion below 1%	Trust	
Yes	Originally passengers displayed ticket on demand; now at all times	Public perception of fare coll. integrity Control fare evasion	

Table D-1.4: Operational/Financial Issues

Agency Name	Q4.1.1 Fare Structure	Q4.1.2 POP Influence	Q4.2 Transfers	Q4.3 Tranfers Handled	Q4.4 Purchase	Q4.5 No. Locations	Q4.6.1 Pay Options	Q4.6.2 TVM v. Other	Q4.6.3 Percent Use	Q4.6.4 Fare Media
ATC Spa Transporti Pubblici Bologna	Zone Fare	Yes	Free to bus or other rail	NR	TVM Agents Other: News Vendors	1,250	Coin Debit	NR	NR	see Appendix A.3
Bi-State Development Agency	Flat Fare	No	Charge 10¢ for adult	NR	TVM Agents Grocery Store Other: Retail	150	Coin Dollar High	Only Outlets sell weekly & monthly	Cash (100%)	see Appendix A.3
Calgary Transit	Flat Fare	No	Free to bus or other rail	Drivers issue/time stamped (90 min validity)	TVM Agent Outlet Grocery Store	NR	Coin Dollar High Credit Debit	TVMs use only coins, no change	NR	see Appendix A.3
Dallas Area Rapid Transit	Flat Fare	No	Free to bus or other rail	Transfers are inspected for validity	TVMs Agents Outlets Mail Internet Grocery Store	NR	Coin Dollar High Credit	Agents accept credit cards	NR	NR
Denver RTD	Zone Fare	No	Free to bus or other rail	NR	TVM Agents Grocery Store	25	Coin Dollar High Other: TOKEN	Agents sell monthly and 10-ride books	NR	NR
Go Transit	Zone Fare	No Note: but it complicates matters	Zone system, ticket is the transfer	Fare integration with other systems	Agents Outlets FAX	n/a	N/A	N/A	N/A	see Appendix A.3
Helsingin kaupungin liikennelaitos (HKL)	Flat Fare	No	Free to bus or other rail	Transfers time stamped	TVM Agents Outlets On-board Internet Other: Kiosks	260	Coin Credit Other: FINNISH 20, 50, 100	None	Cash (99%) Other (1%)	see Appendix A.3
Lane Transit District	Flat Fare	No	Free to bus or other rail	N/A	TVM	N/A	N/A	N/A	N/A	NR
Los Angeles County MTA	Flat Fare Note: plus weekly, semi-monthly and monthly flash passes	No Note: recent focus is on multi-modal, inter-agency fares incl. distance and time based	$0.25	On-board (bus) TVM (rail)	TVM Agents Outlets Mail On-board (transfers)	52 Metro Rail Stns. > 800 third-party vendors	Coins Dollar High ($5 only) Tokens	TVMs - one-ride - round-trip - transfers Agents - passes - stamps - tokens	Cash(18%) Tokens (15%) Transfers (19%) Passes (42%)	see Appendix A.3
Maryland MTA	Flat Fare	No	Free to bus or other rail	All MTA transfers accepted	TVM Agents Mail	n/a	Coins Dollar High	Yes	n/a	see Appendix A.3
New Jersey Transit	Flat Fare	Yes Note: HBLR would have been multi-zone, but POP led to flat fare	Monthly Pass: free 1-way: $0.45 (NCS only)	Transfer inspected on NCS; N/A on HBLR	TVM Agents Outlets Mail Grocery Store HBLR - TVM & Mail only	NCS: 41 TVMs NCS: 100+ agents HBLR: 62 TVMs	Coins Dollar High Credit Debit	Agents accept checks, Transit Checks and State vouchers.	Cash (90%) Others (10%)	see Appendix A.3
Niagara Frontier Transportation Authority	Flat Fare	No	Free to bus or other rail	Transfer is POP	TVM Outlets Mail	14	Coin Dollar High Other: TOKEN	Only Outlets sell monthly	Cash (90%) Other (10%)	see Appendix A.3
Oahu Transit Services (The Bus)	Undetermined	No	Free to bus or other rail	Transfer issued on bus as POP	TVM Agents Outlets	N/A	N/A	N/A	N/A	NR
Ottawa Regional Transit Commission (OC Transpo)	Flat Fare	Yes 75% of fares are prepaid; evasion is minimal	Free to bus or other rail	Passengers needing transfer must board front to obtain (good for 90 minutes)	Agents Outlets	Agents: 5 Outlets: 400	NR	N/A	NR	see Appendix A.3

Table D-1.4: Operational/Financial Issues

Q4.7 TVM Issues	Q4.8 Validated	Q4.9 Where Validated	Q4.10 Electronic Media	Q4.11 How Used	Q4.12 Value Read	Q4.13 Boarding	Q4.14 Track Passes	Q4.15 Labor Issues	Q4.16 Marketing, Customer Service
TVMs hard to use	After purchase	On-board	Smart Card (contactless)	Decrement, no print	Readers/displays	Front/Back - board Center - alight One side	Yes	No	
Have manual ticket sales during special events	On print After purchase	Validator	NR	NR	NR	Front (Bus - board) Both (Bus - alight) NR for sides or LR	Yes, farebox (bus) sampling on LR	No	NR
Other: must use exact change	On print After purchase	TVM Validator	N/A	N/A	N/A	All doors Both sides	Yes, surveys	No	Announcement on-board
TVMs hard to use	On print (TVM) After purchase (multi-ride tickets)	Validator	Smart Card (contactless) (future)	Other: not determined	Other: not determined	All doors(LRT only) One side	No	No	NR
TVM hard to use Long queues at peak	On print (TVM) After purchase	Validator	N/A	N/A	Monthly expire	All doors NR for sides	No	No	NR
N/A	On print After purchase	Validator	Smart card (contactless)	Decrement, no print	Readers/displays	All doors (trains) Front only (bus) One and/or Both	Yes, surveys	Yes, many but all solvable	Benefits to customer must be effectively communicated
None	On print (TVM) After purchase	Validators On-board	Smart Card (contactless)	Decrement, no print	Readers/displays	All doors One side	Yes, surveys	No	NR
N/A	N/A	N/A	N/A	N/A	N/A	All doors	N/A	N/A	N/A
TVMs hard to use Long queues at peak Note: Adequate psgr info is on-going issue; what's fare evasion? Tranfer rules? Plus Inspector knowledge of rules	TVM validates on print Passes are dated	N/A	Smart card (contactless) Mag-Stripe (transport)	Decrement, no print Farecards to buy POP Farecards as flash pass	Print value (poss.) Readers/displays Printing is possible but unlikely scenario.	All doors (rail) Front only (bus)	Yes, surveys	No	Transfers difficult to explain; - none for RT - line continuation for specific stops and svcs - signage complex and impacts enforcement due to numerous options
Long queues at peak Note: event days (NFL) will supplement with cashboxes ad collectors	Pre-validated	N/A	N/A	N/A	N/A	All doors NR for sides	NR	NR	NR
TVMs hard to use Long queues at peak	Validate after purchase	Validator	N/A	N/A	N/A	All doors One or both (depends on station)	No	No	Handouts Hands-on assistance during initial implementation
N/A	On print	N/A	N/A	N/A	N/A	All doors One side	No	No	N/A
N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
N/A	Time-based passes	N/A	Smart card (contactless)	Decrement, no print	Readers/displays	All doors One side	Yes, surveys	No	NR
TVMs hard to use Long queues at peak	On print After purchase	TVM Validator	N/A	N/A	N/A	All doors One side	Yes	No	Brochures, postings and customer service

Table D-1.4: Operational/Financial Issues

Agency Name	Q4.1.1 Fare Structure	Q4.1.2 POP Influence	Q4.2 Transfers	Q4.3 Tranfers Handled	Q4.4 Purchase	Q4.5 No. Locations	Q4.6.1 Pay Options	Q4.6.2 TVM v. Other	Q4.6.3 Percent Use	Q4.6.4 Fare Media
Sacramento Regional Transit District	Flat Fare	No	Free to bus or other rail	Inspected for date/time	TVM Agents Outlets Mail Internet Grocery Store	NR	Coin Dollar	NR	NR	see Appendix A.3
San Diego Trolley	Zone Fare	Yes, facilitates floating zone; customer figures out fare	Free to bus or other rail	Inspect value and time remaining, if fare upgrade needed buy at TVM	TVM Agents Outlets Mail Grocery Store Other: Univ./School, Soc. Svc., Employers, Retail	250	Coin Dollar High	Agents and other outlets accept checks and credit	Cash (40%) Other (60%)	see Appendix A.3
San Francisco Municipal Railway (Muni)	Flat Fare	No	Free to bus or other rail	Inspected for validity	TVM Agents Outlets On-board Grocery Store Other: MTC clearinghouse	200	Coin Dollar High	TVMs and Muni run outlets are cash only; Grocery Stores accept checks and credit	Cash (99%) Other (1%)	see Appendix A.3
Santa Clara VTA	Flat Fare	No	Free for passes only	Passes	TVM Agents Mail Grocery Store	200	Coin Dollar High	Only agents sell monthly	Cash (100%)	see Appendix A.3
SEMIACS	Flat Fare	No	Free to bus or other rail	NR	Agents On-board Grocery Store	130	Coin Credit	NR	NR	see Appendix A.3
Sound Transit	Zone Fare	No	Other: transfers from other services	Fare paid on other plus difference of CR ticket	TVM Agents Outlets Mail Internet Grocery Store Other: Employer programs	>100	Coin Dollar High Credit Debit	Agents and other outlets sell only single, monthly, 3-month and annual passes	NR	see Appendix A.3
Southern California Regional Rail Authority (MetroLink)	Zone Fare Peak/Off-Peak (single and round trips only)	Yes, allowed agency to use complex fare zone structure on a fixed zone basis	Free to bus or other rail	MetroLink ticket accepted on connecting bus and LR services	TVM Agents Mail Internet (future)	100	Coin Dollar High Credit Debit	Agents and mail accept checks, transit checks and other vouchers	Cash (40%) Other (60%)	see Appendix A.3
Toronto Transit Commission	Flat Fare	No	Free to bus or other rail	Transfers show date and time (issued by driver)	Agents Outlets On-Board	NR	NR	NR	NR	NR
Transports publics genevois (TPG)	Zone Fare	Yes, zonal + time system	Free to bus or other rail	NR	TVM Agents On-board Grocery Store Other: Retail	~750	Coin Credit Debit Farecards	TVMs grant bonuses options: - 5% add-on - last chance ticket - eco-bonus (10% on returned empty cards)	Cash (55%) Other (45%)	see Appendix A.3
Tri-Met	Zone Fare	No	Free to bus or other rail	Transfer issued on bus as POP	TVM Agents Outlet Internet Grocery Store	>100	Coin Dollar High Credit Debit	TVMs - no credit/debit - $20 bill limit - $16 change limit	Cash (100%)	see Appendix A.3
Tri-Rail	Zone Fare Flat on weekends	No	Free to bus or other rail	Tri-Rail cost less base fare price; Honor others tickets	TVM Agents Mail	NR	Coin Dollar High Credit	Agents accept checks and up to $100; TVMs accept up to $20	Cash (80%) Other (20%)	see Appendix A.3
Virginia Railway Express (VRE)	Zone Fare	No	Free to bus or other rail	N/A	TVM Agents Outlets Internet Grocery Store	56	Credit Debit Other: Cash, Transit Vouchers	Agents and others accept cash, checks, Transit vouchers	Credit/Debit (100%) (no data for off station locations)	see Appendix A.3

Table D-1.4: Operational/Financial Issues

Q4.7 TVM Issues	Q4.8 Validated	Q4.9 Where Validated	Q4.10 Electronic Media	Q4.11 How Used	Q4.12 Value Read	Q4.13 Boarding	Q4.14 Track Passes	Q4.15 Labor Issues	Q4.16 Marketing, Customer Service
TVMs hard to use Long queues at peak	On Print (TVM) After purchase	Validator Note: soon to be discontinued due to abuse	N/A	N/A	N/A	All doors One or both (depends on station)	Yes, surveys	No	Postings in stations Issue related to citing new riders Inspectors confused with police, causes problems (resistance of authority v. frustration at inability to take action)
Long queues at peak Other: when TVMs breakdown	On print	N/A	Other: Hybrid card (TransLink)	Currently not trip based, TransLink will include readers	Monthly expire	All doors One side	No	Yes, TWU resistance - issue resolved with staged implementation	Brochures, banners, on-board, in-station decals, radio spots, press releases -- determined that campaign could have been stronger
Other: bill acceptor problems	On print	N/A	Other: Hybrid card (TransLink)	Decrement, no print	Readers/displays	All doors Both sides	No	Yes, inspectors were contracted now ATU as a result of action	NR
TVM hard to use Long queues at peak	After purchase	NR	Smart Card (contactless) Mag-Stripe (transport)	Decrement, print (mag-stripe) Decrement, no print (smart card)	Print number trips (mag-stripe) Readers/displays (smart card)	Front only NR for sides	No	Yes	NR
TVMs hard to use Long queues at peak Maintenance cost of TVMs Transaction costs for credit/debit	On print (TVM) After purchase (scratch tickets from Agents)	Other: scratch ticket (i.e., single use ticket valid for calendar month for which purchased)	Smart Card (contactless) (future) Mag-Stripe (swipe) - on bus (current)	Decrement, no print	Readers/displays	All doors One side	No	No	TVM interface is difficult for passengers to learn TVM breakdowns cause problems High volume stations have slow TVM transaction speeds
TVMs hard to use Long queues at peak	On print After purchase (multi ride tickets)	Validator	Smart card (contactless) Mag-Stripe (transport) (both future application)	Buy POP tickets	Readers/displays	All doors One side	Yes, samples by conductors	Yes, hand-held units resisted (already carrying radio, cell phone, etc.)	NR
NR	On print/issue (transfers validated by TVM or by Driver)	N/A	Mag-Stripe	Other: pass has photo ID	NR	All doors NR for sides	No	NR	Brochures and postings
TVM hard to use	On-print (TVM)	N/A	Smart Card (contact)	Decrement, no print	Readers/displays Other: TVM displays	All doors One side	Yes	No	Fares and zonal system explained on ticket
TVMs hard to use Long queues at peak Note: TVMs hard for 1st timers; long lines during special events	On print (single trip) After purchase (mult-ride)	Validator	N/A	N/A	N/A	All doors One side	Yes, surveys	Inspectors cannot work alone after 4pm	1st timers confused by validating tickets
TVMs hard to use	On print (single/round) After purchase (multi)	Validator	Smart card (either type) to purchase from TVM	Not sure, conducting feasibility study	NR	All doors (platform) One side	No	No	Customers prefer personal interaction People don't always read public info Customers can't always rectify mistakes
NR	After purchase (single/multi)	Validator	Mag-Stripe (transport)	Post billing, discount based on use Also, participating in regional Smart Card program	NR	All doors One side	Yes, conductor counts	No	NR

Table D-1.5: Fare Equipment

Agency	Q5.1					Q5.2
	Type	Qty.	Make/Model	Year Purchased	Capital Cost	ATM Vending
ATC Spa Transporti Pubblici Bologna	NR	NR	NR	NR	NR	N/A
Bi-State Development Agency	TVM	62	Scheidt & Bachmann	1993	$3,000,000	N/A
	Validators	62	Klusenndort	1993	Incl w/ TVM	
Calgary Transit	TVM	38	B8001	1985	NR	N/A
	TVM	36	B8001	1987	NR	
	TVM	45	B8046	1993	NR	
	Validators	NR	NR	NR	NR	
Dallas Area Rapid Transit	NR	NR	NR	NR	NR	N/A
Denver RTD	TVM	32	Scheidt & Bachmann	2000	$1,248,000	N/A
	Validators	20	NR	1994	$70,000	
Go Transit	TOM	151	AES2103	1987	n/a	N/A
	Validators	249	AES	1987	n/a	
Helsingin kaupungin liikennelaitos (HKL)	TVM	80	NR	1982	NR	N/A
	Validators	960	NR	1967		
Lane Transit District	N/A	N/A	N/A	N/A	N/A	N/A
Los Angeles County MTA	TVM	227	GFI-Genfare	1988	NR	N/A
Maryland MTA	Hand-Held Citation	42	Autocite	1995	$109,200	N/A
New Jersey Transit	TVM (NCS)	41	Ascom B8070	1996	$2,776,000	N/A
	TVM (HBLR)	62	Ascom B8070N	1998	$3,733,000	
	TOM (NCS)	~40	Almex	NR	NR	
	Validators (NCS+HBLR)	118	Elgeba MC605mo	1998	$1,506,000	
Niagara Frontier Transportation Authority	TVM	45	Scheidt & Bachmann	1998	$3,000,000	N/A
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A	N/A
Ottawa Regional Transit Commission (OC Transpo)	None	N/A	N/A	N/A	N/A	N/A
Sacramento Regional Transit District	N/A	N/A	N/A	N/A	N/A	N/A
San Diego Trolley	TVM	22	Autelca BE-20	1980	NR	N/A
	TVM	54	Autelca B128	1985	NR	
	TVM	5	Scheidt & Bachmann FAA90	1991	NR	
	TVM	15	Autelca B8040	1992	NR	
	TVM	26	VenTek Pro Vend I	1997	$956,410	
	TVM	43	VenTek Pro Vend II	2001	$1,995,286	
San Francisco Municipal Railway (Muni)	TVM	22	Scheidt & Bachmann	1995/96	NR	N/A
	TVM	12	Autelca	1988	NR	
Santa Clara VTA	TVM	82	Autelca	1987	$3,782,244	N/A
	TVM	123	Ventek	2000	$5,362,800	
	Validators	50	NR	NR	NR	
SEMIACS	TOM	12	NR	NR	NR	N/A
	Validators	1500	Ascom VP412	1999	f 18,000,000	
Sound Transit	TVM	40	Scheidt & Bachmann	NR	$7,440,000	N/A
	TOM	3	Scheidt & Bachmann	NR	$91,500	
	Validators	10	Scheidt & Bachmann	NR	$50,000	
Southern California Regional Rail Authority (MetroLink)	TVM	98	Ascom B8050	1992	NR	N/A
	TOM	3	NR	1992	NR	
	Validators	120	NR	1992	NR	
Toronto Transit Commission	NR	NR	NR	NR	NR	N/A
Transports publics genevois (TPG)	TVM	520	SYVE01	1999	NR	N/A
Tri-Met	TVM	46	Autelca	1985	NR	N/A
	TVM	99	Scheidt & Bachmann	1997	NR	
	Validators	150	NR	NR	NR	
	Hand-Held Citation	13	NR	NR	NR	
Tri-Rail	TVM	48	Ascom	1995	$4,873,123	N/A
	TOM	5	Ascom	1995	$255,000	
	Validators	48	Ascom	1995	Incl w/ TVM	
Virginia Railway Express (VRE)	TVM	NR	Schlumberger	1972	$1.5 M	N/A

Table D-1.6: Fare Inspection and Enforcement

Agency Name	Q6.1 Authority	Q6.2 Jurisdiction	Q6.3 Appeals	Q6.4 Framework	Q6.5 Fines	Q6.6 Repeat Offender
ATC Spa Transporti Pubblici Bologna	Regional	State/Provincial	No	Fare surcharge	First: ITL 72,000 to 270,000	Liens on assets if not paid
Bi-State Development Agency	State (Both IL & MO)	Municipal County	No	Citation	First: $25 Highest: $500	Judges discretion
Calgary Transit	NR	NR	NR	NR	First: C$150 Highest: C$150	N/A
Dallas Area Rapid Transit	NR	NR	NR	NR	NR	NR
Denver RTD	State	County	No	Citation	First: $48 Second: $78 Highest: $118 ($15 less if paid early)	Can result in trespass and eventual exclusion
Go Transit	Provincial	Provincial Note: changing to municipal	No	Citation	First: C$90 Second: C$90-2K Highest: C$5,000	None
Helsingin kaupungin liikennelaitos (HKL)	Local Ordinance	County	Yes Admin. Court of Helsinki	Other: collectable w/o court proceedings	First: $42 (FIM 250)	None
Lane Transit District	State	Municipal County	Yes, to GM w/in 10 days of citation	Citation Exclusion	Highest: $250	Exclusion indefinitely
Los Angeles County MTA	State Note: Penal Code Section 640	County	No	Citation	First $76 Second $150 Highest $250 (plus bail amount)	Bail amount increases $25, $50, $100, not to exceed $250; court discretion
Maryland MTA	State	State	NR	Criminal Charge	Fine: $35	None
New Jersey Transit	State	Municipal	No	Citation	Highest $50	Mandatory Court Appearance
Niagara Frontier Transportation Authority	State	Municipal	Yes, Hearing officers review transcripts	Civil Penalty, fine and lien on real property	First: $20 Second: $40 Highest: $80	Entered on list
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A	N/A
Ottawa Regional Transit Commission (OC Transpo)	Provincial	Provincial	Yes	Citation Fare Surcharge	First C$80 Second: C$500 Highest: C$2000	Given summons to appear (second fine or higher)
Sacramento Regional Transit District	State	County Combined	Yes, hearing by deparment manager for return of confiscated pass/ID card	Citation	First: $54 Highest: $250	Commisioner's discretion, increased fine
San Diego Trolley	Local Ordinance	Superior Court	No	Citation	First: $25 Second: $50 Highest: $100 (Plus 170% penalty assessment)	Work with DA; 3rd offense considered misdemeanor
San Francisco Municipal Railway (Muni)	Municipal	State	No	Citation	First: $103 Second: $157 Highest: $250	Incremental fine
Santa Clara VTA	State	Municipal	No	Citation	First: $145 Second: judge discretion Highest: $325	None
SEMIACS	NR	State/Provincial	No	Fare surcharge	First: f 30	Judicial procedure
Sound Transit	State	County	No	Citation	First: $50 + court cost Second: $100 + court cost Highest: $250 + court cost	Incremental fine
Southern California Regional Rail Authority (MetroLink)	State	Municipal	Yes, passenger service reviews requests to dismiss	Citation	First: court decides Highest: $275	Tracked by database info forwarded to court
Toronto Transit Commission	Municipal	Municipal	Yes, based on corporate policy petition for return of pass	Citation	First: C$115 Highest: C$500	Summons and court appearance
Transports publics genevois (TPG)	Federal & County	County	Yes	Citation	First $37.50 ($50 if late)	None
Tri-Met	State	County	Yes, exclusions may be appealed to Hearings officer	Citation Exclusion after 3 offenses in 12 mos	First: warning Second: $75 Third: $75 + exclusion (30 days then 60, then 90)	Exclusion from transit property, if violated may be arrested for trespassing
Tri-Rail	State	County	Yes, to Safety/ Security Administrator	Citation Civil Infraction or Bench Warrant	$50 per offense	Exclusion
Virginia Railway Express (VRE)	State	Municipal	No	Citation	Highest: $150	Court Discretion

Table D-1.6: Fare Inspection and Enforcement

Agency Name	Q6.7 Track Outcome	Q6.8 No. Citations	Q6.9 Inspection	Q6.10 Uniforms	Q6.11 No. on Team	Q6.12 Police Roles	Q6.13 Ancillary Duty	Q6.14.1 Other Staff
ATC Spa Transporti Pubblici Bologna	Court provides	Total - 55,000	Agency Staff	Plainclothes	2 to 4	Local police called for ID checks	NR	N/A
Bi-State Development Agency	No	n/a	Contract Security Contract Police	Uniforms	15 varies by ridership	Transit and local law enforcement work cooperatively	Security (10-15%)	Fixed-post security Bus Operators Police Officers
Calgary Transit	NR	NR	Agency Staff	Uniforms Plainclothes	2	NR	NR	NR
Dallas Area Rapid Transit	NR	NR	Agency Police	Uniforms	2	NR	Security duties	Supervisors Agents Maintenance
Denver RTD	Upon request to the court; plan to do weekly	Total - 832	Agency Staff	Uniforms	2 varies by time	Work cooperatively	Passenger counts (~2%)	Contract security Supervisors Other staff
Go Transit	Yes, monthly reports	Total: 5,300	Agency Police	Uniforms	2 - 10 varies by ridership	N/A	Security and other law enforcement (25%)	Ticket seller
Helsingin kaupungin liikennelaitos (HKL)	No legal proceedings	Total - 25,575	Agency Staff	Uniforms	3 to 4	NR	Customer assistance(5%)	Security
Lane Transit District	Yes, from DA	Total: 12	N/A	N/A	N/A	N/A	N/A	Field Supervisors Private Security
Los Angeles County MTA	No Working towards accesss though	Total: 23,551	City Police County Sherrif	Uniforms	2	N/A	Security and law enforcement	NR
Maryland MTA	Yes, thru courts	n/a	Agency Police	Uniforms	1	N/A	Security and law enforcement (50%)	NR
New Jersey Transit	No	n/a	Agency Staff	Uniforms	2	Transit and local law enforcement work cooperatively	Passenger assistance and customer service	NJ Transit Police Operations Staff
Niagara Frontier Transportation Authority	Yes, but do not	First: 2518	Agency Staff	Uniforms	7 varies by time	Radio contact with Authority police	Customer assistance(10%) Psgr counts (1%)	Maintenance staff
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ottawa Regional Transit Commission (OC Transpo)	Yes, thru courts	First: 1713 Second+: 33	Agency Staff	Uniforms	11 varies by time of day	Transit and local law enforcement work cooperatively	None	Security Transit Supervisor
Sacramento Regional Transit District	Only, if case goes to court	n/a	Agency Staff Agency Police Local Police Other: probation dept.	Uniforms Plainclothes	1-2 varies by time of day	Police provide ID checks, assist with uncooperative violators	N/A	Contract security
San Diego Trolley	No	Total - 36,000	Agency Staff	Uniforms	5 per shift varies by time	Work cooperatively, focus on specific crimes	Monitor parking and cite for violations	Return to work employees, Volunteer ambassadors and station security
San Francisco Municipal Railway (Muni)	Yes, but don't (unreliable data)	Total - 2857	Agency Staff	Uniforms	2 varies by time	Supported by SFPD	Security for special events, % varies	Station Agents Supervisors
Santa Clara VTA	None	NR	Agency Staff	Uniforms	1	Radio contact with Sheriff's deputies for ID checks or security issues	None	Contract security
SEMIACS	NR	Total - 24,000	Agency Police	Uniforms	30 (total) varies by time varies by ridership	Police join inspectors sometimes	NR	NR
Sound Transit	Not yet	Only verbal warnings	Other: contract employees (BNSF conductors)	Uniforms	1	Agency security available as needed	Operations and safety duties	Agency Security
Southern California Regional Rail Authority (MetroLink)	Some courts supply; others don't	N/A	Agency Staff L.A. County Sherriff (contracted)	Uniforms	1 to 2	Conductors and contracted law enforcment work cooperatively	Conductors only inspect 10% of time; Sherriffs - security duties	Ambassadors assigned to stations on rotating basis
Toronto Transit Commission	Only, if case goes to court	NR	Agency Staff	Uniforms	2 Transit Officers	Corporate Security work in plainclothes Special Constables support inspectors	None for POP assigned officers	Station Collector
Transports publics genevois (TPG)	NR	NR	Agency Staff	Uniforms	2 to 4 varies by time	Call police in case of resistance	NR	NR
Tri-Met	Yes, thru courts in one county (serve 3 counties)	Warnings: 15,000 Citations: 3,000 Exclusions: 2,000	Agency Staff Agency Police (contracted from local juris.)	Uniforms	1 (2 after 4pm)	Transit and local law enforcement work cooperatively	Security and other law enforcement concurrent with inspection (80%) Other = 20%	Private Security at some stations Rail and Road Supervisors also, but limited
Tri-Rail	Yes, but do not	Total: 6,141	Contract Security	Uniforms	Varies, 10 officers cover 90% of trains	N/A	Security	Security zone patrols
Virginia Railway Express (VRE)	Yes, court dispositions	NR	Other: conductors	Uniforms	2 per train	NR	NR	None

Table D-1.6: Fare Inspection and Enforcement

Agency Name	Q6.14.2 Special programs	Q6.15 Surveillance	Q6.16 Select Veh.	Q6.17 Insp. Procedure	Q6.18 Full Inspect	Q6.19 No. Inspected
ATC Spa Transporti Pubblici Bologna	NR	Cameras (pilot program)	Planned	All passengers are inspected	N/A	200
Bi-State Development Agency	Undercover Officers	Cameras on each platform and PnR lot	Random	All passengers are inspected	Random	5,000
Calgary Transit	NR	Cameras at each station	Random	Random	NR	NR
Dallas Area Rapid Transit	None	Cameras (future)	Target every trip	All passengers are inspected	Comprehensive	n/a
Denver RTD	N/A	N/A	Random	All passengers are inspected	Other: not enough staff to do sweeps	200-300
Go Transit	Safety programs, school programs, auto theft avoidance	Remotely monitored cameras	Assigned by Supervisor	All passengers are inspected	N/A	300
Helsingin kaupungin liikennelaitos (HKL)	None	Cameras	SOP	All passengers are inspected	N/A	~300
Lane Transit District	NR	Transfer Center has cameras and 24 hour surveillance	N/A	N/A	N/A	N/A
Los Angeles County MTA	NR	All stations monitored by rail operations center	Random	All in car	Random	100
Maryland MTA	NR	Cameras at one station	One officer per train	All passengers are inspected	NR	varies
New Jersey Transit	N/A	All stations monitored by rail operations center	Random	Not always all	Targeted	300 to 3,000
Niagara Frontier Transportation Authority	N/A	68 cameras in 8 stations	Scheduled	All passengers are inspected	Random	435
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A	N/A
Ottawa Regional Transit Commission (OC Transpo)	N/A	All stations monitored by rail operations center	Random	All passengers are inspected	Random Comprehensive Trageted	NR
Sacramento Regional Transit District	Point inspection-saturation, area concentrations, specific ordinance (i.e., bike) enforcement	None	Random	All passengers are inspected, suspended when violation found	Comprehensive Targeted	800
San Diego Trolley	Bike team ride between station monitor vandalism; Special enforcement units - saturation checks; Crime Suppression Units - vandalism	Cameras at high volume stations, not very effective (outdated equipment)	Inspector discretion	All in car	Targeted	1,100
San Francisco Municipal Railway (Muni)	Sweeps at selected stations	None	Board at staggered points w/in assigned area	All passengers are inspected	N/A	250
Santa Clara VTA	NR	None	Passenger loads and transfer points	All passengers are inspected	NR	200 - 1000
SEMIACS	NR	NR	Planned	All passengers are inspected	Comprehensive	250-500
Sound Transit	NR	None	Presently all are inspected, may use random in future	All passengers are inspected	N/A	1,800
Southern California Regional Rail Authority (MetroLink)	Specially assigned Sherriffs under contract	N/A	Planned Targeted	All in car Only some capture all	Comprehensive Targeted	250
Toronto Transit Commission	Inspectors supported by Special Constables	Cameras at each station monitored locally	Random	All passengers are inspected	NR	2,580
Transports publics genevois (TPG)	Security on-board, school buses handling	NR	Inspector discretion	All passengers are inspected	Comprehensive	2,200
Tri-Met	NR	Camera at some stations and some buses	Officer Discretion	All in car/vehicle	Random Targeted	N/A
Tri-Rail	Sweep teams used to cover some trains	None	Entire train	All passengers are inspected	Random	400
Virginia Railway Express (VRE)	NR	None	Contract specifies 1/3 of train	Other: Inspect displayed tickets	N/A	NR

Table D-1.6: Fare Inspection and Enforcement

Agency Name	Q6.20 Pct. Inspected	Q6.21 Zone Inspected	Q6.22 Evasion	Q6.23 Priors	Q6.24 Repeat Proc.	Q6.25 Evasion Rate	Q6.26 Revenue Loss	Notes
ATC Spa Transporti Pubblici Bologna	NR	NR	Citation issued/can be paid on the spot/higher fine if paid later	No	N/A	6% fines/controlled psgrs	NR	
Bi-State Development Agency	20%	N/A	Cited	Yes, thru dispatcher	Two or more priors, then Police are called	2% evasion/inspection	n/a	
Calgary Transit	NR	N/A	NR	NR	NR	NR	NR	
Dallas Area Rapid Transit	n/a	NR	Removed from vehicle	NR	NR	NR	NR	
Denver RTD	20-25%	Check OD pair	Contact, ID check, Citation	Check database via radio	Removed from train and cited	<2% surveys/audits	NR	
Go Transit	4%	Visually	Officer discretion	Yes, thru database	Higher fine, poss. Criminal charges	0.8% Audits	$1.3 million	
Helsingin kaupungin liikennelaitos (HKL)	1%	N/A	Penalty plus single ticket price	No	NR	2%	$1.7 M (FIM 10 M)	
Lane Transit District	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Planned BRT system
Los Angeles County MTA	15 to 20%	N/A	Officer discretion citation or warning	Yes, through dispatch	Repeat Offenders list	<1% (cite+warn)/inspect	Attached report	No attachment for Q26
Maryland MTA	n/a	NR	Citation issued	No	N/A	0.5%	n/a	
New Jersey Transit	NCS: 50% HBLR: 30%	N/A	Officer discretion citation, warning or courtesy ticket	Yes, through Police Central Communications	Citation	NCS: <1% HBLR: 1%-2% (cite+warn)/inspect	n/a	
Niagara Frontier Transportation Authority	11.50%	N/A	Removed from vehicle, cited	Yes, thru radio	Higher fine, poss. Arrest	3.4%, field audit	$129,000 (3.4%)	
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Planned BRT system
Ottawa Regional Transit Commission (OC Transpo)	NR	Upon Request	Escorted off, then issued citation or summons	Yes, through Security Control	Summons	2% fraud/inspections	n/a	
Sacramento Regional Transit District	10%	N/A	Officer discretion	No	Citation, removal and exclusion	2% evasion/inspection	NR	
San Diego Trolley	25%	Inspectors check tickets within zone at stations (bike team)	Removed from train, cite/warn	No, but inspectors might note on citation to alert court clerk if known	No, but inspectors might note on citation to alert court clerk if known	6% surveys/audits	$1.26 M 6%	
San Francisco Municipal Railway (Muni)	1.50%	N/A	Officer discretion	No	N/A	1% evasion/inspection	$180,000 (1%)	
Santa Clara VTA	12%	N/A	Removed from vehicle, cited or warned	Yes, database of written warnings	Citation	1.80%	NR	
SEMIACS	5%	N/A	Fined	NR	NR	15% surveys	10%	
Sound Transit	100%	Ticket shows OD pair	Warned, soon will issue citations	No	Citation	1-2% field review	$5,000 (1-2%)	System began service in September of 2000
Southern California Regional Rail Authority (MetroLink)	25%	Ticket shows OD pair	Citation issued	No	N/A	1-2% evasion/inspection	1-2%	
Toronto Transit Commission	5%	N/A	Officer discretion	Yes, thru cell phone to Police	Escalation of enforcement	2.4% evasion/inspection	C$382,505	
Transports publics genevois (TPG)	0.70%	Ticket shows OD pair	Removed from vehicle, pay fine or citation (fine+admin. Tax)	No	None	2% Inspectors statistics	$900,000	
Tri-Met	N/A	POP specific zones	Officer discretion citation or warning	Yes, thru dispatcher Note: future hand-held computers	Citation plus possible exclusion depending on number of priors	N/A	N/A	SOP is very specific as to handling fare evaders
Tri-Rail	75%	Zone on ticket	Cited, but allowed to continue trip	Yes, thru list	Local police issue "Trespass Warning" or arrest evader	2%, statistical analysis	$25,000 (0.5%)	
Virginia Railway Express (VRE)	33%	Zone on ticket	Conductor discretion, cite/warn	No	N/A	NR	NR	

Table D-1.7: Financial Information

Agency Name	Q7.1 Staff/Labor Costs			Q7.2	Q7.3
	Type	Number	Cost/Year	Cash Cost	Dist. Cost
ATC Spa Transporti Pubblici Bologna	NR	NR	NR	NR	NR
Bi-State Development Agency	Inspectors (contract) Security (contract) Other: POLICE (contract)	15 85-100 75-100	$414,000 $1.2 M $1.5 M	$570,000	$253,000
Calgary Transit	NR	NR	NR	NR	NR
Dallas Area Rapid Transit	NR	NR	NR	NR	NR
Denver RTD	Inspectors Security (contract)	NR NR	$265,000 $636,700	$979,000	N/A
Go Transit	n/a	n/a	n/a	n/a	n/a
Helsingin kaupungin liikennelaitos (HKL)	Inspectors Security (contract)	55 NR	$1.3 M $1.7 M	NR	$3.2 M
Lane Transit District	N/A	N/A	N/A	N/A	N/A
Los Angeles County MTA	Inspectors (contract) Maintenance (contract)	400+ 16	$53 M $1.4 M	$4.2 M	$4.3 M
Maryland MTA	Security	40	$1.4 M	n/a	n/a
New Jersey Transit	Inspectors Maintenance (contract) Supervisory	22 103 3	$1.2 M $616,000 $260,000	n/a	n/a
Niagara Frontier Transportation Authority	Inspectors Security (police) Maintenance Supervisory	7 40 6 1	$356,696 $2.2 M $312,000 $70,000	$901,000	$100,000
Oahu Transit Services (The Bus)	N/A	N/A	N/A	N/A	N/A
Ottawa Regional Transit Commission (OC Transpo)	Inspectors Security	11 22	NR NR	NR	NR
Sacramento Regional Transit District	Inspectors	6	$384,000	NR	NR
San Diego Trolley	Inspectors Security (contract) Maintenance Supervisory Collectors/Processors Ridership Surveyors Sales Agents	29 5 12 8 6 9 varies	$1,116,000 $160,000 $558,400 $427,150 $188,450 $274,350 $64,000	$1,512,350	N/A Covered by TDB
San Francisco Municipal Railway (Muni)	Inspectors Security Supervisory	21 NR 4	$1.25 M $370,000 $250,000	NR	NR
Santa Clara VTA	Inspectors	9	$700,000	NR	NR
SEMIACS	Inspectors Security Maintenance Customer Service Supervisory	NR NR NR NR NR	f 7,000,000 f 5,000,000 f 500,000 f 300,000 f 500,000	NR	NR
Sound Transit	Inspectors (contract) Security	3 7	NR NR	NR	NR
Southern California Regional Rail Authority (MetroLink)	Inspectors/Conductors Security/Sherriff (contract) Customer Service Supervisory	59 29 41 3	$800,000 $208,000 $825,477 $212,279	$300,000	$1.0 M
Toronto Transit Commission	NR	NR	NR	NR	NR
Transports publics genevois (TPG)	NR	NR	NR	NR	NR
Tri-Met	Inspectors	19	$1.3 M	n/a	n/a
Tri-Rail	Security (contract) Maintenance (contract) Customer Svc Supervisory Other: COLLECTOR	35 3 14 2 1	$110,000 $406,850 $250,000 $60,000 $30,000	$180,000	$696,850
Virginia Railway Express (VRE)	NR	NR	NR	N/A	NR

Table D-1.7: Financial Information

Q7.4 Insp. Cost	Q7.5 FC Cost	Q7.6 Cost Effective	Q7.7 Fine Rev.	Q7.8 Pct.	Q7.9 Balance To	Q7.10 Established By
NR	NR	NR	$1.2 M	100%	ATC	Municipality/County
$1,549,000	$2.5 M	Yes	$0	N/A	NR	NR
NR	NR	Yes	C$450,000	NR	NR	NR
NR	NR	Yes	NR	NR	NR	NR
$265,000	NR	Yes	$0	0%	NR	NR
n/a	n/a	Not material, just wasn't feasible due to growth	C$0	0%	Province	NR
$2.1 M	NR	Yes	$1.0 M	NR	Helsinki City Transport	Other: Helsinki City Transport
N/A	N/A	N/A	N/A	N/A	N/A	N/A
Part of contract	$5 M	Yes, but more difficult as ridership increases and fare policies change	$402,350 (FY99)	n/a	Shared State, Courts, & Municip.	State
n/a	n/a	Yes	NR	NR	NR	NR
n/a	n/a	Yes Not sure	$35,000 (to date)	50%	Municipal Courts	State
$400,000	$4.2 M (6%)	Yes, high maintenance cost of barrier system	$35,000	100%	N/A	State
N/A	N/A	N/A	N/A	N/A	N/A	N/A
C$750,000	NR	NR	C$25,000	NR	Agency	Municipality/County
NR	NR	NR	$0	0%	County	State
$1,386,000	$2,898,350 (9%)	Not sure Will soon evaluate the cost/benefits of barrier v. POP	$50,000	12%	15% to courts Balance to State	State
$2.3 M	$2.3 M (0.5%)	Yes	n/a	n/a	State	State
$800,000	NR	Yes	None	NR	County	Municipality/County
NR	NR	Not sure	f 2.6 M	100%	NR	NR
NR	$916,599	Not sure	$0	0%	County	Other
$300,000 (30% of conductor/ sheriff time)	$1.6 M (2.5%)	Yes	$0	0%	County	State Municipality/County
NR	C$41 M	Yes, cost effective	NR	NR	NR	NR
NR	NR	NR	$600,000	NR	NR	NR
n/a	n/a	Yes, barrier feasibility and costs of conductors prohibit	miniscule	n/a	Courts (50%)	County
NR	$140,000 (20%)	Yes	$40,000	90%	Courts	Tri-Rail
n/a	NR	Yes	None	N/A	NR	NR

Table D-1.8: Service Characteristics

Bi-State Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	NR	42,000	NR	7.5 min
Bus	MB	NR	124,000	NR	NR

Calgary Transit Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	282	187,700	4,670	2-9 min
Bus	MB	4,818	219,550	n/a	3-15 min
Community Shuttle	MB	854	12,870	n/a	20-30 min

DART Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	20	38,000	NR	10 min
Commuter Rail	CR	18	4,800	NR	25 min
Bus	MB	20	165,000	NR	5 - 30 min

Denver RTD Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	NR	22,467	NR	NR
Bus	MB	NR	239,197	NR	NR

Go Transit Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Commuter Rail	CR	19	136,000	600/train	20-40 min
Bus	MB	22	29,000	full	5-120 min

HKL Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Metro	HR	18	142,000	NR	NR
Street Car	LR	20	155,200	NR	NR
Commuter Rail	CR	20	46,600	NR	NR
Bus	MB	20+2	289,600	NR	NR
Ferry	FB	20	3,900	NR	NR

LTD Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Bus	MB	19	20,391	varies	10 min

LACMTA Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Blue line	LR	4am - 12:40am	63,725	NR	NR
Green Line	LR	4am - 1:40am	26,800	NR	NR
Red Line	HR	4am - 12:00am	120,516	NR	NR

Table D-1.8: Service Characteristics

NJ TRANSIT Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
HBLR	LR	5:18am - 1:41am	2,000	NR	6 minutes
NCS	LR	4:38am - 12:42am	7,000	NR	< 4 minutes
Commuter Rail	CR	3:48am - 3:09am	103,500	NR	6 to 20 minutes
Bus	MB	2am - 2am	254,300	NR	2 to 60 miutes

NFTA Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	20	25,000	2000	5 min

The Bus Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Bus	MB	4,160	240,000	80.5/hr	3.3 max
Demand Response	DR	1,100	NR	NR	NR

OC Transpo Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Bus	MB	7,600	300,000	NR	3 to 10 minutes

Sacramento RT Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	21	28,481	n/a	15 min

San Diego Trolley Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
SDTI	LR	4:176 am-1:52 am	83,474	NR	7.5 min
MTS/NCTD	CR	5:23 am-7:39 pm	5,000	NR	NR
MTS/NCTD	MB	4:30 am-2:30 am	223,000	NR	NR

Muni Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	4:30 am - 1 am	140,000	NR	1.25min (common) 6-8 min (branch)

VTA Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	24	29,771	NR	NR
Bus	MB	24	155,702	NR	NR

SEMIACS Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Bus	MB	6 am - Midnight	130,000	NR	NR

Table D-1.8: Service Characteristics

Sound Transit Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Commuter Rail	CR	NR	1,230	614	30 min
Bus	MB	NR	20,131	n/a	5 - 30 min

MetroLink Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Commuter Rail	CR	NR	31,000	NR	NR

TTC Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	6 am - 1:30 am	39,200	2,700	3.5 min
Street Car	SC	5 am - 1:30 am	269,600	n/a	4 min
Bus	MB	5 am - 1:30 am	1,182,300	n/a	2.3 min
Heavy Rail	HR	6 am - 1:30 am	792,700	14,700	2.3 min
Other: Late Night	MB/SC	NR	7,000	n/a	30 min

Tri-Met Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Light Rail	LR	410	65,100	NR	NR
Bus	MB	6,624	200,200	NR	NR

Tri-Rail Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Commuter Rail	CR	56	8,000	670	60 min

VRE Service Characteristics

	Mode	Hours of Operation	Avg. Daily Ridership	Peak Hour Boarding	Peak Hour Headway
Commuter Rail	CR	5:15 am - 9:25 pm	10,000	NR	30-60 min

Table D-1.9: Fare Media Availability

ATC Spa (Bologna) Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	47%	X	X	X			
Round trip							
Multi-trip	Incl. Single	X	X	X			
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	47%	X	X	X			
Stored Value Farecards							
Other: ANNUAL	Incl. Month	X	X	X			

Bi-State Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X					
Round trip	NR	X					
Multi-trip	NR	X	X	X			
Day pass	NR	X	X				
Weekly/7-Day pass	NR			X			
Biweekly/14-day pass							
Monthly/30-Day pass	NR			X			
Stored Value Farecards							
Other:	NR		X				

Calgary Transit Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	14%	2%	2%	4%	6%		
Round trip							
Multi-trip							
Day pass	0.20%	0.05%	0.10%	0.05%	- -		
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	48%	- -	20%	28%	- -		
Stored Value Farecards							
Other: SENIORS, STUDENT, FREE FARE ZONE	37.80%	- -	- -	- -	- -		

Go Transit Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	3%		X	X			
Round trip							
Multi-trip	48%		X	X			
Day pass	2%		X	X			
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	47%		X	X			
Stored Value Farecards							
Other:	0.1%		X	X			

Table D-1.9: Fare Media Availability

HKL Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	12%	NR	NR	NR	NR		
Round trip							
Multi-trip	8%	NR	NR	NR	NR		
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	78%	NR	NR	NR	NR		
Stored Value Farecards							
Other:	2%	NR	NR	NR	NR		

LACMTA Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	11%	X					
Round trip	1%	X					
Transfers	35%	X			X		
Day pass							
Weekly/7-Day pass	4%		X	X		X	
Biweekly/14-day pass	4%		X	X		X	
Monthly/30-Day pass	39%		X	X		X	
Stored Value Farecards							
Other: TRANSFERS	5%	X					

Maryland MTA Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X					
Round trip	NR	X					
Multi-trip							
Day pass	NR	X					
Weekly/7-Day pass	NR	X	X	X			
Biweekly/14-day pass							
Monthly/30-Day pass	NR	X	X	X		X	
Stored Value Farecards							
Other							

NJ Transit Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	45%	X					
Round trip	25%	X					
Multi-trip							
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	30%	X					
Stored Value Farecards							
Other							

Table D-1.9: Fare Media Availability

NFTA Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	85%	X					
Round trip	15%	X					
Multi-trip							
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	n/a		X			X	
Stored Value Farecards							
Other:							

OC Transpo Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip							
Round trip							
Multi-trip							
Day pass	NR		X	X			
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	NR		X	X			
Stored Value Farecards							
Other: ANNUAL	NR		X	X			

Sacramento RT Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	25.8%	X	X	X		X	
Round trip							
Multi-trip							
Day pass	8.2%	X	X	X			
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	38.3%		X	X		X	
Stored Value Farecards							
Other:	27.8%	X	X				

San Diego Trolley Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	37%	100%					
Round trip	2%	100%					
Multi-trip							
Day pass	2%			100%			
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	36%			90%		10%	
Stored Value Farecards							
Other: TRANSFER, FREE	23%			100%			

Table D-1.9: Fare Media Availability

Muni Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	45%	NR	NR	NR	NR		
Round trip							
Multi-trip							
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	55%	NR	NR	NR	NR		
Stored Value Farecards							
Other:							

VTA Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X					
Round trip							
Multi-trip							
Day pass	NR	X					
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	NR		X	X		X	X
Stored Value Farecards							
Other:							

SEMIACS Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	15%				X		
Round trip	2%				X		
Multi-trip	10%		X				
Day pass	3%		X		X		
Weekly/7-Day pass	1%		X				
Biweekly/14-day pass							
Monthly/30-Day pass	60%		X				
Stored Value Farecards	9%		X				
Other:							

Sound Transit Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X	X				
Round trip	NR	X					
Multi-trip							
Day pass	NR	X					
Weekly/7-Day pass	NR	X					
Biweekly/14-day pass	NR	X					
Monthly/30-Day pass	NR	X	X	X		X	X
Stored Value Farecards							
Other:							

Table D-1.9: Fare Media Availability

MetroLink Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X	X				
Round trip	NR	X	X				
Multi-trip	NR	X	X			X	
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	NR	X	X			X	
Stored Value Farecards							
Other: 10 TRIP TICKETS	NR	X	X			X	

TPG Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip (3 stops tickets)	NR	X					
Round trip (1 hour tickets)	NR	X					
Multi-trip							
Day pass	NR	X	X		X		
Weekly/7-Day pass	NR		X				
Biweekly/14-day pass							
Monthly/30-Day pass	NR		X				
Stored Value Farecards	NR		X		X		
Other:	NR		X				

Tri-Met Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	NR	X					
Round trip							
Multi-trip	NR	X	X	X		X	X
Day pass	NR		X	X	X	X	X
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	NR	X	X	X		X	X
Stored Value Farecards	NR		X			X	X
Other: ANNUAL & 3-DAY	NR		X			X	X

Tri-Rail Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	83%	X	X				
Round trip	15%	X	X				
Multi-trip	1%	X	X				
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	1%	X	X	X			
Stored Value Farecards							
Other:							

Table D-1.9: Fare Media Availability

VRE Fare Media

	% of Riders	TVMs	Ticket Office	3rd-Party Outlets	On-Board	By Mail	Internet
Single trip	54%	X		X			
Round trip							
Multi-trip	40%	X		X			
Day pass							
Weekly/7-Day pass							
Biweekly/14-day pass							
Monthly/30-Day pass	6%	X		X			
Stored Value Farecards							
Other:							

Appendix E: Executive Summary

Background: Self-Service Fare Collection

Self-service, barrier-free fare collection (SSFC)—also known as *proof of payment* (POP)—is the newest fare collection strategy to be adopted by transit agencies and has seen increasing use over the past 20 years. Beginning with the opening of the San Diego Trolley in 1981, most light rail transit (LRT) operators in the United States have implemented SSFC. Of the 18 North American LRT systems, 15 use the strategy—as do 9 commuter rail services. These tend to be the newer systems, that is, the more established commuter rail systems serving the denser urban areas (e.g., New York, Chicago, Philadelphia, and Boston) use on-board fare collection, with conductors.[1]

SSFC actually began in Europe in the 1960s, with early applications in Germany and Switzerland. Till then, many European transit systems had relied on on-board fare collection using conductors. In order to cope with growth in both labor costs and labor shortages, many transit operators began to convert to SSFC, which required fewer fare collection personnel. This approach was—and continues to be—based on a strategy of checking only a percentage of riders for proper fare payment. Thus, SSFC is largely an "honor system," requiring that the rider take responsibility for carrying a ticket/pass that is appropriate for the ride he/she is taking.

Each transit agency must decide on the most appropriate fare collection strategy whenever it introduces a new type of service. As suggested above, SSFC has become a common choice for LRT and commuter rail services. However, a handful of heavy rail and bus services have opted for SSFC as well and, as indicated above, not all LRT and commuter rail services use SSFC. The Red Line of the Los Angeles County Metropolitan Transportation Authority (LACMTA), for instance, is a subway service with a number of fully enclosed stations; yet, the LACMTA chose to use SSFC on all of its new rail lines, including the Red Line. With regard to use on bus, Tri-Met in Portland is the best known U.S. example. Tri-Met introduced SSFC on bus as part of a federal demonstration project in 1982. However, SSFC was deemed impractical for Tri-Met's buses, and bus fare collection was subsequently changed back to the more conventional pay-on-boarding approach; Tri-Met continues to use SSFC for LRT. SSFC is widely used on bus service in Europe.

The Study

Now that SSFC has been widely used, the collective experience can be tapped to provide guidance to agencies now developing SSFC—or seeking ways to improve existing systems. New LRT systems are in development across the United States, and lines are being added to existing systems. In addition, new commuter rail and bus rapid transit (BRT) services are

[1] The distinguishing characteristics of SSFC are the combination of (1) barrier-free platforms or entrances, (2) boarding without needing to take any payment-related action in view of a driver/conductor, (3) inspection for valid proof of payment, and (4) not being able to pay the fare to the inspector. Thus, a commuter rail "conductor-validated" system, which allows on-board fare payment, does not fall into this category.

planned for several locations, and operators continue to look to improve existing systems. SSFC's applicability in a particular setting depends on the agency's specific requirements and constraints (e.g., station configurations and expected ridership).

The objective of TCRP Project A-24, *A Toolkit for Self-Service, Barrier-Free Fare Collection*, was to develop a set of guidelines for use by transit agencies implementing or considering use of SSFC. The Toolkit has thus been designed to provide practical guidance to policy makers, planners, researchers, and operating managers, both in assessing SSFC as part of the overall fare collection decision and in designing and successfully implementing an SSFC system. The Toolkit addresses the full range of issues and parameters that an agency must consider in determining the applicability of SSFC; these issues fall into the following general categories:

- Policy and Enforcement Issues (e.g., legal authorization for enforcement, measuring the evasion rate, fare inspection rate and strategy, and fare evasion fine structure);

- Operational Issues (e.g., fare policy and structure, fare media distribution, use of electronic fare media, educating passengers, and station monitoring and security); and

- Capital and Equipment Issues (e.g., types of ticket sale and validation equipment and technologies, and system and station design considerations).

The study included the following elements:

- *A comprehensive literature review of research related to North American and international use of SSFC:* An annotated bibliography was produced.

- *Collection of additional data on the use of SSFC in the United States and abroad:* A survey of transit agencies currently operating—or planning—SSFC was conducted; 40 agencies in North America and Europe were sent the survey, and responses were received from 26 of these (see Table E-1).

- *Development of a set of tables of key parameters (characteristics, principles, and techniques) of SSFC systems related to policy and enforcement, operations, and capital and equipment issues:* These tables served as the framework for individual sections of the Toolkit.

- *Development of a draft Toolkit and industry review:* The draft document was submitted to agencies that had responded to the survey, as well as to three other agencies currently considering introducing SSFC; the final Toolkit addresses the comments and suggestions of the industry reviewers.

This Executive Summary summarizes the study research results and the key elements of the Toolkit; the individual task elements of the study are reviewed in the separate Final Report.

Table E-1: Survey Respondents

Transit Agency	City	Type of Service*
Maryland MTA	Baltimore, MD	L
ATC	Bologna, Italy	B
NFTA-Metro	Buffalo, NY	L
CalgaryTransit	Calgary, Alberta	L
Dallas Area Rapid Transit	Dallas, TX	L/C
Denver Regional Transportation District	Denver, CO	L
Lane Transit District	Eugene, OR	B
Transports Publics Genevois	Geneva, Switzerland	L/B/F
Helsingin Kaupungin Liikennelaitos	Helsinki, Finland	L/C/F
Oahu Transit Services	Honolulu, HI	B
Los Angeles County MTA	Los Angeles, CA	L/B
Southern CA Regional Rail Agency	Los Angeles, CA	C
New Jersey Transit	Newark, NJ	L
SEMIACS	Nice, France	B
OC Transpo	Ottawa, Ontario	L/B
Tri-Rail	Pompano Beach, FL	C
TRI-Met	Portland, OR	L
Sacramento RTD	Sacramento, CA	L
San Diego Trolley	San Diego, CA	L
MUNI	San Francisco, CA	L
Santa Clara Valley Transportation Authority	San Jose, CA	L
Sound Transit	Seattle, WA	L/C
Bi-State Development Agency	St. Louis, MO	L
GO Transit	Toronto, Ontario	C
Toronto Transit Commission	Toronto, Ontario	L
Virginia Railway Express	Washington, DC	C

** Type of Service: L = LRT/streetcar or heavy rail, C = commuter rail, B = BRT orbus, F = ferry*

Current and Potential Use of SSFC

The Toolkit includes a discussion of the use of SSFC by different types of transit agencies in North America and in Europe. This information is summarized below.

Current Use of SSFC in the United States and Canada

Light Rail—As mentioned above, most LRT services in the United States and Canada use SSFC. The newer systems (i.e., those established beginning in the 1980s) generally adopted SSFC from the start. Several older systems have converted to SSFC (e.g., NJ Transit Newark City Subway, and San Francisco Muni), and some others are considering this conversion

(e.g., PAT in Pittsburgh and MBTA in Boston). There are some instances, such as at Muni, where the SSFC operation is only partial—some stations are not equipped for ticket sales and riders have the option to pay on board at the farebox by boarding the first car.

Heavy Rail—Only two North American heavy rail services currently use SSFC: LACMTA (on its Red Line) and Vancouver's SkyTrain. The Los Angeles Red Line subway has SSFC primarily for consistency with the SSFC on the Green and Blue LRT lines; however, the MTA has given consideration to converting the Red Line—and possibly the Green and Blue Lines as well—to a barrier system. Vancouver uses SSFC to support a zonal fare system without requiring entry/exit faregates; however, it too has considered conversion to a barrier system for SkyTrain. Most heavy rail systems were initiated prior to the introduction of the SSFC concept into North America and, thus, did not even consider it as an option. However, the strategy has been evaluated by at least one agency (MARTA in Atlanta) for its heavy rail lines and may be considered by others in the future.

Commuter Rail—Although they are generally barrier-free, allow the advance purchase of tickets, and involve inspection by conductors, the "conductor-validated" fare collection systems on most older commuter rail services are not considered "proof of payment"; Unlike the case with a true SSFC system, a conductor-validated approach allows the payment of the fare to the conductor, on board the train. A conductor-validated approach also differs from SSFC in that the latter typically involves inspection of only a portion of passengers.[2] As indicated earlier, several newer commuter rail systems have opted for SSFC fare collection (i.e., all riders must have a validated ticket or pass before boarding the train); in addition, one older system, GO Transit (Toronto), converted from conductor-validation to SSFC, and another system, Caltrain (Northern California), has begun such a conversion.

Bus/Bus Rapid Transit—SSFC is not typically used in North America for bus and streetcar-type services. The exceptions (e.g., OC Transpo Transitway in Ottawa and the Toronto Transportation Commission's Queen Street Streetcar) involve cases where minimizing boarding time is critical because a multiple-unit streetcar or articulated bus is used. Even in these cases, however, SSFC is not the only fare collection strategy employed. Passholders can board through any door; riders without passes need to pay on board at the farebox and collect a POP receipt from the operator. This is quite similar to the partial SSFC used on SF Muni's LRT. As explained earlier, Tri-Met in Portland experimented with SSFC on its buses at one time, but discontinued it in favor of the traditional pay-on-boarding strategy; no other North American agencies are known to have used SSFC on regular bus service since then. The strategy is being considered for some of the newly developing BRT services, however, as explained below.

Potential SSFC Services in the United States and Canada

Numerous new LRT and commuter rail services (i.e., in addition to extensions under development to existing systems) are currently being developed. At least 14 North American cities are now developing plans for—or in the process of implementing—LRT lines, and a

[2] A few commuter rail systems, such as Virginia Railway Express, actually conduct 100% inspection, but are considered POP in that they do not accept on-board fare payment.

number of regions are also planning or exploring commuter rail service. All of the new LRT lines are likely to use SSFC, and many of the commuter rail services could well decide to use SSFC as well. No new heavy rail services are expected in North America for the foreseeable future, with the exception of extensions to existing service.

With regard to bus services, various cities have implemented measures to speed bus service in specific corridors. A consortium of agencies—with FTA support—is currently developing demonstrations for BRT service. In some cases, off-board fare collection will be employed to reduce boarding times; types of off-board fare collection being considered include both SSFC and barrier strategies.

SSFC Services in Europe

As indicated earlier, SSFC fare collection was pioneered in Europe. As in North America, the strategy is used extensively for LRT and to a lesser degree for heavy or commuter rail services. The main difference lies in the extent to which SSFC is used for bus/streetcar operations. SSFC was inaugurated on buses in Europe largely to address labor shortages. Self-service ticket sales/validation equipment was installed on board, and this was supported with random ticket inspection (i.e., to replace the previous approach of using conductors to collect all fares). In some cases, bus operations have evolved along lines more similar to those in North America. For example, UK operators often do monitor fare collection—as the driver receives fares and operates the on-board ticketing equipment.

In certain countries (e.g., Germany and Switzerland), SSFC is quite common on heavy rail services. To some degree, this is related to the use of SSFC for other transit services in these cities (i.e., when a new rail service was introduced, SSFC was adopted to retain consistency with established fare collection services for other modes).

Overview of the Toolkit

The Toolkit is designed for use by agencies at various points in the fare collection decision process. The types of situations in which transit agencies might wish to use the document include the following:

- Agencies implementing a new service (e.g., LRT or BRT) and seeking to choose between SSFC and another fare collection strategy;
- Agencies trying to decide whether to switch to SSFC from another strategy;
- Agencies currently using SSFC and trying to decide whether to switch to another fare collection strategy; and
- Agencies looking for opportunities to improve an existing SSFC system.

The Toolkit is divided into chapters that cover each of the aforementioned issue categories (i.e., policy/enforcement issues, operational issues, and capital/equipment issues); each chapter contains sections that address the key design parameters/decision areas associated

with that category. Each section (1) identifies the *issues* that have to be addressed and/or *decisions* that have to be made for the parameter in question; (2) identifies the *other sections* that are closely related to this parameter; (3) presents the *techniques* or *approaches* that might be considered related to the parameter; (4) describes the key *considerations* involved in selecting the most appropriate technique/approach; (5) reviews *industry practice* in this area; (6) and presents a *summary of the findings* and *recommendations* as to the best—or most reasonable—technique/approach to employ. The chapters of the Toolkit are as follows:

- **Chapter 1: Introduction and Overview**
- **Chapter 2: Fare Collection Strategies**
- **Chapter 3: Policy and Enforcement Issues**
- **Chapter 4: Operational Issues**
- **Chapter 5: Capital and Equipment Issues**
- **Appendices: A. Glossary**
  B. Survey Effort and Results
  C. Literature Review
  D. Contact Information

Each of chapters 2 through 5 is reviewed briefly below.

Fare Collection Strategies

Chapter 2 discusses the relative advantages/disadvantages of SSFC in comparison with the other major types of fare collection: *barrier, conductor-validated,* and *pay on boarding*; Table E-2 presents a summary comparison of the different strategies. The chapter also provides guidance in the estimation of capital and operating costs for introducing SSFC and reviews the results of analyses conducted by several U.S. transit agencies that have considered alternative strategies.

Policy and Enforcement Issues

Chapter 3 discusses the types of SSFC *policy and enforcement* issues an agency must address. The major decision/issue areas are summarized below; key considerations and techniques or approaches in each area are shown in Table E-3.

- **Legal Authorization for Enforcement**—How does an agency establish its legal authority governing inspection and enforcement?
- **Measuring the Evasion Rate**—How should an agency measure and estimate its fare evasion rate?

Table E-2: Comparison of Fare Collection Strategies

Factor/Issue	Self-Service Barrier-Free Fare Collection	Barrier	Conductor-validated	Pay on boarding
Equipment needed	TVMs, validators, TOMS, hand-held readers*	Faregates, TVMs, add-fare machines	TVMs,* TOMS,* validators,* hand-held readers*	Fareboxes, ticket processing units*
Station or platform characteristics	Open (elevated) or on-street platform	Requires space for gates and TVMs, and defined entry/exit	Open platform	NA
Handling large passenger volumes	Crowded cars can interfere with inspection. May require high no. of TVMs	Does not affect ability to collect fares.	Crowded cars can interfere with inspection.	Slows boarding
Fare evasion	Depends on inspection pattern, fine structure, level of crowding	Caused by faregate "jumping," short-swiping farecards	Minimal, since conductor inspects or collects fare from everyone; could be problem at congested times	Caused by using invalid pass or transfer. Also caused by crowding at boarding point
Handling intermodal transfers	Transfer from bus can be used as SSFC on LRT; SSFC can include transfer to bus	Transfer from bus must be machine-readable; transfer to bus must be issued with rail ticket	Transfer from other mode can be shown to conductor	(see other strategies)
Handling zonal fares	More complicated (to use and to enforce); must include origin for validation	Requires exit gates and add-fare machines	Commuter rail lines invariably zoned	Rider tells driver destination (or zone), pays accordingly
Use of AFC	Use to buy SSFC ticket, or have to validate farecard—or have pass (inspectors need hand-held readers)	Faregates read farecard and deduct value—or indicate valid pass	Conductors need hand-held farecard readers / processing units	Need ticket processing units/card readers; ease of revaluing is issue
Security and customer service	Inspectors provide presence on vehicles and platforms. Added security needed at other times	If no ticket agents, security needed in stations and on trains	Conductors provide presence on all trains	Driver responsible for security and customer assistance on bus
Customer Convenience	Needs validation of multi-ride or stored value tickets; may be queues to buy or validate, but not to board	Depends on types of payment accepted in gates (easiest if cash accepted); may be queues	No need to prepay or validate, no need for exact change, and no queuing (to pay or board)	Needs either prepayment (pass or multi-ride option) or exact change;** may be queues
Capital costs	Lower than barrier, unless high vol. Requires many TVMs	Cost of faregates high, but requires fewer TVMs than for SSFC (validation at faregate)	Lower than SSFC; may be lowest (depending on no. of TVMs used)	Lowest costs: fareboxes, but no TVMs
Operating costs	Higher labor cost than barrier	Lower labor cost than SSFC	Highest labor cost	Lowest labor cost

*optional; may be required if AFC is used
**validating fareboxes will not require exact change, but change will be in form of stored value card

- **Inspection Strategy—**What general inspection strategy should be pursued? What pattern of inspection should be followed when inspecting a train?

- **Inspection Rate and Number of Personnel**—What is a reasonable inspection rate? What is the appropriate number of inspection personnel? What is a reasonable productivity for inspectors?

Table E-3: Summary of Policy and Enforcement Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Legal Authorization for Enforcement	• Limitations in existing law • Relationships with state and local governments	• State enacts legislation • Local governments enact legislation • Governing board of agency authorizes
Measuring the Evasion Rate	• Enforcement data needs • Inspection strategy • Treatment of evaders • Consistency of enforcement	• Use regular inspection results, i.e., the totals reported by the inspectors from their normal inspection tours • Use the results of 100% inspection "sweeps" • Conduct special field audits and/or surveys on a periodic basis • Include only riders who are actually given citations • Include all riders found not to be carrying POP
Inspection Strategy	• Philosophy of deterrence • Treatment of evaders • Impact on number of inspection personnel needed • Tracking evasion patterns • Public safety • Labor issues	• Covering the whole system • Random inspections, at the discretion of inspection teams • Targeting peak periods (i.e., targeting the largest volumes of riders) • Targeting specific evasion problem areas • 100% "sweeps"
Inspection Rate and Number of Personnel	• Length and configuration of system • Daily passenger volumes • Inspection strategy • Type and cost of inspection personnel • Available budget • Ancillary duties • Use of inspection teams	• Consider industry experience: – Inspection rate – Number of inspectors/ 1000 riders – Productivity of inspectors – Relationship between inspection and evasion rates
Type of Inspection Personnel	• Effectiveness • Cost/budget • Role of inspection personnel • Liability if armed • Legal authority • Management control • Ability to conduct "sweeps" • Scheduling	• Agency police • Contract police • Agency staff (non-police) • Contract security
Treatment of Fare Evaders	• Impact on deterrence and ability to track repeat offenders • Image of agency • Inspection strategy • Level of conflict with evaders • Impact on productivity of inspection personnel	• Issuing citations to most evaders • Issuing warnings, rather than citations, to most evaders • Giving inspectors discretion as to whether to issue a citation or warning • Removing evaders from the vehicle (i.e., in addition to being cited/warned)
Fare Evasion Fine Structure	• Basic fine strategy • Treatment of evaders • Image of agency • Ease of implementation/ administration • Judicial environment • Prevailing fine structure for other violations • Receipt of fine revenue	• Assessing the same fine for all offenses • Assessing different fines for different types of offenses (i.e., based on the nature of the violation) • Assessing escalating fines for repeat offenses • Excluding passengers from the system for repeat offenses
Fare Evasion Follow-up Program	• Impact on deterrence • Cost • Court system procedures • Number of courts • Ability to track cases • Agency share of fine revenue	• Book citations • Track selected citations • Follow all citations through to resolution • Appeal procedure within the agency

- **Type of Inspection Personnel**—What type of personnel should be used to perform inspections (i.e., police versus other staff; in-house versus contract)? What are the advantages of uniformed versus plainclothes inspection personnel?

- **Treatment of Fare Evaders**—What types of action can—and should—an inspector take when an evader is apprehended? What special circumstances, if any, will the inspector consider when apprehending an evader?

- **Fare Evasion Fine Structure**—What is an appropriate fine structure?

- **Fare Evasion Follow-up Program**—How can an agency track evaders who have been cited—and the outcomes of court cases?

Operational Issues

Chapter 4 discusses the types of *operational* SSFC decisions an agency must address. Major decision/issue areas are summarized below; key considerations and techniques or approaches in each area are shown in Table E-4.

- **Fare Structure**—What issues/challenges does SSFC present for different types of fare structures, including transfer policy and fare differentiation? How are zonal fares handled under SSFC?

- **Fare Media Distribution**—What types of distribution options are available for the sale of SSFC fare media? What is the appropriate mix of distribution channels in an SSFC system?

- **Use of Electronic Fare Media**—How can electronic farecards (i.e., magnetic or smart cards) best be used in an SSFC system? What are the trade-offs involved in the different approaches to decrementing value and checking validity of farecards? What types of equipment and procedures should be considered?

- **Station Monitoring and Security**—What are the advantages/disadvantages of alternative strategies for providing security and customer assistance at stations/stops? Under what circumstances does it make sense to monitor stations/stops remotely?

- **Marketing/Educating Passengers**—What types of information must be communicated to passengers in an SSFC system? What types of techniques are useful in the marketing/education process?

Capital and Equipment Issues

Chapter 5 discusses the types of SSFC *capital/equipment* issues an agency must address. The major decision/issue areas are summarized below; key considerations and techniques or approaches in each area are shown in Table E-5.

Table E-4: Summary of Operational Issues/Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Fare Structure	• Existing fare structure • Impact on equity • Impact on revenue • Impact on ridership • Ease of use of system • Enforcement requirements • Feeder system design	• Basic fare strategy: – Flat fare – Zonal or station-to-station fare – Peak/off-peak differential – Rail (or BRT) premium • For zones: – Color-coding tickets – Printing zonal info. on tickets • For transfers: – Free intermodal transfers – Small transfer charge – No transfer – Day pass (with no transfer)
Fare Media Distribution	• TVM queuing • Passenger convenience • Distribution costs	• TVMs • On-board vehicles • Attended sales outlets • Remote sales
Use of Electronic Fare Media	• Passenger convenience • Options for purchasing/revaluing farecards • Payment options supported • Consumer education • Capital cost • Maintenance requirements • Revenue accounting (in regional farecard system)	• Modify TVMs or install stand-alone unit: use stored value to buy ticket • Install processing unit: deduct fare from stored value (inspector carries hand-held unit) • Tag on/tag off reader at each door • With time-based pass, inspector checks with hand-held unit
Station Monitoring and Security	• Perceived passenger security • Support for customer assistance • Cost • Station design	• On-site monitoring using security personnel • On-site monitoring using agency (non-security) staff • On-site staff complemented or replaced by remote equipment • Selective use of on-site personnel or equipment
Marketing/Educating Passengers	• Complexity of fare structure and payment options • Ease of use of TVMs • Policy re treatment of evaders • Cost of producing signs/materials	• Post signs in stations and vehicles • Print rules on tickets • Print informational brochures • Prominently post customer info. no. • Train agency personnel • Use surveys/focus groups to identify issues and design materials

- **Types of SSFC Equipment**—What types of ticket sale and validation equipment are available? What are the core equipment requirements?
- **Determining TVM Quantities**—How should the required number of TVMs at each station be calculated?
- **Validation of Tickets**—What are the relative advantages of different validation approaches (e.g., at time of purchase, after purchase, during boarding)?
- **SSFC at Stops/Stations without TVMs**—How can the agency provide for ticket sale/validation at stations without TVMs? Will there be attended and/or on-board sales options?

Table E-5: Summary of Capital/Equipment Issues/Decision Areas

Decision Area	Considerations	Techniques/Approaches/Options
Types of SSFC Equipment	• Sales • Validation • Inspection	• Ticket Vending Machines (TVMs) • Attended sales devices • Stand-alone validators • Portable or hand-held devices
Determining TVM Quantities	• Cost • Passenger wait time • Passenger convenience • Infrastructure constraints	• Install enough TVMs at each stop/station such that queues – except perhaps during certain periods of unusually high demand –will not exceed "tolerable" levels • Install enough TVMs to meet the off-peak demand, but plan to augment these with additional sales staff during peak periods • Install at least two TVMs at each location, to provide a backup in case one is out of order
Validation of tickets	• Cost • Passenger convenience • Evasion opportunities • Fare options • Maintenance	• Automatic validation at the time of ticket purchase only (i.e., no advance purchase tickets) • Validation of advance purchase fare media (i.e., multi-ride tickets or stored value farecards) on the platform before boarding, using a stand-alone validator • Validation of advance purchase tickets using a self-service validator during boarding
SSFC at Stops/ Stations without TVMs	• Station/stop layout • Cost • Dwell/running time impacts • Driver responsibilities	• Cash passengers use only the front door and pay at a driver-attended farebox • Cash-accepting TVMs installed at rear door entrances • Temporary attended sales locations (e.g., during busiest periods)
TVM Placement	• Type of paid area • Space required • Power supply and data lines • Customer amenities	• Before the entrances to rail platforms • On rail platforms or at streetside stops • On-board railcars or buses
TVM Fare Media Options	• Cost • Passenger convenience • Inspection	• Using distinct type of ticket stock (colors/graphics) for each type of fare medium provided • Offering some payment options at attended locations only (i.e., only selected fare media through TVMs) • Offering only a limited set of fare media through certain TVMs
TVM Ticket Purchase Options	• Cash handling • Cost • Passenger convenience • Data lines • Passenger security	• Offering change • Accepting credit and/or debit cards • Accepting stored value in lieu of cash for purchasing POP tickets • Not accepting any cash
TVM User Interface	• Cost • Transaction time • Passenger convenience • Fare structure • Accessibility	• Software programmable buttons or touch-screen • Accessibility features, such as wheelchair access, audible feedback, and multiple languages

- **TVM Placement**—Where should TVMs be placed in stations (or on vehicles)? What customer amenities should be built into TVMs?

- **TVM Fare Media Options**—What are the advantages of different fare media options (e.g., multiple ticket stocks for different payment options)?

- **TVM Ticket Purchase Options**—What types of purchase options should be supported at TVMs (e.g., credit/debit, use of stored value)? Should all TVMs accept the same options? Will TVMs provide change?

- **TVM User Interface**—What design features should be considered to maximize the convenience of the TVM user interface for customers? How will passengers be informed about fare/purchase options—as well as TVM malfunctions?

Concluding Remarks

TCRP Project A-24*, Toolkit for Self-Service Barrier-Free Fare Collection,* has led to the development of a set of guidelines for transit decision makers, operators and researchers in considering whether—or how best—to utilize this fare collection strategy. The resulting Toolkit represents a distillation of the lessons learned regarding the implementation and operation of SSFC in North America and abroad. The study team developed these guidelines based on research on existing and planned SSFC systems. Sources included (1) a review of literature on the topic, including both published reports/articles and unpublished project reports; (2) a survey of transit agencies in North America and Europe currently using—or planning to use—SSFC; and (3) discussions with operating personnel at many of these agencies. Through this effort, the team has been able to develop a Toolkit that is expected to be a useful resource to the transit industry as the use of SSFC increases in the coming years.

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
U.S.DOT	United States Department of Transportation

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